Lesotho

First National Communication to the
Conference of the Parties
to the United Nations Framework
Convention on Climate Change

NATIONAL REPORT ON CLIMATE CHANGE

Ministry of Natural Resources

April 2000

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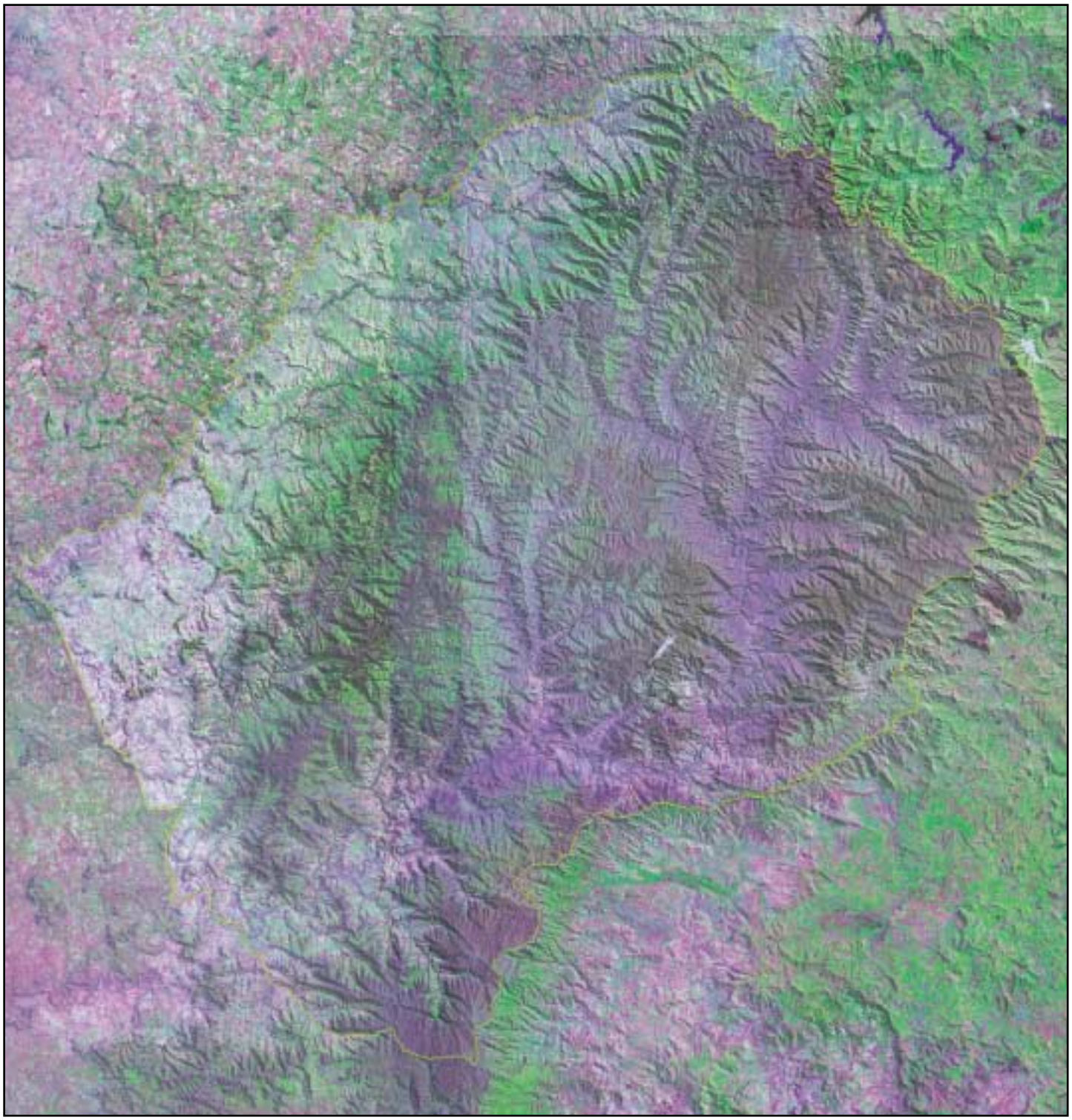
TABLE OF CONTENTS

Basic Statistics

Indicator	1994	1996
Population:	1,883,573	1,959,669
Males	926,707	964,146
Females	956,866	995,523
Urban population as percentage of total population	13.6	16.8
Population in absolute poverty	25.8%	n.a.
Life expectancy for females at birth (years)	56.9	61.6
Life expectancy for males at birth (years)	55.2	51.7
Literacy rate (percentage)	70	84
Relevant areas (square kilometres):		
Lowlands	5,200	5,200
Foothills	4,588	4,588
Mountains	18,047	18,047
Senqu River Valley	2,753	2,753
Lesotho	30,588	30,588
GDP (US$) (millions)	759	860.1
GDP per capita (US$)	379.2	407.1
Estimated share of the informal sector in the economy in GDP (percentage)	n.a.	n.a.
Share of industry in GDP (percentage)	41.4	44.1
Share of services in GDP (percentage)	45.6	42.8
Share of agriculture in GDP (percentage)	12.9	12.9
Crop land area (Hectares)	300,553	246,784
Range land area (Hectares)	1,437,214	n.a.
Forest area (Hectares)	10,362	
Livestock population:		
Cattle	577,975	538,885
- Dairy	2,956	3,170
- Non-dairy	575,019	535,715
Sheep	1,276,595	951,445
Goats	875,695	731,710
Horses	112,900	98,145
Donkeys	140,100	174,625
Pigs	45,800	63,705
Poultry	6,218,000	5,393,000
– improved	3,290,000	2,037,000
– unimproved	2,928,000	3,356,000



A satellite picture of Lesotho

FOREWORD

The Hon. Minister
Monyane Moleleki

In 1988, the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP), established the Intergovernmental Panel on Climate Change (IPCC), whose mandate was to assess the available scientific information and the environmental and socio-economic impacts of climate change, and to formulate response strategies to the same. The IPCC was adopted by the United Nations Organization (UNO) on the 27th January 1989 through Resolution A/RES/43/53 of its General Assembly. It submitted its "First Assessment Report" to the Second World Climate Conference in August 1990, and this Report served as the basis for negotiating the United Nations Framework Convention on Climate Change (UNFCCC). Lesotho, along with over 150 other countries, signed the Convention at the Earth Summit in Rio de Janeiro, Brazil, in June 1992. It subsequently ratified the same in February, 1995.

As the IPCC reports indicate, climate change is not any more a myth, or a subject of controversy. It is a reality which has to be combatted to ensure sustainability of life, not only for the present but for the future generations. Lesotho, like the rest of the international community, is conscious of the serious consequences of climate change, and fully identifies with the ultimate objective of the UNFCCC, "to achieve stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system".

In pursuit of her commitments under the Convention, Lesotho has been developing her National Programme of Action on Climate Change since October 1996. This Communication represents a summary of achievements so far in this painstaking exercise. The National Programme of Action is coordinated by the Lesotho Meteorological Services, and represents the product of a collective commitment by government agencies, the private sector, and non-governmental organizations. Although some of the analyses are still preliminary and a lot of proposed actions are still on the drawing boards, this Communication also represents a major benchmark in Lesotho's endeavour to join the international community in combatting the fundamental causes of the instability of climate systems and their negative impacts.

Lesotho has been a keen participant in various fora on climate change. By submitting this Communication, Lesotho wishes to demonstrate her unreserved will and commitment to meeting international obligations under the UNFCCC. It is indeed a singular honour and great pleasure for me to present, on behalf of the Government of Lesotho, the Initial Communication of Lesotho to the Conference of Parties to the UNFCCC. This document, which is the product of a collective effort of development practitioners in the country, will also serve as a cardinal point in the planning, execution, and evaluation of future development programmes.

Monyane Moleleki
Minister of Natural Resources

ACKNOWLEDGEMENTS

The Government of Lesotho wishes to convey special thanks to the Global Environment Facility (GEF) which provided funding for the compilation of Lesotho's National Programme of Action on Climate Change of which this Initial Communication is one of the components, and to the Implementing Agency, the United Nations Environment Programme. In particular, many thanks go to Dr. Pak Sum Low of UNEP who played a pivotal role in the drafting of the project proposal, and to Dr. Ravi Sharma, also of UNEP, for providing technical guidance and administrative support.

The Government wishes to acknowledge the invaluable contributions and inputs into various parts of the National Programme of Action on Climate Change that were made either directly or indirectly by various institutions and government agencies. Special gratitude is extended to members of the National Climate Change Study Team (NCCST) who worked relentlessly to bring baseline studies to a logical conclusion and solicited the formulation of appropriate National Programme of Action policies and strategies from various stakeholders.

The preparation of the National Action Plan could not have been concluded without the support of the entire staff of the Lesotho Meteorological Services (LMS), in particular, S.P. Raboqha, M. Mahahabisa, J. Mphethi, L. Bulane, and S. Tsukulu, who assisted in the gathering of base data and model interpretations, and M. Molopi who provided some of the secretarial services. The Initial Communication was compiled by Michael Mhlanga, a consultant from Business Support Southern Africa (Pty) Ltd, with inputs from reports that were prepared by the NCCST and support services of the staff of LMS. A special indebtedness goes to him for his patience in a tedious effort of consolidating and enriching inputs from several multi-disciplinary sources.

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National Coordinator and Focal Point for the United Nations Framework Convention on Climate Change

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LIST OF ACRONYMS

ABP	Annual Business Plan
ARD	Agricultural Research Division
ATS	Appropriate Technology Section
BOS	Bureau of Statistics
CBO	Community Based Organization
CCCM	Canadian Climate Centre Model
CEP	Capital Expenditure Programme
CH_4	Methane
CM^3	Cubic Centimetres
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide emissions
CO_2s	Carbon Dioxide sinks
COP	Conference of Parties
CWS	Civil Works Section
DMA	Disaster Management Authority
DMM	Disaster Management Manual
DOE	Department of Energy
DRWS	Department of Rural Water Supplies
DSSAT	Decision Support System for Agrometeorological Transfer Model
DWA	Department of Water Affairs
EAP	Environmental Action Plan
EIA	Environmental Impact Assessment
GA	Grazing Association
GCM	Global Circulation Model
GDP	Gross Domestic Product
GEF	Global Environmental Facility
GFDL	Geophysical Fluid Dynamics Laboratory model
Gg	Gigagram
GHG	Greenhouse Gas
GISS	Goddard Institute for Space Studies model
GNP	Gross National Product
HA/HA	Hectare
IDWSD	International Drinking Water and Sanitation Decade
IMF	International Monetary Fund
INC	Intergovernmental Negotiating Committee
IPCC	Intergovernmental Panel on Climate Change
KM^2/KM^2	Square Kilometre
LCU	Labour Construction Unit
LEC	Lesotho Electricity Corporation
LEMP	Lesotho Energy Master Plan
LFCD	Lesotho Fund for Community Development
LHDA	Lesotho Highlands Development Authority
LHRF	Lesotho Highlands Revenue Fund
LHWP	Lesotho Highlands Water Project
LMS	Lesotho Meteorological Services
LPG	Liquid Petroleum Gas
M	Maloti

MACLR	Ministry of Agriculture, Cooperatives and Land Reclamation
MCC	Maseru City Council
Mg	Milligram
MHP	Muela Hydro Power scheme
N_2O	Nitrous Oxide
NAPCC	National Action Plan on Climate Change
NCCSC	National Climate Change Steering Committee
NCCST	National Climate Change Study Team
NDI	National Disposable Income
NDMP	National Disaster Management Plan
NEAP	National Environmental Action Plan
NES	National Environment Secretariat
NGO	Non-Governmental Organization
NMVOC	Non-Methane Volatile Organic Compounds
NO_x	Nitrogen Oxide
NRSP	National Rural Sanitation Programme
NTSC	National Tree Seed Centre
O&M	Operation and Maintenance
OECD	Organization for Economic Cooperation and Development
OSU	Oregon State University model
PSIP	Public Sector Investment Programme
RMA	Range Management Area
RSA	Republic of South Africa
SACU	Southern African Customs Union
SADC	Southern African Development Community
SPUR	Simulation and Production and Utilisation of Rangelands model
TJ	Terajoule
UKHI	United Kingdom Meteorological Office High Resolution model
UKTR	United Kingdom Meteorological Office Hardley Centre Transient model
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
VAU	Village Affairs Unit
VIP	Ventilated Improved Pit Latrine
WASA	Water and Sewerage Authority
WFP	World Food Programme

EXECUTIVE SUMMARY

Introduction

In accordance with Article 4 of the United Nations Framework Convention on Climate Change (UNFCCC), all parties to the Convention face a global challenge to stabilise "greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system". Lesotho is a signatory and has ratified this Convention which recognises that the objective of the UNFCCC is to be achieved within a time frame that allows ecosystems to adapt naturally, that ensures that food production should not be threatened, and that enables sustainable economic development to prevail.

Following the adoption of the UNFCCC in May 1992, all parties to the Convention were expected to prepare national communications that detailed out Inventory of Greenhouse Gas Emissions (GHGs) and identified appropriate mitigation and adaptation policies and measures. Lesotho joined the international community in this exercise which was carried out with financial assistance from GEF and technical backup from UNEP. In preparing for the national communication, the following activities, which constitute the national programme of action on climate change, were carried out:

- Public awareness campaigns on climate change;
- Compilation of Inventory of GHG emissions;
- Assessment of vulnerability to climate change;
- Assessment of mitigative policies and measures;
- Assessment of adaptive policies and measures; and
- Formulation of a national implementation strategy.

The execution of these activities involved active participation by all major stakeholders that included government agencies, NGOs, and the private sector. The national programme of action on climate change therefore represents the real national aspirations of the country, and falls within the framework of national plans, policies, and programmes.

National Circumstances

Lesotho comprises a small landlocked country that occupies 30,588km^2 which is inhabited by an almost homogeneous ethnic grouping. The country is divided into 4 ecological zones: the lowlands (17%), the foothills (15%), the mountains (59%), and the Senqu River Valley (9%). Because of the country's topography, economic activities are largely confined to the lowlands, the foothills, and the Senqu River Valley, leaving the mountain region only suitable for grazing and water resource development in particular hydro-power. The country is known to be resource-poor although there is a tremendous potential for hydro-power development. With high levels of environmental degradation that include severe soil erosion, Lesotho also experiences very harsh climatic conditions that limit the growing season for many crops.

The 1996 census put the population at 1,959,700. At 2%, the country's population growth rate is still considered too high. Density on arable land increased from 569 people per km^2 in 1986, to 588 people per km^2 in 1996, leading to migrations of people to peri-urban areas where social facilities are now

overstretched. In the ten years ending 1996, the country registered high economic growth rates and substantial improvements in the balance of payments. Real GDP grew at an average 7.8% per annum, real GNP at 4.1%, and inflation dropped from 19.9% to 9.1%. However, in 1998, political riots and labour instability led to a reversal of these gains, as the economy entered into a recession. The country is still highly dependent on migrant workers' remittances from the RSA, and on regional customs union earnings and on foreign aid inflows.

Despite significant progress in economic and financial performance over the past few years, Lesotho still faces an uphill battle against poverty. Unemployment is still estimated at 30-35%, 50% of the households are still classified as poor and 25% ultra-poor. There has been a gradual decline in factor incomes from abroad as the employment of migrant workers declines. On the political front, democracy remains fragile and unstable although there are now regional efforts to stabilize the situation. The country, however, remains committed to its goal of sustainable human development, a goal which broadly encompasses the objectives of poverty alleviation, employment creation and social integration.

Inventory of Greenhouse Gas Emissions

In an effort to meet one of its major obligations under the Convention, Lesotho initiated a programme to assess the levels of GHG emissions in the country. Inventory studies were conducted by a multi-disciplinary National Climate Change Study Team (NCCST) which used 1996 Intergovernmental Panel on Climate Change (IPCC)/Organisation for Economic and Cooperation Development (OECD) standard methodologies, and adopted 1994 as a base year. The GHGs which were considered in the study included carbon dioxide (CO_2), carbon monoxide (CO), methane (CH_4), nitrous oxide (N_2O), nitrogen oxide (NO_x) and non-methane volatile organic compounds (NMVOC).

Unfortunately, Lesotho, like many other developing countries, suffers a weak data base. In addition to the poor state of the natural resources data base are problems posed by the unsystematic and unstandardised presentation of data, lack of update and series data in many sectors, the low national data collection capabilities, and the general unreliability of methodologies used, particularly for estimations in the rural sector. Problems were also encountered in the application of IPCC/OECD methodologies to the country's conditions in some areas.

Results of the inventory studies show that in 1994, Lesotho's GHG emissions amounted to an estimated 5,149.09 Gigagrams (Gg), while sinks amounted to 3,039.20Gg. This resulted in net GHG emissions of 2,109.89Gg. The major share came from carbon dioxide which accounted for net 1,896.56Gg or 89.89% of the country's total GHG emissions. Carbon monoxide and methane respectively contributed 143.81Gg (6.83%) and 41.46Gg (1.97%). Other GHG emissions such as nitrous oxide, nitrogen oxide, and non-methane volatile organic compounds contributed 23.25Gg (1.1%).

A carbon dioxide equivalent shows that in 1994 (see Appendix 5b) a total gross GHG emissions of 6,288.66 Gg, while sinks are 3,039.20 Gg leading to net emissions of 3,249.46 Gg. A breakdown by sector shows that land use change and forestry is the largest source, being responsible for net emissions in the order of 1,260.57 Gg of CO_2 equivalent or 38.80% of the country's total carbon dioxide equivalent emissions. The second largest source was found to be agriculture which contributed 1,074.05Gg or 33.06%. Energy occupied third position with a contribution of 854.99Gg or 26.31%, although it was the second highest emitter of CO_2, mainly from the combustion of biomass fuels. The least contribution came from waste, a source of 59.85Gg of carbon dioxide equivalent or 1.84% of the total.

GHG emission statistics that were computed by the inventory studies revealed that small countries with low economic activities have very minimal contribution to global warming. Indeed, while it is incumbent

upon every country that is a signatory to the UNFCCC to develop and implement policies to reduce GHG emissions, small vulnerable countries such as Lesotho, with limited resources, will be forced to put priority on developing adaptive as opposed to mitigative strategies as most of the impacts of global warming are externally induced through anthropogenic activities of more developed countries.

There is no doubt that Lesotho's GHG emission statistics will need refinement over time to accommodate the country's peculiar circumstances, to incorporate more accurate and more update statistics, and to include new sets of assumptions. What has also emerged is that these studies were not an exercise in futility as they resulted in substantial national capacity building and produced results which are somewhat comparable with other small developing countries. It is hoped that resources will be secured to enable updating and further refinement, and to modify some of the methodologies to be more relevant to local conditions. A lot of technical assistance will also be required in various areas as the supply of scientific skills remains a pervasive constraint in the country.

Vulnerability Assessment

In accordance with the provisions of the UNFCCC, the extent to which Lesotho is critically vulnerable to climate change was assessed by the NCCST. A detailed review of the current climate was made, together with an analysis of the intricate relationship between climate on the one hand, and agro-ecological and socio-economic conditions on the other. A number of climate change scenarios were then developed to simulate, using global circulation models (GCMs), likely changes in temperature and precipitation as a result of the doubling of CO_2. The potential impacts of these scenarios were then assessed across eight sectors that were deemed likely to be vulnerable to climate change: water, agriculture, rangelands and forestry, where models were run; and soils and desertification, health, biodiversity, and culture, where expert judgement analyses were applied.

Climatological Conditions

The geographical location of Lesotho on the plateau of the tapering Southern African subcontinent exposes the country to significant influences of both the Indian and the Atlantic Oceans, two oceans which have wide temperature differences. Weather patterns which result from this location combine to modify the usual conditions that are created by the annual movement of the Inter Tropical Convergence Zone (ITCZ). The behaviour of the ITCZ determines whether the year is wet or dry. Since the behaviour of the ITCZ varies from year to year the climate of the country, in particular rainfall and temperature, indicates high variability in all time scales.

Agro-ecological Conditions

Analysis of Lesotho's current climate indicates that its variability places critical constraints on crop production in the country. While sunlight is not a limiting factor, water supply (the result of rainfall and evaporation), together with soil/terrain characteristics, and the climate regime, remain major factors. The prevalence of unstable climatic conditions limits cultivable area, as well as the duration of the growing season, and hence places limits on potential crop/land productivity. The choice of crop, cultivar, ecological region, and planting date need to be decided upon in the light of frost risks, the prevailing temperature regime, and precipitation occurrence during the growing season. Lack of capacity and capability amongst relevant institutions to capture these erratic climate conditions over many years of Southern Africa have proven to be detrimental to crop production. These factors influence the adaptability and distribution of different types of crops as well as different cultivars within each crop category.

Socio-economic Conditions

Since close to 85% of the households in Lesotho live in rural areas and 70% derive all or part of their

livelihood from agriculture, the contribution of this sector is of critical importance in the determination of socio-economic conditions in the country. However, the country's limited arable area, together with a mountainous topography, variable climate, and severe soil erosion are constraining the agricultural sector to generate adequate levels of employment and incomes to support the rapidly increasing population. As a result, both absolute and relative poverty have been increasing over time. Climate has been found to be intricately related to many indicators of poverty, particularly that both the incidence and depth of poverty are higher amongst rural and farming communities.

Climate Change Scenarios

Climate change scenarios that were generated with the assistance of six global circulation models using historical data for the years 1961 to 1994 predict warmer future climatic conditions over Lesotho, lower precipitation, particularly in the spring and summer seasons, a higher precipitation in winter, and a gradually increasing precipitation in autumn. The result could be a shift in precipitation patterns in such a way that good seasonal rains that characterize the summer season could then set in late in autumn. This is likely to have serious implications for agro-ecological conditions in the country as the growing season is pushed forward and perhaps shortened. On the other hand, an increase in precipitation in winter may suggest increased activity in frontal systems which may result in heavier snowfall occurrences and strong devastating winds which often bring disasters and human suffering.

The Water Sector

GCM simulations of future scenarios show a reduced surface and sub-surface runoff under climate change as a result of the predicted lower precipitation. Taking the current population growth rate and climate, and a fresh water availability of 5.4km^3 per annum, it is estimated that the country will enter a water stress period of less than 1700m^3 per capita per year by year 2019, and a water scarcity period of less than 1,000m^3 per capita per year by year 2062. Under climate change, these lower levels of service could be reached earlier, implying suffering for both livestock and households. Lower runoff could also translate itself into an ecological disaster, and lead to the closure of many water-based economic and social activities. Dry conditions for most of the year and the resultant lower sub-surface flow would lead to dry springs and wells, lower water tables and higher borehole costs, reduced yields of many water sources, and severe water stress, particularly for the rural population who mainly depend on ground water.

The improved water supply coverage stood at 56% in 1995. Unless sufficient surface storage and reticulation infrastructure are developed over time, the predicted lower runoff could also lead to conflicts between Lesotho and the Republic of South Africa (RSA) as the latter is likely to be increasingly more dependent on the former for water by year 2075. It is logical to think that Lesotho will have a moral obligation to provide for its domestic water needs before exporting any 'surplus' to the RSA. This will have to be addressed during the future re-negotiations and reviews of the Lesotho Highlands Water Project (LHWP) treaty between the two countries.

The Agricultural Sector

Lesotho's crop production is dominated by maize which accounted for 63% of the area planted in 1995/96. The other major crops are sorghum, with a 1995/96 share of area planted of 28%; wheat, with a share of 12%; beans with a share of 5%; and peas, with a 1995/96 share of area planted of 3%. In the 6 years beginning 1990/91, total area under cultivation fluctuated between 136,500 and 300,500 hectares, down from 450,000 hectares in 1960. In general, area under cultivation, production, and yields are very erratic and closely related to rainfall figures. The country is heavily dependent on food imports to satisfy local demand.

What emerges from GCM simulations is that the projected climate change conditions are likely to have a slight positive impact on maize production during normal and wet years. However, their impact

on sorghum and dry bean production during these years is somewhat indeterminate, with dry bean production likely to fall below baseline levels during normal years. The performance of all the crops is likely to go through a dramatic improvement during dry years, leading to possibilities for reduced imports in the case of maize, and higher exports in the case of sorghum and dry beans.

Lesotho will only realize the potential of improved crop production that is predicted by these GCM climate change scenarios if the obstacles that currently face agriculture are removed and policies and programmes that encourage the country to adapt to new agro-climatic conditions are adopted. This may require the adaptation of new production technologies that could include irrigation because of the need to minimise the adverse impacts of dry conditions. Other important factors could be the success of land reform, the prevailing population/land ratios and the availability of agricultural land, and the effectiveness of research and extension services.

The Forestry Sector

There is no comprehensive and update data on the extent of tree cover in Lesotho. However, it is generally known that the country is one of the least forested in Africa. Indigenous trees and shrubs comprise the mixed evergreen and deciduous tree patches which are usually found in the valleys and gullies of the lowlands and foothills, and stands of trees and scrubby areas found in the lower mountain zone up to 2,500 metres altitude. It is estimated that these native forests cover a mere 34,685 hectares of land, with a total crown cover of 34.14% of the country. Although these indigenous forests are of low occurrence, they remain a very important resource to rural communities by providing fuelwood, construction materials, medicines, forage and shelter. However, despite various efforts at conservation, the destruction of this natural vegetation continues unabated although the rate of depletion has not been determined quantitatively.

Results generated by the Holdridge Life Zone Classification model show a potential for a widespread occurrence of sub-tropical dry forest and temperate moist forest cover under climate change. Such climatic conditions would impact positively on afforestation programmes. This is confirmed by the Forest Gap model generated results of the performance of various tree species which show that warmer conditions would have a positive impact, albeit a marginal one, on the growth of both indigenous and exotic species, particularly when the plants are 20-40% of their maturity life, leading to improvements in biomass production in the country. The impact of all these positive changes would be felt throughout the economy provided the current constraints to afforestation are relaxed and relevant development programmes are successfully implemented.

The Rangelands Sector

Rangeland utilisation has become one of the contentious issues in Lesotho today. Overstocking is currently estimated at 50% in a country that is dominated by extensive communal grazing systems. Twenty-five percent of the rangelands is classified as in poor condition, while the rest is classified as in fair condition. Over the years there has been a rapid invasion by sub-climax species. Results that were generated by the SPUR model indicate that due to reduced and delayed precipitation under climate change, the country is likely to loose a lot of its nutritious climax grass species and gain a lot of hardy and less nutritionous varieties, with serious consequences for livestock productivity in a sub-sector which contributes an average 55%-65% of agricultural output in any one year. The poor performance of forage grasses that is predicted by most of the GCMs is likely to negatively impact on livestock, leading to low output and productivity, lower farmer incomes, and increased meat imports to meet the demands of an increasing population. Supplementary feeding will also be required all the year round, a cost which many subsistence farmers cannot shoulder.

Soils and Desertification

The importance of the soil resource in Lesotho derives from the fact that close to 85% of the population derive all or part of their livelihood from agriculture. However, the suitability of these soils is greatly influenced by topography, the highly variable rainfall pattern that includes both droughts and floods, animal and human pressure, the cultivation of marginal lands, and poor land management practices, factors which have combined to expose the country to severe forms of soil erosion. It is estimated that the country losses close to 40 million tons of soil every year.

The GCM scenarios predict conditions that will have an incremental effect on the rate and magnitude of soil erosion in the country. High temperatures, poor grass cover, lower rainfall, frequent droughts , rainstorms, strong winds and the melting of heavier snow are all likely to increase soil loss far above current levels, further weakening the capacity of the soils to support the country's biological and economic well-being, unless drastic adaptive measures are designed and implemented.

Biodiversity

The variation in soils, the undulating topography, and micro-climatic differences that are found within each ecological region, have led to the development of a biodiversity with a specific endemism, especially in the mountain region. However, it is generally accepted that the setting in of desertification conditions has been very detrimental to the country's biodiversity. The loss of some of Lesotho's biodiversity has been directly associated with the siltation and drying up of many rivers and their sources, increased aridity and disappearance of many wetlands and marshlands, accelerated soil wash and loss of soil fertility, reduced arable land, and reduced vegetation cover.

Since Lesotho is likely to experience a warmer climate in future, it is likely that the species diversity will improve, either through migrations, or through improved adaptation of imported species. On the other hand, with lower rainfall in the spring and summer seasons, it is those species which thrive in dryland areas that are likely to proliferate in the future, resulting in an improvement in the number of herbal, floral, and reptile species which are characteristic of dry forests. Unfortunately, indications are that the current global warming might result in a rapid change which might not allow gradual changes in the species genetic makeup to adapt to drier conditions, hence if no special efforts in conservation are carried out, many species, including endemic plants, are likely to become extinct.

The Health Sector

So far Lesotho is free from many climate-related diseases that are common in tropical countries because of high altitude and severe winter temperatures. However, climate-related, life-threatening fatalities frequently occur where people die from exposure to severe winters that sometimes include prolonged snowfalls. The complex relationship between water quality and availability and sanitation and hygiene on the one hand, and disease prevalence on the other, is well demonstrated where respiratory tract infections, gastro-intestinal, genito-urinary, and skin diseases top the list of reported cases, together constituting 55% of these cases.

The GCM climate change scenarios indicate that Lesotho is likely to have a warmer climate in future. This could lead to invasions by tropical diseases for which the country is currently ill-prepared. On the other hand, dry conditions that are likely to set in during the spring and summer months might lead to further increases in the incidence of respiratory tract infections like tuberculosis, and waterborne diseases like typhoid. Some of these diseases are already on the increase despite phenomenal improvements in medical services in recent years. The GCM scenarios also predict the setting in of severe winter conditions in future. This is likely to exacerbate the problems of acute respiratory infections, particularly in those rural areas where poverty is very severe and energy resources very scarce.

Basotho Culture

Present climatic trends have severely dented the culture of Basotho people. However, GCM generated climate change scenarios seem to indicate that some of the future conditions might be favourable to cultural restoration. For example, improvements in biodiversity that is predicted by these models might lead to improvements in traditional medicine. Similarly, the predicted improvements in biomass are likely to reduce the use of dung and paraffin for energy sources, while improvements in sorghum and bean production are likely once more to lead to higher consumption of these nutritionally rich crops, provided there are technological improvements on the processing side.

Summary of the Vulnerability Assessment

The vulnerability assessment has revealed Lesotho as a small country which is land-locked, prone to natural disasters, liable to drought and desertification. Lesotho also has a fragile mountainous ecosystem. Hence in accordance with article 4 of the UNFCC these conditions present Lesohto as a country highly vulnerable to climate change. The country is already paying high premiums as a result of the impacts of global warming. This is evidenced by the increasing frequency of natural disasters, devastating droughts and emerging signs of progressive desertification. The fragile soil/terrain characteristics, erratic climatological conditions, difficulties of realising the full potential of agro-ecological conditions, the growing level of poverty which is currently estimated at more than 50% of the households, and the relative deprivation of the inaccessible mountain region which makes up more than 60% of the country, ranks Lesotho as one of the most highly vulnerable developing countries.

Nationwide Policies and Measures

Although Lesotho joined the international community in a worldwide concern about negative impacts of global climate change by signing, together with 155 other countries, the UNFCCC at the Earth Summit in Rio de Janeiro, in June 1992, and went on to ratify the same in February, 1995, there is as yet no coordinated national policy to deal with this pervasive problem. However, a number of sector-specific policies have been drawn up and incorporated into national programmes. It is recognised that most of the country's vulnerability to climate change emanate from the wide prevalence of poverty, hence poverty alleviation has become an important national objective which is incorporated into national plans. A lot of programmes have been designed for poverty alleviation in recent years. These include social funds, special employment schemes, and restoration and resettlement schemes for households that are affected by development activities. The country has also improved its disaster management strategy quite considerably in recent years.

Sector-Specific Mitigative Policies and Measures

Due to financial and institutional constraints, as well as technological limitations, Lesotho's experience in the mitigation of GHG emissions has been limited. The country puts more priority on adaptive measures because of its extreme vulnerability to the adverse effects of climate change. This generally leaves very little resources available for mitigation. However, some of the adaptive measures, particularly in energy and forestry, although planned and implemented with the main objective to reduce the vulnerability of rural populations in energy provision, carry important mitigative impacts as well. These measures include the following: (a) promotion of renewable sources of energy for the residential and commercial sectors, (b) the promotion of energy efficient devices, (c) the encouragement of energy switching to cleaner sources such as electricity, (d) reforestation of indigenous forests, (e) afforestation of gullies and degraded lands, and (f) rehabilitation of wetlands.

The mitigated scenario in the energy sector progressively reduces GHG emissions from the baseline figure of 1,404.14Gg of CO_2 equivalent by year 2005 to 1,045.30Gg, and from 5,197.20Gg of CO_2 equivalent in year 2030 to 4,416.27Gg. This respectively represents reductions of 26% and 15% for the two periods. With effective control over biomass fuel consumption in its adaptation strategies, therefore,

Lesotho will shift the structure of energy demand to a point where the main focus of mitigation will lie with energy consumption in the transport sector, a sector which is already being targeted for future policy interventions. On the other hand, interventions in forestry are projected to increase sinks from a 1994 level of 289.2Gg to 3,770Gg by year 2030. Although the increase in sinks will be offset by increased emissions resulting from grassland conversions and abandoned managed lands for some time, the 2030 conditions show a dramatic improvement in containing emissions in the forestry and land use sector that result in net emissions of -1,266.32 Gg as compared to 6,888.85Gg in 2005. Apart from increased energy provision, employment creation, income redistribution, improved biodiversity, soil stabilization, enhanced aesthetic values, and educational impacts, therefore, the expansion of the forestry programme will lead to improvements in CO_2 abatements, albeit to a very limited extent.

Sector-Specific Adaptation Policies and Measures

In accordance with the requirements of the Convention, Lesotho has isolated a number of sector-specific development policies and measures that are aimed at facilitating the country's adaptation to climate change in specific sectors of the economy. These policies and measures are integral components of the country's national development strategy. They derive from the recognition that Lesotho, as a critically vulnerable country, does not on its own have the resources, capacity, and capability to either take full advantage of new opportunities and potential that may come with climate change, or avert the human suffering that may come with adverse impacts of the same.

Lesotho has come to realise that for agriculture to support a growing population in the face of various future climate change scenarios, the sector needs to be transformed from its current subsistence orientation into a nationwide commercial business. This is to be done through policy reforms, changing social attitudes about natural resource conservation, disseminating technologies, introducing new and more drought resistant crop varieties, and relaxing a number of institutional capacity constraints. The strategies emphasise advocacy for increased private sector participation, crop diversification to high value crops, irrigation development to meet dry future conditions, and the promotion of intensive livestock production.

In the water and sanitation sector, the policies emphasise universal coverage in the provision of sustainable safe water supply and sanitary disposal of waste. The strategies centre on the development of a water resources management policy and strategies, the rationalisation and improvement of sector institutions, improvement of water quality and the regulatory framework, development of a national drought policy to mitigate adverse impacts of periodic droughts, accelerating the investment programme, effecting improvements in the operation and maintenance of systems, and reviewing the current tariff levels.

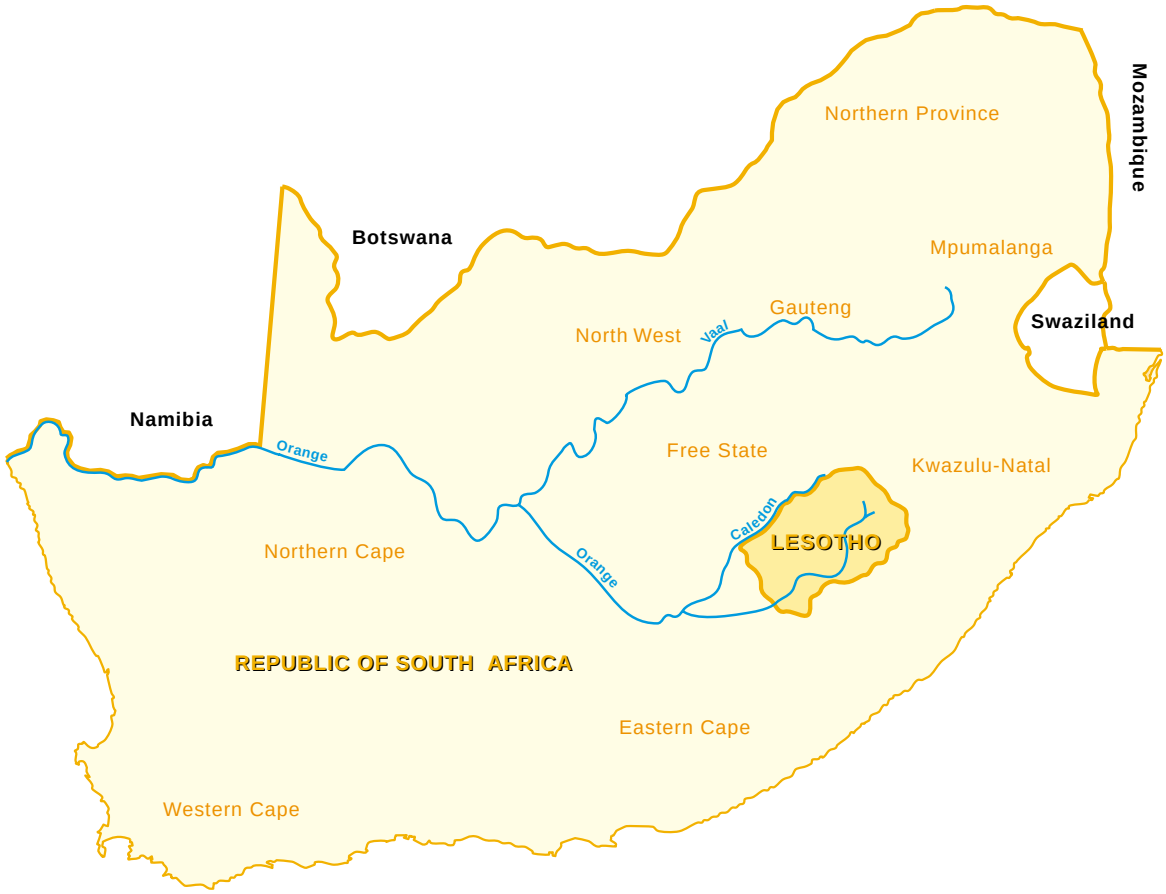
In the land use change and forestry sector the policies emphasise the utilisation and conservation of the environment and natural resources for the benefit of both present and future generations, preservation of the biodiversity and cultural heritage, land reclamation, and establishment of adequate environmental standards. These policy objectives are to be achieved through environmental legislation, improved landuse planning, land reform, and improved range management and utilisation.

National Implementation Strategy

The national programme of action on climate change has been designed for complete integration with existing national development programmes in accordance with UNFCCC guidelines, and forms an integral part of the national socio-economic and environmental policies and actions. The government recognises the sectoral cross-cutting nature of climate change issues, and as such has adopted an all-inclusive approach which brings together multi-disciplinary expertise into a common purpose through regular consultations, workshops and seminars. The programme also brings together a broad spectrum of stakeholders, from grassroots levels to policy-making echelons.

Although a few core institutions have been identified to play a leading role, the country has constituted amulti-sectoral steering committee to oversee climate change planning and programming. This committee is assisted by a national study team of professionals who carry out specific assignments in various sectors. The programme is coordinated by the Lesotho Meteorological Services which has isolated a number of indicators for the purposes of monitoring and evaluation, and for reporting to the Conference of Parties to the United Nations Framework Convention on Climate Change.

The regional map of Southern Africa



1 INTRODUCTION

The Global Challenge

1. International public concern about climate change began in the 1980s with the accumulation of scientific evidence that linked anthropogenic gas emissions with global climate change. It became evident that over the last century, atmospheric concentrations of greenhouse gases such as carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O), had increased by 30-145%, mainly as a result of human activities, and were by then expected to continue to increase over time[1]. Similarly, average global temperatures had increased by 0.3-0.6°C, as a result of this increase in greenhouse gas concentrations. It is expected that average global temperatures will rise by 1-3.5°C and the mean sea level by 15-95cm by the year 2100. This change in average temperatures is likely to be accompanied by changes in precipitation and drought patterns, and might have very significant effects on agriculture, water supplies, health, and terrestrial and aquatic ecosystems worldwide.

2. In response to concerns about increased global warming, a series of international conferences made urgent calls for a global treaty to address the problem. In 1990, the United Nations General Assembly responded by establishing the Intergovernmental Negotiating Committee for a Framework Convention on Climate Change (INC/FCCC). This committee drafted the Convention which was adopted on 9 May, 1992.

3. The main objective of the United Nations Framework Convention on Climate Change (UNFCCC) is to stabilise greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system[2]. This level is to be achieved within a time frame that allows ecosystems to adapt naturally to climate change, that ensures that food production is not threatened, and that enables sustainable economic development. In addition, the UNFCCC recognizes the need for global cooperation in order to effectively control greenhouse gas emissions. As such, Article 4 calls upon all parties to the Convention to prepare national communications that detail out inventories of greenhouse gas emissions and identify mitigation and adaptation response measures. These climate change action plans will not only assist countries to meet their UNFCCC obligations, but enable them to set priorities for action, and to integrate climate change concerns into their national development plans.

4. Lesotho, like many countries in Southern Africa, has a highly variable climate. In recent years, the country has experienced unprecedented and frequent droughts that were associated with El Niño conditions. Very severe droughts in the years 1991/92 and 1993/94 resulted in poor crop harvests and large stock losses to rural farmers, exacerbating poverty and suffering. The country has also been struck by sudden snow falls, strong winds, and floods from time to time, with devastating social impacts. Uncertainty about weather conditions is increasingly making the already low-productivity agriculture a more risky occupation. At the present moment, prospects for increased employment creation in this sector

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[1]Houghton, J.T., Meira Filho, L.G. Callander, B.A., Harris, N., Kattenberg, A. And Maskell, K. (eds) "Climate Change 1995: The Science of Climate Change", Contribution of Working Group I to the Second Assessment Report the Intergovernmental Panel on Climate Change, New York: Cambridge University Press, quoted in Ron Benioff and John Warren, *Steps in Preparing Climate Change Action Plans: A Handbook*, Version 1.0 March 1996, U.S. Country Studies Programme.

[2]UNEP/WMO Information Unit on Climate Change, *United Nations Framework Convention on Climate Change*, Switzerland, May, 1992, p.5.

look gloomy, and will largely depend on the government's success in implementing its strategic programme that involves diversification to high value crops, deregulation of the markets for agricultural products, improvements in the land tenure system to encourage both foreign and domestic investment in the sector, and improvements in the management of natural resources.

The National Action Programme on Climate Change

5. After signing the UNFCCC in 1992, and ratifying the same in 1995, Lesotho initiated a project *Enabling Activities for the Implementation of UNFCCC* with the assistance of the United Nations Environment Programme (UNEP), and obtained funding for this project from the Global Environment Facility (GEF), a financial mechanism of the UNFCCC which is jointly implemented by the World Bank, UNDP, and UNEP. The main objectives of this project are to assist Lesotho to meet her obligations under the UNFCCC, and to lay down a framework for the formulation and implementation of a national programme of action on climate change (NAPCC). The development of NAPCC has been done in stages that involve multi-disciplinary inputs and are marked by the following clearly identifiable activities: public awareness campaigns, compilation of inventories of GHG emissions, vulnerability assessments, and the assessment of policies and mitigation and adaptation measures.

Activity I: Public awareness campaigns

The objective of this ongoing activity is to raise public awareness and understanding about the trends and implications of global climate change on the day-to-day lives of citizens, and to sensitize the latter on their obligations to guarantee both present and future generations a healthy life. Workshops have been held for influential people – chiefs, local government representatives, school headmasters, church leaders, non-governmental organizations, etc. – in all of Lesotho's ten districts and at the national level, with attendances ranging from 100 to 120 participants. A number of talk shops have also been organized at tertiary institutions. The activity included poster messages and extensive air coverage.

Activity 2: Compilation of inventory of GHG emissions

A 19 member national study team (NST) was constituted to evaluate the amount of greenhouse gases that are emitted in Lesotho. This multi-disciplinary team included staff from the Lesotho Meteorological Services; the Department of Energy, the National University of Lesotho; the Ministry of Trade and Industry; the Bureau of Statistics; the Land Use Planning, Forestry, and Soil Conservation Division; the Department of Livestock Services; and the Lesotho National Development Corporation. The study, which has already produced its first report, concentrated on four sectors: energy, agriculture, Land use and forestry, and waste management. The study used methodologies developed by the IPCC/OECD, and benefitted from backup services that were organized through UNEP.

Activity 3: Assessment of vulnerability to climate change

Also carried out by some members of the multi-disciplinary national study team and a few local consultants, this activity isolated eight sectors and assessed their vulnerability to climate change. The IPCC/OECD vulnerability assessment models were applied to the water, agriculture, and rangelands and forestry sectors, while professional assessments were applied in the cases of soils and desertification, biodiversity, health, and culture. The first report has also been concluded with active participation by affected sectors.

Activity 4: Assessment of Policies and Strategies for Mitigation and Adaptation

This activity involved a review of existing and planned policies and measures to mitigate and adapt to climate change. Two reports have been prepared, one that addresses mitigation options for the energy and land use sectors, and the other which assesses adaptation measures for the water and agriculture sectors, as well as for cross-cutting areas in land use.

6. The development of NAPCC has therefore been a process. It incorporated findings of activities listed above and, together with the active participation of major stake holders, undertook in-depth assessments of the level of GHG emissions in Lesotho, vulnerabilities of the country to the impacts of climate change, and mapped out various sectoral mitigative and adaptive options, including reviews of reports of the national study team and consultants. The plan therefore represents real national aspirations and priorities, with sectoral inputs. The latter were solicited through broad consultation, as well as through a national conference to which a draft national action plan was presented for in-depth review by major stake holders, including NGOs and the private sector. It is hoped that NAPCC will form a very important input in the preparation of Lesotho's seventh development plan (1999/00-2001/02), and will become an integral part of all of Lesotho's policy formulation and planning efforts.

This National Communication represents a consolidation of Lesotho's NAPCC activities. It has been prepared in fulfilment of Article 12 of the UNFCCC, and in accordance with the Conference of Parties Guidelines for National Communications (10/CP2). The document is divided into 8 chapters. Chapter 1 constitutes this introductory note. Chapter 2 summarises Lesotho's national circumstances, while chapter 3 summarizes the findings on Lesotho's greenhouse gas emissions by gas type and sector of emission. Chapter 4 gives a summary of vulnerability analyses by sector. On the other hand, chapter 5 attempts to isolate relevant nationwide policies and measures, while chapters 6 and 7 respectively describe sector-specific mitigative and sector-specific adaptation policies and measures. Chapter 8 concludes the document by specifying Lesotho's national implementation strategy.

2 NATIONAL CIRCUMSTANCES

Size and Location

7. Lesotho comprises 30,588 km^2 of land surface that is entirely surrounded by the Republic of South Africa (RSA) and lies entirely outside the tropics between latitudes 28°S and 31°S, and longitudes 27°E and 30°E. The country is bounded by the RSA's provinces of the Free State in the west and north, the Eastern Cape in the south, and Kwazulu-Natal in the east. Although there are 22 official border crossing points, it is literally possible to cross the boundary at any point, as it often happens when people visit their relatives on either side of the border.

History

8. Historical records show that by the late 18th century, *Sesotho*-speaking, cattle-owning agriculturalists were spread in small ethnic groups that shared territory with San hunters over the plains between the Lekoa *(Vaal)* and Senqu *(Orange)* rivers. During the 1820s, these scattered ethnic groups were forced by the marauding Nguni armies of the Lifaqane wars to find refuge on mountain top fortresses that were established on sandstone plateaux to the east. It was in the early 1830s that Moshoeshoe I, the first King of *Basotho*, created a united *Basotho* nation out of shattered remnants of the clans that were scattered by these wars.

9. Although Moshoeshoe I gained British protection in a treaty that was signed in 1843, territorial wars that followed between *Basotho* and *Boers* who invaded Lesotho from the Cape Colony culminated in a British negotiated *Treaty of Aliwal North* of 12th February, 1869, whereby *Basotho* ceded much of their rich farmlands west of the Mohokare (Caledon) river and adopted the current boundaries, which then formed what became *Basotholand Protectorate*[3].

10. By the late 19th and early 20th centuries, population pressure had begun to be acutely felt in the *Basotholand Protectorate*. Territorial wars had pushed *Basotho* farmers to remote mountain valleys where arable land became increasingly scarce, and where overstocking did not only lead to a deterioration of land and animals but to accelerated rates of soil erosion. When Lesotho got its independence on 4th October, 1966, the prosperous country which Moshoeshoe had entrusted to British protection had become an over-populated and impoverished labour reserve which was heavily dependent on the RSA for the employment of 50% of its male labour force, totally dependent on grants-in-aid to support the development budget, and where customs earnings from the Southern African Customs Union (SACU) constituted 50% of the country's generated revenues. This historical legacy of territorial loss and dependency is one of the root causes for Lesotho's classification as one of the poorest countries in the world today.

Physical Features

11. Lying west of the watershed of the Drakensberg mountains, Lesotho forms part of the eastern escarpment of the Southern African Plateau. Its geology derives from the Karoo sedimentation which began around the carboniferous to the middle of the Jurassic period. Although much of this sedimentation has been lowered by erosion (which began during the Jurassic period) to form the Karoo basin, Lesotho remains the

[3]This name was changed to Lesotho at independence in 1966.

highest remnants of the plateau surface. The latter has been extensively dissected by the headwaters of the Orange (Senqu) River and its tributaries which drain in a north-south direction, and, together with an extensive network of mountain wetlands, which today forms an important segment of the Southern African region's water resources.

Table 1 Lesotho: Ecological Regions

Ecological Region	Area (km^2)	Altitude (metres)	Characteristics
Lowlands	**5,200 (17%)**	1,388-1,800	Narrow arable belt along western border with very fragile soils. Rich soils in the north, sandy/clay soils in the south.
Foothills	**4,588 (15%)**	1,800-2,000	Rich volcanic soils with agricultural potential.
Mountains	**18,047 (59%)**	2,000-3,482	Bare rock outcrops, deep river valleys and gorges, suitable mainly for grazing.
Senqu River Valley	**2,753 (9%)**	1,388-2,000	Mainly poor soils with low agricultural potential
Lesotho	**30,588 (100%)**	1,388-3,482	Small country with very vulnerable topography.

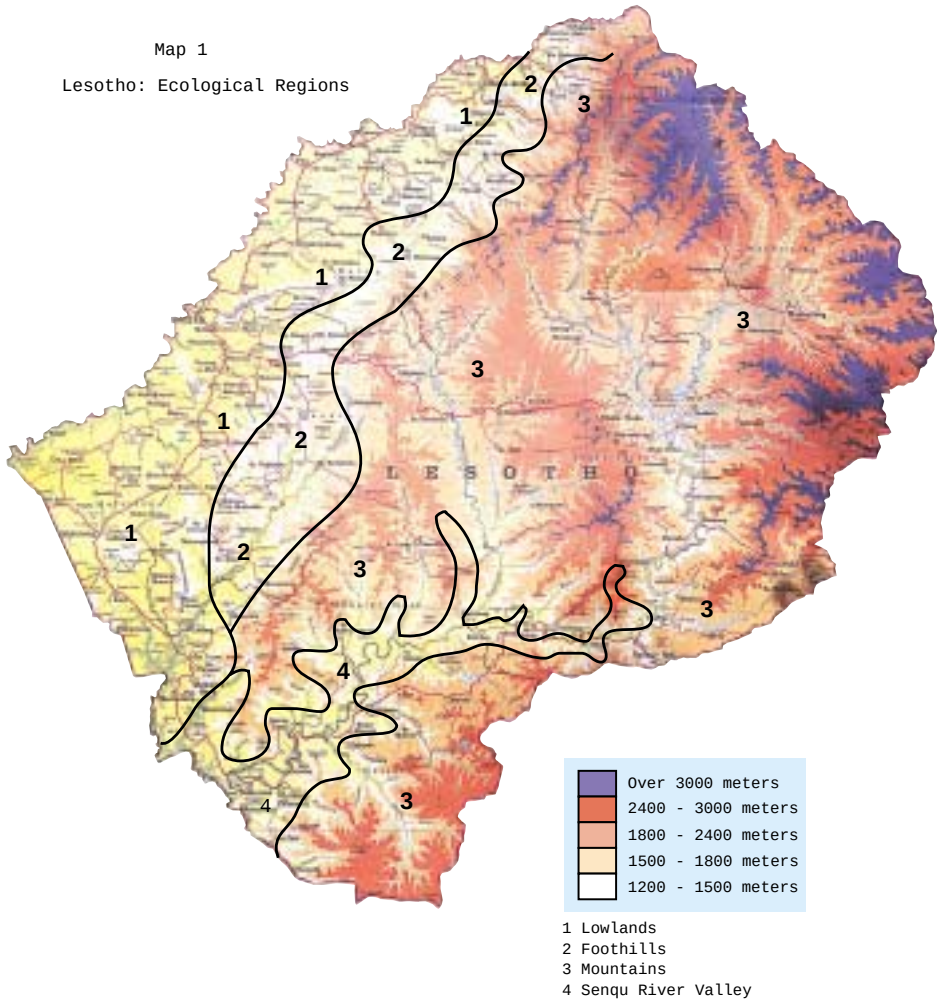
Source: Bureau of Statistics

12. Lesotho is the only country in the world with all its land surface situated more than 1,000m above sea level. The lowest point in the country, where the Senqu River flows across the border, is 1,388m above sea level, while the highest part, Thabana Ntlenyana, is 3, 482m above sea level. The country is divided into four topographic land categories as shown on table 1. The lowlands region covers an area of 5,200 km^2 or 17% of the total surface area. It consists of a narrow belt of land that lies 1,800 metres above sea level along the western border, with a width that ranges between 10 and 65 kms. The foothills comprise 4, 588 km^2 of a strip of land that lies between 1,800 and 2,000 metres above sea level (between the lowlands and the western watershed of the Drakensberg Mountains), and forms 15% of the total land area.

13. The largest ecological region, the mountains, covers an area of 18,047 km^2 of the Drakensberg ranges, with a lot of high altitude plateaux, bare rock outcrops, and deep river valleys and wetlands. It is the source of many rivers which drain towards both the Indian and Atlantic Oceans. The fourth region, the Senqu River valley, forms a narrow strip of land that flanks the banks of the Senqu River and penetrates deep into the Drakensberg ranges, reaching lower parts of the main tributaries of this river. This region covers 9% of Lesotho's total surface area.

14. The northern and central lowlands are characterized by large deposits of rich volcanic soils, while the southern or "border" lowlands are characterized by poor soils and low rainfall. The foothills, on the other hand, consist of very fertile land that is associated with high agricultural productivity. The drainage pattern of the mountain region has produced deep river valleys, gorges, and gullies that, in general, make human life difficult and environmental degradation rife. The mountain region forms the main livestock grazing area in Lesotho. The soils of the Senqu River valley vary from rich to very poor, making this the most unproductive region in the country.

MAP: Ecological Regions



Natural Resources

15. Except for its abundant water resources, Lesotho is known to be a resource-poor country in which (a) minerals exist in non-economic deposits; (b) arable land not only constitutes a mere 9% of total land area, but is gradually shrinking due to severe soil erosion and land degradation; (c) there is a growing food deficit as both agricultural production and productivity are undermined by growing animal and human pressure, poor land management practices, and adverse weather conditions; and (d) there is very little vegetation cover due to environmental degradation. Because of steep slopes, severe soil erosion and degradation, as well as low and variable rainfall, crop cultivation is limited to a narrow belt in the western lowlands and foothills. The high altitude plateaux and mountains are only suitable for grazing.

Climate

16. Lesotho has a continental temperate climate that is marked by four clearly identifiable seasons, and normally receives 85% of its average annual rainfall of 700mm in the seven months from October to April, with higher averages of 1200mm recorded in the mountain region, and low averages of 500mm recorded in the Senqu River Valley which forms a rain shadow area.

17. Precipitation has become increasingly erratic, resulting in periodic droughts and hazardous farming conditions. The last twenty years have seen the highest occurrence of droughts than any period of similar time span in the last 200 years. Rainfall is often marked by heavy torrents which are associated with severe soil erosion. Snowfall is a common occurrence in the mountains, the coldest region of the country. The lowest temperature of -21°C has been recorded and on the other hand, the highest temperature recorded in the country is 38.5°C.

The Energy Sector

18. The available statistical data indicate that households exhibit strong rural characteristics in their energy consumption, with paraffin and candle contributing substantially towards lighting, and paraffin and various forms of biomass towards heating and cooking. There is, however, evidence of a limited energy switch as households substitute more convenient sources for the relatively scarce and smoky biomass sources. The residential sector claims 88% of the total energy consumption in the country, a strong indicator for the low economic activity. On the other hand, biomass sources of energy, particularly wood and shrubs, remain the main sources of energy for rural households.

19. With a poor energy resource base and severe deforestation, the country has, until recently been totally dependent on imports for her commercial energy requirements. Imports of petroleum fuels, including LPG, have been growing rapidly over the years, from 35,000m^3 in 1975 to 200,000m^3 by 1996, while those of electricity rose from 88Kwh million in 1979/80 to 330Kwh million in 1995/96. However, the country is already saving substantial import bills with the commissioning in September 1998 of the 'Muela' hydropower station which will provide almost all of the future domestic electricity requirements. The potential hydro-power energy supply is estimated at more than 1200 Gwh per year. Unfortunately, the rate of electrification remains one of the lowest in the sub-region, due primarily to the poor state of the economy.

Population

20. The 1996 population census estimate the population of Lesotho at 1.96 million people, suggesting that the intercensal annual growth rate had gone down from 2.8% in the 1976-86 period to 2.0% in the 1986-96 intercensal period. Although the growth rate might be decreasing, this exaggerated drop is attributable to possibilities of over-enumeration during the 1986 population census, and under-enumeration during the

1996 population census[4]. Table 2 shows that most of the population is concentrated in the lowlands region which claims 59% of the total. This is due to the high endowment of this region with arable land and socio-economic activities. Both the lowlands and mountains seem to have increased their relative shares of the total population since 1986, a change in the population distribution which is largely influenced by the concentration of socio-economic facilities in lowland towns, and by activities of the LHWP in the mountain region.

Table 2 Distribution of the Population by Ecological Zone, 1976, 1986, and 1996

Ecological Zone	1976	1986	1996
Lowlands	46.0	49.0	58.6
Foothills	22.5	22.7	12.4
Mountains	20.7	16.8	22.8
Senqu River Valley	10.6	11.5	6.2
All Zones	**100.0**	**100.0**	**100.0**

Source: African Development Bank, *African Development Report 1997*, Oxford University Press, 1997

21. High population growth rates generally lead to high population-land ratios except in cases where permanent emigration provides safety valves. In Lesotho, total population density increased from 53 people per km^2 in 1986, to 61 people per km^2 in 1996, while density on arable land increased from 569 people per km^2 in 1986 to 588 people per km^2 in 1996. Those who have no access to arable land are compelled to swell the ranks of the urban population. Urbanization increased rapidly from 11.2% in 1986 to 16.8% in 1996, leading to a mushrooming of informal settlements, and to a lot of stress in the provision of social services in the country's 11 currently gazetted urban settlements.

The Economy

22. When compared with other sub-Saharan countries (table 3), Lesotho has made considerable progress in its economic performance in the past few years as a result of the implementation of the IMF/World Bank supported structural adjustment programmes, the implementation of construction activities of the LHWP, and the rapid expansion of the manufacturing sector. During the decade 1986-96, the country registered high growth rates and substantial balance of payments improvements. Real GDP grew at an average 7.8%, real GNP at 4.1%, and inflation dropped from 17.9% to 9.1%[5]. On a year-to-year basis, however, the growth rates exhibited volatility that characterised periodic droughts, progress in the implementation of the LHWP, and the retrenchment of *Basotho* migrant workers from the RSA mines.

23. Remittances from migrant workers from the RSA are the largest single source of livelihood in Lesotho today, this being the main source of income for about one third of the country's households. In 1996, net factor incomes from abroad, 91% of which are made up of migrant labour remittances, accounted for 33% of the GNP of M5,485 million, and 29% of the national disposable income (NDI) of M6,219 million. Together with the country's heavy reliance on regional customs union earnings and foreign aid inflows, this external dependence makes Lesotho critically vulnerable to international and, in particular, regional changes.

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[4]Source: Bureau of Statistics, *1986 Population Census Analytical Report, Volume IIIA: Population Dynamics*, November, 1998, p.4.

[5]Central Bank of Lesotho, 1997.

Table 3 Sub-Saharan Africa: Selected Basic Indicators

Country	Area ('000 km²)	Population ('000)	GNP per capita (US$)	Real GDP (1995)	Average annual Growth (%)		
					80-85	86-90	91-95
Angola	1,247	11,072	1,690	62,396	5.4	1.1	0.5
Botswana	600	1,487	2,800	2,273	11.1	10.1	4.4
Lesotho	**30**	**2,030**	**700**	**466**	**1.0**	**7.6**	**5.6**
Malawi	119	11,129	140	1,370	2.0	3.0	1.4
Madagascar	587	14,763	230	3,222	-0.9	2.7	-0.3
Mozambique	802	16,004	80	4,505	-8.0	5.6	6.4
Namibia	823	1,540	2,030	1,865	-1.2	3.2	4.6
South Africa	1,220	41,465	3,010	62,283	2.3	1.6	0.8
Swaziland	17	855	1,160	657	3.9	9.9	2.6
Tanzania	945	29,685	–	9,529	1.3	4.9	3.2
Uganda	236	21,297	200	4,746	1.4	5.7	7.6
Zaire	2,345	43,901	–	4,632	1.5	-0.0	-8.2
Zambia	753	9,456	350	2,357	1.0	1.6	-0.6
Zimbabwe	391	11,261	490	5,306	5.3	3.9	-0.4

Source: African Development Bank, *African Development Report 1997*, Oxford University Press, 1997

24. In terms of the sectoral distribution of the real GDP (figure 1), the tertiary and manufacturing sectors claim the biggest shares, respectively 44,1% and 43.2% of the real GDP in 1997[6]. The tertiary sector is dominated by public administration, health and education, while the secondary sector mainly constitutes manufacturing and construction. The primary sector, responsible for a mere 12.7% of the real GDP in 1997, mainly comprises agriculture, an activity which has generally not performed well in recent years due to recurrent droughts.

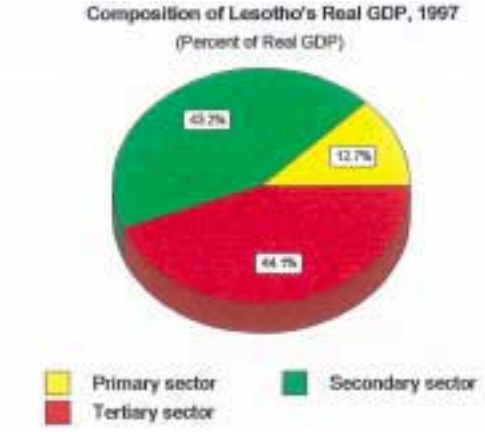

Figure 1

Social Conditions

25. Despite significant progress in economic and financial performance over the past few years, Lesotho still faces an uphill battle against poverty. The economic growth of the past few years has not led to significant increases in the demand for labour in the domestic economy. In fact there has been an increase in the poverty ratio since the mid-1980s[7]. Unemployment is officially estimated at 30-35%[8], and 50% of the country's households, mainly in rural areas, are classified as poor[9].

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[6]Central Bank of Lesotho projected figure.

[7]UNDP/ILO, *Demand for Labour and the Potential for Increased Labour Absorption in the Formal and Informal Sectors*, 1998 pp 3-6 (Draft).

[8]This estimate includes the underemployed. The 1996 Population Census found the unemployment to be 23% of the labour force.

[9]World Bank, *Lesotho: Poverty Assessment*, August 1995, p.15

26. Close to 85% of the population live in rural areas where agriculture and migrant remittances are the main means of livelihood. There is a gradual decline in migrant remittances as the number of those employed in the RSA mines continues to decrease. On the other hand, population and livestock pressure, the increased cultivation of marginal lands, over-exploitation of rangelands and fuel wood, soil erosion and the rugged terrain, recurrent drought conditions, and uncontrolled land use practices have inflicted heavy penalties on the fragile ecosystems, resulting in low agricultural productivity and increased social stress for those who depend on the agricultural sector for livelihood.

27. Lesotho devotes more public resources to the delivery of social services than most of countries in sub-Saharan Africa. Real per capita public spending on health and education has increased steadily over the years despite inflation and high population growth rates, and the accelerated relative share of the water and construction sectors. Although the mountain region remains under-served according to many health and education indicators, notable improvements have been made since the early 1980s. A primary health care system with supporting referral infrastructure is in place, while a lot of donor assistance has been utilised to upgrade both health and educational infrastructure in rural areas. However, these commendable efforts are likely to be undermined because of the HIV/AIDS pandemic.

Government and Administration

28. Lesotho is a multi-party democracy whose head of state is a constitutional monarch. The head of government is the Prime Minister who is elected by parliament. General elections are held every five years. The country gained its independence from the British colonial administration in 1966. The pre-independence elections held in April 1965 were won by the Basotho National Party (BNP), which ruled through independence up to January 1970 when the first post-independence were held. These were however cancelled when the BNP "annulled the elections it had lost" (UNDP, Human Development Report 1998, page 13). In 1974 some members of opposition went into exile, and later, between 1978 and 1986, conducted a low level insurgency against government. The BNP was ultimately removed from power by a military coup in 1986. The military ruled the country until a new constitution was drawn up, leading to the second post-independence general election of 1993 in which the Basotholand Congress Party (BCP) won all the seats in a 65-member parliament. During the 1993-98 term the ruling BCP suffered a serious split in Parliament, with a big majority of MPs following the charismatic old leader, Dr. Ntsu Mokhehle in forming a new party, the Lesotho Congress for Democracy, LCD. The third post-independence elections were held as scheduled in May 1998 and the newly formed Lesotho Congress for Democracy won all but one of the 80 parliamentary seats.

29. Lesotho's democracy has been fragile and unstable mainly because of the rejection of the election results by opposition parties. This demonstrated a lack of a democratic culture and political tolerance, in particular, among the previously priviledged groups. Furthermore institutions which could support a fledgling democracy through some effective conflict resolution mechanisms had not always existed. As a result, following their second poor performance at the polls in the 1998 elections some militant opposition parties attempted a coup d'etat with the support of elements within the army, which had been recruited from BNP sources during that party's rule. Hundreds of millions of Dollars worth of damage of property was wreaked by opposition youths in the commercial centres of Maseru, Mafeteng and Mohales' Hoek. The elected government was only rescued by an intervention of the Southern African Development Community (SADC) forces in September 1998. After the SADC intervention the Interim Political Authority (IPA), with representation from all political parties that contested the 1998 elections, was established. Its mission was to assist the Independent Electoral Commission to hold a fresh election, to which the Government had agreed. It was also intended to formulate a new, more inclusive, electoral system for the country.

30. Although the country has experimented with various forms of local government, none of these experiments have resulted in a meaningful devolution of authority to local communities. With a political settlement in sight, the government has prepared a new legislation that will hopefully speed up the process of decentralisation with a view to accelerating service delivery at the local levels.

Development Policies

31. Despite resource constraints and a very vulnerable environmental and socio-economic landscape, Lesotho's development policies strongly focus on the attainment of sustainable human development, a goal which broadly encompasses poverty reduction, employment creation, and provision of social services[10].

In pursuing this goal, the government has adopted the following key strategies:

- Sound macro-economic management involving the establishment of a stable and predictable macro-economic environment;
- Commercialisation and privatisation of economic activities, and private development;
- Regional economic integration with other Southern African states;
- Improvement of the effectiveness of the public sector;
- Employment creation through the development of the semi-formal and informal sectors;
- Employment creation through the promotion of labour-intensive development projects;
- Implementation of measures to contain and reduce environmental degradation, and
- Implementation of measures to commercialise agriculture.

[10]Ministry of Economic Planning, *Sixth National Development Plan*, March, 1997 p.57.

3 INVENTORY OF GREENHOUSE GAS EMISSIONS

Introduction

32. Signatories to the UNFCCC have made commitments, according to paragraph 1 of Article 4, to develop, periodically update, and "make available to the Conference of Parties (COP)" national inventories of anthropogenic emissions by source, and removals by sinks, of all greenhouse gases not controlled by the Montreal Protocol, to the extent of their capabilities, using comparable methodologies to be promoted and agreed upon by the COP[11]. In an effort to meet its obligations under this article, the Lesotho Government set up a National Climate Change Study Team (NCCST) to prepare a report on GHG emissions with technical support from UNEP and financial assistance from the Global Environmental Facility (GEF). This chapter is based on the findings of the NCCST which conducted inventory studies using comparative 1996 standard methodologies developed by IPCC/OECD. The study used 1994 as the base year for evaluating greenhouse gas emissions (GHGs) in Lesotho, using methodologies provided in the 1996 revised IPCC/OECD guidelines.

33. The study considered four of the six categories of inventories which were recommended in the IPCC methodologies: energy, agriculture, land use change and forestry, and waste management. Since there is very little industrial activity in the country, the only industrial pollutant which was considered was waste water. On the other hand, since there is no methodology for the calculation of GHGs from solvents and other product uses, these were also not considered. The GHGs which were considered in the study included carbon dioxide (CO_2), carbon monoxide (CO), methane (CH_4), nitrous oxide (N_2O), nitrogen oxide (NO_x) and non-methane volatile organic compounds (NMVOC). Total net GHG emissions from Lesotho for the year 1994 were computed as follows:

$$\mathbf{TnetE_{94}} = \sum_{i=1}^{4}\{(\mathbf{CO_2e - CO_2s}) + \mathbf{CH_4} + \mathbf{N_2O} + \mathbf{CO} + \mathbf{NO_x} + \mathbf{NMVOC}$$

Where:

$\mathbf{TnetE_{94}}$	=	**Total net GHG emissions from Lesotho in year 1994**
$\mathbf{CO_2e}$	=	**Carbon dioxide emissions**
$\mathbf{CO_2s}$	=	**Carbon dioxide sinks**
$\mathbf{CH_4}$	=	**Methane**
$\mathbf{N_2O}$	=	**Nitrous Oxide**
CO	=	**Carbon Monoxide**
$\mathbf{No_x}$	=	**Nitrogen oxide**
NMVOC	=	**Non-methane volatile organic compounds**
i	=	**Sector of emissions**

34. Lesotho inventory studies were carried out under very limiting conditions. The country, like most of the developing countries, suffers a weak data base. In addition to the poor state of the natural resources data base is the problem posed by the unsystematic and unstandardised presentation of data, lack of update

[11]UNFCCC, p.7.

and series data in many sectors, the low national data collection capabilities, and the general unreliability of methodologies used, particularly for estimations in the rural sector. For the inventory studies, some of these problematic issues were relaxed through on-the-job training, seminars and workshops, twinning arrangements with some institutions, and through the use of technical assistance.

35. Difficulties were also encountered in the application of IPCC/OECD guidelines to Lesotho conditions. For example, these guidelines were silent on issues which could greatly affect GHG emissions in Lesotho. These are the rampant overgrazing, the expansion of croplands into marginal grasslands, and the encroachment of settlements onto croplands and rangelands. Similarly, the methodologies did not fully capture emissions caused by sanitation from the rural and peri-urban areas. As was reiterated in the introductory chapter, close to 85% of Lesotho's population live in concentrated rural settlements where excreta and grey water management is still posing serious problems and could be major sources of GHG emissions. The same could be said of the fast growth peri-urban areas.

Emissions from the Energy Sector

36. GHG emissions from the energy sector were primarily estimated from the 1994 actual combustion of fossil fuels, and that year's projected consumption of biofuels. The main sources of data were Department of Energy actual consumption records in the case of fossil fuels, and in the absence of update data, 1994 projections of biofuel consumption from energy consumption surveys that were carried out for the Lesotho Energy Master Plan (LEMP) in 1984. The sectoral distribution of energy consumption was also sourced from LEMP projections which maintained the proportions that were observed for the years 1984-1986. The 1994 consumption of biofuels was estimated at 1, 478.14 kilotonnes which were made up of 479.5 kilotonnes of fuelwood, 481.08 kilotonnes of shrubs, 92.22 kilotonnes of crop residues, and 425.33 kilotonnes of cow dung. These had an average moisture content of 12.3%, 10.5%, 8.7%, and 9.4% respectively. The 1994 consumption of coal was estimated at 87,943 tonnes, while that of petroleum fuels stood at 162,295m^3. On the whole, the country consumed an estimated 31,128.2 TJ in this year.

37. For the purposes of modelling by the NCCST, calorific values were sourced from the 1991 Southern African Development Community (SADC) statistics, while the motor vehicle population figures were obtained from the 1994 national transport study that was conducted for the Department of Transport. A number of other fuel properties such as emission factors, carbon content, fractions of oxidised carbon were drawn from the IPCC/OECD guidelines.

38. After applying sectoral emission factors, an analysis of model results on table 4 shows that in 1994, the energy sector emitted a total 803.29Gg of GHGs, all from fuel combustion activities. Of this, 79% or 635.99Gg was made up of carbon dioxide, mainly emitted from the residential and transport sectors (see table 4). In the residential sector, CO_2 was mainly emitted from the consumption of coal, kerosene and LPG, while in the transport sector it was mainly emitted from the consumption of fossil fuels, mainly gasoline, diesel, and jet fuel. The residential sector was also found to emit significant quantities of CH_4 and CO from the combustion of coal, and non-methane volatile organic compounds from the consumption of fossil fuels, mainly coal and liquid petroleum gas (LPG). The carbon dioxide equivalent shows the total emissions as 854.99Gg (see Appendix 5a).

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[12]These are mainly based on Lesotho bulk imports. They exclude net fuel tank imports of fossil fuels through vehicular traffic across borders. With price differentials that exist between Lesotho and the RSA, and the location of a number of RSA towns around Lesotho, net vehicular tank fuel imports could make significant differences to local consumption levels.

Table 4 The Energy Sector: Summary of Greenhouse Gas Inventories (Gg)

Greenhouse Gas Source	CO_2e	CH_4	N_2O	NO_x	CO	NMVOC
Total Energy	**635.99**	**7.63**	**0.10**	**4.92**	**137.08**	**17.57**
A. Fuel Consumption Activities (Sectoral Approach)	**635.99**	**7.63**	**0.10**	**4.92**	**137.08**	**17.57**
2. Manufacturing Industries and Construction	**27.87**	**0.00**	**0.00**	**0.09**	**0.03**	**0.00**
3. Transport	**220.69**	**0.05**	**0.00**	**2.10**	**17.70**	**3.33**
a. Civil Aviation	0.25	0.00	0.00	0.00	0.00	0.00
b. Road Transportation	220.44	0.05	0.00	2.10	17.70	3.33
4. Other Sectors	**382.55**	**7.58**	**0.10**	**2.73**	**119.25**	**14.22**
a. Commercial/institutional	2.15	0.00	0.00	0.00	0.05	0.00
b. Residential	357.42	7.58	0.10	2.72	119.20	14.22
c. Agriculture/Forestry/Fishing	22.99	0.00	0.00	0.01	0.00	0.00
5. Other Sources	**4.87**	**0.00**	**0.00**	**0.00**	**0.10**	**0.01**

Source: NCCST, *Climate Change Study in Lesotho: GHG Emissions Inventory Report for the Year 1994*, 1998

Emissions from the Agricultural Sector

39. A number of agricultural activities contribute directly to the emission of GHGs through various processes. For example there is methane emission from enteric fermentation in domestic animal products and animal wastes, and carbon dioxide emissions from the indiscriminate burning of rangelands and, sometimes, agricultural residues. Methane is emitted from herbivores as a by-product of enteric fermentation, a digestive process whereby carbohydrates are broken down into simpler molecules by micro-organisms for absorption into the animal's bloodstream. The amount of methane that is released depends on the animal category[13], age, weight; quality and quantity of feed; and the energy expenditure of the animal.

40. The emission of methane from animal manure occurs as a result of its decomposition under anaerobic conditions, particularly where animals are managed in confined areas such as dairy farms, feedlots, and pig and poultry farms. Lesotho is an extensive grazing country where animals are generally confined in kraals only overnight. On the other hand, intensive management of poultry, dairy cattle, and pigs is dominated by small farmers with holdings of no more than 300 for poultry, and no more than 5 for both dairy cows and pigs. This seems to suggest that the domestic livestock management system does not lead to high emissions of GHGs.

41. The Lesotho grasslands are somewhat different from typical savanna ecosystems in that small semi-woody shrubs have spread very widely during the 20th century in the grasslands at medium and higher altitudes. The most dominant species are *chrysocoma tenuifolia* and *aster filifolius*, both of which have adversely affected grazing potential. The growth cycle of the grasslands mainly depends on seasonal variations in temperature and moisture. However, most of the grasses become dormant during the cold and

[13]For example, ruminants (cattle, sheep, and goats) emit more methane than non-ruminants (pigs/swines, horses, donkeys) since they are able to digest cellulose because of the presence of special micro-organisms in their digestive tracts.

dry winter season, making the grasslands susceptible to burning. Since prescribed burning is rare in Lesotho, most of the incidences are indiscriminate and rare. It is estimated that a total 37,000 hectares are burnt annually.

42. The burning of agricultural wastes to clear the fields for the next cropping cycle has a potential to produce large quantities of carbon. However, it is not a net source of CO_2 since the carbon that is released to the atmosphere is re-absorbed during the next growing season. Crop residue burning also makes a significant contribution to the pool of other trace gases. However, in Lesotho, there is a very insignificant level of crop residue burning since they are also grazed by animals if not collected for household fuel needs. Agricultural soils also contribute to GHG emissions through synthetic fertilizer use, nitrogen from animal wastes, biological fixation, and mineralization of organic matter. However, this contribution is quite minimal in Lesotho since there is very little use of organic fertilizers.

43. The data used to estimate emissions from animals and animal manure came from annual surveys of the Bureau of Statistics (BOS) as well as from data compiled by the Livestock Division of the Ministry of Agriculture. The best estimate of rangeland burning was sourced from annual reports of the Department of Range and Livestock Services and from Forestry Annual Reports. Data for synthetic fertilizers with nitrogen compounds were extracted from records of annual fertilizer imports, while estimates of crop residues and of biological fixation by legumes was made from annual crop production figures. Results of 1987 LEMP energy surveys were also used in the estimation of areas of crop residues that are usually burnt for the preparation of fields for the next cropping cycle. A number of default values in the IPCC/OECD guidelines were used in cases where there were no documented specific values.

Table 5 The Agriculture Sector: Summary of Greenhouse Gas Inventories (Gg)

Greenhouse Gas Source	CO_2e	CH_4	N_2O	NO_x	CO	NMVOC
Total Agriculture	**0.0**	**37.31**	**0.50**	**0.13**	**6.73**	**0.0**
A. Enteric Fermentation	**0.00**	**31.91**	**0.00**	**0.00**	**0.00**	**0.00**
1. Cattle	0.00	18.58	0.00	0.00	0.00	0.00
3. Sheep	0.00	5.65	0.00	0.00	0.00	0.00
4. Goats	0.00	3.75	0.00	0.00	0.00	0.00
6. Horses	0.00	1.80	0.00	0.00	0.00	0.00
7. Mules/Asses	0.00	1.46	0.00	0.00	0.00	0.00
8. Pigs/Swines	0.00	0.67	0.00	0.00	0.00	0.00
B. Manure Management	**0.00**	**5.21**	**0.01**	**0.00**	**0.00**	**0.00**
1. Cattle	0.00	0.58	0.00	0.00	0.00	0.00
3. Sheep	0.00	0.18	0.00	0.00	0.00	0.00
4. Goats	0.00	0.13	0.00	0.00	0.00	0.00
6. Horses	0.00	0.16	0.00	0.00	0.00	0.00
7. Mules/Asses	0.00	0.13	0.00	0.00	0.00	0.00
8. Pigs/Swines	0.00	4.00	0.00	0.00	0.00	0.00
9. Poultry	0.00	0.03	0.00	0.00	0.00	0.00
12. Solid storage and dry lot	0.00	0.00	0.01	0.00	0.00	0.00
D. Agricultural soils	**0.00**	**0.00**	**0.49**	**0.00**	**0.00**	**0.00**
E. Prescribed burning of savannas	**0.00**	**0.19**	**0.00**	**0.13**	**6.73**	**0.00**

Source: NCCST, *Climate Change Study in Lesotho: GHG Emissions Inventory Report for the Year 1994*, 1998

44. According to table 5 which shows an analysis of model results, the agriculture sector in Lesotho was found to have emitted an estimated 44.67Gg of GHGs in 1994. Methane was found to be the main GHG emitted in this sector, accounting for 84% of the total emissions from the sector, and almost 100% was released from enteric fermentation and manure. Carbon monoxide emissions from the agricultural sector,

mainly from burning of savanna, constituted 15.1% of the total emissions from the sector, while nitrous oxide that was released from savanna burning made up a mere 1.1%. The carbon dioxide equivalent shows the total emissions as 1,074.85Gg (see Appendix 5a).

Emissions from Land Use Change and Forestry

45. It is widely believed that the widespread clearance of vegetation cover to accommodate human activities such as fuelwood harvests, settlements, cropping on marginal lands, and overgrazing is threatening Lesotho's bio-diversity and has the potential to escalate the emission of GHGs. From a number of sources, it appears that the current rate of consumption of vegetation cover exceeds the rate of regeneration, with the result that the net loss contributes to CO_2 emissions.

46. The past few decades have seen an accelerated conversion of lowland grasslands and croplands into villages as population growth, urbanisation, and the concentration of development infrastructure in this ecological region force people to settle in those areas that are in the immediate vicinities of urban areas and major transport routes. Although there has been no quantitative assessment of the scale of this problem, there is no doubt that it has a significant effect on the stock of the national greenhouse gas emissions. As the progressive encroachment of settlements onto grazing lands and croplands, and that of croplands onto grazing lands, continue with population growth, the chances of biomass regrowth are becoming increasingly minimal. It is estimated that 14% of the total surface area of Lesotho had been converted from rangeland to cropland in the 12 years ending 1993[14].

47. According to Lesotho's 1993 environmental synopsis, about 5% of the land that was originally grasslands and/or croplands has been rendered unusable due to gully formation, most of which occurred since the drought of the 1930s[15]. Although figures differ considerably according to source, estimates of the annual soil loss range from one million tonnes through gully erosion, to 38 tonnes through sheet erosion (15 tonnes from croplands and 23 tonnes from rangelands). The soil carbon uptake of lands that have been abandoned for regeneration, estimated to be 25% in 1994, should once again improve. However, most of the soils in Lesotho are characterised by light texture, shallowness, and low organic content, characteristics which reduce the carbon holding capacity.

48. Data and assumptions that were used to run models for assessing GHG emissions from land use and forestry was obtained from a variety of sources: the *National Range Inventory*, 1988, the *Forest Inventory*, 1995/96, the *National Conservation Plan for Lesotho*, 1988, the *Environmental Synopsis of Lesotho*, 1993, the *Lesotho Energy Master Plan*, 1987, the *National Forestry Action Plan*, 1996, and Bureau of Statistics publications.

49. Model results of GHG emissions from land use change and forestry are shown on Table 6. It can be seen that in 1994, this sector emitted 4,299.77Gg of CO_2, 62% of which came from agriculturally impacted soils, and 38% from grasslands conversion. It was also the only sector which registered sinks, amounting to 3,039.20Gg of CO_2, mainly originating from the abandonment of managed lands. This gave the sector a 1994 net GHG emission of 1,260.57Gg of CO_2, the only GHG that is emitted from the sector.

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[14]National Environmental Secretariat, *Environmental Synopsis*, 1993.

[15]Op cit, 1993.

Table 6 Land use Change and Forestry: Summary of Greenhouse Gas Inventories (Gg)

Greenhouse Gas Source & Sink Category	CO_2e	CO_2s	CH_4	N_2O	NO_x	CO	NMVOC
Total Land use Change and Forestry (Net)	**4,299.77**	**-3039.20**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
A. Changes in Forest and Other Biomass Woody Stocks	**0.00**	**-289.20**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
B. Forest and Grassland Conversion	**1,630.20**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
4. Grasslands	1,630.20	0.00	0.00	0.00	0.00	0.00	0.00
C. Abandonment of Managed Lands	**0.00**	**-2,750.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
2. Temperate Forests	0.00	-896.50	0.00	0.00	0.00	0.00	0.00
4. Grasslands	0.00	-1,853.50	0.00	0.00	0.00	0.00	0.00
D. CO_2e and CO_2s from soils	**2,669.57**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Source: NCCST, *Climate Change Study in Lesotho: GHG Emissions Inventory Report for the Year 1994*, 1998.

Emissions from Waste

50. The estimation of GHG emissions from this sector faced formidable data problems since waste management has not received adequate attention in Lesotho. At the present moment formal operations are only limited to urban areas, leaving out rural areas and vast communities in per-urban informal settlements. Data on waste water came from Water and Sewerage Authority (WASA) reports which limited themselves to sewerage treatment plants in Maseru and other urban areas, leaving out substantial quantities of commercial and domestic waste water and other forms of waste that accrue in per-urban and rural areas. Most of the households in these areas are served by dry systems and ordinary pit latrines, or, in the case of some households in peri-urban areas, by wet systems that connected to soakaways and conservancy tanks.

51. WASA operates two large sewerage treatment plants in Maseru, the capital town: a biofilter treatment plant which handles 40% of the sewerage, and an oxidation lagoon sewerage treatment plant which handles the remaining 60%. These plants, with a total catchment area of 20km^2 sewerage which comes from domestic, commercial, and industrial sources, have a combined treatment capacity of 10,000m^3 of flow per day. The lagoon system is mainly used as a pretreatment system for industrial effluents. In addition to the two main treatment works, there are other smaller facilities that serve special areas such as the airport, agricultural projects, hospitals, etc. In all these operations, methane is released through aerobic activities and the decomposition of organic matter during the treatment and disposal process.

52. Data on solid waste disposal was obtained from collection records of the Maseru City Council (MCC)and district town clerks. These records are generally not only inaccurate but incomplete and limited to formal parts of urban areas, leaving out rural areas and peri-urban settlements. The inadequacy of collection services has encouraged a lot of illegal dumping in various parts of urban areas. Waste that is found in these illegal dumps is quite substantial although it is not incorporated into MCC reports.

53. Results of the model that was used to assess 1994 GHG emissions from waste (table 7) show that in waste management in Lesotho, GHG emissions comprised mainly methane and nitrous oxide. The

former came from solid waste in landfills and industrial waste water, while the latter came from human sewage. As shown on table 7, the sector had a 1994 GHG emission level of 1.36Gg of which 93.4% was methane and the rest nitrous oxide. The carbon dioxide equivalent shows the total emissions as 59.85Gg (see Appendix 5a).

Table 7 Waste Management: Summary of Greenhouse Gas Inventories (Gg)

Greenhouse Gas Source	CO_2e	CH_4	N_2O	NO_x	CO	NMVOC
Total Waste	**0.00**	**1.27**	**0.09**	**0.00**	**0.00**	**0.00**
A. Solid Waste Disposal on Land	**0.00**	**1.27**	**0.00**	**0.00**	**0.00**	**0.00**
B. Waste Water Handling	**0.00**	**0.00**	**0.09**	**0.00**	**0.00**	**0.00**
2. Domestic and Commercial Waste Water	0.00	0.00	0.09	0.00	0.00	0.00

Source: NCCST, *Climate Change Study in Lesotho: GHG Emissions Inventory Report for the Year 1994*, 1998.

Total GHG Emissions

54. Results of the inventory studies show that in 1994, Lesotho's GHG gross emissions amounted to an estimated 5,149.09 Gigagrams (Gg), while sinks amounted to 3,039.20Gg. This resulted in net GHG emissions of 2,109.89Gg. As shown on table 8(a) and figure 2, the major share came from carbon dioxide which accounted for net 1896.56Gg[16] or 89.89% of the country's total GHG emissions. Carbon monoxide and methane respectively contributed 143.81Gg (6.82%) and 46.21Gg (2.19%). Other GHG emissions such as nitrous oxide, nitrogen oxide, and non-methane volatile organic compounds contributed 23.30]Gg (1.1%).

Table 8 Summary from Appendix 5a Report for GHG Emissions in Lesotho by Sector, 1994

Greenhouse Gas Source and Sink Categorgies		CO_2e	CO_2s	CH_4	N_2O	NO_x	CO	NMVOC
Total National Emissions and Removals		**4,935.76**	**-3,039.20**	**46.21**	**0.69**	**5.05**	**143.81**	**17.57**
1 Energy	**Reference Approach**	**637.01**						
	Sectoral Approach	**635.99**	**0.0**	**7.63**	**0.10**	**4.92**	**137.08**	**17.57**
4. Agriculture		**0.00**	**0.00**	**37.31**	**0.50**	**0.13**	**6.73**	**0.00**
5. Land-Use change and Forestry		**4,299.77**	**-3,039.20**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
6. Waste		**0.00**	**0.00**	**1.27**	**0.09**	**0.00**	**0.00**	**0.00**

Source: NCCST, *Climate Change Study in Lesotho: Inventory Report 1994*, 1998, Summary of tables 7A & 7B.

55. From Appendix 5a it is observed that a carbon dioxide equivalent[17] of the GHG emissions in all the four sectors that the total gross emissions in 1994 were 6,288.66 Gg. The sinks amounted to 3,039.20Gg. This led to the net emissions of 3,249.46 Gg of CO_2 equivalent. A breakdown by sector on figure 3 shows that land use change and forestry is the largest source, being responsible for net emissions in the order of 1,260.57 Gg of CO_2 equivalent or 38.80% of the country's total emissions in units of carbon dioxide equivalent. The second largest source was found to be agriculture which contributed 1,074.05Gg or 33.06%. Energy occupied third position with a contribution of 854.99Gg or 26.31%, although it was the

[16]This figure is net CO_2 emissions (4,935.76 – 3,039.20).

[17]This refers to the conversion of emission values into their global warming potential using indices 320 for nitrous oxide, 24.5 for methane and 1 for carbon dioxide.

second highest emitter of CO_2, mainly from the combustion of biomass fuels. The least contribution came from waste, a source of 59.85Gg carbon dioxide equivalent or 1.84% of the total. CO_2 in this sector is only from the use of fossil fuels since the combustion of biofuels has, by assumption from IPCC Guidelines, carbon emission factor of zero. Otherwise the total GHG emissions in this sector would increase to make this sector the second largest emitter. This would not be surprising since biomass fuel provide more than 70% of the national energy demand.

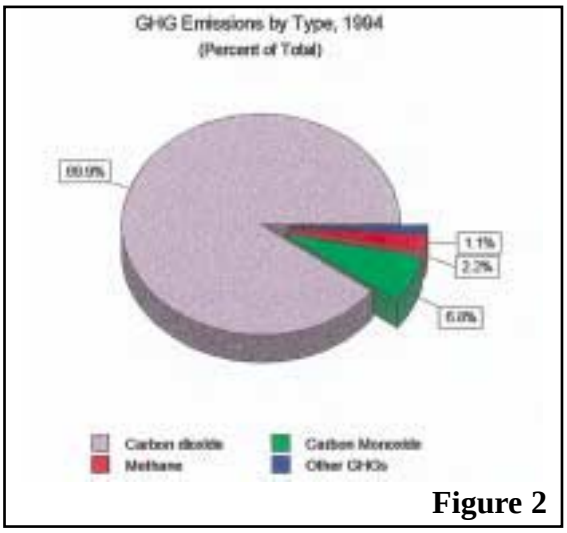


Figure 2

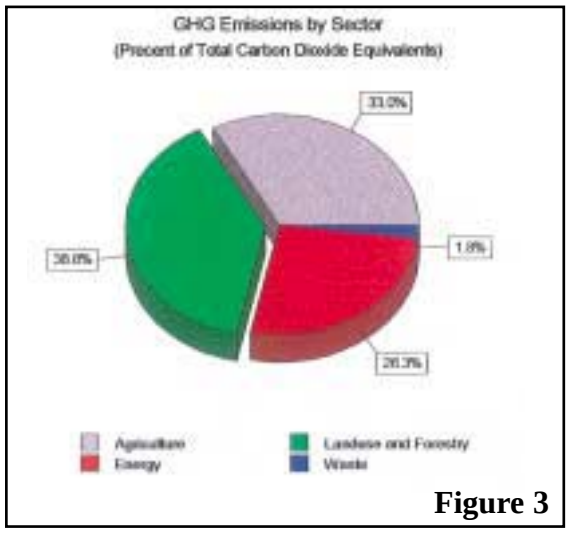


Figure 3

56. In terms of carbon dioxide equivalent, both methane and nitrous oxide showed very significantly in the country's total GHG emissions although carbon dioxide still took the lead with 58.40% share of total emissions. On the other hand, methane and nitrous oxide respectively constituted 34.86% and 6.75%.

Baseline Projections

57. The baseline data that was generated from the Inventory study was projected under various scenarios with the aim to map out the quantities of GHG emissions and sinks from various sources over a period up to year 2030. In addition to a set of assumptions for each sector, a number of major variables were used to build different scenarios for projections. These included demand figures, population growth rates, GDP growth rates, and sectoral activity coverage. These were individually projected using projection models and assumptions that are peculiar to each.

58. Data problems and poor documentation in some sectors presented the projection exercise with a lot of problems. For example, population projections were made before the publication of the 1996 population census figures, which compelled the study group to use projections that were based on the 1986 population census figures. As was reiterated in earlier chapters, the 1996 population growth rate was found to be 2%, much lower than the 2.6% that was used for 1986 projections. This discrepancy must have overestimated demand projections for many variables in a number of sectors.

59. To assess the magnitude of Lesotho's contribution to global warming if current trends continued, a baseline scenario was included in the projections exercise. This is a scenario which maps out the status of GHG emissions that can be expected in Lesotho in the future, given the currently prevailing trends and pace of development, and that nothing is done to deliberately mitigate these emissions. Projections which showed the path of these emissions after mitigation (mitigated scenarios) are considered in later chapters. These are meant to facilitate evaluations of the impacts of Lesotho's future policies and actions on GHG emissions in the country. The time span that was chosen for the baseline scenario was 36 years (1994-2030). Two points in the projection path, 2005 and 2030, were chosen to facilitate comparisons with other countries. Only those sectors which were responsible for the bulk of emissions, landuse change and forestry and energy, were considered.

Landuse Change and Forestry

60. The baseline scenario in the landuse change and forestry sector was built on the following assumptions which were based on the then currently available information:

- there is a positive correlation between grassland conversion and population size and the population growth rate;
- the annual conversion rate stands at 7%, the rate observed between 1988 and 1994;
- there is a positive correlation between the demand for forest products and the total population growth rate, the rural population growth rate, and the GDP growth rate;
- the reforestation coverage will be maintained at 8.4 hectares per year as stipulated in the national forestry action plan;
- the rate of land degradation is equal to the rate of rehabilitation of abandoned lands, and the rate of loss of land will be constant up to 2030, while the rate of rehabilitation will increase over the years up to 2030;
- the rate of urbanization will continue unchecked, resulting in further encroachments on croplands and rangelands;

61. It can be seen on figure 4 that if the current trends in GHG emissions were allowed to continue without mitigation, the amount of CO_2 emitted from landuse change and forestry in Lesotho will increase by approximately a factor of eight over the 1994 level by 2005, and by close to 1500% by 2030.

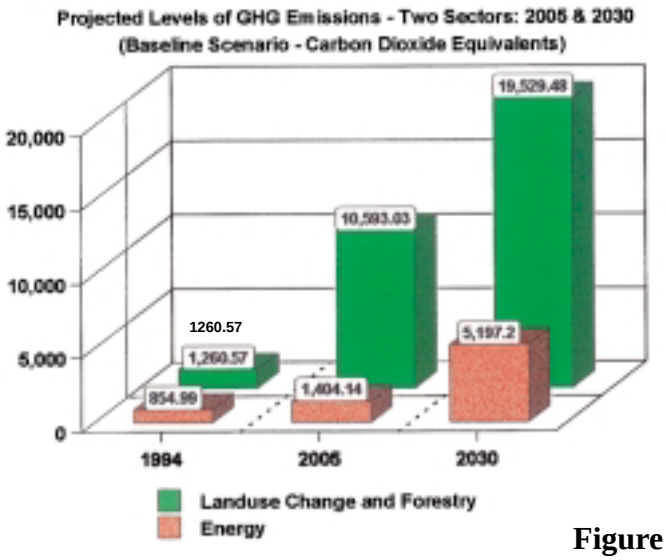


Figure 4

The Energy Sector

62. The baseline scenario for the energy sector was generated from projections of sectoral GDPs up to year 2030, and deriving future energy demand for each sector by adopting the following assumptions:

- 1994 sectoral energy intensities will remain constant over the projection period;
- the 1994 structure of energy demand in each sector will remain static over the projection period; and
- the emission factors used on the 1994 data will be applicable throughout the projection period.

63. Projections were then made for CO_2, CH_4, and N_2O emissions for the years 2005 and 2030. The final figures were then converted to CO_2 equivalents. It can be seen on Figure 4 that if the current trends in GHG emissions were allowed to continue without mitigation, the amount of CO_2 equivalent emitted from the energy sector in Lesotho will increase at an average rate of 5.4% per annum from 1994 to year 2005, and by an average rate of 10.8% per annum thereafter up to year 2030.

Implications for Future Policies

64. There is no doubt that GHG emission statistics that were computed by the inventory studies in Lesotho will need refinement over time to accommodate the country's peculiar circumstances, to incorporate more accurate and more update statistics, and to include new sets of assumptions. What has also emerged is that these studies were not an exercise in futility as they resulted in substantial national capacity building and produced results which are somewhat comparable with other small developing countries. It is hoped that resources will be secured to enable updating and further refinement, and to modify some of the methodologies to be more relevant to local conditions. A lot of technical assistance will also be required in various areas as the supply of scientific skills remains a pervasive constraint in the country.

65. Table 9 gives a comparative summary of GHG emissions from selected developing and transitional countries in their global warming potential. It can be seen that small countries with low economic activities have very minimal contribution to global warming. Indeed, while it is incumbent upon every country that is a signatory to the UNFCCC to develop and implement policies to reduce GHG emissions, small vulnerable countries such as Lesotho, with limited resources, will be forced to put priority on developing adaptive strategies against the impacts of global warming that are externally induced through anthropogenic activities of more developed countries.

Table 9 Comparative GHG Emissions (Carbon Dioxide Equivalents)

Country	Base Year	GHG Emissions in Gg (Global Warming Potential = CO_2 Equivalent)			
		CO_2	CH_4	N_2O	Total
Lesotho	1994	1,896.56	1,132.10	219.14	3,247.80
Gambia	1993	1,853.57	776.41	9.92	2,639.63
Tanzania	1990	58,954.23	37,991.60	1,143.93	98,089.76
Thailand	1990	170,098.40	70,826.60	9,990.70	250,915.70

Sources: Enviro-Management and Research Inc. *National Climate Change Action Plans: Interim Report for Developing and Transitional Countries*, US Country Studies Programme, October, 1997, and NCCST, *Climate Change Study in Lesotho: GHG Emissions Inventory Report for the Year 1994*, 1998.

66. While adaptation to the effects of global warming will deliver immediate and material benefits by contributing to sustainable human development since the country is critically vulnerable, mitigating GHG emissions will have a marginal impact because of Lesotho's minimal contribution to global warming. This seems to indicate that as far as the latter is concerned, more resources should be devoted to adaptive as opposed to mitigative interventions. However, projections of GHG emissions that were carried out using the baseline scenario serve to underline the magnitude of the global warming problem should any country or group of countries renege on their obligations under the UNFCCC. In this regard, therefore, and despite limited resources, Lesotho has started on an assessment of mitigative options in the areas of energy and landuse change and forestry, albeit in a limited extent.

4 VULNERABILITY ASSESSMENT

Introduction

67. Paragraph 2 of Article 3 of the UNFCCC specifies that in their actions to achieve the objectives of the Convention and to implement its provisions, the parties shall be guided by, among others, the specific needs and special circumstances of developing country parties, especially those that are particularly vulnerable to the adverse effects of climate change, and those that would have to bear a disproportionate or abnormal burden under the Convention. In addition, paragraph 8 of Article 4 urges parties to assess what actions are required to meet the specific needs and concerns of developing country parties arising from the adverse effects of climate change and/or the impact of the implementation of response measures. This chapter attempts to assess Lesotho's vulnerability and special needs and circumstances which will need to be attended to for this nation to find its coordinates under the Convention.

68. A number of factors characterize Lesotho's extreme vulnerability to climate change. The first set of factors relates to natural conditions: erratic rainfall, poor soils, and worsening land degradation in the face of rapid population growth and big livestock herds. The root cause of this category of factors can be traced back to the nation's loss of most of its prime agricultural land through territorial wars with Boers in the 19th century. It is generally accepted that this is one of the underlying causes of widespread poverty and deprivation in this country that is totally surrounded by relatively wealthy RSA.

69. The second set of factors is institutional. There is general agreement that the system of land tenure and customary practices continue to undermine individual incentives to maintain and improve the natural resource base, and to invest in land improvements and productivity-enhancing technologies. This problem is exacerbated by capacity constraints within the public sector to design and implement appropriate policies and programmes, and to give support to research and technological development.

70. The third set of factors relates to the "siege environment" which resulted from decades of neighbouring on a hostile and protectionist apartheid RSA, which pursued food self-sufficiency through agricultural policies which were supported by a system of monopolistic commodity control boards and heavy government subsidies. These made the penetration of its agricultural markets very difficult, and significantly reduced farmer benefits for Lesotho. As a result, considerations of national survival forced Lesotho to embark on extensive government intervention in the production, marketing, processing, and pricing of agricultural commodities. This further resulted in distorted market signals, inefficient allocation of resources, low private sector participation in agricultural investment, and severe food deficits for all the major grains.

71. The impacts of these three sets of factors have been exacerbated by the poor resource base and the confinement of a large population on a small land area, 59% of which is characterised by high altitude, bare rock outcrops and deep river valleys and gorges. Most of the population is concentrated in the lowlands since very few human activities, other than livestock grazing, are suitable in the mountain area. The country has experienced a dramatic loss of fertile soil due to its topography, concentrated rainfall, fragile soils, and human and livestock pressure, with the result that land that is classified as arable has been reduced from 13% in the 1960s to 9% in the late 1980s.

72. In attempting to assess the extent to which the country is critically vulnerable to climate change, a detailed review of the current climate is made, together with an analysis of the intricate relationship between climate on the one hand, and agro-ecological and socio-economic conditions on the other. A number of climate change scenarios were then developed to simulate, using general circulation models

(GCMs), likely changes in temperature and precipitation as a result of the doubling of CO_2. The potential impacts of these scenarios were then assessed across eight sectors that were deemed likely to be vulnerable to climate change: water, agriculture, rangelands and forestry, where models were run; and soils and desertification, health, biodiversity, and culture, where professional analyses were applied.

Climatological Conditions

73. The climate of Lesotho is primarily influenced by the country's location in the centre of a large Southern African Plateau. Since the latter is in the centre of the sub-tropical high pressure zone, the basic air circulation is anticyclonic, with a westerly air current superimposed at heights of 3,000m above sea level. In winter, southerly polar cyclones generally result in frontal type weather with low temperatures, some precipitation, and strong winds in the west and southwest, and heavy snow falls at higher altitudes in the mountains. In summer, the southward movement of the intertropical convergence zone allows an inflow of moist air of tropical origin, producing 85% of the country's total annual rainfall.

74. The average annual rainfall varies from area to area from as low as 500mm in the Senqu River Valley to as high as 1,200mm in a few localities in the northern and eastern border. Precipitation totals show considerable variation from year to year, and comparisons of annual distribution show little similarities between any two years. Most of the rainfall comes in the seven-month wet summer season from October to April. The peak rainfall period is from December to February when most of the parts of the country record over 100mm per month. The lowest rainfall occurs in June when the totals of less than 15mm are recorded at most stations. Although most of the summer rainfall is in the form of ordinary showers, severe thundershowers of short and orographic origin are common. The initial showers at the end of the dry winter period fall on very dry and loose soil, creating conditions for severe soil erosion.

75. Monthly mean totals of evaporation range from 60-70mm in the period June/July, to 175-225mm in the period December/January. The mean for the whole country ranges from 1,400mm to 1,600mm per annum although lower in the cooler mountain areas. In general, therefore, evaporation is greater than rainfall over most of the year, with the deficit at its greatest in summer.

76. Sunshine records indicate that the country receives 60-80% of the maximum possible sunshine throughout the year. The lowlands enjoy annual average sunshine hours of around 3,211. Although data on radiation are not available, figures from the neighbouring Free State Province town of Bloemfontein indicate an annual total radiation of 7,620 J/m^2. It is clear therefore that total radiation, particularly in the lowlands, is no constraint to plant growth.

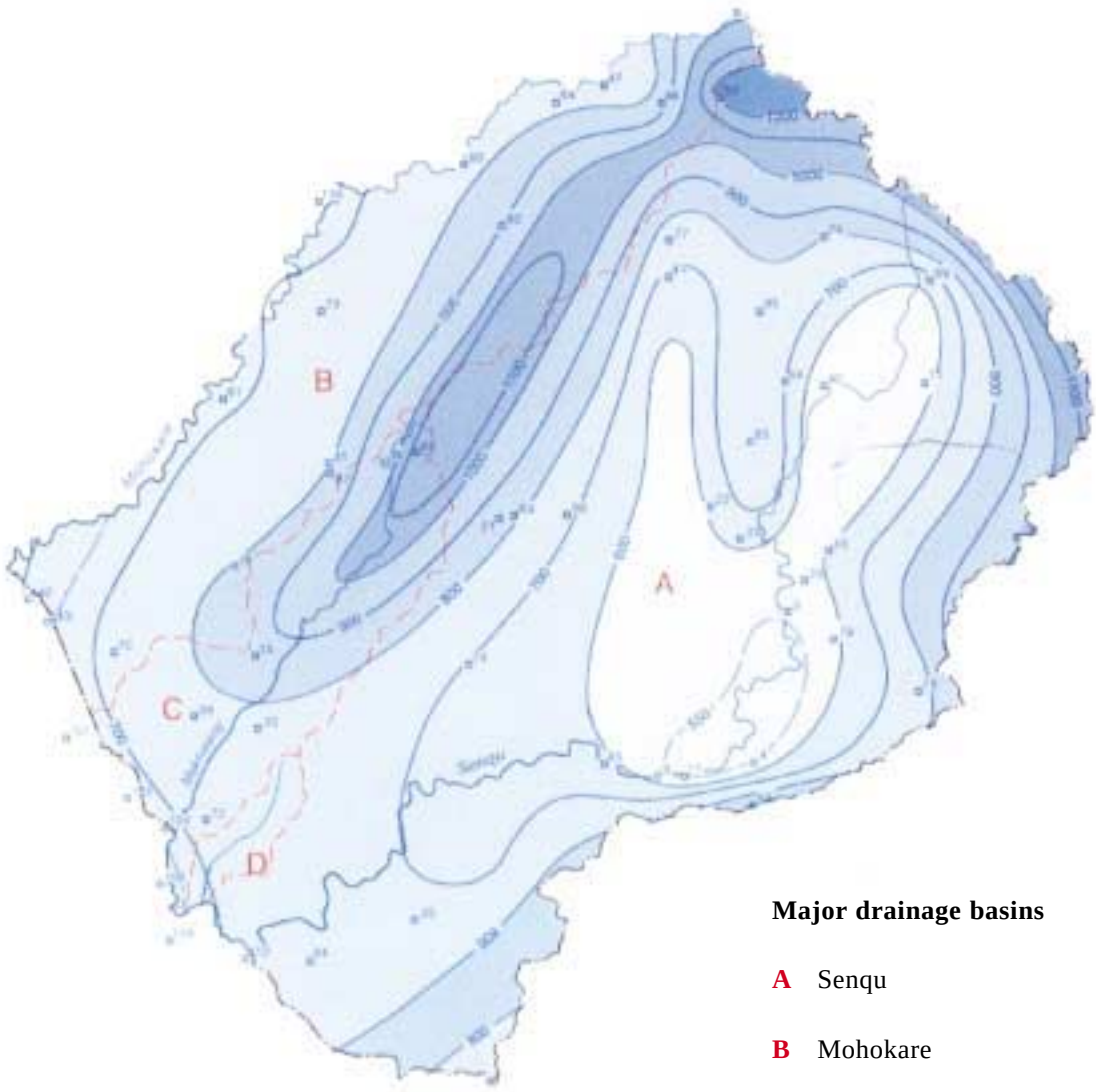
77. Temperatures in Lesotho are generally lower than those of other inland regions of similar latitude in the larger land masses of both the north and southern hemispheres. This is partially due to the tapering of the African subcontinent, and the overall altitude of the country. Records show mean annual temperatures of about 15.2°C for the lowlands and 7°C for the mountains. Maximum and minimum temperatures recorded at various locations show a wide variation. January produces the highest mean maximum temperatures throughout the country, ranging from 20°C in high altitudes to 32°C in the lowlands. On the other hand, mean minimum temperatures of around 0°C are common in June the coldest month, with the lowlands recording -1°C to -3°C and the mountains -6°C to -8.5°C.

78. On average, the first and last days of frost occurrence in the lowlands are respectively 18 May and 6 September, while those for the mountains are 16 February and 19 November. This respectively gives a

Lesotho: Mean Annual Rainfall

(Mean values in mm/year)

Scale 1:1 500 000



Major drainage basins

A Senqu

B Mohokare

C Makhaleng

D Maphutseng

frost risk of 111 days for the lowlands and 276 days for the mountains. Under extreme conditions, however, the first and last days of frost occurrence are respectively 2 April and 4 October for the lowlands, and 1 January and 31 December for the mountains, implying a frost risk of 276 days for the former ecological region and 365 days for the latter.

79. From the above, it is clear that climate places critical constraints on crop production. While sunlight is not a limiting factor, water supply (the result of rainfall and evaporation), together with soil/terrain characteristics, and the climate regime, remain major factors. The choice of crop, cultivar, ecological region, and planting date need to be decided upon in the light of frost risks, the prevailing temperature regime, and precipitation occurrence during the growing season. However, the current low capacity amongst relevant institutions to capture erratic climatic conditions over many parts of Southern Africa have been detrimental to crop production. For example, in the 1997/98 summer cropping season, the country lost 65% of its potential cereal crop after large areas of arable land were left fallow following a widely publicised prediction of a severe drought due to the emerging "Mother of all El-Niños". While El Niño materialised, it did not lead to drought situation, and instead good rains occurred[18].

Agro-ecological Conditions

80. Two important factors characterize the formation of distinct agro-ecological zones in Lesotho. The first is the high altitude plateau which intrudes into western Lesotho at an altitude of roughly 1,500m along the western and south western borders, forming a narrow strip known as the "lowlands". Altitude then increases through the foothills to an elevation of 2,000-2,500m, and then finally rises to the eastern escarpment where substantial areas of Lesotho exceed an altitude of 3,000m. The second factor is the tapering of the African subcontinent which exposes the interior to significant airflows from both the Indian and Atlantic Oceans. The two ocean masses have wide temperature differences, a phenomenon which has a marked effect on inland weather patterns.

81. Weather patterns which result from the above factors combine to modify the usual conditions that are created by the annual movements of the intertropical convergence zone, thereby determining the suitability of land for agricultural activities. They limit the cultivable area, as well as the duration of the growing season, and hence place limits on potential crop/land productivity. These factors influence the adaptability and distribution of different types of crops as well as different cultivars within each crop type. For example, rainfall and temperature regimes combine to restrict agricultural activity throughout the country during the winter season.

82. Table 10 shows a summary of the characteristics of the major agro-ecological zones. Using these characteristics and data from detailed soil surveys, the Ministry of Agriculture has developed a comprehensive reference for all field crops and vegetables. Each crop is listed by zone, and recommendations are made as to the suitable cultivar, planting dates, seeding rates, fertilizer requirements, pest control, and harvesting. Despite this valuable work, it appears that a more detailed agro-ecological area determination is still necessary. A programme of work involving specific soil/crop cultivar matching needs to be undertaken to determine exactly how different cultivars perform under accurately recorded conditions. Unfortunately, shortage of highly qualified staff and poor coordination amongst relevant government departments have delayed progress in this direction.

83. As long as the population continues to increase and soil loss accelerates through soil erosion, there will be an increasing burden on the government to ensure that the remaining arable land is used more

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[18]Southern African Development Community *Food Security Bulletin* tabled at the Southern African Regional Climate Forum meeting of July 1998 at Pilanesberg, RSA.

productively. It is essential that the full genetic potential of each cultivar is realised by ensuring that it is grown under conditions that are as close to ideal as possible. However, success in this direction hinges upon the prevalence of stable climatic conditions. Erratic climatic conditions such as are likely to occur as a result of increased global warming will only increase the risk of closely following agro-ecological recommendations.

Table 10 Summary of the Characteristics of Major Ecological Zones

Parameter	Mountains	Lowlands	Foothills	Senqu River Valleys
Typography	Very steep bare rock outcrops and gentle rolling valleys	Flat to gentle rolling	Steeply rolling	Steeply sloping
Soils	Fragile, thin horizon of rich black loam except on valley bottoms	Sandy textured, red to brown in the north clayey in the south	Rich, alluvial along valleys, thin and thick rock on slopes	Calcarious clayey red soils with poor penetration by rainfall
Climate	Cold, moist	Moist in the north, moderately dry in the south	Moist, sheltered	Dry
Risks	Long period of frost, snow, hail, high soil erodibility	Parching sun, strong winter winds, hail, periodic droughts, high soil erodibility.	Floods, high soil erodibility	Severe drought, moderate soil erodibility.
Main crops	Maize, wheat, peas, potato	Maize, wheat, beans, vegetables	Maize, wheat, peas, fodder crops, potatoes	Maize, sorghum, beans, few trees in valleys
Vegetation	Denuded grassland, indigenous shrubs in some river valleys, stunted peach trees near homesteads	Crop stubble, reforestation on some hills, fruit trees near homesteads	Poplar and willow trees along streams and gullies, crop stubble, a lot of fruit trees near homesteads	Denuded dry shrubs, brush, few trees in valley
Summer Grazing	High mountain cattle posts	Around villages	Around villages	Unsuitable, too dry
Percent of total livestock popul:				
– cattle	32%	26%	31%	11%
– sheep	19%	10%	58%	13%
– goats	19%	20%	45%	16%
– horses	18%	19%	49%	14%
– donkeys	39%	23%	25%	13%

Source: Adapted from FAO, *Lesotho: Sustainable Mountain Area Agriculture Development -Inception Repor*t, February, 1996.

Socio economic Conditions

84. Since close to 85% of the households live in rural areas and 70% derive all or part of their incomes from agriculture[19], the contribution of the latter sector is of critical importance in the determination of socio-economic conditions in the country. It has already been pointed out that Lesotho's limited natural resource endowment, together with a mountainous topography, limited arable land, unreliable climate, and severe soil erosion are constraining the agricultural sector to generate adequate levels of employment and incomes to support the country's rapidly increasing population. However, in the face of stagnation in RSA mine employment and sluggish growth in the domestic formal economic sectors, the government is convinced that agricultural employment and incomes must be expanded in order to avert worsening levels of poverty in the short- to medium-term.

[19]In fact 35-40% rely on this sector for incomes.

85. Although absolute levels of poverty in Lesotho are much lower than in many countries in Sub-Saharan Africa, nearly half of the population is classified as poor and a quarter as ultra poor[20]. In addition, the poverty gap between the poor and the ultra poor is relatively small, at 9.12%, implying that a slight reduction of consumption levels of the poor would throw a significant number of households into the ultra-poor category. On the other hand, the World Bank estimates that with accurate targeting, it would require an expenditure of M44.2 million and M232.9 million per year to respectively eliminate ultra-poverty and poverty in the country[21].

86. Table 11 shows an analysis of the geographical incidence of poverty in Lesotho. As shown on this table, 54% of the households in rural areas fall below the poverty line as compared to 28% in the Maseru urban area and 27% in other urban areas. The rural areas, the mountain and foothills ecological zones, and the Senqu River Valley are the hardest hit, with incidences of poverty ranging from 56% to 71% of the households. Both the incidence and depth were found to be highest among farmers and casual labourers where it respectively stood at 74% and 71%, implying therefore that there is a direct relationship between climate change and poverty because of the high dependence of rural households on agriculture for livelihood. This is further confirmed by the fact that the incidence of poverty was found to be highest among households which had small land holdings as compared to those which had either large land holdings or no land at all[22].

Table 11 Incidence of Poverty by Ecological Region

Region	Percentage of Households Classified as:		Share of the country's Poor Population (%)
	Poor	Ultra-poor	
Lowlands	44.1	21.7	38.9
Foothills	56.4	29.1	17.0
Mountains	71.2	41.4	14.2
Senqu River Valley	61.7	35.6	11.8
Rural	53.9	28.6	81.9
Other Urban	26.8	11.0	4.5
Maseru Urban	28.1	13.6	13.6
Lesotho	49.2	25.8	100.0

Source: World Bank, *Lesotho: Poverty Assessment*, August 1995, table 2.9

87. There has been a worsening situation in both income inequality and the incidence of poverty over the past years. The Gini coefficients for rural areas increased from 0.23 in 1967/69 to 0.55 in 1993. On the other hand, poverty in 1993 was up 2% from its 1986 level of 47% (figure 6). This worsening situation has largely been attributed on protracted droughts and the poor performance of

[20]World Bank, Lesotho: Poverty Assessment, August 1995, p.15

[21]Using 1995 prices.

[22]Those who have small land holdings are more prone to adverse climatic conditions than those with large holdings since they have less diversification possibilities. On the other hand, those without land are mainly engaged in more lucrative sources of income, e.g. wage employment.

agriculture, government cutbacks on social expenditures following the adoption and implementation of the IMF/World Bank supervised structural adjustment programmes, rapid environmental degradation, the pursuit of inappropriate policies, failure to target interventions to the poor, and the poor performance of the domestic economy in terms of employment creation.

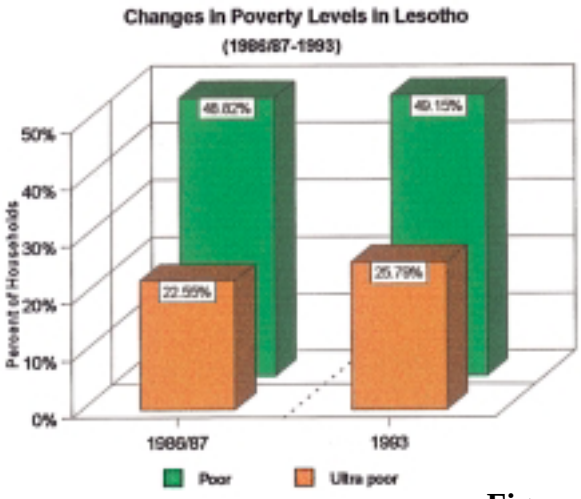

Figure 5

88. In 1995, the World Bank[23] used a semi input-output model to analyse the effects of the following factors on household incomes:

- Reduced fiscal expenditures of structural adjustment programmes that began in 1988;
- Severe droughts of 1991 and 1992;
- Declines in migrant worker's remittances; and
- Increased construction activities of the LHWP.

Model simulations based on trends in a selected number of macro and sectoral aggregates showed that structural adjustment had a limited and somewhat undifferentiated impact as it did not disproportionately affect the poor. As shown on Table 12, of the four factors whose impacts were analysed, drought and declining migrant workers' remittances were found to have had the worst impact on the incomes of the poor although the latter had far more impact on the incomes of the non-poor as well. On the other hand, impacts of construction activities of the LHWP seem to have increased household incomes to a point where they offset adverse shocks of drought, reduced migrant remittances, and fiscal austerity.

Table 12 Impact of Various Factors on Household Incomes
(Percentage change)

Household Category	Factors with Impact on Household Incomes (Percent Change in HH Income)					
	Reduced Government Spending	Drought	Reduced Migrant Incomes	Sub-Total	LHWP	All Factors
Poor	-1.69	-5.39	-5.67	-12.75	10.68	-2.07
Non-poor	-1.54	-0.79	-11.90	-14.24	-3.32	-11.00
All HHs	-1.58	-.85	-10.46	-13.89	4.95	-8.94

Source: World Bank, Lesotho: Poverty Assessment, August 1995, Table 1.2

89. The geographic distribution of many socio-economic indicators of poverty such as malnutrition, mortality and morbidity, access to safe water and sanitation facilities, and school enrollment ratios seems to follow the same pattern as that of poverty. Since climate is intricately related to most of the socio-

[23]World Bank, Lesotho: Poverty Assessment, p.3.

economic indicators, it is clear that unless Lesotho joins the international community to combat the impacts of global warming, by adopting and implementing appropriate and effective mitigative and adaptive interventions in the short to medium-term, suffering amongst vulnerable groups is bound to deepen.

Climate Change Scenarios[24]

90. The Lesotho Meteorological Services (LMS) has developed climate change scenarios for Lesotho for the years 2030, 2050, and 2075 using 5 carefully selected Global Circulation Models (GCMs), one transient model, and historical meteorological data collected from 12 stations from 1961 to 1990, with an adopted assumption of a mid-range estimate of future GHG emissions with a modest policy intervention for the reduction of such emissions (IPCC, 1992). Under this set of assumptions, it is projected that the CO_2 concentrations in the atmosphere will increase from 340 ppmv for the base period 1961-90 to about 530 ppmv for the year 2075, and that the global temperature will on average increase by 1.5°C, and the mean sea level rise by 35cm. The scenarios that were estimated included future monthly, seasonal, and annual temperature and precipitation changes for the years under consideration.

91. The six models which were run included the United Kingdom Meteorological Office High Resolution model (UKHI), the Canadian Climate Centre model (CCCM), the USA Geophysical Fluid Dynamics Laboratory model (GFDL), the USA Oregon State University model (OSU), the Goddard Institute for Space Studies model (GISS), and the United Kingdom Meteorological Office Hardley Centre Transient model (UKTR). In assessing the suitability of these models in creating optimized future climate change scenarios for Lesotho, the following criteria were employed:

- the model that simulates the 1961-90 climate of Lesotho with high precision would also better represent the future climate of the country;
- the best model is the one that gives a magnitude of temperature and precipitation change that is equivalent to the average of all model experiments; and
- a high resolution model with a dense grid would provide a more realistic representation of geographic climate features of a small and mountainous country like Lesotho.

Figure 6 shows that these three criteria seemed to favour the USA Geophysical Fluid Dynamics Laboratory (GFDL) and the United Kingdom Meteorological Office High Resolution (UKHI) models. These two models were therefore generally given more weight in the sectoral assessments of the possible future impacts of climate change in Lesotho.

92. The temperature scenarios that were estimated by all models indicate an increase in temperature for most of the months up to year 2075 (see figures). Over the 1961-90 average monthly mean temperature, the highest warming is estimated for June for which one of the GCM models, the UKHI, showed an increase of 4.7°C, and the GFDL gives an increase of 0.2°C. The least warming is estimated for May during which the UKHI and the GFDL showed an increase of 0.4°C and 0.2°C respectively.

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[24]A climate change scenario is defined as an internally consistent representation of the future climate that is constructed from methods based upon sound scientific principles and that can be used to give an understanding of the response of the environmental and social systems to the future climate change (Viner and Hulme. 1992).

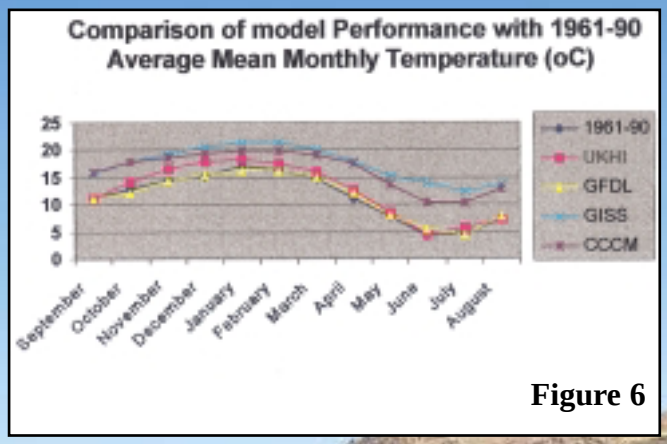

Figure 6

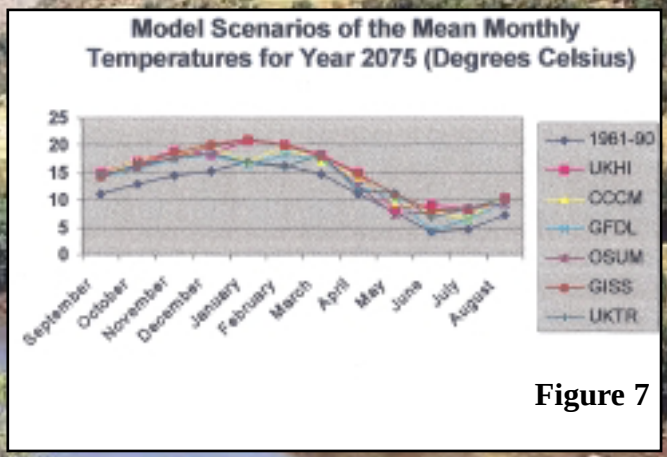

Figure 7

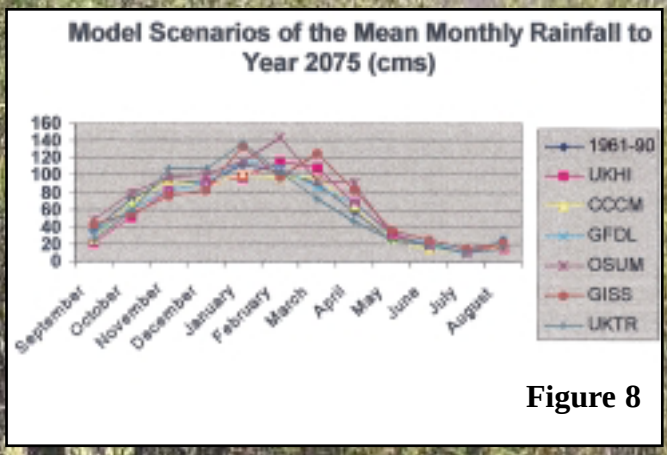

Figure 8

93. The precipitation scenarios that were estimated indicate a reduction in precipitation for most of the models, with the highest drop of 0.7mm/day depicted by the UKHI, and 0.4mm/day by the GFDL for the month of October, 2075. The only increase in precipitation occurs in the month of April, where both the UKHI and GFDL models estimate an increase of 0.3mm/day (see figure 8).

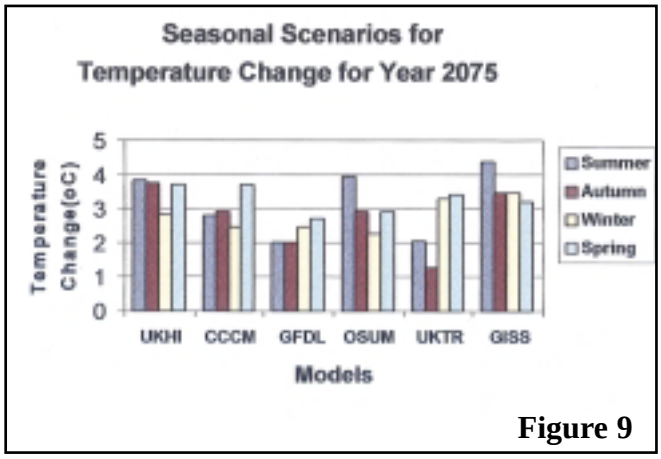

Figure 9

94. Seasonal climate scenarios were created to assess the likely impacts of climate change on seasonal rains, as well as the possible shift in seasonality that could result from anticipated temperature changes. In terms of seasonality, all the models result in progressive increases in warming for all seasons up to year 2075. As shown on table 13, the GFDL results in a 0.7°C increase in temperature for all seasons by year 2030; an increase of 1.1°C for both winter and summer and 1.0°C for both spring and autumn by year 2050; and increases of 2.0°C for both summer and autumn, 1.5°C for winter, and 2.7°C for spring by year 2075. The table further shows a range of increases estimated using other models, the highest being the 4.7°C estimated using the GISS for summer in year 2075. The profiles of these model results are shown in figure 9.

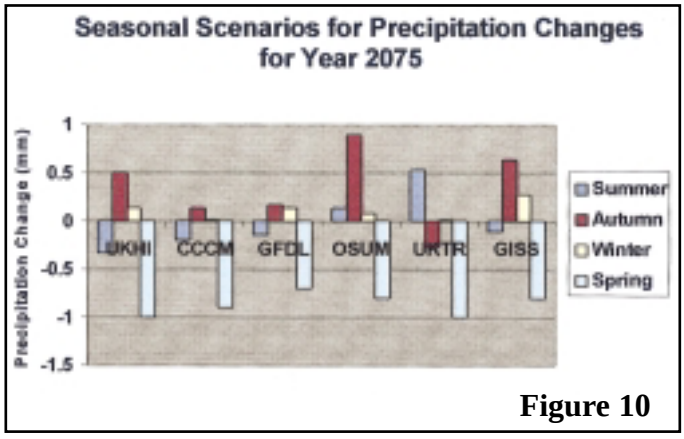

Figure 10

Table 13 Seasonal Temperature Scenarios for Years 2030, 2050, and 2075.
(Increases in Temperature in Degrees Celsius)

Model	Year 2030				Year 2050				Year 2075			
	Autumn	Winter	Spring	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter	Spring	Summer
UKHI	1.1	1.2	1.1	1.0	1.7	1.8	1.7	1.5	3.7	2.8	3.7	3.8
CCCM	0.9	0.8	1.1	0.9	1.4	1.3	1.7	1.4	2.9	2.5	3.7	2.8
GFDL	0.7	0.7	0.7	0.7	1.0	1.1	1.0	1.1	2.0	1.5	2.7	2.0
OSU	0.9	0.9	1.0	0.7	1.4	1.4	1.5	1.4	2.9	2.2	2.9	3.9
GISS	1.0	0.9	0.9	1.0	1.5	1.7	1.4	1.6	3.5	3.5	3.2	4.4
UKTR	1.0	1.1	0.9	0.9	1.6	1.5	1.5	1.4	1.2	3.3	3.4	2.0

Source: Lesotho Meteorological Services

95. Seasonal precipitation scenarios shown on Table 14 indicate a decrease in summer and spring precipitation up to year 2075, a decrease in winter precipitation which is reversed to an increase in year 2075, and a minimal decrease in autumn precipitation which becomes significant in year 2075. For year 2075, all GCM models indicate a decrease in precipitation of between 0.5 and 1.0mm per day for spring, while both the UKHI and GFDL models estimate a decrease of 0.5mm per day for both autumn and summer seasons. However, winter is estimated to have an increase in precipitation of 0.5mm per day. The profiles of these model results are shown on Figure 10.

Table 14 Seasonal Precipitation Scenarios for Years 2030, 2050, and 2075.
(Changes in mm)

Model	Year 2030				Year 2050				Year 2075			
	Autumn	Winter	Spring	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter	Spring	Summer
UKHI	0.04	-0.02	-0.80	-0.10	0.05	-0.03	-0.90	-0.03	0.50	0.14	-1.00	-0.33
CCCM	0.01	-0.06	0.80	-0.04	-0.01	-0.09	-0.80	-0.05	0.13	0.01	-0.90	-0.20
GFDL	0.01	0.02	-0.70	-0.04	0.00	0.04	-0.70	-0.04	0.17	0.14	-0.70	-0.13
OSU	0.02	-0.01	-0.70	0.00	0.17	-0.02	-0.70	0.03	0.90	0.07	-0.80	0.13
GISS	0.09	0.13	-0.70	-0.02	0.12	0.19	-0.70	0.00	0.63	0.27	-0.80	-0.10
UKTR	-0.06	-0.06	-0.90	0.05	-0.12	-0.09	-1.00	0.09	-0.27	0.01	-1.00	0.53

Source: Lesotho Meteorological Services

96. The implications of these scenarios are that Lesotho is likely to experience a warmer climate with lower rainfall in the spring and summer seasons, a higher precipitation in winter, and a gradually increasing precipitation in autumn. The result could be a shift in precipitation patterns in such a way that good seasonal rains that characterize the summer season could then set in late in autumn. This is likely to have serious implications for agro-ecological conditions in the country as the growing season is pushed forward and perhaps shortened. On the other hand, an increase in precipitation in winter may suggest increased activity in frontal systems which may result in heavier snowfall occurrences and strong devastating winds which often bring disasters and human suffering.

The Water Sector

Water Resources Inventory

97. Geological tectonics have largely influenced the hydrography of Lesotho. The country is drained by 3 major rivers which run in a north south-westerly direction with head waters in the central and eastern ranges of the Drakensberg/Maluti Mountains. These rivers cross the south-western border at an altitude of 1,400 metres above sea level. As shown on Table 15, the largest river, the Senqu, has a drainage area within Lesotho of 20,847km^2 and a mean annual runoff at the point of exit of 128m^3 per second. On the other hand, the Mohokare, which forms the western border with the RSA, has a drainage area within Lesotho of 6,890km^2 and an average annual discharge rate of 35.4m^3 per second at the point of exit. The smallest of the 3 rivers, the Makhaleng, runs from the Central Range to join the Senqu at the RSA border, registering a mean annual runoff of 16.7m^3 per second at the lowest point, and covering a drainage area of 2,911km^2. In general, the natural yields of most of the rivers vary significantly from basin to basin[25].

Table 15 Hydrometric Data of Three Major River Basins

River Basin	Drainage Area within Lesotho		Mean Annual Runoff at Lowest Point (m^3/second)
	Km2	Percent	
Senqu	20,847	96.8	128.0
Mohokare	6,890	51.3	30.0
Makhaleng	2,911	99.5	16.7

Source : TAMS Consultants, *Water Resources Management: Policy and Strategies*, Final Report, Ministry of Natural Resources, September, 1996

[25]TAMS Consultants, *Water Resources Management Policy and Strategies*, Final Report, Ministry of Natural Resources, September, 1996, p.15.

One of the major rivers of Lesotho, Makhaleng.

98. It is estimated that Lesotho has a total 5,925 million cubic metres of static and 341 million cubic metres of renewable ground water resources[26]. On the other hand, reliance on ground water ranges from as low as 5% of the rural population in the Thaba-Tseka District to as high as 72% of the rural population in the Maseru District. As indicated on Table 16, the national average utilisation of renewable ground water resources stands at a mere 1.7%, a very small percentage of what is potentially available. However, it ranges from as low as 0.2% in the mountain districts of Thaba-Tseka and Qachas' Nek, to as high as 12.2% in the Quthing District. This shows that in terms of both urban and peri-urban high capacity boreholes, as well as of a multitude of village hand pumps that are largely found in rural areas, there is still a wide scope for the further development of ground water resources.

99. So far ground water investigations have revealed a poor overall permeability and transmissivity of the aquifers of the Karroo and igneous formations. Dolerite dykes are usually used as indicators for borehole siting and yields usually range between 0.3 and 4 litres per second. In sedimentary rocks, yields are usually less than 0.3 litres per second (Barney, 1975, Hydrogeological Map, 1994). Similarly, springs, which are often located at the interface of sedimentary rocks with their basaltic overladen rocks, have also been of limited yield. However, alluvial deposits have been recorded to yield as high as 40 litres per second, with a lot of promise for the future.

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[26]Depending upon the approach adopted, it is estimated that the renewable ground water resources correspond to 1.4-4.2% of the average rainfall in Lesotho (TAMS, p.28).

Table 16 Summary of Static and Renewable Water Resources and Estimates of Ground Water Draft by District, 1996

District	Static Resources (m^3 million)	Renewable Resources (m^3 million/year)	Estimated Ground Water Draft (m^3 million/year)		Percent Renewable Resources Utilised
			Urban	Rural	
Butha-Buthe	303	18.04	0.073	0.215	9.2
Leribe	698	37.02	0.347	0.962	6.4
Berea	449	22.21	0.146	0.659	6.2
Maseru	728	45.35	0.066	1.223	6.5
Mafeteng	490	34.42	0.189	0.996	4.6
Mohales' Hoek	900	44.31	0.146	0.754	3.7
Quthing	569	30.43	0.000	0.073	12.2
Qacha's Nek	432	19.99	0.000	0.039	0.2
Mokhotlong	626	41.70	–	–	–
Thaba-Tseka	730	47.77	0.050	0.061	0.2
TOTAL	5,925	341.24	1.017	4.921	1.7

Source: TAMS Consultants, *Water Resources Management: Policy and Strategies*, Final Report, Ministry of Natural Resources, September, 1996

Water Resources Development

100. The relatively high rainfall of the past and widespread availability of perennial springs in the mountains, as well as low population enabled the establishment of a dense pattern of settlements which usually depended on one or two springs throughout the year. However, rapid population growth, the introduction of water supply infrastructure and borehole technology in the past 3 decades, as well as the migration of people from the mountain to more developed lowland and peri-urban areas, has enabled settlements to rapidly expand into more arid parts of the western lowlands[27], compelling the government to increasingly intervene in water supply, in both urban and rural areas.

101. The water resource figures given above seem to suggest that water is available in sufficient quantities throughout the whole country, and therefore any reported shortages cannot be of a permanent nature. However, in the current demand and supply situation, shortages of water resulting from protracted droughts have had severe impacts on the economy. A detailed analysis of the capacities of urban water resources that is presented on Table 17 shows that the maximum capacity in a normal year stands at 84,682m^3 per day. This compares with a current urban demand level of 26,225m^3 per day or 31% of the maximum capacity of the urban water resources. However, the same table shows that water supply coverage statistics for gazetted urban areas generally ranges between 33% and 80%, the main limitation being water supply infrastructure, operation and maintenance problems, limited cost recovery in some areas, and management problems within the Water and Sewerage Authority (WASA). It is no surprise, therefore, that droughts have had serious impacts on large communities who reside in peri-urban areas which have either limited or no water supply infrastructure.

102. The artificial adequacy of urban water sources in the country hides a number of salient issues. Firstly, with full coverage, the excess capacity could be substantially reduced or even wiped out. Secondly, the potential drought yield only stands at 37,067m^3 per day. In fact, during the 1994 drought, total yield stood at 35,703m^3 per day, and the individual demand levels of 8 tows fell below their drought yields, necessitating water rationing. Thirdly, the 1995 urban water supply coverage was estimated at 55%, of which 47% was made up of house connections and the rest stand pipes. In this regard, improving

[27]TAMS Consultants, p.60.

levels of service could also seriously undermine the excess capacity of the water sources that have been presented on Table 16.

Table 17 Water Supply Capacities of Urban Areas, 1994

District	% Water Supply Coverage 1993	Water Sources	Estimated Ground Water Draft (m^3 million/year)			
			Current Use (1994)	Maximum Capacity	1994 Drought yield	Potential Drought yield
Mokhotlong	71	Surface & Spring	301	1,040	258	675
Butha-Buthe	33	Borehole & Surface	446	2,501	952	–
Hlotse	55	Surface & Wells	880	880*	850	1,650
Maputsoe	58	Borehole & Surface	978	1,864	1,141	1,265
Teyateyaneng	69	Borehole & Surface	791	2,132	868	1,088
Mapoteng	78	Springs	251	648	234	234
Peka	55	Surface	222	1,008	500	1,000
Maseru	37	Surface & Wells	19,400	67,840	26,640	26,640
Roma	3	Borehole & Surface	525	1,284	557	699
Morija	65	Borehole & Surface	207	410	174	174
Mafeteng	41	Borehole & Surface	627	3,240	2,121	2,121
Mohale's Hoek	56	Borehole & Surface	716	1,624	590	1,070
Quthing	80	Surface	404	864	367	n.a.
Qacha's Nek	38	Surface & Springs	346	895	300	300
Thaba-Tseka	34	Borehole & Surface	161	452	151	151

Source: Ministry of Economic Planning, *Water Supply and Sanitation Action Plan*, Volume II, November, 1995.
* Yield of wells

103. Since the advent of the International Drinking Water Supply and Sanitation Decade, Lesotho attracted high levels of donor funding for its rural water supply programmes, leading to a phenomenal increase in coverage nationwide from less than 15% of the population in 1984, to 56% in 1995. However, the levels of progress have not been very evenly distributed countrywide. As can be seen on figure 11, coverage in the mountain districts of Mokhotlong, Qacha's Nek, and Thaba-Tseka lags far behind that in lowland districts. Amongst those areas which are covered, the country has registered an average yield level of 63 litres per capita per day, although 35% of the projects, mainly in the lowlands, fall far below the national target of 30 litres per capita per day within a distance of 150 metres. In addition to this, an inspection survey carried out in 1995[28] showed that 7% of the total population served, also mainly in the lowlands, had no access to improved water because of system failures, a problem attributable to poor maintenance. As the population increases and spring yields decline, it is conceivable that these percentages will rise.

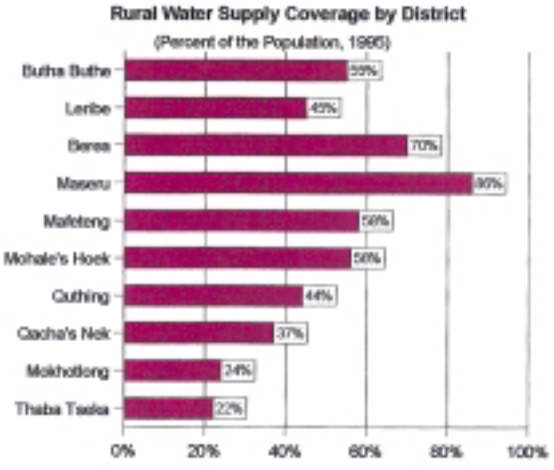


Figure 11

[28]TAMS Consultants, p.76.

104. In order to rationalise water use, rationing is commonly applied to rural water systems. Rationing can either result from management problems as in the case of poor maintenance, or from drought conditions. Table 18 shows results of these two scenarios for the year 1995. Although rationing is not purely climatic, the large differences between these two scenarios reflects the impact of drought on household water allocation. During periods of drought, rationing is highest amongst those districts where litres per capita per day are normally low, namely Mafeteng and Thaba-Tseka.

Table 18 Percent of Rural Water Systems Rationed by District, 1995

District	Percent Rationed After Rain	Percent Rationed After Drought
Leribe	0	29
Berea	5	39
Maseru	12	32
Mafeteng	8	23
Mohale's Hoek	3	40
Quthing	4	26
Qacha's Nek	5	30
Mokhotlong	4	32
Thaba-Tseka	0	21
Lesotho	17	42
	6	31

Source: TAMS Consultants, *Water Resources Management: Policy and Strategies*, Final Report, Ministry of Natural Resources, September, 1996, Table 9.3

105. As a result of shifts in urban boundaries as the towns grow, many settlements which were defined as rural villages before the passage of The Declaration of Urban Boundaries Act, 1980 now constitute parts of the fast growing peri-urban areas of many towns in the lowlands. Because of the high growth rates of these areas, as well as the overlap of functions between WASA and the Department of Rural Water Supplies (DRWS), infrastructure development in these areas remains low, and the water supply situation precarious, particularly during drought periods when many DRWS-operated water sources dry up.

Vulnerability Assessment

106. In assessing the vulnerability of the water sector to future climate change, the national study team assessed the runoff response to climate change of the Phuthiatsana River[29] at Masianokeng, 15kms south of Maseru. The analysis was facilitated by the use of calibrated and verified water balance model (CLIRUN). Predicted mean values of rainfall, evapotranspiration, and temperature that were generated by various GCM climate change scenarios were used as inputs into water balance model. The results are presented on figures 12 to 14 which represent scenarios for runoff under average, extreme ten wet years and extreme ten dry years.

[29]Tributary of the Mohokare River

107. The GCM model simulations up to 2075 show decreased surface runoff when compared to the normal historical surface runoff (figure 12). On the other hand, there was no significant difference between what the GCM climate change scenarios predicted and the observed mean annual surface runoff during wet years (figure 13). However, the surface runoff predicted by these models for dry years showed persistently lower values compared to the observed mean annual runoff (figure 14).

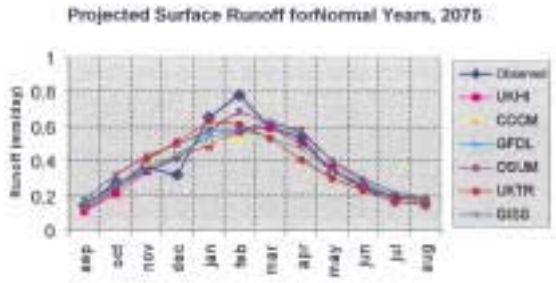


Figure 12

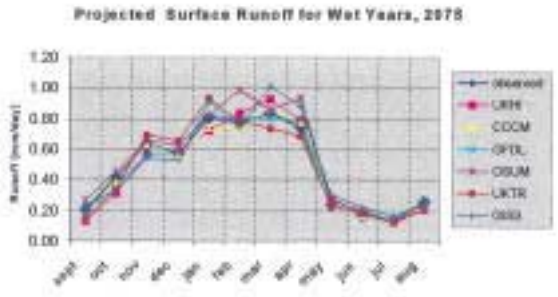


Figure 13

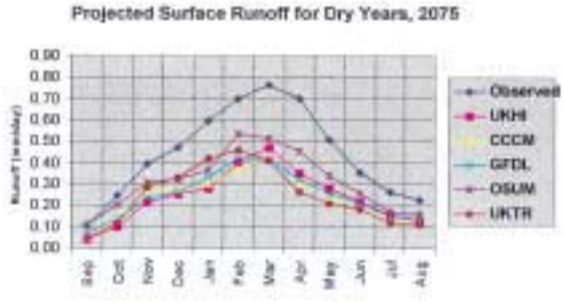


Figure 14

108. Figures 15 to 17 show the deviation of GCM scenarios from the observed mean annual surface runoff. The positive deviation occurs when the observed mean annual surface runoff is lower than the predicted runoff, while the negative one indicates that the observed mean annual surface runoff is higher than the predicted one. The range of this deviation, on the other hand, indicates the variability of change. It can be observed that there are insignificant deviations of GCM model climate change scenarios from the observed mean annual surface runoff during wet (figure 16) as compared to dry (figure 17) years. It appears that those catchments which have high precipitation that results in high surface runoff appear to be less sensitive to climate change, while those which have low precipitation that results in low runoff would show significant changes under climate change. GCM generated climate change scenarios also show high deviations from the observed mean annual surface runoff during normal years (figure 15).

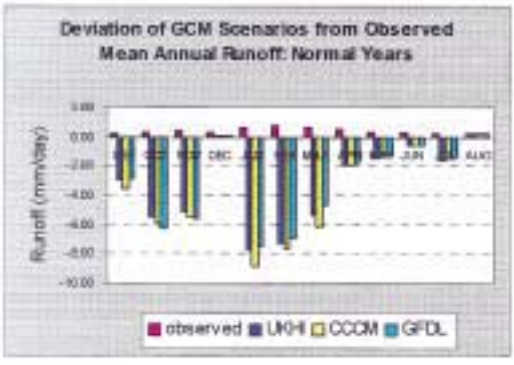


Figure 15

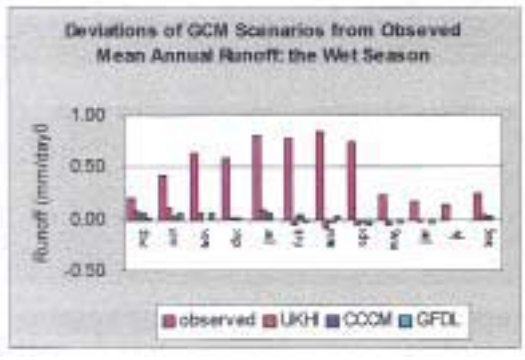


Figure 16

109. The situation analysis showed that the majority of households in Lesotho, particularly in rural areas, depend on sub-surface water which they access through boreholes, wells, and springs. For this group of the population, surface water indicators are not very relevant. It is sub-surface water indicators that will determine the level of stress that could come with various climate change scenarios. GCM simulations show that for the months of September to December for normal years, most of the climate change scenarios would yield less sub-surface runoff than the current climate or observed sub-surface runoff. However, the situation would start changing from January to April. From May to August, most of the climate change scenarios would yield higher runoff than the current climate. This finding, which is clearly illustrated on figures 18 to 20, is consistent with the predicted rainfall pattern under climate change. The same pattern is observed for wet and dry years. Climate change is likely to cause a lower sub-surface runoff in the 7 months of the year beginning September. The situation would improve in the winter months, beginning April through August.

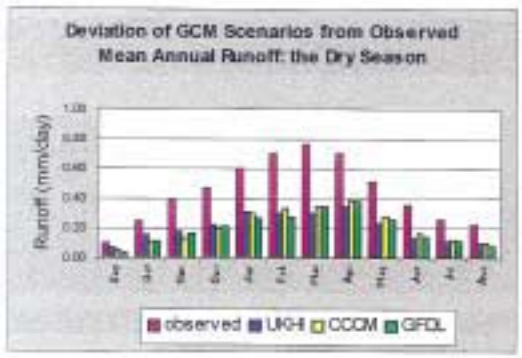


Figure 17

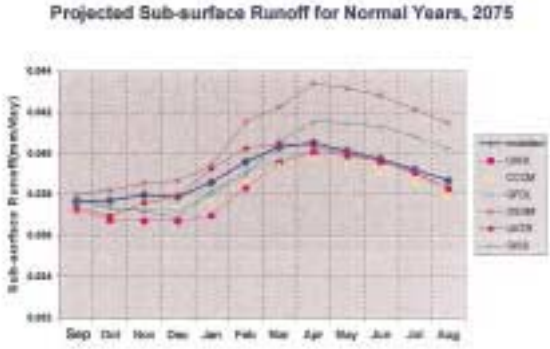


Figure 18

110. Taking Lesotho's current population growth rate and climate, and a fresh water availability of 5.4km^3 per annum, it is estimated

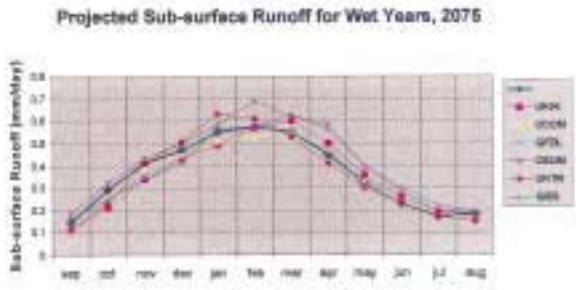


Figure 19

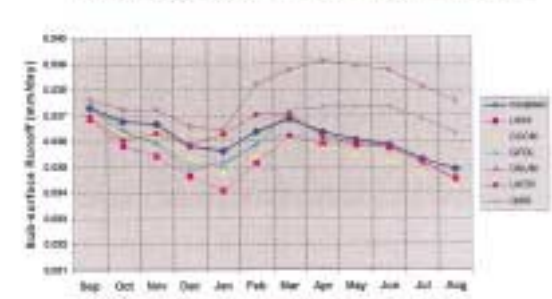


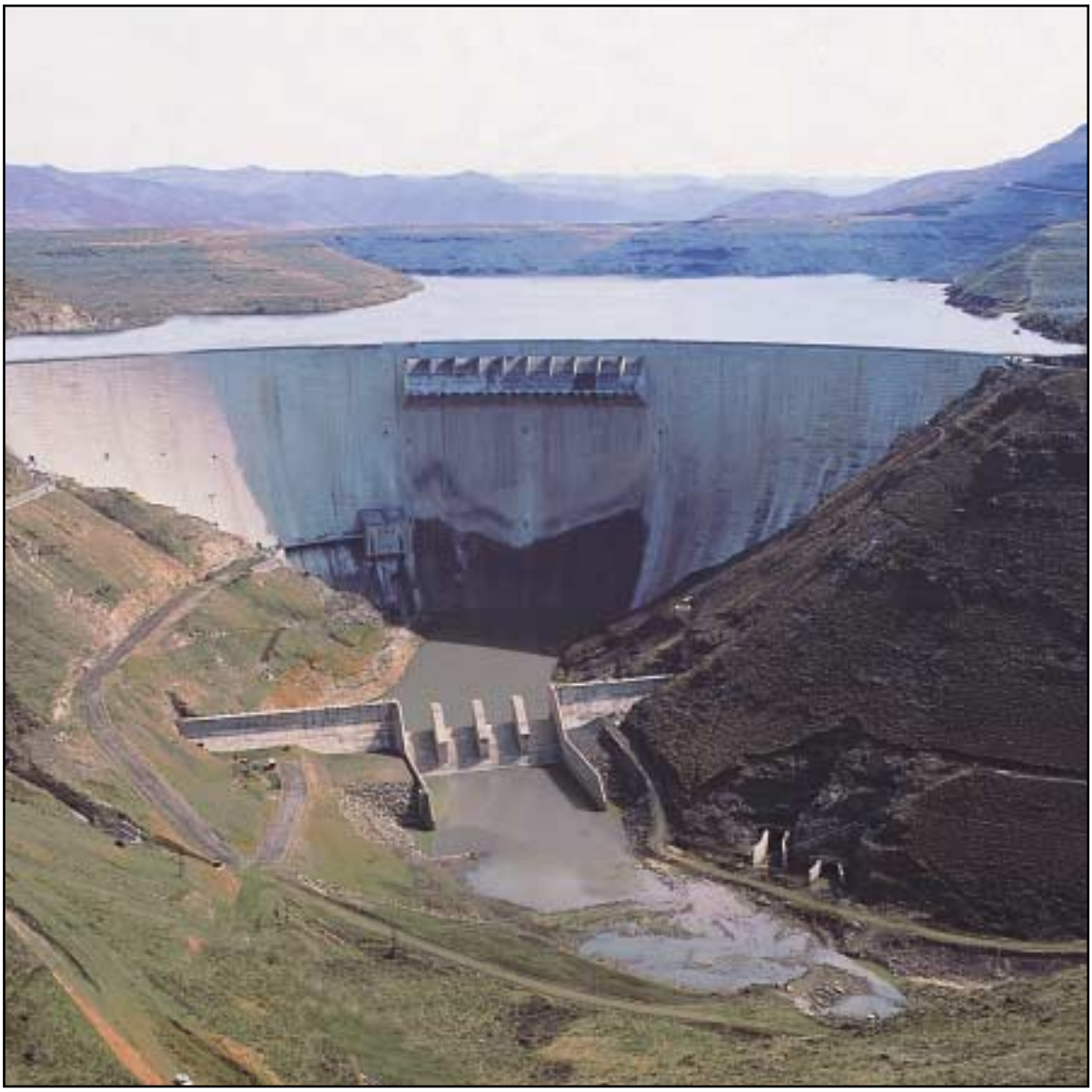
Figure 20

that the country will enter a water stress period of less than 1700m^3 per capita per year by year 2019, and a water scarcity period of less than 1,000m^3 per capita per year by year 2062. In line with precipitation patterns under climate change scenarios, both surface and sub-surface runoff would be lower, implying increased water scarcity for both livestock and households. The surface flow in many streams is likely to be lower or totally dry for most of the year, leading to severe water stress for livestock and some households, and a disaster for aquatic life. There is also a host of other economic activities that are likely to be affected: surface water dependant irrigation, the brick-making industry, and river-based laundry activities in rural areas.

111. On the other hand, dry conditions for most of the year and the resultant lower sub-surface flow would lead to dry springs and wells, lower water tables and higher borehole costs, reduced yields of many

water sources, and severe water stress, particularly for the rural population who mainly depend on ground water. Unless sufficient surface storage and reticulation infrastructure are developed over time, this could also lead to conflicts between Lesotho and the RSA which is likely to be increasingly more dependent on Lesotho for water by year 2075. It is logical to think that Lesotho will have a moral obligation to provide for its domestic water needs before exporting any 'surplus' to the RSA. This will have to be addressed during the future renegotiations and reviews of the LHWP treaty between the two countries.

112. Reduced precipitation in Lesotho under climate change translates itself into reduced run off in the catchment area of some of the biggest rivers in Southern Africa. Therefore a lot of water-based activities are likely to be affected in many of the RSA's provinces and in Namibia. Depending on the length of dry spells, the yield of many storage dams in the LHWP is likely to be lower, leading to reduced water exports to the RSA, and lower royalty incomes for Lesotho. The latter have become an important non-tax revenue source in the country and therefore a lower level could translate into lower social expenditures and human suffering and poverty. The country's overall hydro-electricity generation and irrigation potential are also likely to be affected by the expected lower surface and sub-surface flows. The same would happen with water-based sport and tourism potential.



The Katse Dam wall

The Agricultural Sector

Sectoral Trends

113. Maize is the basic staple food crop of the people as it contributes 40% to the daily diet. Sorghum is the next important cereal, its importance deriving from its use in porridge and traditional beer brewing, as well as in the manufacture of animal feed. Legumes, particularly beans and peas, have been grown in Lesotho as cash crops for many years. These provide major sources of protein in the local diet. Wheat has also occupied a special place in the diet since its introduction more than a hundred years ago. Other crops grown to a significant scale include potatoes and vegetables, and a large variety of crops that have been promoted under the government's crop diversification programme such as sunflower and a number of fodder crops. Almost every homestead has 5 or more fruit trees, mainly of the peach variety.

114. Crop production is dominated by maize which accounted for 63% of the area planted in 1995/96. The other major crops are sorghum, with a 1995/96 share of area planted of 28%; wheat, with a share of 12%; beans with a share of 5%; and peas, with a 1995/96 share of area planted of 3%. In the 6 years beginning 1990/91, total area under cultivation fluctuated between 136,500 and 300,500 hectares, down from 450,000 hectares in 1960. In general, area under cultivation, production, and yields are very erratic and closely related to rainfall figures. For example, good rains in the 1995/96 summer cropping season encouraged most of the farmers to increase both area planted and area harvested, and agricultural output increased by 54.7% over the previous year, thereby increasing agriculture's share in the GDP by 3.2 percentage points to 11.9%. As shown on Table 19, the 1995/96 production of maize, wheat and peas exceeded the levels recorded in the previous ten years, while that of beans became the highest in 5 years.

115. Yield levels are generally low in Lesotho. It is however recognised that there is room for improvement. Depending on each crop, yields in Lesotho fall 2.5 to 9 times below those in the Free State Province of the RSA in which agro-climatic conditions are almost similar. Further, some project trials in Lesotho have produced higher yields for maize and wheat, clearly indicating that the country's crop yields could be improved.

116. Although rainfall is the most significant determinant of output and yields of major staple food crops in Lesotho, crop agriculture is fraught with a number of intractable problems which make it even more vulnerable to climate change. These include severe soil erosion as was pointed out earlier; low soil fertility; inadequate use of organic fertilizers; inefficient technologies that are characterised by untimely planting, poor land preparation, inadequate weeding, and delayed harvesting; inadequate

development funds and credit facilities; inappropriate agricultural development policies that were pursued in the past; and the slow pace of land reform. The incidence of landlessness amongst rural households has also risen sharply due to the high population growth rate, leading to the cultivation of mountain slopes and marginal lands, with hazardous implications for range recovery and general agricultural productivity.

Table 19 Trends in the Production and Average Yields of Major Crops (Metric Tons)

Year	Maize		Sorghum		Wheat		Beans		Peas	
	Product	Yield	Product	Yield	Product	Yield	Product	Yield	Product	Yield
1986/87	94.9	5.9	31.3	4.0	19.0	6.5	3.4	1.9	1.8	3.2
1987/88	159.9	8.4	53.3	6.7	19.2	5.9	7.4	2.4	2.6	3.5
1988/89	137.0	7.4	31.1	5.7	29.7	6.2	9.6	4.0	1.6	1.7
1989/90	171.7	9.1	36.1	7.5	19.0	3.3	8.3	8.0	2.9	1.7
1990/91	49.2	4.4	9.9	3.9	6.9	1.7	2.4	2.0	1.0	0.8
1991/92	61.1	3.6	19.6	3.8	12.0	5.9	1.5	1.5	1.9	3.1
1992/93	91.8	7.5	52.0	11.7	8.1	6.0	1.6	6.3	0.9	4.1
1993/94	149.1	8.2	60.7	8.5	12.0	3.7	2.7	3.0	1.4	2.5
1994/95	62.5	6.8	6.9	6.3	10.6	4.7	4.5	7.1	1.1	2.2
1995/96	188.5	12.0	36.1	8.3	31.3	10.6	6.6	5.8	7.1	10.6

Source: Central Bank of Lesotho, *Annual Report for 1996*, Table 3 (b).

117. Unlike arable agriculture, the livestock subsector has been found to be less prone to erratic climatic conditions. It should, however, be pointed out that a recovery from the 1995 drought that was mentioned above also improved livestock condition in 1996. Good rains positively affected rangelands and the water flow in streams and rivers on which livestock depend[30]. However, the productivity of this subsector is severely undermined by failure to maintain an appropriate balance between range resources and animal populations, and by adherence to traditional management practices which include non-economic reasons for keeping livestock. Range is communal property in Lesotho and the government recognises that communal range utilization leads to overgrazing as it encourages farmers to maximize individual benefits by holding more animals, making it impossible to maintain desired stocking rates. The resultant reduction in the nutritional value of the rangelands is largely responsible for low birth weights for all categories of livestock, low and largely stagnant reproduction rates, high mortality, low carcass weights, low fleece weights for small stock and, low farmer incomes[31].

118. At the dawn of independence in 1966, agriculture, by far the largest productive sector then, contributed 40% to the country's GDP. Figure 21 shows that this relative contribution has been gradually declining, averaging 18.2% in the 10-year period 1980-89, and 11.3% in the 7-year period 1990-96. While this decline has largely resulted from the rapid growth of the secondary sector, it has also resulted from absolute fluctuations in the output of agriculture which seem to be closely associated with climatic and other agro-ecological conditions, and, to a lesser extent, to the pursuit of inappropriate policies.

119. Lesotho was a net exporter of food grains until the 1960s when its food self-sufficiency began to steadily decline as a result of a rapidly increasing population, shrinking arable area, declining sectoral

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[30]Central Bank of Lesotho, *Annual Report for 1996*, p.7.

[31]Mhlanga, M. L. *A Framework for the Development of a Policy on Agriculture in Lesotho*, MOA/FAO, October, 1994 p.10.

productivity, and recurrent droughts. It is estimated that even in a normal rainfall year, 60-65% of the national requirements for the maize staple food crop is met from imports, and that only 14% of the country's national food requirements is home grown[32]. Of the country's 250,000 metric tons of annual food requirements, an estimated 150,000 tons are imported each year. Sorghum is the only crop where production is almost adequate to meet local demand.

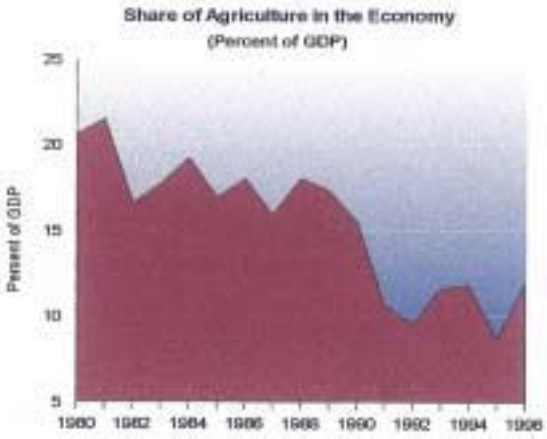

Figure 21

120. Despite the declining share of agriculture in the economy and its high sensitivity to climatic conditions, close to 85% of the population derive all or part of its livelihood from this sector. In 1985/86, agriculture was a main source of income to 34-38% of the country's households. It also provided employment to an estimated 60% of the labour force. However, in 1994/95, the sector was now a main source of income to 45-53% of the households[33]. The government therefore believes that agricultural employment and incomes must be expanded in order to avert increases in poverty that are likely to be caused by a high population growth rate, dwindling opportunities for mine labour employment in the RSA, and the sluggish growth of employment in the domestic sector.

Vulnerability Assessment

121. In assessing the potential sensitivity and vulnerability of the Lesotho agricultural sector to climate change, the NCCST used the Decision Support System for Agrometeorology Transfer Model Version 3.0 (DSSAT 3.0) which was provided by the Country Studies Programme of the USA. DSSAT 3.0 utilises soil, crop, and weather databases for crop models and application programmes to simulate multi-year outcomes of climate change scenarios and various crop management strategies. Both baseline and climate change scenarios that were used in this model (encompassing daily maximum air temperatures, daily precipitation, and daily solar radiation) came from the LMS, while characteristics of the study area came from the Lesotho Agricultural Research Division, and crop management data (fertilizer use, planting dates, plant population, crop cultivar, irrigation practices, and other crop management practices) came from Agricultural Information Services.

122. The assessment mainly involved comparing growth parameters – leaf weight, stem weight, grain weight, and dry matter weight at maturity of maize, sorghum, and beans during normal, wet, and dry years for different GCM climate change scenarios. The site that was selected for the study fell within the Southern Phuthiatsana catchment, approximately 29° 30' south and 28° 15' east. The area was found to be representative of the 4 broad agro-ecological zones of the country. The major crops that were cultivated in the study area were maize, sorghum, and beans. These are the crops that were included in the study. A few minor crops – potatoes, peas, and vegetables – that were grown in the area were excluded from the study.

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[32]Lesotho: Poverty Assessment, p.52.

[33]Bureau of Statistics, Household Budget Survey, 1994/1995, Table 19.

Potential Impacts on Maize Production

123. Model results indicate that under normal years, the projected climate change will result in higher leaf, grain and dry matter weights for maize than the baseline scenario. Models predict increases of 0.6% to 1.6% in the leaf weight, 1.7% to 3.0% in the grain weight, and 0.6% to 1.4% in the total dry matter weight. However, the UKHI predicts a slight fall of 1.6% in the stem weight, while the GFDL predicts an increase of 1.5% in the same. The increases in leaf, stem, and dry matter weight (biomass) were found to be higher during wet years. Model results showed increases of 0.3% to 3.0% over the baseline in the leaf weight, 2.0% to 4.0% over the baseline in the stem weight, and 2.5% to 3.3% over the baseline in the case of dry matter weight. However, most of the climate change models, save the CCCM, predicted a marginal decrease over the baseline of 0.1% to 0.9% in the grain weight during wet years.

124. The projected climate change showed a marked potential improvement in maize production over the baseline scenario during dry years for all growth parameters. As can be seen on Table 20, leaf weight increased by 16.8% to 18.1%, stem weight by 34.8% to 38.8%, grain weight by 18.1% to 21.2%, and total dry matter by 38.1% to 38.7%. Results further show that the planting date of 15th October gives the highest maize yield for all the four models. In the exception of the CCCM and GFDL, most of the models gave lower yields for the planting dates of 15th November and 15th December.

Table 20 Estimates of Growth Parameters of Maize Under Current Climate and Climate Change for Dry Years

Parameter	Baseline/ Current	Model Estimates			
		CCCM	GFDL	GISS	UKHI
Leaf Weight (mg)	1938.1	2288.9	2264.6	2289.6	2276.4
% above/below baseline		18.1	16.1	18.1	17.5
Stem Weight (mg)	1679.2	2264.0	2264.1	2264.1	2271.7
% above/below baseline		34.8	34.8	38.8	35.3
Grain weight (mg)	83.8	100.4	98.2	100.8	100.6
% above/below baseline		20.8	18.1	21.2	21.0
Total Dry matter weight (mg)	4403.0	6107.7	6080.0	6108.1	6102.7
% above/below baseline		38.7	38.1	38.7	38.6

Source: National Climate Change Study Team.

Potential Impacts on Sorghum Production

125. The potential impacts of the projected climate change on sorghum production showed increases in the leaf, grain, and dry matter weight over baseline conditions in normal years for all models save the UKHI. The leaf weight is projected to increase by 3.5% to 12.5%, the grain weight by 4.8% to 9.8%, and the dry matter weight by 3.0% to 9.8%. However, all models predict a marginal stem decrease of 0.4% to 1.3%. On the other hand, the performance of sorghum during wet years does not seem to be good under climate change. Most of the models save the GFDL predict a fall in the leaf, grain, and total dry matter weight respectively in the order of 10.9% to 11.6%, 2.7% to 3.4%, and 8.8% to 9.0%. The GFDL predicts a respective increase of 1.8%, 2.7%, and 2.1% in these growth parameters.

126. The projected climate change showed very dramatic potential improvements in sorghum production over the baseline scenario during dry years for all growth parameters. Table 21 shows that the leaf weight is predicted to increase by 50.6% to 59.7%, stem weight by 67.6% to 68.8%, grain weight by 108.1% to 115.1%, and total dry matter by 77.2% to 85.2% over the baseline values. Unlike maize production, sorghum production does not seem to significantly respond to changes in planting date.

Table 21 Estimates of Growth Parameters of Sorghum Under Current Climate and Climate Change for Dry Years

Parameter	Baseline/ Current	Model Estimates			
		CCCM	GFDL	GISS	UKHI
Leaf Weight (mg)	17.6	26.7	28.1	26.6	26.5
% above/below baseline		51.7	59.7	51.1	50.6
Stem Weight (mg)	119.9	201.5	202.4	201.1	200.9
% above/below baseline		68.1	68.8	67.7	67.6
Grain weight (mg)	59.4	123.5	125.8	123.2	127.3
% above/below baseline		108.6	12.5	108.1	115.1
Total Dry matter weight (mg)	260.3	463.0	481.7	461.1	466.8
% above/below baseline		78.0	85.2	77.2	79.4

Source: National Climate Change Study Team.

Potential Impacts on Dry Bean Production

127. The potential impacts of the projected climate change on dry bean production for normal years showed a decrease from the baseline across all the growth parameters for all the GCM models. Leaf weight is projected to decrease by 2.0% to 25%, stem weight by 43.6% to 45.4%, grain weight by 59.9% to 61.2%, and total dry matter by 0.4% to 0.5%. Under wet conditions, however, the models predict increases over the baseline which range from 52.5% to 57.5% for the leaf weight and 4.8% to 9.8% for the stem weight. However, they predict decreases in the grain weight that range from 36.1% to 38.3%. The CCCM and UKHI respectively predict increases in the total dry matter of 4.2% and 2.0%, while the GFDL and GISS models predict decreases of 0.1% and 0.5%.

128. The positive impact of the projected climate change was recorded for dry bean production for dry years over all growth parameters. Table 22 shows that the leaf weight is predicted to increase by 329% to 335.7%, the stem weight by 321.9% to 334.1%, the grain weight by 350% to 348.3%, and the total dry matter by 240.8% to 250%. Like sorghum, dry bean production does not seem to be seriously affected by changes in the planting date under climate change although late planting causes a minor decrease in yields under baseline conditions and a slight improvement under climate change.

Table 22 Estimates of Growth Parameters of Dry Beans Under Current Climate and Climate Change for Dry Years

Parameter	Baseline	Model Estimates			
		CCCM	GFDL	GISS	UKHI
Leaf Weight (mg)	1.4	6.0	6.1	6.0	6.1
% above/below baseline		329	336	329	336
Stem Weight (mg)	66.3	297.7	287.8	283.6	286.4
% above/below baseline		322	334	328	332
Grain weight (mg)	6.0	27.0	27.0	27.0	26.9
% above/below baseline		350	350	350	350
Total Dry matter weight (mg)	93.2	317.1	325.4	321.0	323.8
% above/below baseline		241	250	245	248

Source: National Climate Change Study Team.

Implications of the Impacts of Climate Change

129. From the above analysis, what emerges is that the projected climate change conditions, with warmer temperatures and lower precipitation, are likely to have a slight positive impact on maize production during normal and wet years. However, their impact on sorghum and dry bean production during these years is somewhat indeterminate, with dry bean production likely to fall below baseline levels during normal years. The performance of all the crops is likely to go through a dramatic improvement during dry years, leading to possibilities for reduced imports in the case of maize, and higher exports in the case of sorghum and dry beans. Wet years are likely to lead to extensive crop destruction, particularly in the case of sorghum and dry beans, while dry years will create suitable agro-ecological conditions for most of the crops.

130. It is evident that Lesotho will realize the potential of improved crop production that is predicted by these GCM climate change scenarios if the obstacles that currently face agriculture are removed and policies and programmes that encourage the country to adapt to new agro-climatic conditions are adopted. This may require the adaptation of new production technologies that could include irrigation because of the need to minimise the adverse impacts of dry conditions. Other important factors could be the success of land reform, population/land ratios and the availability of agricultural land, and the effectiveness of research and extension services.

The Forestry Sector

Situation Analysis

131. There is no comprehensive and update data on the extent of forest cover in Lesotho. What is generally known is that the country is one of the least forested in Africa. Fossil pollen analyses indicate that the predominance of grassland and heathland has existed in the country for at least 23,000 years. According to missionary records of 1833, closed low forests were restricted to patches under escarpments and in some mountain valleys, and they had difficulties in getting suitable trees for roofing as the trees were too short to make required trusses.

132. For analytical purposes, the Forestry Division has categorized forests into 5 groups: indigenous trees and shrubs, forest reserves, private tree lots, trees in individual homesteads, and trees in the urban environment. Indigenous trees and shrubs comprise the mixed evergreen and deciduous forest patches which are usually found in the valleys and gullies of the lowlands and foothills, and stands of trees and scrubby areas found in the lower mountain zone up to 2,500 metres altitude. It is estimated that these native forests cover a mere 34,685 hectares of land, with a total crown cover of 34.14% of the country[34]. The two most predominant species categories are *Leucosidea*- and *Rhus-dominated*, and these are now classified as shrubland. Their crown cover was respectively estimated at 10.88% and 11.32% of the total land area in the National Rangeland Inventory data that was gathered in 1988. On the other hand, total crown cover of all woody plants within these two categories of vegetation respectively stood at 21.24% and 12.90%, revealing the overall openness of woody growth the country.

133. Although indigenous forests are of low occurrence, they remain a very important resource to rural communities by providing fuelwood, construction materials, medicines, and forage and shelter. However, despite various efforts at conservation, the destruction of this natural vegetation continues unabated although the rate of depletion has not been determined quantitatively.

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[34]National Environment Secretariat, *Lesotho: State of the Environment Report*, p. 155 (1998 draft manuscript).

134. Forestry initiatives in Lesotho date back to 1855. Overall, their success record has been somewhat poor. Although millions of trees were planted, very few survived to harvestable age. Both bio-physical constraints, mainly harsh climatic conditions, and socio-economic factors were responsible for this limited impact. Most of the earlier efforts were directed at encouraging individuals to plant trees, either for provision of wood or for soil conservation. Planting for soil conservation purposes intensified from 1942 to 1947, focussing on communal planting in dongas or other unproductive areas. This scheme was largely unsuccessful as tree survival rates were constrained by sub-standard planting practices and the absence of supervision and protection of planted areas from human and animal damage.

135. Most of the forest reserves of today comprise trees that were planted in the lowlands and foothills through government projects from early 1970's. Table 23 shows that up to 1993/94, 10,363 hectares had been planted to trees although only 59% or 6,131 hectares were actually stocked. The Leribe and Maseru districts claim over 50% of the area planted to trees. For silvicultural reasons, eucalyptus mainly predominate in the north, pines in the drier south, and cypress at higher elevations. On the other hand, a lot of private tree planting involving small groves or patches of grey poplar or silver wattle has often taken place in dongas, usually as part of the government's soil conservation programme.

Table 23 Distribution of Woodlots by Districts, 1993/94
(Hectares)

District	Area Plantable	Area Planted up to 1993/94	Area Actually Stocked	Area Stocked with Eucalyptus	Area Stocked with Pine	Area Stocked with Other
Butha Buthe	1,087.1	946.2	507.2	351.3	128.0	27.9
Leribe	3,186.3	3,064.8	1,798.8	1,241.1	495.2	65.5
Berea	1,188.3	1,111.7	807.8	508.8	288.7	10.3
Maseru	3,953.2	2,478.4	1,590.7	534.2	927.2	129.3
Mafeteng	1,078.0	921.0	454.5	126.7	288.9	39.0
Mohale's Hoek	688.8	484.1	441.3	160.4	263.1	17.8
Quthing	955.7	925.4	426.6	48.1	350.3	28.2
Qacha's Nek	461.4	211.0	34.3	1.5	29.1	3.7
Mokhotlong	143.0	44.0	20.5	0.0	4.5	16.0
Thaba Tseka	254.0	176.0	49.5	7.3	9.0	33.3
Total	12,995.8	10,362.6	6,131.2	2,979.4	2,784.0	391.0

Source: Forestry Division, Forestry Inventory, 1995/96.

136. The extent of private or community tree planting or ownership in Lesotho is not known as there has been no comprehensive survey. In the main, they consist of small grey poplar *(Populus canescens)* or silver wattle *(Acacia dealbata)*, often in dongas. These include areas compulsorily established under the tree planting scheme of 1942-47, and government-supported planting for soil stabilisation undertaken as part of wider conservation programmes, dating from around the same period. Although many of the community woodlots are not systematically managed, they have been able to regenerate themselves into well utilised resources. This is significant in view of the heavy grazing impacts by livestock.

137. The majority of households in Lesotho plant trees, mainly for shade or fruit[35]. Although the country enjoys a climatic advantage in the production of temperate fruits, potential levels of production have in general not been realized because of poor plant care. There is a high prevalence of poor grades, plant diseases, and fruit losses, with the result that a major part of the country's requirements are met from imports.

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[35]Swallow B. and Mpemi, M. *The Marketing System for Fresh Vegetables in Lesotho*, ISAS, April, 1986, Table 3.1

138. On the whole, the government recognises the importance of trees in soil stabilisation and other sustainable land management aspects of fragile mountain ecosystems such as that of Lesotho, in providing shelter from winds, in improving the water holding capacity of catchments, in improving aesthetics, in providing building materials and meeting fuel needs of rural communities, and in impacting positively on global climate change by absorbing carbon dioxide. However, the country faces a number of management problems. Such as:

- lack of funds and other resources to effectively carry out tending operations,
- poor access to many forests which are located on the high mountain plateaux,
- meagre harvesting and illegal felling,
- large losses of stocks and tree quality resulting from drought, fire, and grazing by animals,
- poor private sector participation, and
- the decline in the government's reforestation activities in recent years.

Vulnerability Assessment

139. The bioclimatic variables of temperature and precipitation are the key factors in the productivity and distribution of terrestrial vegetation whereby the former affects the biochemical and physiological processes, while the latter affects soil processes in a given ecosystem. Because of harsh climatic conditions and periodic droughts, the current climatic conditions in Lesotho limit the scope for the regeneration of the biodiversity. An assessment of the impact of climate change on the forestry sector, therefore, needs to incorporate these two important elements.

140. Two models were used to assess the impact of various climate change scenarios on the future vegetation: the Holdridge Life Zone Classification model and the Forest Gap model. The former is a climate classification model which relates the distribution of major ecosystem complexes to climate variables like biotemperature, mean annual precipitation, and the potential evapotranspiration to precipitation ratio. With the use of the Holdridge classification scheme the country was divided into potential forest cover zones for current and future climate change scenarios.

141. The Forest Gap model, on the other hand, is used for the prediction of the plant species composition, vegetation structure, and associated productivity phenomena, as well as standing biomas through time. The model was used to track the temporal response of vegetation to changing environmental conditions under climate change scenarios that were developed earlier. Tree species and site data are required to parameterize the model for a given site. The parameters from which the optimal growth function is derived are maximum age, maximum diameter, and maximum height. The environmental response to light is described by the shade tolerance of a given species, while growing degree-days at base temperature of 0°C (biotemperature) is used to track the response to temperature, and the maximum and minimum degree-day values define the northern and southern boundaries of the geographic distribution of a species.

142. Results of the Holdridge Life Zone Classification model were compared across all the GCM scenarios. It turned out that the classification zones that were generated under GISS and OSU models closely resembled those created under the current climate. Under the latter, Lesotho is dominated by a warm temperate dry forest which covers the north, west and the south of the country. A belt stretching

from the central ranges to the east is covered by a cool temperate moist forest, while a small strip of the northern Drakensbergs along the border with the RSA is covered by a warm temperate moist forest.

143. Under climate change, the GISS scenario shows that while a warm temperate dry forest would be dominant over Lesotho, there would be a big trough of sub-tropical dry forest covering the central range and pockets of cool temperate moist forest in the west, east, and northeast. On the other hand, under the OSU scenario, the country would have more diverse bioclimatic zones where the northern half would be dominated by a sub-tropical dry forest and the southern half by a sub-tropical thorn woodland. Dividing these two would be an east-west belt of sub-tropical desert scrub which would also be prevalent in the *Senqu* River Valley and form strips along the northern and western borders. However, a large trough of a warm temperate dry forest would occupy the northern part of the southern half, and form strips along the southeast, southwest, and northern borders. The setting in of a large sub-tropical dry forest bioclimatic zone that is predicted by both GISS and OSU is likely to dramatically change the forest scene in Lesotho as warmer climatic conditions impact positively on various species. In particular, it seems quite probable that Lesotho could be a producer of sub-tropical fruit in future, although irrigation might be necessary due to predictions of relatively dry conditions.

144. Table 24 shows the Forest Gap model generated results of the performance of various tree species under climate change. It can be seen that warmer conditions would have a positive impact, albeit a marginal one, on the diameters of all the species under consideration, both indigenous and exotic. The largest impacts would occur when the plants are 20-40% of their maturity life. Climate change also had a positive impact on the biomas production of most of the tree species throughout their life spans.

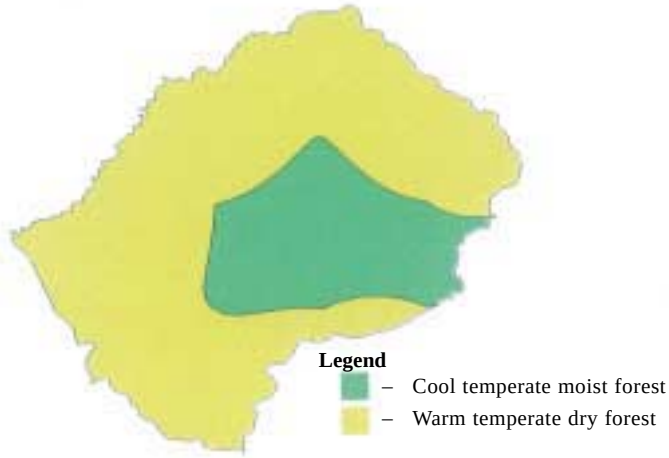
Table 24 Performance of Various Tree Species Under Climate Change

Species	Number of years to maturity	Maximum diameter at maturity, current climate (cm)	Performance under climate change		
			Incremental diameter at full maturity (cm)	Maximum incremental diameter (cm)	Year of maximum incremental diameter
Prunus persica	30	52.746	0.369	3.024	10
Populus spp.	200	82.201	0.085	0.668	41
Artemisia-afra	15	4.733	0.078	0.437	6
Leucosidea sericea	75	152.105	0.455	3.312	19

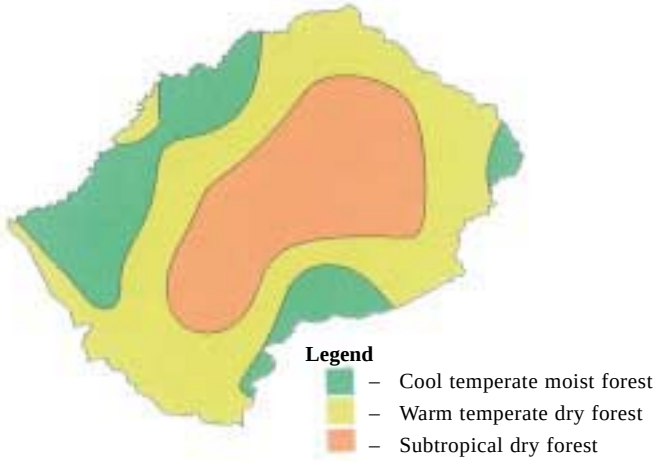
Source: National Climate Change Study Team.

145. The impact of all these positive changes should be felt throughout the economy. Improved tree performance is likely to impact positively on soil stabilization, provision of organic nutrients to the soil, and improvement of the biodiversity. On the other hand, improved biomas production should impact positively on fuelwood supply in rural areas. It is also conceivable that wood-based industries could emerge if the country took advantage of the favourable climate. This could create additional employment opportunities and improve household incomes.

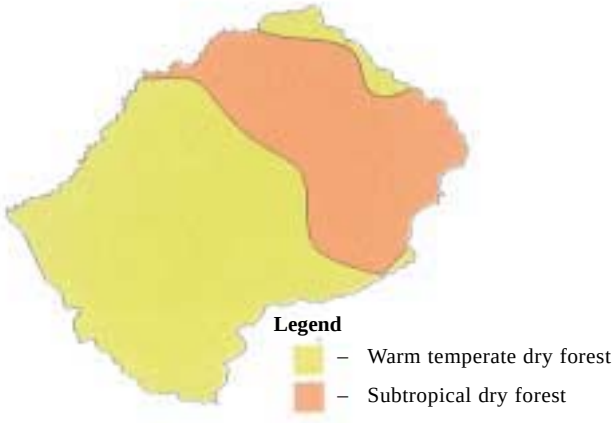
Map 3
Holdridge Classification Zones: Current Climate



Map 4
Holdridge Classification Zones: GISS Climate Change Scenario



Map 5
Holdridge Classification Zones: OSU Climate Change Scenario



The Rangelands Sector

Situation Analysis

146. Lesotho is a grassland country where there is very little natural tree growth. Figure 22 shows that rangelands make 65% of the total land area, and of this, grasslands, mainly of the climax varieties, constitute 61%[36]. The importance of rangelands is both environmental and economic. They do not only play a vital hydrologic function at the head waters of the most important catchment areas in the Southern African region, but also support a large herd of livestock whose contribution to the economy is now relatively higher than that of crop agriculture. However, over the years there has been a rapid increase in grasses of the sub-climax communities, particularly in the river valleys and in the mountain region. The main causes for this development have been cited as shallow soils, steep slopes, a cold and harsh climate, frequent drought spells, communal range utilisation, and a high incidence of uncontrolled burning. As shown on Table 25, a Karoo invader species, *Chryscoma*, currently occupies 12% of the rangelands.

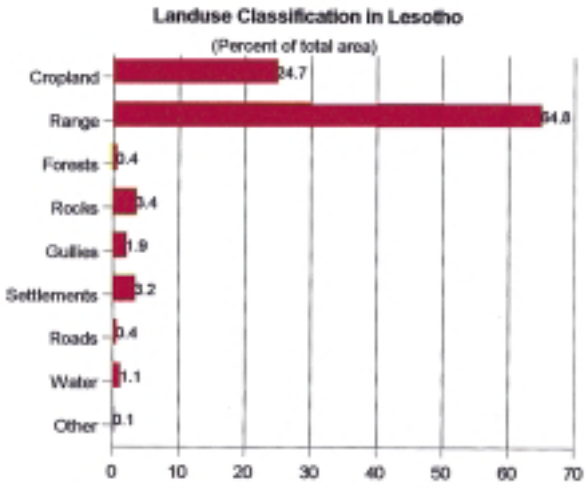


Figure 22

147. Also found within the rangelands are wetlands, tarns and mires (bogs and ferns). The wetlands, a common ecological feature in the mountain region, occur where precipitation exceeds potential evapotranspiration and normal runoff, creating a net surplus. They are commonly found in riverheads and they tend to purify and regulate the flow of water into streams. Mires are variable in size, ranging from several square metres to several square kilometres. Tarns are shallow pools ranging from a few centimetres to a few metres. These occur in depressions at an altitude of about 2,400m above sea level. The edges of the tarns consist of two hydrologic regimes, namely saturated and periodically saturated areas.

148. Rangeland utilisation has become one of the most contentious issues in the country's already fragile ecosystem. Although there is no general agreement on the level of overstocking in official and professional circles due to methodological differences, there is a consensus that Lesotho's rangelands are generally in a poor and declining condition, with widespread erosion of the top soil and an abundance of undesirable and less nutritious vegetation species. An assessment of the stocking rates and carrying capacities of the rangelands which was carried out in 1972/73[37] revealed that in overall terms, they were 41% overstocked. A similar exercise carried out by the Range Division in 1988/89[38] concluded that

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[36]This figure includes invading Chrysocoma species (12%), shrub lands (8%), and boglands (0.1%).

[37]Motsamai, B. *A Review of the Range Resources Use and Management in Lesotho*, University of Idaho, 1984.

[38]Range Management Division, *Lesotho National Rangelands Inventory Methodology: Results and History from 1981 through 1988*, MOA.

The rangeland of Lesotho is under severe livestock pressure: Mohair contributes to the economy.

The rangeland of Lesotho is under severe livestock pressure: Horses are a main means of transport in the rugged highlands.

overstocking had gone up to 75%. This figure was subsequently revised down to 50% after a review[39] of the animal unit equivalents for livestock which took into account the smaller physical size of animals in Lesotho and their lower daily feed requirements since they were geared more towards survival than for higher productivity. The revised animal unit equivalents are shown on table 26. After this revision, almost 25% of the rangelands were classified to be in poor and the rest to be in fair condition.

Table 25 Vegetation Types

Designation No.	Vegetation Type	Area (Hectares)	
		Number	Percent
1	*Hyarrhenia* grasslands	350,190	
2	*Eragrostis/Aristida* grasslands	147,555	
3	*Themeda* grasslands	474,797	
4	*Festuca* grasslands	358,316	
8	*Merxmuellera* grasslands	106,356	
–	Total Grasslands	1,437,214	47.4
5	*Chryscoma/Artemesia* low shrubs	359,680	
6	*Leucosidea* tree/shrublands	131,201	
7	*Rhus* tree/shrublands	110,771	
–	Total Shrublands	601,652	19.8
9	Shallow Rocklands	158,202	
10	Residential areas	69,431	
11	Cultivated fields	765,512	
12	Boglands	2,224	
–	Total Others	995,369	32.8
–	**GRAND TOTAL**	**3,034,235**	**100.0**

Source: National Rangelands Inventory, 1988.

Table 26 Animal Unit Equivalents for Livestock in Lesotho

Livestock Category	Animal Unit Equivalent (AU)	Number of Animals per AU
Cow+calf/Ox	0.721	1.39
Sheep	0.089	11.24
Goat	0.072	13.89
Horse	0.560	1.79
Donkey	0.340	2.94

Source: Meissner, H. H. *Report on Animal Unit Equivalents for Livestock and their Influence on National Carrying Capacity Estimates*, MOA, 1989.

149. At the present moment, it is estimated that there are 539,000 cattle, 951,000 sheep, 732,000 goats, 98,000 horses, and 175,000 donkeys which are kept under an extensive communal grazing system. Although there have been high disparities in carrying capacity data in successive periods due to general inaccuracies in livestock estimates and differences in methodologies of assessing rangeland capacity, the

[39]Meissner, H.H. *Report on Unit Equivalents for Livestock and their Influence on National Carrying Capacity Estimates*, MOA, 1989.

official view is that there has been neither dramatic decline in livestock numbers nor significant improvements in range management. According to official statistics, the size of the national herd has oscillated around the same figures for more than 20 years. Although there seems to be some relationship between rainfall and livestock numbers, it is not a significant one[40]. The major reason is that livestock is mainly kept for social and subsistent as opposed to commercial reasons[41]. A trend which shows clearly, however, is the decline in the output of livestock and quality of livestock products over the same period. This has been attributed to declining animal nutrition that has mainly resulted from degraded and overgrazed rangelands.

150. In addition to domestic animals, wild ungulates also utilize the rangelands quite extensively in Lesotho, although there are currently no significant populations. The species which are known to exist include the *redunca fulvorufula* (mountain reedbuck), *taurotragus oryx* (eland), *sylvicapra grimmia* (common duiker) *oreotraguso oreotragus* (klipspringer) *pelea capreolus* (grey rhebuck) *hystrix africae australis* (porcupine), and *ourebia ourebi* (oribi). Unfortunately, the current numbers and distributions of wild ungulates are not known.

Vulnerability Assessment

151. The assessment of the projected impact of climate change on the rangelands was carried out with the assistance of the Simulation and Production and Utilisation of Rangelands model (SPUR), which combines hydrology and soil characteristics, plant growth, animal characteristics, and economics. The hydrology/soil component of the model incorporates quantities of runoff, snowmelt, peakflow, upland sedimentation yield, and channel stream flow, while a number of parameters (standing green, standing dead, live roots, dead roots, seeds, litter, and soil organic matter for each plant species) are used to simulate the response of the same to various abiotic parameters for both cool and warm seasons. The animal component of the model uses selected animal characteristics to simulate the impact of both wildlife and domestic animals on available forage, and the impact of the latter on the former.

152. Table 27 shows various water balance parameters that were simulated for the Phuthiatsana river catchment area using GCMs. It can be seen that compared to the current climate, all models predict average deficits under climate change ranging between 52.86% and 56.35% for rainfall, between 17.77% and 23.09% for infiltration, between 5.21% and 15.26% for plant transpiration, and between 21.14% and 28.58% for deep percolation. On the other hand, soil evaporation is predicted to increase by between 15.75% and 24.04% under climate change because of increased warming. Two of these models, the UKHI and the CCCM, predict a drop in the amount of water that is available for plants respectively in the order of 2.24% and 2.02%. Only the GFDL predicted a marginal increase of 0.02% in the water that is available for plants under climate change. This finding has serious implications for the future condition of the range in the country.

Table 27 Water Balance Parameters for the Phuthiatsana Catchment Area

Parameter	Current Climate (mm)	UKHI		GFDL		CCCM	
		mm	% of Current	mm	% of Current	mm	% of Current
Precipitation	1453.32	643.41	55.73	685.16	-52.86	634.31	-56.35
Infiltration	786.96	610.55	-22.42	647.13	-17.77	605.27	-23.09
Potential evapo-Transpiration	172.57	173.50	0.54	167.29	-3.06	170.60	-1.14
Soil evaporation	9.73	15.75	61.87	24.04	147.07	19.63	101.75
Plant transpiration	160.57	152.20	-5.21	136.06	-15.26	143.99	-10.33
Deep percolation	613.22	439.15	-28.39	483.56	-21.14	437.99	-28.58
Water available for plants	958.72	937.21	-2.24	958.88	0.02	939.32	-2.02

Source: National Climate Change Study Team.

[40]National Environment Secretariat, *Lesotho: State of the Environment Report*, p.130 (1998 draft manuscript).

[41]Swallow, B. M. et al, *A survey of the Production, Utilization and Marketing of Livestock and Livestock Products in Lesotho*, MOA, May 1987.

153. An examination of the temporal distribution of water that is available for plants revealed that the amount was lower under climate change in the months of August to November, while the opposite was true for the period January to June. The impact of the availability and distribution of water that is available for plants on live biomas for selected plant species could be far reaching in future. Table 28 shows that GCMs predict a drop in the live biomas of these species under climate change in the order of 8.14% to 51.35% for warm season grass, 7.39% to 15.88% for cool season grass, 19.07% to 55.15% for warm season forb, 12.60% to 50.14% for cool season forb, and 4.31% to 44% for shrub.

Table 28 Estimates of Live Biomas for Selected Species Under Various Scenarios

Species	Current Climate Kg/ha	UKHI		GFDL		CCCM	
		Kg/ha	% of Current	Kg/ha	% of Current	Kg/ha	% of Current
Warm season grass	532.18	488.92	-8.14	259.41	-51.35	392.53	-26.28
Cool season grass	1646.45	1524.76	-7.39	1484.94	-15.88	1462.36	-11.18
Warm season forb	34.80	28.16	-19.07	15.60	-55.15	19.28	-44.58
Cool season forb	226.42	197.86	-12.60	112.86	-50.14	168.22	-25.69
Shrub	97.54	93.29	-4.31	54.59	-44.00	74.37	-23.72

Source: National Climate Change Study Team.

154. In general, most of the GCMs predict a worsening situation of forage under climate change although the results do not show clear trends (table 29). While GISS predicts an improvement of 12.8% in forage from warm season grass, the other models predict decreases of between 3.4% and 47.3%. Similarly, while GISS and the UKHI predict increases in forage from cool season grass of 11% and 18.9% respectively, the other models predict decreases of between 0.3% and 13.8%. Although there is a lot of variability between the current and climate change scenarios in relation to forage from grasses, this is not the case with forage from forbs. While the GFDL, OSUM and UKTR predict increases in forage from warm season forb of between 3.6% and 10.3%, the UKHI and GISS respectively predict decreases of 1% and 3.1%. On the other hand, only GISS predicts decreases in forage from cool season forb. The other models predict increases of between 1.4% and 13.9%. All models predict a drop in forage from shrubs, with estimates ranging between 0% and 38.5%.

Table 29 Estimates of Forage Harvested for Selected Species Under Various Scenarios

Species	Current Climate Kg/ha	UKHI		GFDL		GISS		OSUM		UKTR	
		Kg/ha	% of Current	Kg/ha	% of Current	Kg/ha	% of Current	Kg/ha	% of Current	Kg/ha	% of Current
Warm season grass	322	311	-3.4	170	-47.3	363	12.8	262	-18.7	218	-32.4
Cool season grass	123	146	18.9	106	-13.8	136	11.0	122	-0.3	112	-8.7
Warm season forb	1339	1326	-1.0	1477	10.3	1298	-3.1	1387	3.6	1414	5.6
Cool season forb	237	240	1.4	270	13.9	222	-6.2	249	5.2	259	9.3
Shrub	18	15	-18.8	11	-38.5	18	0.0	17	-4.7	12	-34.2

Source: National Climate Change Study Team.

155. In general, it does appear that forb forage harvests will result in better yields under climate change than grass forage harvests. An analysis of 18-year trends in forage harvests of both warm and cool season grasses shows that there is a downward trend under the current climate. However, this declining trend tends to worsen under climate change for almost all the models. The situation is different in the case of both warm and cool season forbs where there is an upward trend in forage harvests under the current climate. This improvement will continue under climate change, although with a lower performance than under the current climate. What this translates to is that the country is likely to lose a lot of its nutritious climax grass species and gain a lot of hardy and less nutritious species. This will have a pervasively negative impact on the livestock subsector which currently contributes an average 55% to 65% to agricultural output.

156. A comparison of the average monthly livestock forage intake over a year shows a consistently lower weight under climate change than under the current climate, with the UKHI model occupying a position very close to the latter scenario. This result translates directly into the average monthly livestock weight which shows a consistently lower performance under climate change than under the current climate. It does appear, therefore, that the poor performance, particularly of the grass forage species that is predicted by most of the GCMs, will negatively impact on the quality of livestock, leading to low output and productivity, lower farmer incomes, and increased imports to meet increased demand by a higher population. There is a constant increase in the livestock forage intake from January to July, after which there is a sharp decline until September. Under climate change, the latter period would therefore require supplementary feeding in order to sustain the increase in livestock weight through to December. However, under climate change, supplementary feeding will be necessary all the year round, a cost which most of the farmers cannot shoulder.

Soils

Extent of the Problem

157. There are five major soil categories in Lesotho:

- the rich, volcanic agricultural mollisols which are mainly found on the mountain slopes, foothills and river valleys, and in some areas of the lowlands and Senqu River Valley, and cover a total area of 1.7 million hectares or almost 50% of the country;

- the infertile and very vulnerable alfisols that cover about 300,000 hectares of widely cultivated areas in the lowlands and foothills;

- young and shallow soils of the entisol and inceptisol varieties; and

- young and deep vertisols which are clayey and are generally found all over the country. In general, most of these soils are very vulnerable to soil erosion because of steep slopes, low organic content, and poor structure (high K values).

158. The importance of the soil resource derives from the fact that close to 85% of the population derive all or part of their livelihood from agriculture. However, the suitability of the soils for agriculture is greatly influenced by topography, the highly variable rainfall pattern that includes both droughts and floods, animal and human pressure, the cultivation of marginal lands, and poor land management practices, factors which have combined to expose the country to severe forms of soil erosion. Only 9% of the country is currently classified as arable while the rest is suitable for grazing.

159. The most visible form of erosion is gully erosion, which occurs mainly in the lowlands and is most rampant on the alfisol soils. On the other hand, sheet and rill erosion occur in every region of the country. However, although gully erosion is the most spectacular form of soil erosion, it accounts for relatively small amounts of soil loss – 730,771 tons per year, as compared to sheet and rill erosion – 38,842, 399 tons per year (National Conservation Plan, 1988). The latter figure is equivalent to

Soil erosion is a major environmental problem in Lesotho

... and yet the vast majority of Basotho derive their livelihood from arable agriculture.

The latter figure is equivalent to more than 2% of the top soil every year, and at this rate, all top soil will be lost by the year 2040 unless proper conservation measures are implemented. This would result in a further depression of the yields of both croplands and rangelands.

160. Sediment load is one of the indicators of the amount of soil loss that is commonly in the country. It has been assessed in various places in the country to confirm the estimate of soil loss per annum. Table 30 indicates the sediment yield for selected stations in the country. Although the two estimates seem to differ quite significantly, this table serves to emphasise the magnitude of the problem.

Table 30 Sedimentation Load Estimates of the Major Rivers

Stations	Area (Km^2)	Tons/Km^2/year (1977 estimate)	Tons/Km^2/year (1984 estimate)
South Phuthiatsana at Masianokeng	945	1,979	940
North Phuthiatsana at Mapoteng	386	2,968	1,140
Matsoku at Seshote	662	327	7
Malibamatso at Paray	3,240	219	50

Sources: Jacobi, *S. Sediment Load Estimates of Rivers in Lesotho, 1977, and Makhoalibe, S. Challenges in African Hydrology and Water Resources*, 1984.

161. Major concerns regarding soil erosion were formerly registered by the colonial government around 1935 when a special commission was mandated to draw up a policy that would address the problem. However, the approach of the country to soil conservation has not changed much since that time. Emphasis has mainly been on the construction of structures. Lack of involvement by the affected communities in the planning and design of these structures has resulted in a lot of disinterest on their part. Attempts are currently underway to fully involve farmers, but the construction of mechanical structures still continues as the major control measure against erosion and interventions have mainly been concentrated in arable areas.

Vulnerability Assessment

162. Soil erosion is mainly influenced by the erosivity of the eroding agent, the erodibility of the soil, the slope, and plant cover. Lesotho is found to be very susceptible to all these factors. The country is very mountainous with steep slopes, has very little vegetation cover, experiences very dry periods and usually very intense and torrential rains, all conditions which are favourable to water erosion. It is therefore clear that even under the current climate, the physical characteristics of the country are such that erosion would normally take place. However, the situation has been exacerbated by the widespread prevalence of highly erodible duplex soils in many parts of the lowlands, and by unsuitable human activities.

163. Precipitation, temperature and vegetation are three very important factors in soil formation. Our GCM generated climate change scenarios indicate that in future Lesotho is likely to have a warmer climate that could possibly be accompanied by a shorter growing season and severe winter conditions. Although soil formation is normally considered to be a long-term process, warm conditions and heavy snow storms are likely to accelerate soil formation of course texture through accelerated weathering. On the other hand, the shortened growing season is likely to lead to lower levels of grass cover and forage. This, in turn would lead to heavier soil erosion and the formation of infertile soils. Such soils would lead to further declines in the productivity of agriculture in the country.

164. The predicted higher future temperatures are likely to lead to higher rates of evaporation that would reduce the amount of water that is available for vegetation. Predictions indicate that the total amount of rainfall will decrease, and the frequency of droughts and rain storms increase. These scenarios will therefore have an incremental effect on the rate and magnitude of soil erosion. Similarly, the melting of the heavier snow which is expected to fall in early winter is likely to produce torrents that may also exacerbate soil erosion because of the expected reduction in grass cover. All indications are that future soil loss is likely to be far above current levels, further weakening the capacity to support the country's biological and economic well-being, unless drastic adaptive measures are designed and implemented.

Biodiversity

Situation Analysis

165. The variation in soils, the undulating topography, and micro-climatic differences that are found within each ecological region, have led to the development of a biodiversity with a specific endemism, especially in the mountain region. Of special interest is the biodiversity of the Afro-Alpine and Afro-Montane vegetation that is found on the Drakensberg/Maluti Mountains which has made this area be classified as the 'Biodiversity Hot Spot' of Southern Africa, where 4,482 species have been identified. These comprise 3,094 plants, 993 invertebrates, 288 birds, 54 mammals, 20 amphibians, 17 fish species, and 16 reptiles. The plant species demonstrate the high level of endemism in the mountain region. Table 31 shows that 70.6% of the *asteraceae*, 83.7% of the *scrophulsriacea*, and 73.3% of the *ericaceae* were found to be endemic.

Table 31 Endemic Plant Species of the Drakensberg/Maluti Mountains

Species Family	Number Identified	Endemic Species	
		Number	Percent
Asteraceae	167	118	70.6
Scrophulsriacea	43	36	83.7
Ericaceae	15	11	73.3

Source: National Environmental Secretariat.

166. Human activity is the major threat to plant biodiversity in the country. However, protracted droughts have encouraged the advancement of the Karoo invader species which are characteristic of dryland vegetation. Historical records indicate that the western lowlands contained woodland vegetation of the species such as olea capensis, cussonia spicate, poclocarpur latifolius, euclea ramosa, and acotea bulleta on mountain slopes and hills, while valleys were characterised by tussock grass marshes, and reed and Cyprus beds. This vegetation has since disappeared and been replaced by Karoo invader species such as Rhus and Leucosedea, which today are estimated to account for 16.2% of the vegetation in the country.

167. Lesotho's topography and historical climate seem to have supported a very low mammal species diversity compared to the neighbouring South Africa. However, there are historical reports of wildlife such as blesbok, wildebeest, zebra, eland and several species of the antelopes as well as lions which were abundant. Many of these species have disappeared, and the major cause is believed to be human pressure. So far fifty-four mammalian and seventeen fish species have been identified. The majority of these species do not show any clear habitat distribution patterns. Only the Maluti minnow seems to exhibit a clear

ecological interaction as it is found only in the mountain region. The steep slopes of the mountain region result in high flow velocities at the upper reaches of many streams during the rainy season, a condition which confines many species to the lower streams where the velocities are lower. During the dry season, only the species which thrive in muddy waters and under rocks survive since many rivers dry up.

168. Desertification has generally been accepted as being very detrimental to the biodiversity of the country. It is perceived as a phenomenon that consists mainly of two elements: loss of biological diversity, and land degradation. The loss of some of Lesotho's biodiversity has been directly associated with the siltation and drying up of many rivers and their sources, increased aridity and disappearance of many wetlands and marshlands, accelerated soil wash and loss of soil fertility, reduced arable, and reduced vegetation cover. These are all elements of advancing desertification. The mountain region used to be a very important breeding area for migratory birds from Europe. With the gradual destruction of wetlands and the disappearance of some species on which these birds thrieve, less migratory bird species still make this region their breeding ground.

169. The status of Lesotho's biodiversity in agriculture, forestry, and rangelands has already been described in detail in other parts of this chapter. It should be emphasised, however, that with increasing conservation and environmental awareness in recent years, and recurring droughts, there has been a move towards species conservation and expansion through conservation and seeding programmes, and through the development and introduction of new breeds and drought resistant species.

Vulnerability Assessment

170. In general, tropical regions tend to have more species of animals and plants than higher latitudes due to more favourable climatic conditions in the former. Since Lesotho is likely to experience a warmer climate in future, it is likely that the species diversity will improve, either through migrations, or through improved adaptation of imported species. On the other hand, with lower rainfall in the spring and summer seasons, it is those species which thrive in dryland areas that are likely to proliferate in future, hence the prediction of warm temperate/sub tropical dry forests by a number of GCM models. The future might therefore, see an improvement in the number of herbal, floral, and reptile species which are characteristic of dry forests. Unfortunately, indications are that the current global warming will result in a rapid change which might not allow gradual changes in the species genetic makeup to adapt to drier conditions, hence if no special efforts in conservation are carried out, many species, including endemic plants, are likely to become extinct.

171. Drier spring and summer conditions that will be introduced by climate change are likely to force farmers to adopt drought resistant species, yet the shorter growing season is likely to turn their attention to those species which have faster maturity. This might have serious implications for the diets of many subsistent farmers. On the other hand, warm temperatures are likely to increase the population of fish and other water-based species in the larger water masses such as the LHWP dams. However, severe winter temperatures and snow are likely to alter the habitats of many of these species in smaller streams, reducing their survival possibilities.

172. A number of disasters which are detrimental to biodiversity are foreseeable under climate change. Dry conditions in spring are likely to exacerbate the problem of forest and range fires whose increased frequency would not only be detrimental to forage and biomass on which rural people and some species directly depend, but could exterminate a large number of species. On the other hand, some of the conditions that are predicted for winter such as ghastly winds, hail storms, floods, and snow storms are also likely to considerably reduce the stock numbers of many domestic animals and wild ungulates, as well as that of many plant species. In addition, since the models predict lower average annual precipitation figures, it may not be possible to reverse the current processes that have led to the destruction of wetlands and their biodiversity.

The Health Sector

Baseline Issues

173 It is generally acknowledged that improved health is dependent on a number of factors including:

- access to safe and adequate water supplies: and
- improved hygiene and sanitation.

Any occurrences that will tend to undermine these two factors, therefore, are bound to also undermine the health status of the population. It has already been shown that the provision of safe water in adequate quantities is still a pervasive problem in Lesotho, particularly in rural and peri-urban areas. On the sanitation side, what emerges from the 1994 Water Supply and Sanitation Action Plan is that Lesotho has a very low coverage, with only 20% of the population described as having adequate sanitation in that year. As shown on Table 32, the three mountain districts of Qacha's Nek, Mokhotlong, and Thaba-Tseka are generally worse-off than their lowland counterparts. The ventilated and improved pit latrine (VIP) is by far the most popular sanitation technology in the country, both in urban and rural areas. Sewer toilet facilities are confined to urban areas where a mere 3-4% of the population has access to such facilities.

Table 32 Rural and School Sanitation Coverage, 1994

District	Household Coverage, 1994 (% of Population)				School Coverage, 1994*		
	VIP	Other Latrines	Total Coverage	Unserved	Fully Provided	Partially Provided	None/ Insanitary
Butha-Buthe	32.0	–	32.0	68.0	–	54.0	46.0
Leribe	14.0	–	14.0	86.0	22.0	5.0	73.0
Berea	5.6	0.4	5.9	94.1	65.0	2.0	32.0
Maseru	33.0	–	33.0	67.0	13.0	–	87.0
Mafeteng	38.0	10.0	48.0	52.0	60.0	–	54.0
Mohale's Hoek	46.4	–	46.4	54.0	–	–	100.0
Quthing	5.0	5.0	30.0	70.0	25.0	–	75.0
Qacha's Nek	na	3.0	8.0	92.0	7.0	–	82.0
Mokhotlong	na	na	7.0	93.0	na	na	na
Thaba-Tseka	na	na	7.0	na	14.0	–	86.0

Source: Ministry of Economic Planning, *Water Supply and Sanitation Action Plan*, Volume II, November, 1995.
* One latrine to 30 pupils

174. In general, dry on-site sanitation systems like pit latrines do not pose environmental dangers as the soil is generally fine, and the ground water table deep (usually±30 metres). However, where they are not properly constructed and maintained, these may present health hazards. In this direction, a survey carried out in 1995[42] found that only 25% of the latrines met the "VIP" standard which includes

[42]TAMS Consultants, *Water Resources Management: Policy and Strategies*, Final Report, Ministry of Natural Resources, September, 1996, Annex N.

a fly screen, concrete slab, and intact door. Similarly, the emptying of conservancy tanks is sometimes infrequent due to shortage of equipment. Poorly maintained sewerage systems and conservancy tanks sometimes pose serious environmental and health threats because of frequent occurrences of blockages, overflows, and leakages. It is clear, however, that on-site sanitation systems will remain the most cost-effective solution to environmental and health protection in resource-poor Lesotho for some time.

175. A recent study[43] shows that Lesotho generates an estimated 802,390 tons of dry waste per annum[44], of which only 5,025 tons or less than 1% is recovered for recycling. The waste generation capacity has increased quite significantly in recent years in the face of very unsatisfactory waste collection and disposal practices. With a very low or non-existent collection service, particularly in peri-urban and rural areas, and poor regulatory control, on-site and illegal dumping of waste is very common, with heavy premiums on health and the environment. In addition, the location of many waste disposal sites was not subjected to environmental impact assessments, having emerged as quarry sites. Today, a good many pose serious threats to surrounding communities and water sources.

176. There is as yet no incentive system to encourage waste generators to adopt cleaner production processes and minimise waste generation. On the other hand, due to the absence of a regulatory framework, some toxic and hazardous waste materials and substances find their way to dump sites and water sources, threatening the health of scavengers and exacerbating the problems of water and soil pollution. Although the growth of the recycling industry in the RSA, and worsening unemployment and destitution in Lesotho, seem to have stimulated interest in waste collection, the current waste management system in remains a serious threat to both health and the environment.

177. So far Lesotho is free from many climate-related diseases that are common in tropical countries because of her altitude and severe winter temperatures. However, climate-related, life-threatening fatalities frequently occur where people die from exposure to severe winters that sometimes include prolonged snowfalls. The complex relationship between water quality and availability and sanitation and hygiene on the one hand, and disease prevalence on the other, is well demonstrated in Lesotho where respiratory tract infections, gastro-intestinal, genito-urinary, and skin diseases top the list of reported cases, together constituting 55% of these cases. According to hospital admission records published by the Bureau of Statistics, skin diseases, digestive diseases, diarrhoea with or without dehydration, and intestinal parasites are very common, particularly among children of the 0-4 year age group. Outbreaks of typhoid are also common during the summer months of December through February.

Vulnerability Assessment

178. GCM generated climate change scenarios indicate that Lesotho is likely to have a warmer climate in future. This could lead to invasions by tropical diseases for which the country is currently ill-prepared. The southward movement of the malaria belt to areas like the KwaZulu/Natal Province of the RSA is a good example of such possibility. On the other hand, dry conditions that are likely to set in during the spring and summer months might lead to further increases in the incidence of respiratory tract infections like tuberculosis, and waterborne diseases like typhoid. Figure 23 shows that some of these diseases are already on the increase despite phenomenal improvements in medical services in recent years. The GCM scenarios also predict the setting in of severe winter conditions in future. This is likely to exacerbate the problems of acute respiratory infections, particularly in those rural areas where poverty is very severe and energy resources very scarce.

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[43]Mhlanga, M. And Gulilat, T. *Waste Management in Lesotho: A Baseline Study*, National Environment Secretariat, July 1997.

[44]This figure excludes an estimated 72,440 scrap vehicles which are a common feature in peri-urban and rural areas.

179. Improvements in biomass resources and biodiversity that is predicted by GCM scenarios could lead to gains in the health of some of the rural communities in future. Increased biomass could lead to improvements in energy sources and easy availability of construction materials. On the other hand, improvements in biodiversity could lead to more effective herbal medicines as the species composition proliferates. Together with the predicted improvements in the performance of crops such as sorghum and dry beans, the future biodiversity is likely to have a positive impact on the nutritional status of the population. However, improved biodiversity could also carry adverse impacts as it might encourage the southward migration of crop-threatening pests such as locusts and some venomous snakes which are currently unknown in Lesotho. Indications are that severe droughts could be more prevalent. This will have the potential to undermine the nutritional status of rural communities and encourage the spread of water-related diseases. Under such conditions, unless massive injections of food donations could be mobilised, the disease situation might worsen.

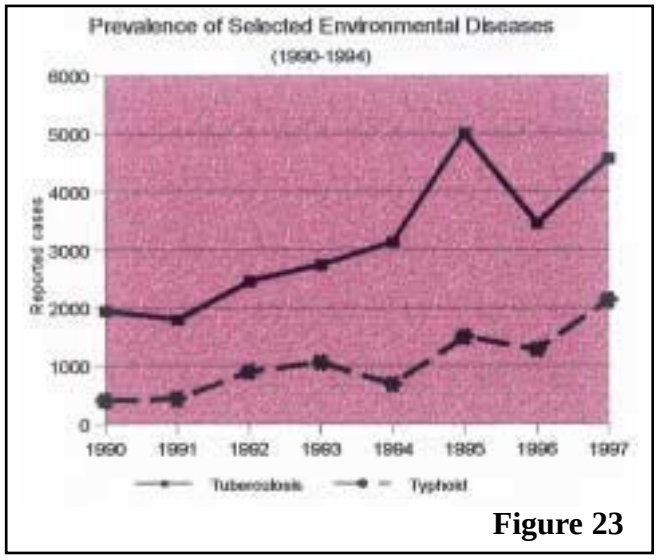


Figure 23

Culture

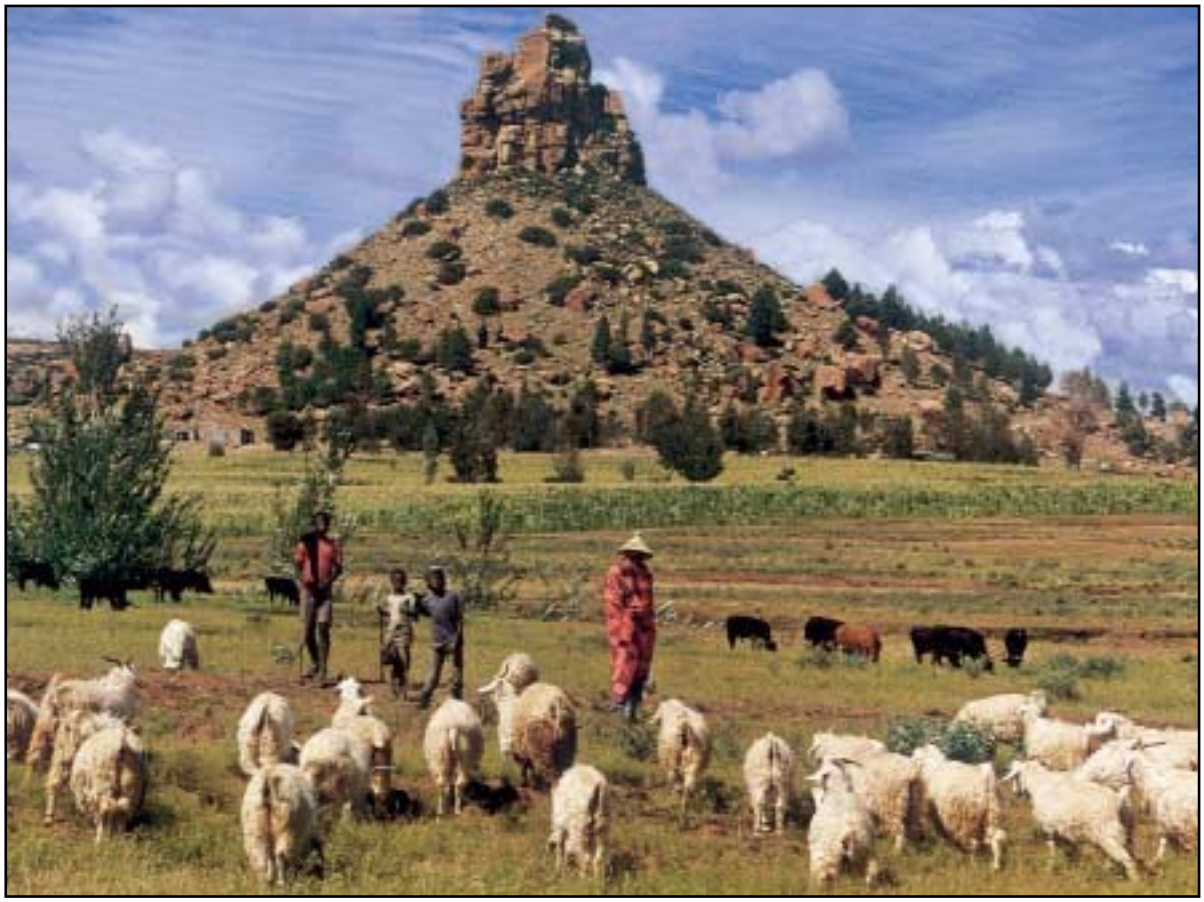
Historical and Situational Context

180. *Basotho*[45] are traditionally an agricultural nation whose daily, seasonal, and annual activities have always been inextricably intertwined with climate. In the absence of sophisticated technology that could facilitate large-scale processing and storage, the majority of the nation has always been directly dependent on the land, rainfall, temperature, and precipitation of the day, and all that nature can give such as the available river flow, wells and springs, and flora and fauna species. The fact that even today, close to 85% of the population derives all or part of their livelihood from agriculture underlines the importance of this traditional relationship which is embodied in the national slogan *khotso pula nala* which stands for "peace, rain, and plenty".

181. Like wars, climate has formed important reference points in the oral history of *Basotho*. For example, when the rains failed, as has often been the case, crops failed, livestock starved, and people depended on the more resistant species of game and edible plants. Historical milestones such as droughts were given specific names which could easily be identified in terms of number of years. Children born during such periods were often given related names for age identification purposes. In general, events of extreme climatic occurrences such as severe droughts and famines, severe hail and snow storms, climate-related epidemics like locust invasions, etc. therefore formed important boundaries of historical epochs in *Basotho* oral history.

182. Climate also played an important role in the determination of *Basotho* settlement patterns and

[45]A Southern African ethnic grouping who mainly speak Sotho languages and constitute the majority of Lesotho citizens.



Livestock plays an important role in the life and culture of the Basotho.

The winters can be harsh, but the Basotho plan their huts to minimise the effects of low temperatures through proper orientation of the huts and use thatched roofs.

architectural designs. In the past, the settlement structure mainly comprised compact villages which were located on sheltered west-facing mountain/hill slopes which were overlooking valleys where building materials were in abundance (wood and reed), where there were reliable springs and wells, where there was adequate grazing for animals, where there was fertile soil for tillage, and where there was adequate sunshine and shelter from severe weather. The mud/stone huts with thatch roofs were cool in summer and warm in winter, and their north orientation was designed to retain heat by capturing the winter sun.

183. Livestock has always played an important role in the history of *Basotho* . In addition to the enrichment of the household diet by providing meat and milk, it provided the fur and skins that were essential for clothing. Even today, livestock still provides the basic ingredients for feasts and important rituals (religion, birth, death, marriage, initiation, etc.), and, above all, it provides social security. On the other hand, grains and vegetables played an important role in balancing the diet. Sorghum was the most important staple food crop long before the introduction of maize and wheat in the mid-19th century. It is a rich crop that is used for making porridge, bread, and beer brewing. However, despite its nutritional superiority, its consumption has gradually gone down due to the absence of processing facilities. On the other hand, crop stover is important as a supplementary animal feed in winter.

184. Wild ungulates have not played a lesser role in the culture of *Basotho* . In addition to the supplementary diet, these provided hides for colourful clothing. On the other hand, wild plants enriched the nutritional value of the diet and supported a host of other activities such as construction, crafts, tools, shelter, grazing, medicine, and sorcery. They also enhanced the environment by providing aesthetics. As a result, *Basotho* understood the importance of maintaining an ecosystemic balance involving plants, animals, and the environment. They also understood the interplay between these three important artifacts of their culture with climate. Hence where signs of environmental fatigue were beginning to show, the community would abandon the land for some time to enable regeneration to take place. A system of transhumance was also practised between the lowlands and mountains to allow seasonal regeneration of forage and biomass. Similarly, water sources and wetlands were protected and hunting regulated to ensure flow and species sustainability. However, a lot has changed since the inception of population pressure, severe overgrazing, and the resultant land degradation.

185. Today, *Basotho* culture has been influenced by a host of adverse factors – water scarcity, widespread poverty, inequitable land distribution, the migration of large numbers of households to relatively flat lowland areas, recurrent droughts, the shortage of traditional building materials and the severe reduction of biodiversity resulting from environmental degradation and progressive desertification. These changes have taken place when other cultural practices are still entrenched, leading to very severe imbalances in the ecosystems, and to extensive damage to the environment. For example, as the quality and quantity of the country's range resources depreciate, domestic animals are still largely kept for non-commercial or traditional reasons, hence the general resistance to destocking programmes. On the other hand, the shortage of woody vegetation has forced rural communities to adopt animal dung and paraffin as main energy sources for cooking, heating and lighting, leading to serious levels of respiratory tract infections.

Vulnerability Assessment

186. There is no doubt that present climate trends have severely dented the culture of *Basotho* people. However, GCM generated climate change scenarios seem to indicate that some of the future conditions might be favourable to cultural restoration. For example, improvements in biodiversity that is predicted by these models might lead to improvements in traditional medicine. Similarly, the predicted improvements in biomass are likely to reduce the use of dung and paraffin for energy sources, while improvements in sorghum and bean production are likely once more to lead to higher consumption of these nutritionally rich crops, provided there are technological improvements on the processing side. However, increasingly severe winters could lead to further migrations of people from the mountains to the lowlands region, resulting in further environmental damage in the latter region, a separation of communities from their ancestral lands, and less dependence on traditionally valued livestock.

187. The improvement in biomass that is predicted by climate change scenarios is likely to improve the availability of traditional construction materials. However, it is unlikely that there will be a reversal of house architectural designs and construction material use since the switch to concrete blocks and corrugated iron is associated with a higher social status. Dry future spring and summer conditions, reduced forage yields, and severe winter spells might reduce the quality of animals and animal products, and possibly reduce the dependence of rural communities on livestock, leading to higher levels of poverty and changes in the nature of traditional rituals. Increasing rural poverty is likely to push large portions of the rural population to urban areas in search of survival.

188. The migration of rural populations to urban areas as is predicted under climate change scenarios is bound to weaken the social fabric of ***Basotho***. For example, the water collection journey serves a multiple purpose. It facilitates socialisation amongst young girls and between girls and boys, it provides a forum for meetings amongst village women, it facilitates courtships, etc. The drying up of water sources and associated migration of people to urban areas would alter the lifestyles of many as the rural fabric weakens. Worse still, there is likely to be a shift in the day's activity pattern for many as the household chores change with increased urbanization.

Integrated Vulnerability Assessment

An integrated vulnerability assessment was undertaken to examine cross-sectoral climate change impacts. The matrix shows in appendix 6 the summary of the assessment.

Conclusion

189. This chapter characterises Lesotho as a small, landlocked, poor country that has an extremely vulnerable ecosystem, and which is highly vulnerability to climate change. The country is already paying heavy premiums as a result of the impacts of global warming. This is evidenced by the increasing frequency of natural disasters, devastating droughts, and emerging signs of progressive desertification. The fragile soil/terrain characteristics, erratic climatological conditions, difficulties of realizing the full potential of agro-ecological conditions, the growing level of poverty which is currently estimated at more than 50% of the households, and the relative deprivation of the inaccessible mountain region which makes up more than 60% of the country, ranks Lesotho as one of the most highly vulnerable developing countries.

190. The future climatic conditions that are predicted by GCM climate change scenarios show that by 2075, Lesotho might be a warmer country with less precipitation, particularly during the cropping season. The lower yield in both surface and sub-surface runoff that goes with this finding indicate that the country could experience an absolute water scarcity as early as 2045 unless bold adaptation strategies are adopted. These climatic conditions, however, are likely to impact positively on crop production and productivity, provided that the country could adopt and implement appropriate agricultural policies and practices. Similarly, the future climatic conditions are projected to impact positively on forest species. Improved tree performance is likely to have far reaching impacts on other critical variables such as soil stabilization, provision of organic nutrients to the soil, and improved biodiversity, while improved biomass production could improve the rural fuel supply situation and promote the growth of rural industries. The projected development of subtropical bioclimatic conditions over Lesotho could make the country one of the major producers of subtropical fruit, particularly in sheltered valleys, provided there could be adequate irrigation development to counter the impacts of dry conditions.

191. The future climate scenarios predict adverse impacts on forage production, particularly of the grass species, that could lead to lower animal weight and productivity, leading to lower incomes for livestock farmers, and increased poverty for those who depend on agriculture for livelihood. Similarly, the projected increased precipitation conditions in autumn and winter could lead to the worsening of soil erosion, while warm climatic conditions could push the belts of many tropical diseases such as malaria southwards, demanding resources for which Lesotho is currently ill-prepared. Both positive and negative impacts of the projected climate change are likely to have a pervasive impact on the Basotho culture as the population seeks to adjust to new ecosystemic conditions that are created by new scenarios, and as the biodiversity changes.

5 NATIONWIDE POLICIES AND MEASURES

Introduction

192. Article 3.1-2 of the UNFCCC calls on all parties to the Convention to protect the climate system for the benefit of present and future generations on the basis of equity and in accordance with their common but differentiated responsibilities and respective capabilities, giving full consideration to the special circumstances of developing countries, particularly those that are vulnerable to the adverse effects of climate change. Further, Article 3.4 emphasises that in promoting sustainable development, policies and measures to protect the climate system against human-induced change should be appropriate for the specific conditions of each party, and should be integrated with national development programmes. In pursuing these principles, Article 4.1(f) requires that all parties should take climate change considerations into account in their relevant social, economic, and environmental policies and actions, and should carry out appropriate methods, such as national impact assessments, with a view to minimize adverse effects on the economy, on public health, and on the quality of the environment, of projects or measures that are undertaken at the national level to mitigate or adapt to climate change.

193. Although Lesotho joined the international community in a worldwide concern about negative impacts of global climate change by signing, together with 155 other countries, the UNFCCC at the Earth Summit in Rio de Janeiro, in June 1992, and went on to ratify the same in March, 1995, there is as yet no coordinated national policy to deal with this pervasive problem. However, a number of sector-specific policies have been drawn up and incorporated into national programmes in the areas of environment, waste management, energy, land use, agriculture, health and sanitation, etc. In all of these cases, international guidelines have been closely followed, with the prioritization of areas of policy concern taking into consideration the country's limited resources. These policy measures are discussed in detail in the next chapters.

194. The last chapter has shown that Lesotho is one of the poorest and critically vulnerable members of the Convention. Although a number of policies which have a bearing on the abatements of GHG emissions or reducing their adverse effects have been articulated in various sectors, this country faces severe challenges in the implementation of these policies because of resource and institutional constraints. However, a number of initiatives have been introduced with massive injections of donor assistance. Although attempts are underway to restructure the country's budget resources, with a view to meeting the provision of the Convention it is clear that in order for Lesotho to take its rightful place under the Convention, the country will continue to depend on such assistance for some time.

195. In assessing the country's performance under the Convention and, in particular, the mitigation and adaptation policies and measures that are elaborated in this and subsequent chapters, consideration should be given to the country's status as a poor and critically vulnerable small land-locked country that is not only very prone to natural disasters, but is part of a fragile ecosystem that is already showing advanced signs of desertification. Lesotho is aware of its obligations under the Convention. However, its ability to develop, adopt, and implement mitigation and adaptation strategies will continue to depend on the support that the country will be able to mobilise from both Annex 1 and Annex 2 countries.

Poverty and Climate Change

196. Serious nationwide concern about the effects of climate extremes such as droughts, snow storms, and other climate-related disasters in Lesotho began in the early 1980s at which time the country sought donor

assistance to set up early warning systems and improve disaster preparedness. Progress has, however, been hampered by the fact that the country has no consolidated climate change policy. Actions have largely been undertaken on a piecemeal, sectoral basis as opposed to adopting nationwide strategies which have sustainable impacts. There is a general consensus, however, that poverty poses the biggest challenge to the reduction of Lesotho's vulnerability to the impacts of climate variability and increased global warming. As such, the country has put some priority on employment creation, poverty reduction, and social development.

197. The issue of poverty has received a highest consideration in recent years with the Sixth National Development Plan 1996/97-1998/99 adopting poverty reduction as a leading development objective and major strategy of achieving the overall goal of sustainable human development. Following a number of inter-sectoral consultations on poverty in 1995 and 1996, the Ministry of Development Planning organized a workshop on poverty reduction in February 1997 at which strategies for programme prioritization were discussed. This was followed by a donors' conference in Geneva in November 1997 which carried the theme *Poverty Reduction Within the Context of Good Governance*. At this conference, the following areas of concern were isolated for focussed intervention:

- Improving governance for poverty reduction by embarking on public sector reform, privatization, private sector development and decentralization;
- Improving access to social services by targeting the poor and expanding social and public assistance programmes;
- Improving employment and income opportunities for the poor by expanding the informal sector and special employment schemes;
- Establishment of social funds as a way of funding programmes of delivery institutions and other community-based organizations; and
- Managing poverty-related environmental degradation.

198. There is a general realization that adverse climatic conditions, the pace of population growth and general low productivity weigh heavily against agricultural production, on which the majority of rural people are directly dependent, keeping pace with population growth. The above measures are therefore intended to augment direct measures such as increased budgetary allocation to social sectors, special employment schemes, and social funds.

The Planning Framework

199. Lesotho's development programmes are planned and executed within the context of development plans which, until 1996/97, were of 5-year duration, but reduced to three year duration. The plan runs concurrently with the Public Sector Investment Programme (PSIP), a document that details out anticipated capital expenditures project by project for three fiscal years. Although the national plan incorporates summaries of sectoral plans, the PSIP represents an attempt to match implementable policies with resources. On the other hand, each year's investment programme is further refined into an annual budget that is normally presented to Parliament at the beginning of every fiscal year. The government also enters into bilateral and multilateral framework agreements that guide the flow of donor inputs.

200. In all of the planning documents referred to above, there is no direct reference to the subject of global climate change for the following reasons:

- the greenfield nature of concerns about climate change

and low awareness at the policy levels of the issues that are involved, and

- until recently, the absence of a focal institution to analyse public investment programmes in terms of their actual and/or potential contribution to global warming, to make regular reviews of resource allocation in favour of those activities or sectors that reduce the country's contribution to global warming, and to monitor progress in both mitigative and adaptive activities aimed at reducing greenhouse gas emissions and/or their impacts.

201. It is significant that the Sixth National Plan provides for the application of the science of meteorology for the attainment of environmentally sound and sustainable socio-economic development in the country[46], and to reduce the country's vulnerability to disasters through interventions in water supply and sanitation, primary health care, and nutrition and food security. This is seen to be essential if the government has to meet the needs of a steadily rising population.

202. The Sixth Plan further calls for the establishment of some working mechanisms for effective disaster management. In this regard, the government considers the development of a National Action Plan on Climate Change as a further advancement of these piecemeal sectoral efforts, and a modest step towards the development of a coordinated policy instrument that will not only guide Lesotho's obligations under the UNFCCC, but contribute toward sustainable economic development in the country.

203. Since the current institutional framework that coordinates and monitors activities relating to climate change is still at its formative stages, it has no capacity to directly influence either sectoral programme content, or the nationwide allocation of resources. However, results of studies that it has already commissioned, the participatory nature of the preparation of the climate change action plan, as well as past and planned public campaigns, will certainly go a long way to sensitize both policy makers and planning authorities about the hazards of a global climate change and possible mitigative and adaptive measures that Lesotho could promote. As a first step towards such sensitization, activities under this national action plan on climate change (NAPCC) have been carefully selected to dovetail into existing national and sectoral development plans.

Financial and Budgetary Measures

204. Increased government commitment to adapt to the impacts of climate change, and, therefore, alleviate poverty through budgetary measures require sound economic management and the formulation and implementation of macro-economic policies that are compatible with rapid economic growth, prudent management of fiscal policy and the public sector investment programme, interventions to reduce the negative impacts of development activities, securing people's participation in development, and constituting effective delivery institutions. These are some of the policy objectives that are embodied in Lesotho's Sixth National Development Plan. At the present moment, however, weaknesses in public sector financial management seem to undermine the efficient mobilization and allocation of the country's financial resources to those sectors through which vulnerabilities could be relaxed. Technical assistance has thus been secured for improving technical capacities of the government to plan financial and budgetary systems on a sustainable basis.

205. Despite the government's concern about climate change and poverty, there has been very little shift in the relative allocation of resources amongst various sectors in favour of those that are directly involved in poverty reduction. It can be seen on Table 33 that the development budget allocation to sectors that are relevant in directly tackling poverty and reducing vulnerability (agriculture, health, and

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[46]Ministry of Economic Planning, *Sixth National Development Plan*, p.247.

natural resources) have not changed significantly between 1996/97 and 1998/99, having gone down from 22.4% of the total development budget in the former year to 21.4% in the latter. In fact, what is worrying policy makers today is that despite improvements in the country's fiscal and economic performance since the adoption of IMF/World Bank supervised structural adjustment programmes, poverty seems to be more widespread, environmental degradation is worsening, and the productivity of agriculture continues to plummet. Some of the officials blame the current situation on the failure of previous efforts to target assistance to the intended beneficiaries, (the poor); failure to effectively coordinate programmes at the local level, and the low capacity of delivery institutions. These problems will be the focus of attention in the next planning cycle.

Table 33 Budget Allocation by Source, 1998/99
(M'000s)

Ministry	Budget Allocation Source, 1998/99					Allocation Share 1996/97
	Government	Donor-Grant	Donor-Loan	All Sources	Percent	
Administration	38,037	19,341	19,908	77,286	11.5	13.1
Agriculture	6,758	32,042	11,012	49,812	7.4	5.4
Health	11,055	1,888	5,135	18,078	2.7	5.0
Natural Resources	17,588	23,120	35,000	75,708	11.3	12.0
Education	19,100	22,597	26,000	67,697	10.1	12.1
Trade & Industry	22,250	4,375	3,580	30,205	4.5	1.4
Works	81,761	15,382	56,230	153,373	22.8	27.8
Defence*	11,800	–	–	11,800	1.8	–
Local Government	13,700	725	–	14,425	2.1	0.1
LHWP	36,814	23,319	37,712	97,845	14.6	23.1
Social Fund	75,000		–	75,000	11.2	–
Total	333,863	142,789	194,577	671,229	100.0	100.0

Source: *Estimates of the Kingdom of Lesotho for the Year from 1st April 1998 to 31st March 1999.*
* Figure for 1996/97 included under administration.

Special Employment Schemes

206. One of the oldest efforts by the government to address problems of poverty and the environment in the rural areas involves utilizing food aid to combat soil erosion, to construct foot bridges in order to contain flood disasters and to facilitate communication during the rainy season, to construct access roads and rural aerodromes, to construct clinics and other community assets, and to plant trees to meet rural energy requirements. With half of the households, mainly in rural and mountain areas, classified as poor, the country has relied on massive inflows of food donations to cushion the impact of dry weather spells, food deficits, and other climate-related disasters since early 1970s. Food aid still plays a vital role in rural development. According to WFP records, a total food allocation of US$ 16.8million was made between 1989 and 1994 in support of the construction of feeder roads and foot bridges, and for forestry and soil conservation activities.

207. Projects of special employment schemes have been found to represent real aspirations of the rural communities amongst whom they are initiated, prioritized, and implemented[47]. They serve a multipurpose

[47]UNDP/ILO/Ministry of Labour and Employment, *Review and Analysis of Special Employment Schemes in Lesotho*, April 1998, p.42.

role of increasing the access of rural communities to socio-economic services, creating rural assets, creating employment and augmenting rural incomes, enhancing environmental protection, and improving the rural diet. The government is, however, aware that in road infrastructure projects, environmental measures were in the past merely confined to the immediate vicinities of the roadway right of way. This, together with poor drainage designs and inadequate maintenance resources, often resulted in extensive scouring, donga development, and poor aesthetics. Attempts are being made to address these shortcomings in future programmes. A 1996 study showed that these schemes employed an estimated 12,300 people or 12% of those who were estimated to be unemployed in that year. However, at the moment most of the schemes are heavily dependent on donor funding for their programmes. Donor financing averaged M26million per annum between 1989 and 1994.

Social Funds

208. The concept of social funds is new in Lesotho. The country has, however, a long history of experience with credit schemes, revolving loan funds and trading accounts which all collapsed because of low community involvement in their planning and running, and due to the general low performance of agriculture in the case of those schemes whose activities were limited to this sector. On the other hand, experiences with special employment schemes such as the Lesotho Highlands Revenue Fund (LHRF), the Labour Construction Unit (LCU), and the Civil Works Section (CWS) of the Ministry of Works have shown that social funds could be effectively used as special funding mechanisms for demand-driven economic and social infrastructure projects. They also constitute a powerful mechanism for the empowerment of delivery institutions – local governments, NGOs, community-based organizations (CBOs), etc. – by directly involving them in the design and implementation of economic and social infrastructure and other activities in their own areas.

Table 34 Types of Projects to be Funded from the LFCD by Sector.

Sector	Type of Project	Project/Asset Management
Health	Health Centre Community	Health post Community
Education	Primary Schools Community	Nursery Schools Community
Water & Sanitation	Rural water supplies Urban water supplies VIP latrines	Community WASA/public works Community
Roads	Footbridges Feeder roads	Community LCU/public works
Natural Resources	Soil conservation Tree planting Donga reclamation Dam construction	Individuals/community Individuals/community Individuals/community Min. of Natural Resources/ public works
Trade	City markets Rural Markets	Individuals/community Individuals/community
Agriculture	Small scale irrigation Improved vegetable production Small dams Tree planting	Individuals/community Individuals/community Individuals/community Individuals/community
Community Development	Community halls	Community
Income Generation	Cottage industries Small-scale manufacturing Livestock production Vegetable production	Individuals/community Individuals/community Individuals/community Individuals/community

Source: Ministry of Economic Planning, *Draft Operational Manual for Lesotho Fund for Community Development*, Maseru, May 1998

209. The LHRF has in the past suffered a number of operational constraints – inadequate skill levels, unsatisfactory operational policies and procedures, unclear criteria for appraising proposals, and lack of targeting guidelines. These weaknesses led to a reformulation exercise which resulted in the launching of the Lesotho Fund for Community Development (LFCD) in May, 1998. The main objectives of this fund, to be run by an independent board, are to finance demand-driven community projects, public works, and income generating projects, and to build capacity amongst participating institutions. Table 34 (see page 69) gives details of the classification of different types of projects to be financed by sector. A detailed operational manual has been prepared to guide activities of the fund. In the meantime, the government has begun to set up a board of directors and a fund Management Unit whose major function will be appraisal, funding, monitoring, evaluations, and training.

210. Another addition to social funds is the recently constituted Roads Fund which has been set up through the World Bank supported Road Rehabilitation and Maintenance Project. The aim of the fund is to finance local government and community demand-driven projects involving routine maintenance, rehabilitation and the upgrading/construction of district and village feeder roads. The fund draws its revenues from five main sources:

- road toll-gate fees collected on all vehicles leaving the country,
- border fees/short-term Southern African Customs Union (SACU) permits charged on all foreign trucks entering the country,
- annual vehicle licence fee collections,
- fines on overload vehicles, and
- a road maintenance levy added to all transport fuels. Also run by an independent board, the Road Fund is currently setting up its secretariat and drawing up operational procedures.

Restoration and Resettlement Schemes

211. For a long time there has been no articulate policy on restoration and resettlement issues resulting from implemetation of development programmes and projects. In recognition of this problem, the LHWP became the first project in the country to be subjected to rigorous environmental impact assessments (EIAs) in line with the recommendations of the National Environmental Action Plan (NEAP) that EIAs should become integral parts of all feasibility studies of projects which have the potential of a significant effect on the environment[48]. The current draft environmental policy ensures that environmental considerations are incorporated at every level of decision-making during the formulation, design, implementation and management of development programmes and projects[49]. This draft policy further makes provision for courts of law to issue environmental restoration orders against individuals or institutions that either cause or are likely to cause harm to the environment[50].

212. In mitigating socio-economic impacts of the project, the overriding objective of the LHWP, which is embodied in the Treaty between Lesotho and the RSA, is that those communities which are adversely affected by the project should be compensated so that their standard of living "shall be maintained at a level not inferior to that pertaining prior to project implementation". The Treaty further provides that all reasonable measures to be taken in order to ensure the implementation, operation, and maintenance of the

[48]Kingdom of Lesotho, National Environment Action Plan, June 1989, p.40.

[49]National Environment Secretariat, National Environmental Policy for Lesotho, undated, p.12.

[50] Environment (Protection and Enhancement) Act, 1996, 93 (1).

project are compatible with the protection of the existing quality of the environment[51]. Indeed, in order to reduce or avoid deleterious effects of development projects of the scale and nature of the LHWP, some environmental considerations were taken into account at the early stages of project planning.

213. In order to realize the above objectives, the LHWP instituted a number of studies between 1988 and 1989 whose findings and recommendations were synthesized into an Environmental Action Plan (EAP). The latter represents an attempt to articulate the environmental dimension of the project into a framework which ensures that project activities are carried out in accordance with sound environmental principles. The Plan is divided into three sections:

- The Natural Environmental and Heritage Plan which addresses the project's obligation to draw up a mitigation and monitoring plan that will, among other objectives, ensure that: (a) construction sites, quarries, borrow pits, roads, etc. are located with appropriate environmental considerations; (b) the quality of waste that is discharged from construction sites is of acceptable standard and is constantly monitored; (c) construction sites are fully rehabilitated after use; (d) drainage and other construction structures have no adverse effects; (e) flora, fauna, aquatic and herbal and rare species are not threatened by project activities; and that (f) project activities do not accelerate soil loss;

- The Compensation Plan which is a restoration strategy whose aim is to compensate affected communities for material losses sustained as a direct consequence of the implementation of the project either through flooding or as a result of construction and infrastructural works; and

- The Rural Development Plan which is designed to enable affected communities to generate sustainable incomes, and to raise their standard of living by employing long-term strategies that involve training and support for income generating activities, promotion of productive activities, particularly agriculture, and infrastructure development.

214. The strategy of dealing with income restoration for people who are seriously affected by the LHWP is contained in action plans which form part of the environmental action plan. Between 1988 and 1996, the project spent more than M20,0million on compensation operations. This consisted of M799,173.0 compensation for loss of garden land, M558,403.0 for loss of arable land, M10.5 million in annual grain, pulses, and fodder distributions, and M8.7million for the replacement of houses in cases where individuals and/or communities had to be resettled. In recent years, the LHWP has strengthened the consultative process with affected communities in order to reduce dissatisfaction. A more comprehensive policy was approved by the board in 1996[52]. The policy is based on the following four principles:

- Households and communities are to be compensated for all physical structures eg. houses, kraals, schools, toilets, graves, etc., that are lost through inundation;

- Households are to be compensated for all arable land losses by providing land-for-land, cash in the form of an annuity or, sometimes, lump sums, or grain;

- Households are to be compensated for loss of access to communal assets such as grazing lands, medicinal and other useful plants, thatch grass, and water sources; and

- Households are to be compensated for the upheaval of relocation through a disturbance allowance.

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[51]This commitment is consistent with paragraph 50 (a) and (b) of the *Lesotho Highlands Development Authority Order*, 1987, and Clause 36 of *The Constitution of Lesotho*.

[52]LHDA, *Resettlement and Development Action Plan*, March 1997.

As was demonstrated on Table 12, the LHDA has impacted positively on the incomes of the poor, thus reducing the level of vulnerability amongst rural communities where the poor are concentrated.

Disaster Mitigation, Preparedness and Response

215. The country's adaptive responses to climate variability have mainly been influenced by drought occurrences, although other disasters like heavy snow storms and unusually low temperatures, severe early frost, localized floods, wind and hail storms, and tornadoes have also become more frequent in recent years. Most noticeable on Table 35 is that the 10-year drought cycle has turned into a more frequent occurrence since late 1970s. Today, drought conditions are a common phenomenon which has to be taken into account in all national development plans. Major drought emergencies were experienced in 1983-84 and 1994-97. Today the country is still in a drought spell period which started in 1994, with strong indications that emergency drought relief programmes – food aid distribution to vulnerable households and children under five years of age, water tank services to rural and per-urban communities, and seed and fertilizer packages – will continue for some time.

Table 35 Prevalence of Drought Conditions by year

Years of Most Severe Drought	Years of Dry Spells
1932-33	1925-33
1945	1944-54
1965	1964-73
1983-84, 1991-1993, 1994-97	1977-97

Source: Lesotho Meteorological Services

216. Experiences of the past have highlighted the need to introduce effective and long-term disaster mitigation, preparedness and response measures to replace short-term and ad hoc measures that were often introduced after each disaster had struck. In April, 1994, the government approved a plan to consolidate all the separate, fragmented agencies that were involved in disaster management into a single institution with a longer-term mandate. Three parliamentary acts have since been passed to support this decision:

- *The Disaster Management Act* 1997, which provides for the institutional framework and terms of reference of various institutions, from the Disaster Management Authority (DMA) to Village Disaster Management Teams;

- *Disaster Management Regulations* 1997 which set out the operational framework of the DMA and related institutions; and

- Finance *(Disaster Management Fund)* Notice 1997, which provides for a standing fund to cover activities of the DMA.

217. The government is convinced that at the macro-level, disaster management and economic development are not two separate concerns that compete for scarce resources. It is therefore necessary to integrate disaster management in all its facets with the country's mainstream policies and plans for national development, poverty alleviation, and environmental rehabilitation. The central philosophy is guided by the following 4 assumptions:

- Disaster management plans should be integrated and funded within the general mainstream of national development plans;

- Disasters often have exacerbated impacts in cases where there is endemic poverty and severe environmental degradation;

- Unless positive measures are taken to alleviate endemic poverty and environmental degradation, Lesotho is likely to remain more vulnerable to climate-related disasters and their adverse effects than otherwise would; and

- In the context of the existing political will and commitment, it is easier to plan and implement disaster management plans through existing institutional and operational arrangements than if new initiatives were started from scratch.

218. As its first task, the DMA produced the National Disaster Management Plan (NDMP) which was approved by the government on April 2 1996, and the first draft of the Disaster Management Manual (DMM) whose final revision was published in September, 1997. The NDMP provides details of the disaster management structure, supporting legislation, and the modus operandi each of mitigation, preparedness, response or relief, and post-disaster recovery. On the other hand, the DMM gives details of procedures to be followed in each programme, responsibilities of each level of disaster management institutions for each programme, and terms of reference of key personnel.

219. According to NDMP, major objectives of national disaster management efforts in Lesotho are to;

- reduce the country's vulnerability to climate related disasters such as sustained and severe drought;

- increase the country's capability to prevent, alleviate, contain, or minimise the effects of these disasters;

- enhance readiness or preparedness to deal with disasters should they strike the country; and

- ensure the country's full recovery from the impacts of disasters. As a preparatory stage, the DMA is currently engaged in a data gathering exercise that will lay down the framework of other stages of the planning process. Table 36 shows the type of data that is being gathered, sources of this data, and the intended utilization

Table 36 Data Gathering Activities of the DMA by Source

Type of Data	Institutional Source	Utilisation
Rainfall, snow, temperatures, and wind records	Lesotho Meteorological Services	Long-term weather forecast to guide informed crop planting decisions
Water supply and spring quality and yields	Department of Rural Water Supply and Water and Sewerage Authority	Long-term water supply demand
Disease and malnutrition patterns	Ministry of Health and the Food and Nutrition Coordination Office	Assessment of impacts of disasters on community health conditions
Agricultural practices and production	Ministry of Agriculture	To facilitate early warming about food shortages and range condition
Household employment, incomes, assets and expenditures	Bureau of Statistics and the Ministry of Transport and Communication	To assess threats to family well-being
Administration structures and capacity	Ministry of Local Government Local government structures Village Development Committees	Assessment of the ability of local structures to manage community affairs
Housing and infrastructure	Ministry of Local Government Local government structures Village Development Committees	Assessment of shelter conditions, sanitary conditions, and infrastructure conditions – roads, water, sanitation, electricity, and communications
Energy and environment	Department of Energy Ministry of Environment and Gender Affairs	To monitor energy supply and trends in environmental management
Trade and communication	Bureau of Statistics, Ministry of Transport and Communications	To monitor trends in the availability and prices of consumer goods, and to facilitate the existence of quick, efficient, and inexpensive transport
Public order	Ministry of Justice and the Lesotho Mounted Police	To assess the effectiveness of the local justice system

Source: Disaster Management Authority.

6 SECTOR-SPECIFIC MITIGATION POLICIES AND MEASURES

Introduction

220. Article 3 (3) of the UNFCCC requires parties to take precautionary measures to anticipate, prevent, or minimise the causes of climate change and mitigate its adverse effects. Articles 4 (b) – (d) require parties to the agreement to formulate and implement national programmes containing measures to mitigate climate change; to promote and cooperate in the development and application of technologies that control or reduce GHG emissions in various sectors of their economies; and to promote and cooperate in the conservation and enhancement of sinks and reservoirs of all GHGs that are not controlled by the Montreal Protocol.

221. Due to financial and institutional constraints, as well as technological limitations, the country's experience in the mitigation of GHG emissions has been limited. The country puts more priority on adaptive measures because of its extreme vulnerability to the adverse effects of climate change. This generally leaves very little resources available for mitigation. Similarly, where legislation to control emission levels could serve the purpose, this avenue has generally not been very attractive because of capacity constraints in law enforcement. Technological initiatives have also met some resistances due to cultural rigidities.

222. Some of the adaptive measures, particularly in energy and forestry, although planned and implemented with the main objective to reduce the vulnerability of rural populations in energy provision, carry important mitigative impacts as well. This chapter therefore aims at examining the technological possibilities whose by-product is the mitigation of GHG emissions, and how the country could develop least-cost GHG abatement strategies in these two sectors. The chapter begins by giving a detailed base-line analysis of the energy sector which reveals that ecological and climatological conditions impose precarious conditions in energy supply to rural populations, and that adaptation strategies, particularly afforestation, are still facing serious problems although the potential seems to be good.

The Energy Sector

Situation Analysis

223. Limited attempts have been made to assess energy consumption characteristics in the country. Reasonably reliable data on commercial sources of energy are available in the Department of Energy and the Lesotho Electricity Corporation (LEC). Statistical data on non-commercial sources are only available from outdated piecemeal surveys of questionable reliability. In fact, indications are that fuelwood, shrubs, and crop residues have been badly undermined by ecological depletion and poor animal and crop husbandry. Nonetheless, both the 1986 and 1996 population census results showed that households exhibited strong rural characteristics of energy consumption, with paraffin and candle contributing substantially towards lighting, and paraffin and wood towards heating and cooking[53].

224. In 1986, paraffin and candle provided lighting for 97% both of households and the population, while biomass energy sources provided heating energy to 68% of the households and 71% of the population, and cooking energy to 69% of the households and 72% of the population. In 1996, paraffin and candle provided energy for lighting to 95% of the households. However, there was a significant reduction in

[53]Bureau of Statistics, 1986 Population Census Analysis Report, Volume III p.8.13.

The heavy dependence of biofuels as a source of energy is a matter of great concern.

Women from another trip to fetch shrubs to make a meal and warm the familiy.

energy switch to more convenient sources of energy. As shown on Table 37, in this year biomass sources respectively provided heating and cooking energy to 60% and 51% of the households.

Table 37 Percent Distribution of Households by Energy Source, 1986 and 1996.

Ministry	Utilisation in 1986 (% of Households)			Utilisation in 1996 (% of Households)		
	Lighting	Cooking	Heating	Lighting	Cooking	Heating
Gas	0.4	1.8	0.7	0.6	6.8	1.9
Electricity	2.2	1.3	1.3	3.5	4.2	1.5
Coal	–	0.7	5.9	–	0.5	4.7
Paraffin	43.7	27.4	23.7	51.5	37.3	31.9
Candle	53.1	–	–	43.8	–	–
Wood	–	45.8	43.1	–	45.7	51.1
Dung	–	8.5	13.8	–	2.9	7.5
Others	0.5	14.5	11.5	0.7	2.5	1.3
All Sources	100	100	100	100.1	100	100

Source: Bureau of Statistics, population census reports, 1986 & 1996.

225. The first comprehensive energy surveys in were conducted in 1987 by the Department of Energy. From results of these surveys and historical records of imports of both fossil fuels and electricity, the first energy balance for the country was developed in 1988[54] together with the first energy master plan. Although the balance sheet has been updated annually through a model, a lot of underlying assumptions, particularly in the rural sub-sector, have since changed, necessitating the commissioning of fresh data gathering surveys. Figure 24 shows projections of energy demand from 1987 to 1996. According to projection figures, energy demand increased from 26,190.5TJ in 1987 to 33,681.7TJ in 1996, an average annual growth rate of 2.5%. The largest consumer is the residential sector which claims 88.5% of the total energy that is consumed annually. On the other hand, the rural sub-sector, which contains close to 85% of the total population, claims 84% of the energy demand by the residential sector. The demand for energy by the transport and production and services sectors respectively stood at 11.1% and 4.1%.

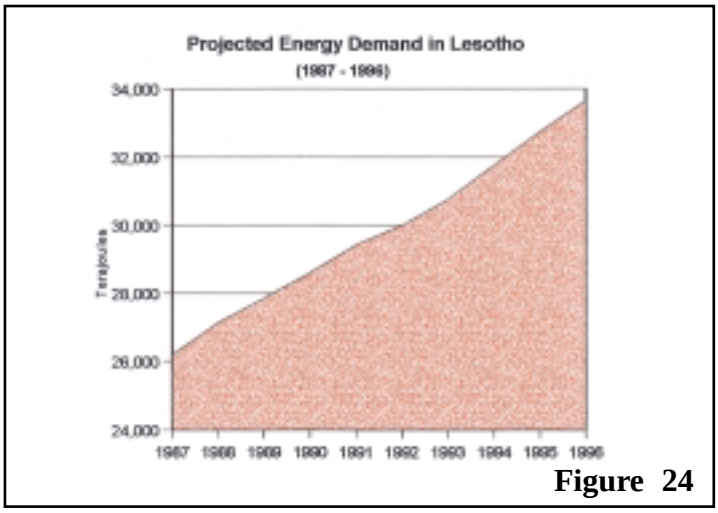

Figure 24

226. Due to a poor resource base and severe deforestation, the country is almost totally dependent on imports for her commercial energy requirements, including firewood and charcoal. As shown on Figure 25, imports of petroleum products increased from 35,177m^3 in 1975 to 200,019m^3 in 1996, representing an average annual growth rate of 8.6%. In 1996, Petrol, illuminating paraffin, and diesel respectively constituted 37.9%, 33.4%, and 25.3% of the total imports, the rest comprising avgas, jet fuel, power paraffin, and domestic gas. In the same year, the country imported 330.4Gwh of electricity from the Electricity Commission (Eskom) of the RSA. However, with the commissioning of the LHWP's 'Muela'

[54]Department of Energy, *Lesotho Energy Master Plan*, 1988, Table 7.

Hydro-power scheme (MHP) in September 1998, this import figure is expected to drop to 7.4Gwh by 1999/00 since Eskom imports will mainly be used to meet maximum demand deficits[55].

227. A breakdown of energy consumption by source indicates that primary sources account for 26,066.6TJ or 75.5%, while secondary sources account for 8,454.3TJ or 24.5%. Most of the secondary sources of energy are products of fossil fuels whose exploration in the 1970s and 1980s concluded that there were no prospects for the existence of commercially viable deposits[56]. On the other hand, imports of electricity, which, until recently, accounted for 97% of local consumption[57], have started to drop as the LHWP's 'Muela' Hydro-Power (MHP) plant generation expands.

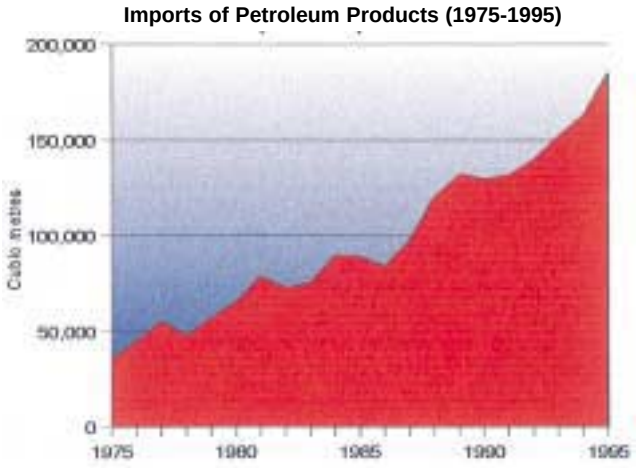

Figure 25

228. Figure 26 shows that primary sources of energy are mainly dominated by firewood and shrubs which contribute 30.5% each, and by cow dung which contributes 21.3%. Crop residues and coal respectively contribute a staggering 6% and 5.7%. Although there is no hard evidence, the general impression is that other sources of energy which are more convenient, notably paraffin, electricity, and gas, are gradually substituting imports of coal and the use of biomass sources. Although latest figures are not available, imports of coal decreased from 69,000 tons in 1980 to 45,000 tons in 1990.

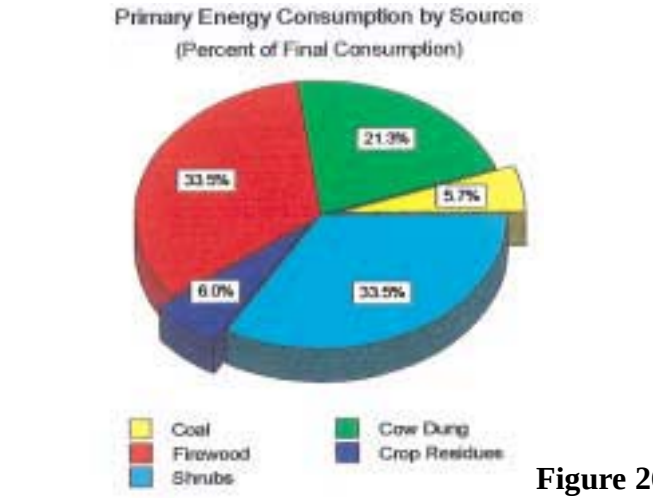

Figure 26

229. In 1995/96, the latest year for which data is available, the country had 11,631 electricity consumers. Of these, 8,462 or 72.7% were classified as domestic, while 3,062 or 26.3% were classified as commercial and services. The rest was largely made up of industrial consumers which, from 1992/93 included LHDA construction companies. Electricity consumption increased from 56.6 Kwh million in 1979/80 to 302.8 Kwh million in 1995/96. The largest consumption sectors were the commercial/services sector, the LHDA, and the domestic sector. These respectively accounted for 31%, 28% and 24% of the country's total electricity consumption. Generally, there has been an increase in average consumption per unit across all sectors in the exception of the commercial/services sector where there was a slight decrease. As shown on Table 38, while the customer base grew at 7.2% per annum since 1980, the overall quantity of electricity consumed and peak demand respectively grew at 8.1% and 7.4% per annum.

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[55]GIBB, *LHDA/LEC Interface Study Update*, November, 1997, Table 5.1

[56]SADCC Energy Sector, *Coal Proceedings – Volume I Country Reports*, SADCC, Gaborone, November/December, 1988.

[57]The rest was met form domestic generation from 4 mini-hydro schemes.

Table 38 Imports and Consumption of Electricity, 1979/80-1995/96

Year	Quantity Imported (Kwh million)	Peak Demand (MW)	Quantity Consumed (Kwh million)	No. of Customers			
				Domestic	Commercial & Services	Industrial	Total
1979/80	88.4	19.6	56.6	2451	1710	20	3591
1980/81	102.1	22.5	65.7	2882	1256	21	4159
1981/82	119.8	26.8	78.2	3377	1306	24	4707
1982/83	119.7	29.7	84.4	3746	1356	33	5132
1983/84	115.5	29.2	96.2	4305	1889	34	6228
1984/85	119.4	30.3	104.4	4823	2000	37	6861
1985/86	125.5	33.8	112.3	5278	2995	39	7412
1986/87	137.8	35.3	112.3	5756	2218	46	8020
1987/88	160.1	42.3	135.6	6150	2365	41	8576
1988/89	174.3	44.3	152.7	6647	2145	64	8856
1989/90	185.3	48.6	168.4	7252	2334	70	9656
1990/91	195.7	47.8	175.7	7832	2394	74	10300
1991/92	206.3	50.1	191.3	7696	2731	72	10499
1992/93		64.9	198.6	8125	2766	84	10962
1993/94	288.9	66.3	241.0	9000	2946	84	12030
1994/95	311.9	68.0	243.7	8450	2985	88	11613
1995/96	330.4	76.0	302.8	8462	3062	107	11631

Source: Lesotho Electricity Corporation.

230. The use of solar power, wind energy, and biogas is not widespread. Some buildings that were constructed with donor funding have been fitted with solar panels for heating although a lot of problems have been reported. About 16 working bio-digesters have been reported. On the other hand, the use of wind energy has only been confined to water pumping although many such pumps are said to be dysfunctional. Although the country has 14 wind measuring stations, these do not generate sufficient data for the estimation of the energy potential[58].

231. It is quite evident from this analysis that biomass will continue to play a very vital role in satisfying energy needs in Lesotho in general, and in rural areas in particular. The 1987 Department of energy surveys established that 1.2 million tons of biomass was gathered every year for energy purposes, resulting in an average consumption of 10kg or 150MJ per household. However, the capability of the country's natural vegetation to meet household energy demands has been drastically reduced through human and animal pressure, forcing households to rely more on dung and crop residues, and to increasingly use paraffin imports for lighting, cooking and heating[59]. Shrubs are now largely confined to mountain slopes, river banks, and dongas, and people have to travel long distances for collection.

Adaptation Options with Mitigative Impacts

232. Although the main objective of intervention in the energy sector has focussed on devising strategies to adapt to increasingly dwindling energy sources, particularly in rural areas, a number of conservation options which have mitigative implications have been considered. While some are still being debated, others have gone through experimental and adoption stages. Table 39 lists some of the strategies that have been tried or are being considered by sector. The strategies emphasise the promotion of renewable sources of energy for the residential and commercial sectors, the promotion of energy efficient devices, and

[58]Koerner, W. *Evaluation of the Wind Energy Potential of Lesotho*, Department of Energy, August 1987, p.2.2.

[59]Mothea, N.M.A. *The Problems and Prospects of Planning Strategies for Wood Energy Supplies in Lesotho* (Dissertation), University of Wales, March 1990, p.28.

encouragement of the energy switch to cleaner sources such as electricity. All these have been tried in the country with varying degrees of success. However, most of the strategies in the transport subsector, other than fuel taxes, have remained proposals which will be difficult to implement because of the strengths of interested and affected parties. On the other hand, there is a serious resolve to review industrial electricity tariffs with a view to make them more attractive to investors and to reduce the consumption of diesel and coal.

Table 39 Energy Mitigation Options by Sector

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: National Climate Change Study Team.

Policy Measures with Mitigative Impacts

233. In a country that is resource poor, where the majority of the population largely depend on dwindling biomass resources for cooking and heating, where, until recently, there was total dependence on imports for commercial energy, and where winters are quite frigid and severe weather spells quite frequent, even in summer, 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 and biomass sources). The country has a comparative advantage in the generation of hydro-electricity due to altitude and the abundance of water resources. By substituting electricity for the use of fossil fuels in the home, industrial and commercial sectors, a significant amount of GHG emissions will be abated. On the other hand, there are good prospects for increased production of solar energy and biogas, particularly for remotely placed mountain communities where electricity and road infrastructure coverage is either low or non-existent.

234. Since 75% of energy demand, representing 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, government policy in this

area has put a lot of emphasis on expanding renewable energy sources and 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:

- energy conservation in buildings, transport, commerce, industry, and in the rural sector;
- development of indigenous energy sources;
- substitution of commercial sources of energy with indigenous alternative sources; and
- expansion of indigenous hydropower generation and electricity distribution infrastructure.

Energy Planning

235. There was no comprehensive energy planning in until 1988 when the first energy master plan (LEMP) was published[60]. This plan, which is updated annually, assisted the elaboration of energy policies and strategies, laid down the framework for professional energy planning, and led to the establishment of the Department of Energy (DOE). The plan, for the first time, made a detailed review of the energy sector, and using a model, made energy demand and supply projections up to year 2010.

236. LEMP is designed to be updated every year. As can be seen on Table 40, Stage I involves macro-economic analyses of energy demand and supply, taking into account demand-side socio-economic indicators, and supply potential and technological possibilities. Using macro-economic models, projections of both supply and demand for various energy items are made under different scenarios. Stage II involves a simulation of different energy demand/supply scenarios, taking into account expansion possibilities, and an analysis of the costs that are associated with each. Depending on the projections of resource availability, an optimum scenario is finally chosen. The final stage involves a periodic review of LEMP, with a view to determine its overall impact on macro-economic variables and on other sectors.

Table 40 The Conceptual Framework for Energy Planning

Stage I Data Base Development	Stage II Integrated Model Analyses	Stage III Impact Analyses
Macro-economic analyses — Energy demand analyses Energy resources evaluation — Energy technology evaluation	Energy supply/ demand balance — Impact analyses	Overall review/evaluation

Source: Adapted from the Lesotho Energy Masterplan.

237. The dynamism that is built into LEMP has suffered a number of setbacks. The inventory and demand and supply of non-commercial or traditional sources of energy for any one year can only be determined from survey data. The last surveys were carried out in 1987, more than a decade ago. The government is therefore planning to update this baseline data to facilitate more accurate projections. The second problem emanates from the complexity of the models in use, and their marginal suitability to the country's conditions, as well as manpower shortages in the Department of Energy.

[60]Department of Energy, Lesotho Energy Master Plan, 1988.

Promotion of Renewable energies

238. The most promising renewable energy source is hydropower. Some studies[61] have shown that the potential energy supply stands at 1260GWh per year, more than 6 times the size of the current electricity demand in the country. Studies on hydropower possibilities started as early as 1970s. Although a number of sites were identified, it is not until mid-1980s that work started on the construction of 4 mini-hydro schemes, with a combined generation capacity of 3.5MW, whose main focus is to meet the power needs of isolated mountain communities (see Table 41 for technical details).

Table 41 Technical Specifications of Mini-Hydro Plants

Mini-Hydro Plant	Generation Capacity	Transmission Lines		Year of Commissioning
		Voltage	Length	
Semonkong	210KW	11KV	3.2km	1988
Mantsíonyane	2MW	11KV	13km	1989
Tlokoeng	850KW	33KV	22km	1990
Qacha's Nek	480KW	33KV	30km	1990

Source: Lesotho Electricity Commission.

239. The government made a big leap at the commissioning of the 'Muela hydropower component of the LHWP in August, 1998. This plant represents a very successful strategy in import substitution by providing the country for the first time with almost all its demand for electricity, and income possibilities from limited export sales. Since commissioning, imports of electricity have been drastically reduced. With the expansion of the distribution network, imports will be further reduced to a minimum. This expansion of the indigenous hydropower generation capacity has improved the country's opportunities and flexibility in the distribution of clean energy to under served communities. It also marks the country's modest contribution towards the future reduction of GHG emissions.

240. Other than afforestation, which is dealt with in great detail below, other efforts at the dissemination of renewable energies, notably the promotion of biogas digesters and wind mills, have not been very successful as the adoptions have not been widespread. In the case of biogas, an evaluation has established the following reasons for low adoption:

- high initial investment costs;
- cumbersome operation and maintenance (feeding and inspection of plant time consuming);
- scarcity of water;
- low and seasonal output; and
- alternative gas (LPG) readily available and inexpensive.

241. Most of the emphasis in renewable energies has now shifted to the development of solar energy. The Appropriate Technology Section (ATS) of the Ministry of Local Government, a unit that is responsible for the development and dissemination of various renewable energy technologies, has in the past mainly concentrated on the development and dissemination of fruit dryers and solar cookers, and the dissemination of photovoltaic systems. There is also a private company that is disseminating solar cookers, solar water heaters, solar dryers, and photovoltaic systems. The latter is the most popular with households. Unfortunately, available designs of solar water heaters are generally those that rely on piped water to which many rural and peri-urban households have no access. It is hoped that increased adoption of solar energy

[61]Khalema, L. "Rural Electrification in Lesotho", in Ranganathan, V. *Rural Electrification in Africa*, Zed Books, Chapter 5, p.148.

will improve considerably with the establishment of a local testing facility for photovoltaic technologies which is under consideration.

Rural Electrification

242. The government's future electrification programme is contained in the Lesotho Electricity Master Plan which was drawn up in 1996. The objective is that by year 2010, about 40,000 domestic consumers, including rural households, should be connected to the country's electricity network. This means that an average 2,000 domestic consumers should be connected each year, an increase of the rate of electrification from the current 4% to 5% by year 2010. A number of rural areas have been surveyed for electrification in the master plan. The target is to cover 21 rural areas which have an estimated 14,240 customers at a total investment cost of US$7.2million.

243. Rural electrification projects are community driven and community financed. As a result, progress has been somewhat slow as communities find it difficult to raise the required capital since construction does not start until the full investment cost has been raised. Discussions are now underway to reduce the investment burden on the communities through a line of credit whereby customers will be required to pay a stipulated deposit for construction to commence, and then gradually pay off the balance.

Energy Conservation

244. Activities in energy conservation mainly focus on the improvement of building designs and the development of heat conserving, energy-efficient technologies (retained heat cookers, metal stoves, and stone paolas). The demand for space heating is very high in winter due to severe winter temperatures. This demand could be met from solar gains that accrue from proper building orientation, as well as by adopting appropriate architectural designs, including the use of thermal insulation. The Department of Energy has thus developed guidelines for energy-efficient buildings.

245. However, the existence of an informal property market in rural and peri-urban areas where there are no regulations governing building plans and construction, lack of enforcement of building regulations in urban areas, extra costs that are associated with some energy conservation measures, and the absence of established property developers have made the adoption and incorporation of these guidelines into building regulations very difficult. A new strategy to disseminate the guidelines through programmes of technical and vocation schools has been pursued with the hope that graduates of these schools will be involved in house construction in future, particularly in rural and peri-urban areas.

246. ATS has been responsible for the development and dissemination of a number of heat conserving technologies since late 1970s. Research carried out by this institution indicated that fuel savings stood at 30% for the retained heat cooker, 60% for the stone paola, and 22% for the metal stove, all being technologies that were developed by ATS to save energy in heating and cooking. Most of these devices have registered low adoption for various reasons, which include design and cultural problems, and failure to appreciate the need to save energy, particularly in rural areas where biomass is freely available.

Projected Mitigation Impacts

247. Baseline projections indicated that if unmitigated, carbon equivalents of GHG emissions from the energy sector would rise from 854.99Gg in 1994 to 5,197.20Gg in year 2030. In attempting to assess the mitigation impacts of adaptation interventions on this baseline trend, only a limited number of options was considered since this was the only data which was complete at the time. A number of

assumptions[62] were made on the acceptance levels and fuel saving potential of three locally developed technologies that were selected for the reduction of the consumption of biofuels: the stone paola, the Mabotle stove, and the retained heat cooker. As shown on Table 42 the acceptance levels for the stone paola and Mabotle stove are both projected to stand at 50% by year 2005, and increase to 100% by year 2030 while that for the retained heat cooker is projected to stand at 10% by year 2005, but increase to 100% by year 2030. The fuel saving potential for the stone paola has been projected to stand at 30% by year 2005 and 60% by year 2030, while that of the Mabotle stove has been projected to stand at 11% by year 2005 and at 22% by year 2030, and that of the retained heat cooker at 3% by year 2005 and at 30% by year 2030.

Table 42 Acceptance Levels and Fuel Saving Potential of ATS Technologies

Technological Device	2005		2030	
	Acceptance Level (%)	Fuel Saving (%)	Acceptance Level (%)	Fuel Saving (%)
Stone *paola*	50	30	100	60
Mabotle stove	50	11	100	22
Retained heat cooker	10	3	100	30

Source: Appropriate Technology Section.

248. The above assumptions were applied to projections of population and outputs of various economic sectors up to year 2030 in order to project total energy demand for the whole economy following the same approach as was adopted for baseline projections, but allowing the structure of demand to vary. The resultant projections of energy demand were then converted into carbon dioxide equivalents of GHG emissions from each sector. Table 43 shows the projected energy demand and carbon dioxide equivalents of GHG emissions for years 2005 and 2030. It can be seen that with the projected reduced biomas consumption in future, transport will remain the main energy demand sector, accounting for 73.7% of total GHG emissions from this sector.

Table 43 Projected Energy Demand and GHG Emissions: Mitigated Scenario

Sector	2005			2030		
	Energy Demand (TJ)	GHG Emissions (CO_2 Equiv.)		Energy Demand (TJ)	GHG Emissions (CO_2 Equiv.)	
		Gg	% of Total		Gg	% of Total
Construction	116.14	9,664.94	0.92	460.81	38,348.35	0.87
Commerce	53.57	4,815.30	0.46	352.33	31,670.58	0.72
Manufacturing	788.95	74,394.25	7.12	5,193.40	489,710.60	11.09
Government	97.55	9,247.96	0.88	548.26	51,977.24	1.18
Agriculture	601.41	49,406.82	4.73	2,324.29	190,944.60	4.32
Transport	5130.00	422,343.00	40.40	39,539.57	3,254,727.00	73.70
Residential-Urban	517.22	38,013.00	3.64	744.30	54,779.23	1.24
Residential-rural	19,751.87	437,474.30	41.85	9,968.56	304,109.20	6.89
Total	27,050.71	1,045,359.60	100.00	59,131.52	4,416,266.80	100.00

Source: National Study Team

[62]Based on ATS research findings.

249. A comparison of the baseline and mitigated GHG emission scenarios is presented on Figure 27. The mitigated scenario progressively reduces GHG emissions from the baseline figure of 1,404,140Gg of CO_2 equivalent by year 2005 to 1,045,300Gg, and from 5,197,200Gg of CO_2 equivalent in year 2030 to 4,416,270Gg. This respectively represents reductions of 26% and 15% for the two periods. With effective control over biomass fuel consumption in its adaptation strategies, therefore, the country will shift the structure of energy demand to a point where the main focus of mitigation will lie with energy consumption in the transport sector, a sector which is already being targeted for future policy interventions.

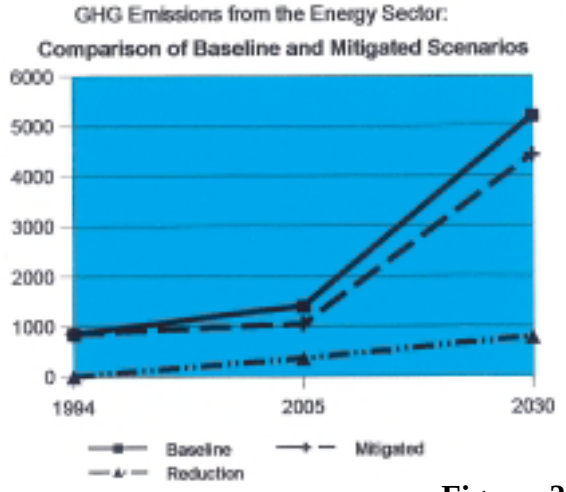


Figure 27

The Forestry Sector

Situational Issues

250. Serious efforts at afforestation started in the 1960s with the ODA-supported Woodlot Project. To date 322 forest reserves have been planted on a total 6,332 hectares, mainly in the lowlands. There are also a number of communal and private initiatives. Compared to the needs of the country, however, these forest resources are extremely limited. Hostile agro-ecological conditions, poor soils, the communal land tenure system, weak extension services, inadequate technical know-how, and poor logistical support for the Forestry Division represent the main constraints to forestry expansion.

251. As was emphasized earlier, the rural population remains heavily dependent on biomass resources – fuelwood, shrubs, animal dung, and crop residues – for an estimated 92% of their energy demand. The need for energy is more acute in the mountain districts where low winter temperatures necessitate extensive use of fuel for heating. Present biomass utilization already exceeds sustainable levels and is a major contributory factor to environmental degradation. Indigenous vegetation is rapidly being removed, exposing large areas to soil erosion. Increasing use of crop residues and dung is responsible for the reduction of the rate of return of biomass to the soils, resulting in low soil fertility and low forage and crop yields. Fuel collection itself is a time consuming burden which falls mostly on women and children, diverting them away from other, often more productive activities.

252. The present state forest reserves present problems of management. In addition to being a financial burden to the government, this large number of small and scattered reserves places heavy demands on the limited human resources of the Forestry Division. Besides, the present marketing system is inefficient and hinders the development of the private sector, and the sustainable utilization of forestry resources by local people. Many local communities are strongly opposed to continued ownership of state forestry reserves by the government and wish to take control of what they perceive to be rightfully their own. The government therefore finds it necessary to transfer the responsibility for the management of these reserves to local communities. It would like to refocus its interventions away from direct establishment and management of forest reserves and the marketing of forest products towards assuming a less direct but very supportive role where communities, private individuals, and NGOs take the lead.

253. Production, processing, and distribution of locally sourced tree seed is still a relatively new activity.

new activity. It is organized through the National Tree Seed Centre (NTSC) which also currently handles imports. The country is heavily dependent on imports of seed for certain tree species, at the expense of producing seed of locally identified and superior genetic materials.

Abatement Options

254. The afforestation programme was originally introduced with the following considerations:

- The importance attached to biomass fuel by rural households;
- The current vulnerability of the biomass resource base; and
- Lesotho's land degradation problem.

Even today, these considerations still weigh heavily in development plans. However, there is a growing awareness and realization of the importance of preserving the country's ecosystem and aesthetics, and providing sinks for CO_2 abatements. Afforestation programmes are therefore increasingly seen to carry a dual role of fulfilling very pressing national objectives and of mitigating, in a very limited way, GHG emissions.

255. Since the GCM climate change scenarios predict a warmer climate and drier future conditions, it is imperative that the government's afforestation programme seriously examine the species composition of their planned forests with a view to improve tree survival, biomass formation, and the country's crown cover. It does appear that an emphasis on indigenous trees and shrubs, and exotics that are suitable for dry forest conditions, is commendable. The future warmer conditions may also favour some of the sub-tropical fruit trees that are not currently grown in the country. The afforestation programme should go hand-in-hand with the conservation programme where indigenous forests, wetlands and marshes are protected and their regeneration encouraged. The government has already formulated policies towards this direction although implementation might take some time to be realized because of resource constraints and shortage of suitable land.

Policy Measures

256. Until recently, the country had no formal policy that guided its forestry activities. However, such a policy emerged as a by-product of the national forestry action programme which was drawn up in 1996. The policy was eventually adopted as a national policy in 1997 although the draft forestry bill is still under consideration by the Parliament. According to the current policy, the government recognizes the potential contribution that forests can make to poverty alleviation, livelihood security, and environmental protection, as well as to the enhancement of the participation of women in development. Unfortunately, forestry activities are still largely government and international NGO supported initiatives.

257. The objective of the government's current forestry programme is to provide a realistic means of meeting the future energy needs of rural populations, to sustainably increase the productivity of both arable and livestock production systems, and possibly reverse the current environmental degradation. This can only be achieved by transferring the management and benefits to the communities, by advancing a gro-forestry, by increasing extension and research capacity within the Forestry Division, and by increasing the capacity of the NTSC to expand local production of tree seed.

258. The major areas of focus of the forestry programme in the current plan period are as follows:

- Mapping out modalities for transferring the management and benefits of state forestry reserves to communities who have a demonstrated interest, willingness, and capability;
- Increasing the sustainable supply of biomass fuel resources with emphasis on indigenous species, particularly in the mountain districts;
- Strengthening research and extension capabilities of the Forestry Division through restructuring and training (both in-service and long-term), and by providing basic research infrastructure; and
- Provision of an adequate supply of high quality seed of exotic and indigenous tree and shrub species by identifying and documenting the best performing species, establishing and managing seed stands of identified superior trees and shrubs, establishing a data base, and improving facilities and procedures at the NTSC.

Reforestation of Indigenous Forests

259. This strategy is aimed at reversing the trend where indigenous trees are being harvested at a massive rate. The aim is to increase indigenous forests up to 286,600 hectares by year 2030 at an average base-year cost of M1,200 per hectare. This is expected to generate an average base-year revenue of M1,700, resulting in an average present value of the annual net benefit of M500 per hectare. With a CO_2 uptake of 185 tonnes per hectare and a cost of CO_2 emissions of M59.57 per hectare, the country stands to benefit an average M8.24 for every tonne of CO_2 that is removed.

Afforestation of Gullies and Degraded Lands

260. This strategy is aimed at securing 451,313 hectares of degraded land, particularly gullies, and afforesting the same with acacia, willow, and poplar species at an average cost of M1,785.4 per hectare. The objective of the strategy is to provide fuelwood for rural communities, to generate sources of income for the same through the sale of trees, to stabilize the soil, and to improve the biodiversity. This will generate a revenue with a present value of M3,164 per hectare, implying a present value of the total annual net benefit of M1378.6 per hectare. On the other hand, the CO_2 uptake will stand at 185 tonnes per hectare, while the present value of the cost is estimated at M83.62 per tonne of CO_2 that is removed. The country will therefore benefit by an average M16.49 for every tonne of CO_2 that is removed.

Rehabilitation of Wetlands

261. This is a strategy that aims at planting plant species on 20,000 hectares of degraded wetlands at an average base-year cost of M2,440 per hectare in order to preserve the ecosystem and the surrounding habitat and improve the biodiversity. This is projected to generate revenue with a present value of M11,000 per hectare from the sale of grass species, and net benefits with a present value of M8,560 per hectare. The CO_2 uptake is also estimated at 185 tonnes per hectare at an average cost with a present value of M185 per tonne of CO_2 that is removed. The country will therefore benefit by an average M246.27 for every tonne of CO_2 that is removed.

Projected Mitigation Impacts

262. Table 44 gives a summary of mitigation impacts of the adaptation strategies that have been elaborated above. As can be seen, interventions in forestry are projected to increase sinks from a 1994 level of 289.2Gg to 3,770Gg by year 2030. Although the increase in sinks will be offset by increased emissions resulting from grassland conversions and abandoned managed lands for some time, the 2030 conditions

show a dramatic improvement in containing emissions in the forestry and landuse sector that result in net emissions of -1,266.32 Gg as compared to 6,888.85Gg in 2005. Apart from increased energy provision, employment creation, income redistribution, improved biodiversity, soil stabilization, enhanced aesthetic values, and educational impacts, therefore, the expansion of the forestry programme will lead to improvements in CO_2 abatements, albeit to a very limited extent.

Table 44 Projected Impacts of the Forestry Sector Mitigation Strategy

Source and Sink Categories	CO_2 Emissions/Sinks: Mitigated Scenario (Gg)	
	2005	2030
Forestry and Biomass Changes	-1,610.07	-3,770.25
Grassland Conversion	5,674.85	1,292.61
Abandoned Managed Lands	2,824.07	1,211.32
Total	6,888.85	-1,266.32

Source: National Study Team

Conclusion

263. This chapter serves to underline the fact that small and critically vulnerable countries with limited resources are compelled to concentrate their efforts in designing and implementing strategies that will assist them to adapt as against mitigate the impacts of climate change. This, however, does not compromise their obligation under the Convention since many of these adaptation strategies carry a dual role that impacts positively on mitigation and abatement. In the preparation of future communications a number of interventions which assist the country to adapt to climate change and at the same time enhance its humble contribution to the mitigation of GHG emissions will be identified and documented.

7 SECTOR-SPECIFIC ADAPTATION POLICIES AND MEASURES

Introduction

264. Article 4 (1) (b) of the UNFCCC requires that all Convention parties should formulate and implement national and, where applicable, regional programmes containing measures to facilitate adequate adaptation to climate change. Further, Article 4 (1) (e) provides for parties to cooperate in the preparation for adaptation to the impacts of climate change and to develop and elaborate appropriate and integrated plans for affected economic sectors and for the protection and rehabilitation of areas that have been affected by drought, desertification, and other climate-related disasters. This chapter therefore presents measures that have been singled out for adaptation to climate change in priority sectors in Lesotho as the country pursues its obligations under the Convention.

265. Although Lesotho, like many critically vulnerable developing countries, puts a lot of priority on adaptation to climate change as opposed to mitigation, national aspirations are severely limited by resource constraints and the weak institutional framework. The country is highly dependent on external assistance for the funding of its development programmes. The success and sustainability of many of the adaptation strategies that are pursued in priority sectors that are considered below will therefore largely depend on the continued support of both multilateral and bilateral donors.

The Agriculture Sector

Adaptation Options

266. Climate has long been identified as the single most important factor in agriculture in general, and in crop production in particular. A number of adaptation strategies were already under investigation or at the stages of dissemination against the backdrop of weak institutions, cultural rigidities, resource constraints, and limited technology. Results of GCM climate change scenarios that were presented in earlier chapters indicate that the country could experience dry conditions in future, particularly during spring and summer months. There is also likely to be a shift in seasonal rains towards winter and autumn, a potential for the further impoverishment of the soil, and increased incidences of severe storms and floods, particularly in winter. The soils are likely to be impoverished also. All these conditions have a potential to adversely affect the future perfor-mance of the already vulnerable agriculture unless bold adaptation strategies are developed and adopted.

267. Table 45 presents some of the predicted adverse impacts of climate change that could occur over the country in future, as well as some of the adaptation options that could be pursued in the agricultural sector. Since climate is regarded as one of the primary factors determining the performance of this sector, the impact of dry conditions could be reduced if the country developed and adopted drought resistant cultivars. This would also require a shift away from the maize monocrop. Other options that could address the impacts of droughts and other disasters include crop diversification, irrigation, and crop intensification, particularly through amongst others mixed and double cropping.

268. In addition to the above, other anticipated future climate changes that could adversely affect the performance of agriculture include a forward shift in seasons which could result in rains setting in late for successful cropping, exacerbated soil erosion that could be accompanied by reduced soil fertility, and frequent occurrences of damaging storms, floods, and field inundation. The impacts of a shift in seasons could be counteracted by rescheduling of the planting dates, and by developing and adopting fast maturity

Growing of vegetables could be a viable option as a crop diversification measure.

Land under irrigation could be expanded.

cultivars, while that of changes in the soil structure and fertility and of flooding and inundation could be reduced by promoting soil liming, increased application of organic fertilizers, soil conservation activities, abandonment of marginal lands and mountain slopes, and improved flood control activities. On the other hand, agricultural damage by storms could be averted by planting trees for wind breaks, by developing hardy species and breeds that could survive harsh weather conditions, by the construction of sheltered housing for domestic animals or adopting intensive production techniques, and by improving disaster preparedness and food security. While the incremental costs of some of these adaptation options could be prohibitive for resource-poor Lesotho, others, eg shifting planting dates, are virtually costless.

Table 45 Possible Adaptation Strategies for Agriculture

Predicted Climate Change Parameter	Possible Adaptation Strategy
Dry conditions	- Development and adoption of drought resistant crops - Crop diversification - Irrigation development - Crop intensification
Shift in seasons	- Shift in planting dates -Development and adoption of fast maturity varieties
Changes in soil structure	- Soil liming - Application of organic fertilizers - Soil conservation - Abandonment of marginal lands and mountain slopes
Severe storms	- Tree planting for wind breaks - Development of hardy species - Improvements in disaster preparedness and food security - Sheltered housing for domestic animals
Flooding and inundation	- Soil liming - Application of organic fertilizers - Flood control

Source: National Climate Change Study Team

Policy Measures

269. Although agriculture has a dwindling share of the GDP, the sector remains a main source of income and food security for a substantial proportion of households in the country. Since prospects for dramatic growth in other sectors do not seem to be in sight, at least in the short-term, interventions in agriculture have been considered to be imperative in order to avert the social, economic, and political consequences of increased future sectoral vulnerability that has been predicted by GCM climate change scenarios. In seeking appropriate development strategies, the country has come to realise that opportunities for agriculture to absorb growing numbers that join the labour force each year can only be strengthened if the country adopts and implements policy reforms aimed at improving the efficiency and competitiveness of the sector.

270. In view of the above, the agricultural sector has adopted the following major policy goals: poverty alleviation, household food security, and employment creation. The major challenge, therefore, is to transform agriculture from the current subsistence orientation into a nationwide commercial business, a long-term strategy that will involve:

- policy reforms in various sub-sectors;
- changing social attitudes about the utilisation and protection of the country's resource base;
- disseminating technologies on new production techniques;

- introducing new and more resistant crop varieties;
- introducing appropriate forms of intensive production; and
- improving farmer responsiveness to market signals.

271. The above strategies have been packaged with a number of other strategies, some of which have been adopted in related sectors, whose major thrust is the improvement of the sector's efficiency:

- reduction of sectoral inefficiencies by eliminating state participation in agricultural production, marketing, and processing activities;

- improvement of the management of the natural resource base, particularly croplands and rangelands, by implementing far-reaching land reforms;

- improvement of the commercial value of the agricultural base by emphasizing high-value crops and intensive livestock and crop production; and

- institutional capacity-building and re-orientation of support services (particularly research and extension) towards the fulfilment of new objectives.

272. The key feature of new policies is that the scale and focus of investments will be determined by market potential and the principle of long-term comparative advantage, while policy reforms and active promotion of private initiative are recognized as being central to its success.

BOX 1

Asparagus Adoption in Lesotho

Asparagus was introduced in Lesotho in 1973. The crop is mainly grown by small-scale farmers within a radius of 25kms from the processing plant which is located at Masianokeng, 15kms south of Maseru, the capital town.

Although there are fluctuations in production levels from year to year, asparagus has adapted well to Lesotho's climatic conditions. The crop is planted in winter (June-July) and, after two years, annually harvested in summer (September to November). Despite its good performance even under limited moisture conditions, December drought occurrences tend to reduce the following year's yields and production from time to time.

Asparagus bears many advantages: suitability to Lesotho's climatic conditions and soils; limited proneness to pests and diseases, a long harvest life of up to 20 years, high income possibilities for farmers, and foreign exchange earnings from the EU market.

The disadvantages include high establishment costs, rigorous management demands, and perishability and heavy demands for prompt delivery to the processing plant. Despite these problems, the performance of asparagus raised a lot of hope in the strategy of crop diversification in the country. Both farmer participation and the acreage under the crop steadily increased in the face of protracted droughts and, since 1991, associated fall in yields.

Crop Diversification

273. Past crop production and marketing policies were guided by considerations of building self-sufficiency in the production of low-value, dryland traditional crops which not only have a marginal impact on household food security, employment and incomes, but are very prone to droughts and have a damaging impact on the environment. The current strategy in crop production puts a lot of de-emphasis on subsistence-oriented food grain monocrops in favour of labour-intensive high-value crops. The government is now focussing on the expansion of the area under crops which are locally-produced, but for which domestic demand is largely satisfied from imports. This is mainly the case with many horticultural crops such as potatoes, cabbages, onions, squash, pumpkin, and spinach, and fruit trees such as apples, peaches, pears, cherries, grapes, and berries. Many of these have demonstrated higher labour intake and better farmer returns than dryland crops.

274. There is also a continuous search for new crops for which the country can identify an export niche. A good example in this respect is asparagus production for the European Union market (see Box 1). Table 46 shows that after the introduction of this crop in 1973, the number of participating farmers grew by an average 11% per annum up to 2,200 in 1994. On the other hand, the number of harvested acres also showed a steady increase during this period from 50 in 1984 to 340 in 1994. This was despite a fall in average yields due to protracted droughts. However, since 1995, asparagus production has been adversely affected by competition with emerging large-scale producers in the neighbouring Free State province of the RSA, by falling productivity due to over-harvesting and droughts, and by marketing and management problems. These negative factors have led to a drastic reduction in the acreage that is devoted to the crop, as well as in the number of participating farmers and total output. In addition to asparagus, many potential crops are being tested for technical viability factors such as temperature, rainfall, frost, hailstorms, and infrastructure. These include chives, paprika, garlic, ginger, and a few bush crops. With the warm weather that has been predicted by GCM results, Lesotho could be an important producer of sub-tropical fruits in future.

Table 46 Asparagus Production and Productivity, 1973-98

Year	Additional Hectares Planted	Number of Participating Farmers	Hectares Harvested	Yield per Year	Total Output (Tonnes)	Price per Kg (Maloti)	Average Farmer Income (Maloti)
1973-84	44	245	n.a.	n.a.	na.	n.a.	n.a.
1984	7	260	50	4.60	231	0.76	844
1985	49	289	54	4.70	255	0.95	736
1986	13	383	77	5.50	422	1.10	1,598
1987	24	679	125	4.20	528	1.45	1,127
1988	61	846	154	4.10	590	1.65	1,150
1989	60	1,035	185	4.20	775	1.95	1,459
1990	64	1,520	229	4.10	939	2.20	1,359
1991	39	1,710	270	5.50	922	2.25	1,120
1992	38	1,954	290	2.00	639	2.30	908
1993	65	2,180	330	2.10	735	2.45	826
1994	0	2,200	340	1.25	425	2.75	527
1995	0	2,134	324	1.20	392	2.60	n.a.
1996	0	1,623	257	1.20	302	2.70	n.a.
1997	0	953	166	1.10	209	2.97	n.a.
1998	0	585	96	1.04	92	2.69	n.a.

Source: Basotho Canners (Pty) Ltd.

275. One of the simplest crop diversification strategies currently pursued involves crop intensification. It has proven to be a simple strategy of increasing farm output that is easily adopted by farmers. It involves a number of strategies like changes in the crop calendar by introducing more cropping seasons, adoption of new crop rotations, inter-cropping, the use of improved genetic material (high-yielding, composite, disease and drought resistant varieties), introduction of integrated plant nutrition systems, and introduction of pest control and post-harvest loss management systems. The current mixed cropping strategies promoted by several extension projects have proven to be a good base to build upon. Crops such as legumes are “good companions” of traditional grain crops. While they help to restore soil fertility, they have been found to carry a lot of potential to increase income-earning opportunities of producers, and minimize labour peaks and troughs.

276. Other strategies adopted for crop diversification include the following:

- a programme to expand the seedling production capacity for fruits and vegetables;
- strengthening coordination lines between research and extension services in the promotion of high-value crops; and
- improvement and expansion of the fresh produce market infrastructure.

Despite these and other actions, the adoption of high-value crops still faces difficulties due to: a) limited private sector involvement; b) lack of appropriate marketing infrastructure, particularly for perishables; c) limited irrigation development, given the country's variable rainfall pattern; d) weak linkages between research and the farmer, which linkages are necessary for the adoption of new crops such as high-yielding and drought-resistant cultivars; and e) insecurity of land tenure in rural areas which is still inhibiting farmers to make productivity-enhancing investments that are necessary for many high-value crops.

Irrigation Development

277. Promotion of commercial vegetable production started in the 1960's with the implementation of a number of irrigation projects. In 1986, the efforts were given a major boost with the inception of 11 donor-funded irrigation projects covering 2,500 hectares. Unfortunately, most of these projects soon collapsed as there was no adequate preparatory work, leading to poor crop returns and conflicts amongst participating farmers. In general, area planted through irrigation varies from year to year and season to season due to droughts, opening of new projects, and closure of old ones. The majority of those schemes which are in operation are producing only at a fraction of design capacity. Irrigation has already demonstrated high employment and income possibilities. Besides, it is the main strategy through which the government can realize its objective of promoting the commercialization of agriculture. Crop diversification can also be easily realized as most of the high-value crops are limited by periodic droughts.

278. The Agricultural Research Division of the Ministry of Agriculture estimates that the current yields per hectare in vegetable production stand at 35 tons for cabbages, 23 tons for potatoes, 30 tons for tomatoes, 30 tons for onions, 22 tons for carrots, 25 tons for beetroot, 22 tons for pumpkins, and 15 tons for spinach. There is a lot of room for productivity and production increases with improvements in technology and management. It is estimated that from the 17,000 hectares of irrigable land, 70,000 tons of vegetables and 25,000 tons of fruit could be produced. This is adequate to feed the entire population and leave a surplus for export. Production has mainly been limited by price fluctuations, lack of credit finance, marketing problems including lack of market infrastructure, competition with RSA producers, and organizational, technological, and management problems, forcing many schemes to close down.

279. The government aims at expanding the employment and income base through the revitalization of dormant irrigation schemes, opening new ones, and through the introduction of appropriate technological packages. This is seen as one of the key strategies to promote crop diversification and realize some of the important objectives of the agricultural sector. Specific short-term actions here include the following:

- Articulation of a national irrigation policy and investigation of the irrigation potential offered by the Lesotho Highlands Water Project;
- Assessment of irrigation infrastructure and equipment in 13 existing projects with a view to restructuring and revitalising both currently operational and dormant irrigation schemes;
- Expansion of the area under irrigation by 500 hectares over a period of 5 years with emphasis on high pressure, low technology irrigation systems;

- Harnessing and expansion of the underutilised but successfully tested gravity-fed irrigation schemes countrywide; and

- Design and implementation of institutional capacity building programmes through short-term/ in-service and long-term training programmes.

Intensive Livestock Production

280. The land tenure practices, grazing systems, and traditional management practices have generally favoured extensive livestock production which in turn is largely blamed for severe overgrazing, soil and environmental degradation, and low farmer returns in the livestock sub-sector. With increasing levels of rangelands depletion and an ever worsening problem of animal malnutrition, there is no doubt that intensive production is the only strategy that will guarantee the farmer a steady income in future, particularly under climate change. The need for supplementary feeding has long been felt by several extensive farmers. In a nationwide survey that was carried out by Swallow et al (1987), 66% of the households reported some form of supplemental feeding of their livestock, particularly milk cows, horses, and oxen.

281. Intensive livestock production is quite widespread in the country. Most of the activities were introduced by the government in the 1970's and 1980's with the aim to improve the nutritional status of rural communities. Today the government's strategy is to confine extensive production to the mountain region and promote intensive livestock production in the lowlands. Emphasis has mainly been put on import substitution in the areas of poultry, piggery, rabbitry, and fish production in rural areas, and milk production in urban areas. Despite high levels of adoption, the performance of intensive livestock production has generally not been sustainable beyond project stages due to weak extension services, poor management, poor market organization, undercapitalization, underdeveloped processing infrastructure, high-cost and unreliable deliveries of inputs, high prevalence of diseases in recent years, undependable veterinary services, and stiff competition from large-scale RSA producers.

The Water and Sanitation Sector

Policy Measures

282. The custodianship of water sector policies lies with the Department of Water Affairs (DWA), an institution which has kept rainfall records from its national network of meteorological stations since early 1950s. DWA published three hydrological yearbooks up to 1980. In the late 1980s, its national network of monthly runoff gauging stations was extended with the construction of additional stations in the Senqu (Orange River) basin as a joint effort with the LHWP. Records from these guaging stations enabled the calibration of a hydrological model that was used to infill and extend flow records in order to generate time series for the design of the project. More recently, DWA commissioned a comprehensive water sector study that generated massive data which is now being utilised for planning and policy formulation.

283. The promotion of a coordinated development of water and sanitation services began during the International Drinking Water and Sanitation Decade (IDWSSD) 1980-1990, during which period a National Steering Committee (NSC) was formed to foster inter-ministerial consultations in the planning and implementation of sectoral activities. The NSC published its second Action Plan in 1994, covering the period 1994-2000. The main objective of this Plan is to facilitate the assessment of the sector's performance towards the achievement of the long-term national development goal of universal coverage in the form of good health and development through the provision of sustainable safe water

supply and sanitary disposal of waste throughout the country, an objective which is consistent with the health sector objective of "health for all by year 2000". As a result, the sector action plan was developed through a participatory and consultative process with the aim to cultivate a sense of ownership and commitment by all major stake holders.

284. In terms of national priorities, water policy aims to enhance proper management and rational exploitation of water resources to ensure adequate supply for all water uses, even during periods of water scarcity. In order to achieve this, the following actions were anticipated in the Action Plan:

- Develop a water resources management policy and strategy – an in-depth and comprehensive study was commissioned by the Department of Water Affairs covering the following issues: the water resources inventory, review of the current sector legislation, review of regulatory systems, review of environmental aspects, and an examination of the most effective mechanisms of user participation in the sector. Policy recommendations are now under consideration by the government;

- Rationalise and improve sector institutions – external assistance has been engaged to improve the corporate status of the institutions that are responsible for the exploitation and distribution of water, and for the provision of efficient sanitation services;

- Review existing and proposed water resources and related projects – in addition to the water and sanitation sector action plan, WASA prepares a four-year corporate plan that is updated annually, while the DRWS prepares a five-year rolling development plan, and LHWP activities are subjected to annual budgetary reviews;

- Develop and implement legislation for regulating and controlling water use and pollution – the development of regulations for water use will follow from the adoption of the water policy, while regulations for pollution control have been included in the draft environmental policy which is now lined up for debate in Parliament;

BOX 2

Harnessing Highlands Waters

Although Lesotho has a water crisis, it is generally acknowledged that the only resource which is available in abundance is water which, until recently, flowed unharnessed into the RSA. In 1986, the government signed a treaty with the latter, giving a provision for the harnessing of water in the mountain region in phases within a 30-year period beginning 1988. This treaty gave birth to the Lesotho Highlands Water Project (LHWP), a massive development comprising a system of reservoirs and tunnels whose major objectives are as follows:

- *To redirect substantial volumes of water from the mountain region of Lesotho to the densely populated Gauteng region of the RSA;*
- *To generate hydro-electricity for both import substitution and export;*
- *To provide opportunities for spinoffs; and*
- *To promote general economic development in Lesotho.*

At a projected cost of US $9.91 billion (1991 prices), the LHWP comprises a system of reservoirs and 230 kilometres of tunnels with a capacity of transferring about 70m^3 of water per second, and a hydro-power plant capable of generating 200MW. The phasing of the project is supposed to facilitate the increase of the water supply capacity in line with the growth of demand for water in the RSA, and the timing is as reflected below. Phase 1A, which is now complete, supplies about 18m^3 of water per second through 64kms of delivery tunnels to the RSA border from the 182m high Katse Dam, and has the installed capacity of 72MW from the 'Muela hydropower plant. The phase also saw the construction of 120kms of transmission lines to Maseru, over 200kms of access roads, and other infrastructure facilities (houses, bridges, etc).

Phases of the Lesotho Highlands Water Project:

Phase	*Period*
1A	*1988-1996*
1B	*1995-2003*
2	*2001-2007*
3	*2007-2016*
4	*2010-2019*

To avoid deleterious effects which are often associated with large-scale water projects, LHWP activities include environmental protection measures, compensation and resettlement, road maintenance, and a wide range of rural development activities which are implemented with the cooperation of rural communities and their local institutions. The government has also created a Development Fund for channelling project revenues to rural development programmes in other areas in the country. After a serious concern with mitigating negative socio-economic impacts, the LHWP has drawn up an environmental action plan which encompasses a broad rural development programme (RDP).

- Develop a national drought policy to mitigate the adverse impacts of periodic droughts – this policy is included in the disaster management strategy;

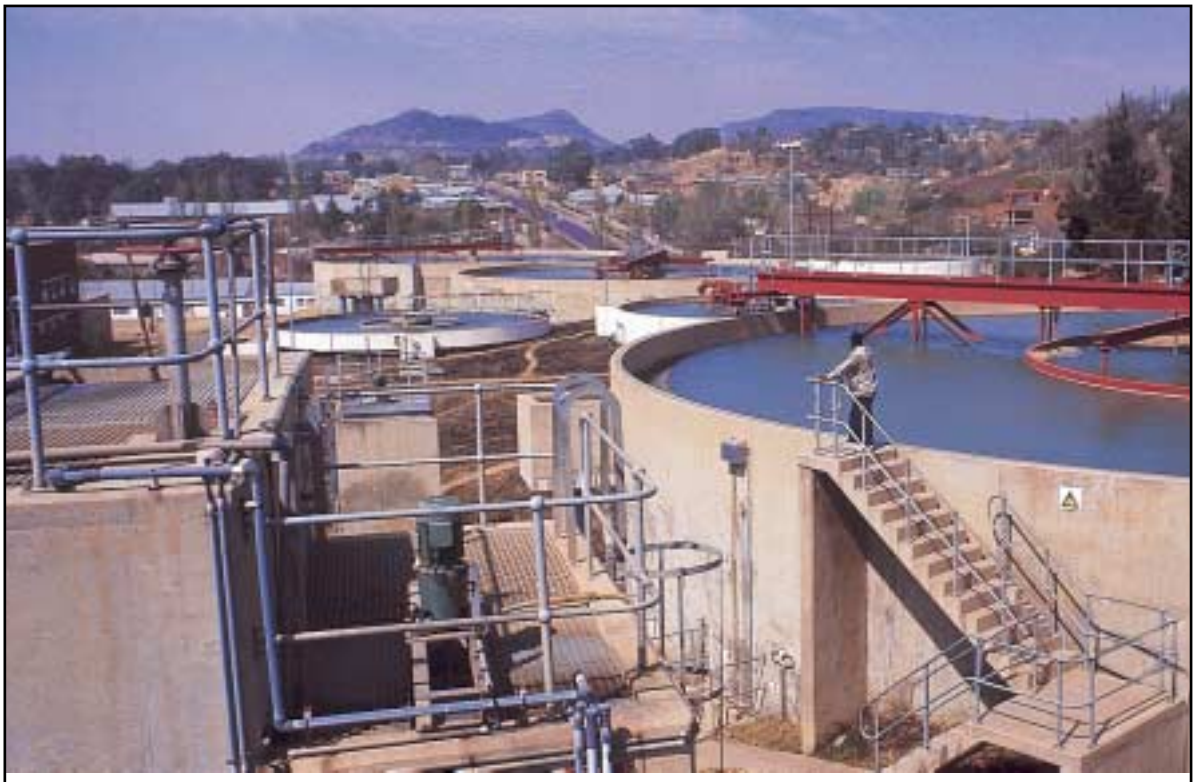
- Make significant and sustainable reductions in morbidity and mortality that is attributable to diseases that are associated with poor sanitation – this is being tackled through a district-based National Rural Sanitation Programme (NRSP) which commenced in 1987 as a pilot project, with a concentration on hygiene education and the promotion of the construction of ventilated improved pit latrines (VIPs).

285. The implementation of the LHWP is likely to shape future water policies (see Box 2). In addition to providing the country with virtually all of its electricity requirements and generating revenues that enable the country to address a host of development challenges that make it critically vulnerable to climate change, the harnessing of highland waters has introduced a new vision in water development. With projections revealing that under climate change water demand will soon outstrip water supply capabilities, particularly in the western lowland settlements, the need to come up with lasting solutions before the safe yields of many water sources are exceeded is increasingly felt. Water supplies to all of these settlements need urgent upgrading in order to improve both reliability and quality, and to meet the rapidly growing demand for water.

286. The policy debate now centres around the possibility of substituting the current complex and very diverse water sources and plant, all of which represent a duplication of maintenance, management, and operating costs, with a single scheme that would deliver water through gravity from one of the mountain reservoirs to the lowland areas. Such a scheme would possibly lead to greater coverage, better dependability, the delivery of higher quality water at lower costs. It could also be one of the cheapest adaptation options open for Lesotho to avert the possible adverse impacts of water scarcity that has been predicted by GCM climate change scenarios.

Rural Water Supplies

287. The overall national objective of developing rural water supplies is to contribute, in a sustainable way, to improvements in the health status and well-being of the rural population through the provision of safe drinking water. The implementation agent for rural water supplies is the Department of Rural Water Supplies (DRWS). In the water sector action plan, DRWS aims at increasing the coverage of rural populations with access to improved water supplies, mainly through the construction of gravity-fed systems and hand pumps, from 58% in 1994 to 81% by year 2000. This department's activities are complemented by those of the LHWP which has an obligation, under the treaty signed between Lesotho and the RSA, to maintain or improve the existing standard of living of communities residing in the project area. The LHWP has a programme to provide water supply and adequate sanitation to affected communities comprising approximately 3,770 households and a number of institutions in the project's catchment areas.



In the rural areas a large part of the population is involved in the struggle to secure safe water supplies.

new pic

Water treatment plant in Maseru.

288. In the revised departmental action plan which is currently under consideration, DRWS aims at implementing 823 projects in the five-year period 1998/99 to 2002/03, an additional coverage of 315,000 people across 9 of the country's 10 districts, with an estimated total investment of M161.6 million. Projected investments per district are shown on Figure 28. The plan period will also see intensified efforts in institutional rationalization, as well as improvements in the operation and maintenance (O&M) of existing water supply systems. Problems encountered in the management of systems are threatening the sustainability of the provision of safe water supplies, and pose health risks as communities are forced to rely on unhygienic water sources.

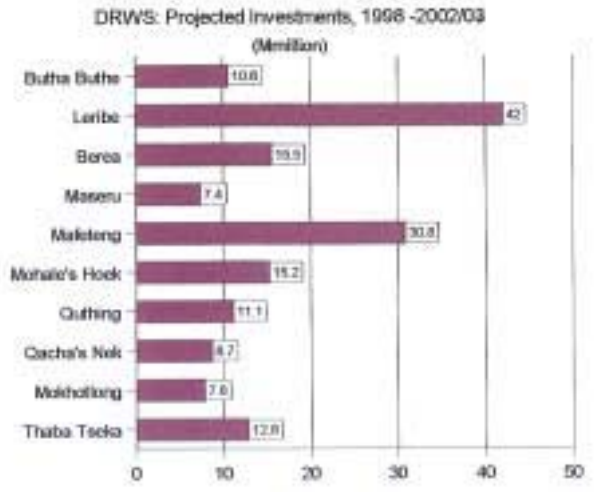


Figure 28

289. In order to deal with management and sustainability problems, DRWS has set up a Village Affairs Unit (VAU) with the aim to strengthen and empower communities to operate and effectively manage completed water systems. This strategy is reinforced by integrating health and hygiene education in rural water supply programmes, and by increasing collaboration with the private sector and non-governmental organizations (NGOs) in the implementation of programme activities. This is more so bearing in mind that DRWS is now posed to move into small, remote, and less accessible mountain villages, a move which is likely to slow down the pace of construction.

290. DWRS has set up a Maintenance Unit to deal with O&M problems. A maintenance system which specifies roles and responsibilities of all stakeholders in rural water supply is being developed. The targeted level of service has been set at 30 litres per capita per day at a collection point not more than 150 metres walking distance except in villages with less than 40 people, in which case a walking distance of not more than 300 metres is acceptable. Community involvement is deemed critical, from initial planning and design through construction to operation and maintenance. Spring-fed gravity systems with standpipes have been found to be the preferred technological option due to low O&M costs and suitability to physical conditions and management capacity. Where these are not feasible, the alternative is usually boreholes that are equipped with hand pumps.

291. According to the current O&M arrangements, the communities collect maintenance funds from their members out of which they hire services of water minders or system operators and purchase spares for minor repairs. Major repairs are undertaken by DRWS with a 50% cost share with community members. The achievement of a target coverage of 81% by year 2000 therefore represents a major step in the promotion of sustainable and safe rural water supplies, and goes a long way in reducing rural Lesotho's vulnerability to climate change.

Urban Water Supply and Sewerage

292. The provision of water supply and sewerage (including the empting of septic and conservancy tanks) to the 12 gazetted towns[63] is done by the Water and Sewerage Authority (WASA), a parastatal

[63]Four towns were degazetted in 1992.

established in 1992 with the main objective to provide safe, affordable, and potable water supply and sewerage collection and disposal services on a full cost recovery basis. Since its establishment, WASA has been struggling to develop itself into an efficient, autonomous, and commercially-oriented organization. In April 1997, WASA produced its first Five-Year Corporate Plan covering the years 1997/98 to 2001/02. The exercise, which covers areas such as institutional autonomy, organisational structure, tariff structure, and the investment programme, is still ongoing, having been delayed by financial constraints and pending policy changes in the future management of the parastatal. As part of this planning process, WASA produces an Annual Business Plan (ABP) and a Capital Expenditure Programme (CEP). The former details out business targets for the year, while the latter outlines the institution's annual investment programme.

293. WASA extracts its water from both surface (rivers and small dam reservoirs) and ground water (wells and boreholes) sources. Most of the reservoirs are threatened by accelerated siltation and pollutants which respectively result from soil erosion and uncontrolled settlements. On the other hand, WASA has also been a victim of protracted droughts, forcing the corporation to resort to tanker services and to the erection of community stand pipes. In addition, financial and human resource constraints remain a pervasive limitation, and a lot of water is lost through frequent pipe bursts, leaks, illegal connections, and inaccurate metre readings. Despite these constraints, WASA has come under increasing pressure in recent years to pursue the national objective of safe water for all by the year 2002.

294. In pursuing its mandate, WASA has completed a number of studies on the future water and sanitation demands of urban populations. It is hoped that results of these studies will facilitate more accurate future demand projections and investment proposals. The corporation has also increased its efforts to close the gap between water supply and water demand. Table 47 shows that this gap has been narrowed from 45% of total supply in 1992/93, to 30% in 1998/99. Efforts are currently directed at institutional rationalisation, improvements in human resources and financial management capacity, improvements in technical operations and operational efficiency, generating adequate revenue to support the institution's financial viability and independence, and pollution control to ensure that WASA continues to serve the urban population with a reliable and continuous supply of water and sewerage collection, and upholds a treatment quality that is closely compliant with WHO guidelines.

Table 47 WASA: Water Demand and Supply Data, 1992/93 to 1998/99

Megalitres per day

Area/Year	Water Demand	Water Supply	Difference
Maseru:			
1992/93	8.9	16.7	7.8
1995/96	11.5	18.6	7.1
1998/99*	12.9	18.7	5.8
Other Towns:			
1992/93	4.0	6.8	2.8
1995/96	5.0	6.9	1.9
1998/99*	5.5	7.7	2.2
Total:			
1992/93	12.9	23.5	10.6
1995/96	16.5	25.5	09.0
1998/99*	18.4	26.4	08.0

Source: WASA * Projections

295. The population in areas that are currently served by WASA is expected to grow from an estimated 500,000 in 1998/99 to 630,000 by 2002/03. During the same period, the proportion of the population served is expected to grow from 42% to 70%. On the other hand, it has been found that while water consumption stands at 15-20 litres per capita per day in areas around WASA's 450 standpipes, this figure rises to a basic level of 35 litres per capita per day or more in cases where there are house connections, a trend which is on the increase. The implications of these trends is that WASA should expand its infrastructure, restructure its human resources, and improve its operational efficiency in order to accommodate increasing demand and ensure a safe, reliable, and sustainable higher levels of service.

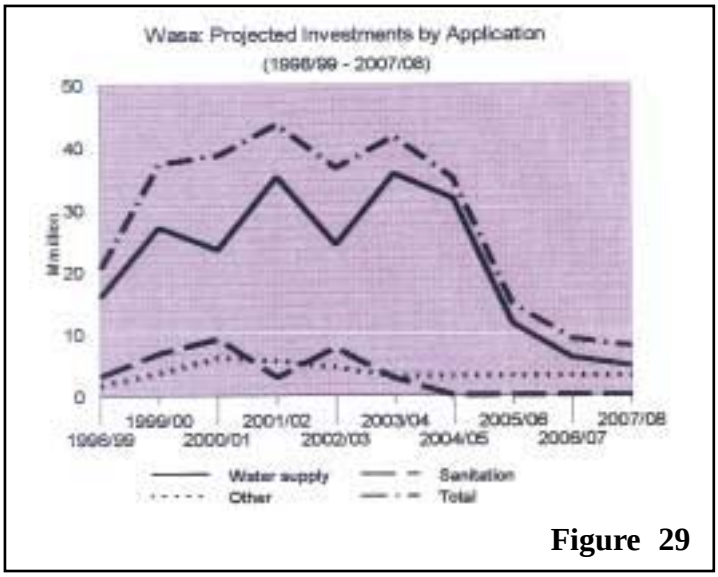


Figure 29

296. Over the years, WASA has developed a capital investment programme for the rehabilitation and expansion of urban water supplies, sewerage, and treatment works in all the urban areas. Pre-feasibility studies have been conducted in all these areas and projects have been ranked using systematic criteria, resulting in a ten-year investment programme that forms part of WASA's corporate plan. The 1999 revision of the investment programme shows that over the period 1998/99 to 2007/08, WASA would have to invest a projected M266.4 million, of which 75% or M198.8million will go towards water infrastructure rehabilitation and expansion, particularly in peri-urban areas where a substantial number of households are critically vulnerable. The rest will go towards sanitation, institutional capacity-building, and support services. Figure 29 shows that a lot of fluctuations are anticipated in this investment programme, a reflection of the inception and phasing-off of either large projects or particular donor involvement.

Landuse Change and Forestry

Policy Measures

297. It has been shown in earlier chapters that the country's environmental problems emanate from the escalating negative impacts of increased exploitation of natural resources as manifest in various forms of landuses – maintenance of large numbers of livestock, collection of firewood, expansion of agriculture and human settlements, etc. These activities have contributed to the severe loss of vegetation cover, leading to increased run-off, soil erosion, land degradation, loss of biodiversity, and low agricultural production and productivity. In 1989, the country developed a National Environmental Action Plan (NEAP)[64], a framework which for the first time presented guiding principles for the development of policies that promote environmental conservation and preservation in each of these diverse areas of landuses.

298. The national environmental policy, as presented in NEAP, listed the following guiding principles:

- assurance to all of the fundamental right to a healthy environment;
- use and conservation of the environment and natural resources for the benefit of both present and future generations;

[64]Government of Lesotho, National Environmental Action Plan, June 1989.

Afforestation programme could be given a fresh impetus.

- preservation of the biodiversity;
- conservation of the cultural heritage;
- reclamation of lost ecosystems, and, where possible, reversal of degradation;
- establishment of adequate environmental standards and monitoring of the same; and
- carrying out environmental impact assessments for all development activities.

299. NEAP was presented as a national policy document at the United Nations Conference on Environment and Development which was held in Rio de Janeiro in 1992. Lesotho is today a signatory to the Rio Declaration on Environment and Development and has endorsed the objectives of Agenda 21[65]: The Global Partnership for Environment and Development. In 1993, Lesotho's constituent assembly adopted the new policy and entrenched it into the country's new constitution[66]. In the following year, the country convened a national workshop to examine the implications of the Earth Summit, and to draw up plans for the implementation of Agenda 21 in Lesotho. Table 48 presents a summary of the priority areas that were identified for national action.

Table 48 Priority Areas for the Targeted Implementation of Agenda 21

Dimension	Measures
Social and economic	- Combatting poverty - Achieving demographic stability - Protecting and enhancing human health - Promoting sustainable human settlements - Integrating environment and sustainable development in decision-making
Conservation and management of natural resources	- Integrated management of land resources - Promotion of sustainable agriculture and rural development - Sustainable mountain development - Protecting and managing fresh water resources - Conservation of biodiversity - Combatting deforestation - Managing energy resources - Combatting drought and desertification
Strengthening the role of major groups	- Recognition of the role of women, young people, farmers, local communities, NGOs, the private sector, workers and trade unions, and scientists and technologists as partners in development, and promoting their active participation at all levels in the decision-making process.

Source: Government of Lesotho, National Plan to Implement Agenda 21, May 1994.

300. Events have since moved fast in the area of environmental policy as the first comprehensive draft legislation was completed in 1997 and published for debate by various stake holders. In 1998, the National Environment Secretariat, which was set up under the requirements of NEAP, was upgraded to a full ministerial status in recognition of the critical vulnerabilities that have been inflicted by various land uses on Lesotho's environment, and the importance and urgency of addressing these.

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[65]United Nations, Agenda 21: The United Nations Programme of Action from Rio, New York.

[66]The Constitution of Lesotho, paragraph 36. The constituent assembly was the predecessor of the democratically elected Parliament of April 1993.

Environmental Legislation

301. A number of laws that govern natural resources management and utilisation and the protection of specific components of the environment have been passed from as early as 1903. Until recently, these laws were scattered and characterised by a degree of overlap, inconsistency, and sometimes conflicting stances. Many studies have concluded that implementation is very poor due to inaccessibility, complexity, gaps and deficiencies, and the top-down approach to legislation. An attempt has thus been made to consolidate the more than 140 pieces of acts, orders, regulations, proclamations, notices, and bylaws. The draft environmental bill which was concluded in 1998 represents a process of legal reform which was initiated with the adoption of NEAP in 1989 with the aim, among others, to enact a comprehensive framework or umbrella environmental law. It also follows from the adoption of a new constitution in 1993 which, for the first time, recognised the importance of the natural and cultural environment for both present and future generations.

302. Lesotho's draft environmental bill, which is at its last stages of consultation before it is presented to parliament for debate, is guided by three major objectives:

- To secure the right of all to a clean and healthy environment, and to obligate a reciprocal duty for every citizen to safeguard and enhance their environment;
- To establish the institutional framework that would respond, in a coordinated and systematic manner, to prevailing and emergent environmental problems; and
- To develop a comprehensive codification of laws relating to the protection and management of the ecosystems and natural resources and set up a cross-sectoral environmental regulatory framework to standardise decision-making principles.

Landuse Planning

303. The earlier sections of this report revealed how the communal land tenure system, with its weak control over land allocation, has resulted in bad landuse practices – encroachments on agricultural land by residential settlements and urban functions, and encroachments on steep slopes and marginal lands by crop farmers. These problems are worsened by the high population growth rate, high livestock numbers, and delays in the implementation of the Land Act, 1979. Migrations of mountain people to lowland areas and the absence of an organized land market and landuse plans are also regarded to be responsible for this widespread disregard for the preservation of land resources.

304. The absence of working landuse plans presents serious constraints to crop diversification, livestock development, and environmental conservation. Although a number of legal instruments have been enacted to enable some landuse planning to take place, implementation has been very slow and limited to urban areas because of resource constraints. Land users have long recognized the problem of indiscriminate loss of agricultural land to non-agricultural uses and want the problem to be urgently addressed.

305. The government pursues the following major objectives in landuse planning:

- to promote the efficient utilization of land resources through the formulation and implementation of update and integrated landuse plans; and
- to empower rural communities and their land allocation committees with skills to improve existing settlements, control settlements expansion, and maintain a balance between agricultural production and demands for non-agricultural landuses.

In the past 5 years, the government has been involved in the identification and mapping of agro-ecological zones in order to determine suitability for food crops, grasses, and trees. Unfortunately, this mapping

exercise excluded the natural vegetation that was found in these agro-ecological zones. Efforts are underway to strengthen the capacity of landuse planning staff in inventorization, organization, storage, and manipulation of natural resources information for landuse planning purposes using GIS. Part of the output of this activity will be the quantification of land production potential and degradation risk.

Land Reform

306. The need to develop a land market that can encourage investments in land improvements is central in the design of strategies to diversify and commercialize agriculture and in the development of effective conservation and environmental policies and landuse plans. In recognition of this, the government has made a number of changes to the land laws since 1979. The current land laws provide adequate security of tenure for those who have the means to invest in productivity-enhancing land improvements, to use the land lease for raising capital, and to sublet to those who have better resources. Unfortunately, very few rural and peri-urban people have taken advantage of these changes due to poor information dissemination. The laws have not been simplified for consumption by people who have no legal background, and the bureaucratic procedures for applying for leases are too cumbersome.

307. The objectives of land reform policies are to lay down a framework for agricultural diversification and commercialization, and to encourage private investment in the land. In the next few years, therefore, the government aims at doing the following:

- Simplify land reform laws, translate these into the local language, and mount nationwide educational and awareness campaigns;
- Streamline the bureaucratic procedures that are involved in the processing of land leases, and make a clear definition of agency responsibilities in the implementation of land laws;
- Assess the feasibility of introducing land taxes and develop lease laws in order to promote a rapid commercialization of the land; and
- Develop an alternative social security system for those that are adversely affected by the land reform process.

Range Management and Adjudication

308. Range management and livestock are inter-linked through extensive grazing systems such that they are appropriately treated as one in the formulation of policies. It has already been pointed out in earlier chapters that communal grazing is one of the basic reasons for large herd sizes, severe overgrazing, and declining soil fertility. In the late 1980's, the government attempted to reduce overgrazing by adopting a number of donor-supported policy initiatives that combined a package of environmental land conservation awareness, rangelands adjudication, breed improvement, and destocking programmes. This preparatory work culminated in the development of the National Livestock Policy Implementation Plan of 1990, a plan which underlines the following:

- Reduction of livestock numbers while increasing rangelands carrying capacities, livestock productivity, and marketing efficiency to absorb increased off-takes; and
- Intensification of culling and breed improvement programmes.

309. To improve rangelands carrying capacities, the livestock policy guidelines call for the expansion of national cattlepost adjudication programmes in order to restrict livestock movements, and the termination of the seasonal transhumance movements of cattle between the lowlands and mountains. They also stress

the need for increasing the number of range management areas (RMAs). The latter are areas of rangeland that have been designated for the improvement of range and livestock condition by a grazing association (GA) through the application of advanced range management practices. Each GA is given exclusive rights by the principal chief of an area to control livestock numbers, movements, and management practices within an RMA. Fifteen years of work by the Range Management Division, with massive donor assistance, has resulted in the establishment of 7 RMAs in four mountain districts. Five more RMAs are at the stages of development.

310. The government believes that this model of community-based control of natural resources offers the best hope for long-term range conservation and livestock productivity improvements. To support this initiative, the government has established an RMA/GA Operations Section within the Range Management Division as an effort to intensify extension efforts. This strategy has been linked with that of marking and registering all livestock throughout the country.

Conservation of Natural Resources

311. Until recently, conservation efforts mainly emphasized structural works such as terracing, contours, silt traps, diversions, etc. This approach was found to merely offer temporary solutions. The current approach emphasizes biological conservation with strong mobilization of community participation. In order to solicit the latter, the new approach seeks to marry production with conservation and environmental objectives, with emphasis on acceptable and affordable techniques.

312. Apart from overstocking the rangelands, livestock, particularly draft and milk cattle and small stock, feed on crop residues after harvesting. In the absence of a widespread cultivation of high-value fodders and forage crops, this is not surprising. On the other hand, due to increasing scarcity of renewable energies, particularly fuelwood, both crop residues and dung that is deposited in the croplands and kraals are widely collected and used as household energy sources. As a result of these two practices, there is no mechanism for replenishing organic nutrients to croplands, contributing to increasing acidity, toxicity, soil fertility declines, and low crop yields. The following activities have been designed to address this problem:

- protect dam catchment areas through grassing, afforestation, and rehabilitation of degraded lands;
- design and implement resource management and conservation courses for government personnel and participating communities;
- improve the current forest nurseries and if necessary, establish new ones; and
- review the legal framework within which conservation activities could be implemented more effectively.

313. The Range Management and Grazing Control Regulations came into being in 1980 and were later amended in 1986. Recognizing that the management of rangelands resources has in general not been effective to ensure its (rangeland's) sustainability, these regulations focused on achieving reduced livestock numbers while at the same time increasing rangeland carrying capacity. They stressed the need to create RMAs and GAs that could enforce grazing fees, national livestock culling efforts, and animal exchanges, and terminate the seasonal transhumance movement of livestock between the lowlands and mountains.

Conclusion

314. This chapter attempted to give a detailed account of those development policies and strategies that Lesotho has isolated as measures to facilitate adaptation to climate change in specific sectors of the

economy. In accordance with the requirements of the Convention, these sector-specific measures are integral components of the national development strategy. They derive from the recognition that Lesotho being critically vulnerable does not on its own have the resources, capacity, and capability to either take full advantage of new opportunities and potential that may come with climate change, or totally avert the human suffering that may come with adverse impacts of the same.

315. Most of the measures that have been cited in this chapter have one main objective: to reduce the country's critical vulnerability. This is because of a realisation that on the whole, future scenarios that were created using GCM models predicted deprivation of unprecedented proportions should this vulnerability not be delt with resolutely. In other words, unless the country adopts and implements effective interventions to reduce vulnerabilities in various sectors, it has a very remote possibility of realizing any potential that will come with climate change. Unfortunately, the rate of policy and programme implementation is highly constrained by funding availability, in addition to institutional and cultural rigidities and technological limitations. Lesotho will therefore continue to depend on the support of the international community in many areas.

8 NATIONAL IMPLEMENTATION STRATEGY

Introduction

316. The national programme of action on climate change has been designed for complete integration with existing national development programmes in accordance with Articles 3(4) and 4(1)(f) of the UNFCCC, and forms an integral part of the national socio-economic and environmental policies and actions. The government recognises the sectoral cross-cutting nature of climate change issues, and as such has adopted an all-inclusive approach which brings together multi-disciplinary expertise into a common purpose through regular consultations, workshops and seminars. The programme also brings together a broad spectrum of stakeholders, from grassroots levels to policy-making echelons. The seriousness of the issues that are concerned in this programme has been underlined by the active participation of policy makers at both national and international forums.

The Institutional Framework

317. Although the subject of climate change is inherently multi-faceted, demanding inputs from all sectors of the economy, a few institutions have been isolated to carry critical components of the national programme of action. As shown on diagram 1, these institutions include the Ministries of Natural Resources; Environment, Gender and Youth Affairs; Agriculture, Cooperatives and Land Reclamation; and Health and Social Welfare. These institutions represent the sectors on which the impacts of climate change are directly felt. This concentration does not relegate the relevance of the Ministries of Education; Local Government; Finance; Planning and Development; Trade and Industry; Transport and Communications; and Tourism, Sports and Culture; especially in the areas of research, education and public awareness campaigns, pollution control, resource allocation, programme formulation, emission regulation, and environmental protection. The private sector, NGOs, and community-based organizations (CBOs) are also playing an invaluable role through relevant line ministries.

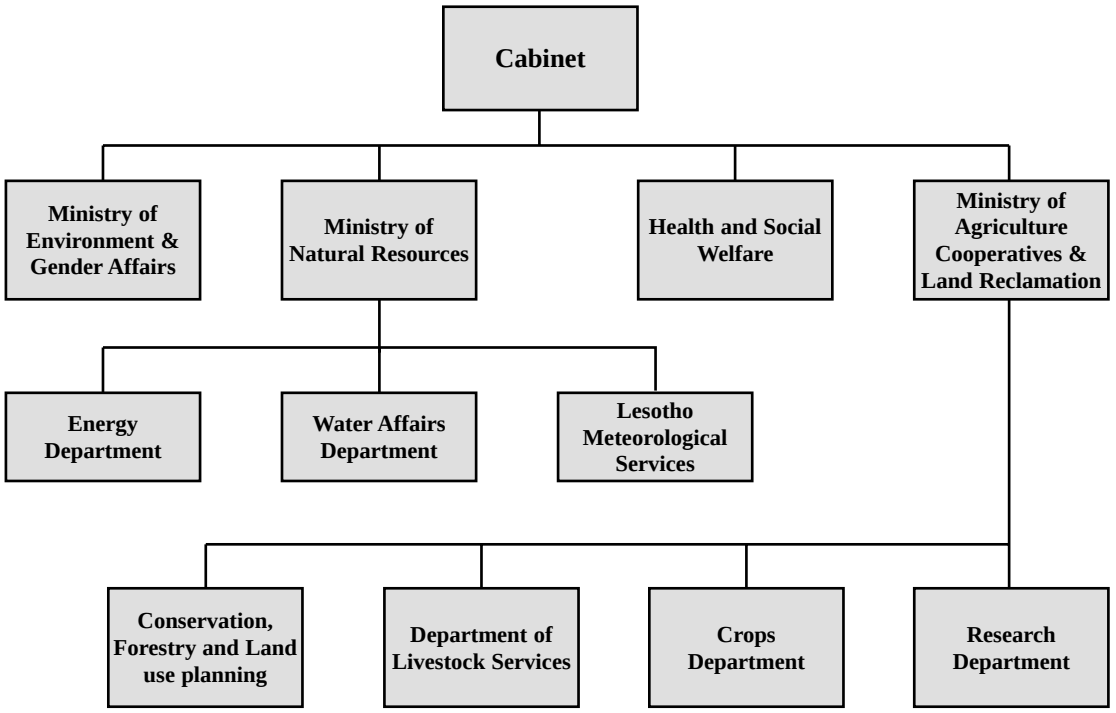
The Ministry of Environment, Gender, and Youth Affairs

318. This newly formed Ministry is a direct product of NEAP. It was created under the Office of the Prime Minister in April 1994 under the name National Environment Secretariat (NES), an institutional support for the formulation, implementation and coordination of environmental programmes. As a recognition of the critical nature of environmental concerns, and as a commitment to environmentally sustainable development, the government elevated this institution into a full Ministry in May 1998. The current draft environmental policy gives the new Ministry coordinating, advisory, regulatory, and enforcement duties. It empowers the same to institute environmental impact assessments of any development activity in the country.

319. In recognition of its capacity constraints, the Ministry of Environment, Gender and Youth Affairs has appointed individuals in line ministries to act as liaison officers who ensure the integration of environmental issues in the planning and implementation of sectoral programmes and projects. It is also actively involved in building environmental management capacity at the district, ward and village/local levels in line with the government's decentralisation policy. Capacity constraints have also been addressed through increased cooperation with NGOs, CBOs, schools, tertiary institutions, and the private sector. Although there are no fully-fledged environmental NGOs, it is estimated that close to 100 NGOs are involved in the implementation of environmentally-related projects, particularly in soil

conservation, afforestation, and agriculture. The Ministry also maintains very close cooperation with the LHWP since the latter has a very comprehensive environmental programme whose objective is to mitigate all negative environmental impacts that are associated with its activities.

Diagram 1:
Institutional Structure – Main Stake-holders in Climate Change Action Plan



320. Since women and youth play a crucial role in environmental management and governance, their participation has been enhanced with donor assisted programmes. Donor assistance has been utilised to build environmental management capacity at the national and local levels since 1994. The Ministry will be expected to review the state of the environment periodically, and design and implement environmental rehabilitation programmes that are consistent with development with sustainability considerations.

The Ministry of Natural Resources

321. This is a relatively new Ministry that is made up of some of the oldest departments in the country. In addition to the Departments of Energy, Water Affairs, and the Lesotho Meteorological Services (LMS), the Ministry of Natural Resources encompasses the Departments of Mining and Science and Technology. Institutional responsibilities between this Ministry and the Ministry of Environment, Gender and Youth Affairs are somewhat diffuse since both ministries are still at their formative stages. However, the pivotal position of the Ministry of Natural Resources in the coordination of climate change programmes through LMS is unquestionable although capacity constraints remain a pervasive problem.

322. The Energy Department is mainly concerned with the planning and coordination of programmes in the energy sector although its activities have mainly been concerned with fossil fuels and electricity, both of which account for a small fraction of total energy demand in the country. In addition to promoting energy conservation, the department is currently conducting baseline surveys that will assist the updating

of the energy master plan and provide valuable data on energy consumption characteristics of various sectors of the economy. It will also continue to monitor trends in GHG emissions from the energy sector, and liaise very closely with the Ministry of Local Government to promote the adoption of various energy conservation devices.

323. The Department of Water Affairs (DWA) is the custodian of water sector policies and programmes. The Department has a host of functions that include baseline studies, quality monitoring, pollution control, conservation promotion and some regulatory functions. Its activities are broadly divided into rural and urban water supplies. The former largely comprises relief-type community based water supply programmes that are implemented at the village level, while the latter focuses on commercial water supplies to urban and peri-urban settlements through a parastatal service provider, WASA. DWA will be actively involved in the monitoring of trends in both static and renewable water stocks and in water utilisation, and well as assess water stress levels over time.

324. The Department of Mining has not yet been brought on board in climate change forums. However, mining activities are largely responsible for a lot of noise and dust pollution. They are also partially responsible for accelerated soil erosion, river and dam siltation, and poor aesthetics that emanate from open pits. Attempts will be made to actively involve them in the implementation of some of the action plan activities.

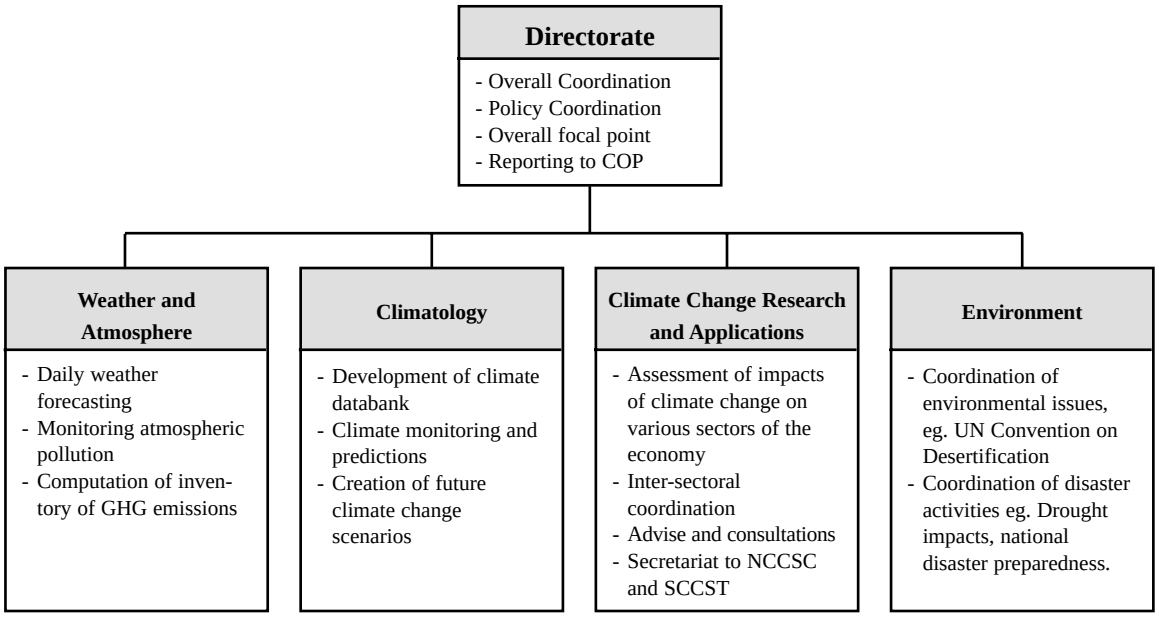
The Lesotho Meteorological Services

325. This is one of the oldest institutions in the Ministry of Natural Resources. Formed in 1974, the Lesotho Meteorological Services (LMS) is the government arm which carries responsibility for monitoring and reporting on weather and climate, and for advising on both atmospheric and meteorological applications. It is also responsible for the implementation of the Vienna Convention and its Montreal Protocol on Substances that Deplete the Ozone Layer. It is also an active participant in activities of other international conventions like the Convention on Drought and Desertification and the Convention on Biodiversity. The Government has given LMS the responsibility to act as a focal point in the planning and coordination of activities aimed at the realization of its commitments under the UNFCCC.

326. In line with the obligations bestowed upon it, LMS has defined its main objective as the provision of meteorological services that contribute towards the environmentally sound and sustainable development of the country. As a recognition of this critical role, the past six years have seen a rapid expansion in LMS responsibilities, and a strengthening of its capacity with the creation of additional posts, an increase in the operational budget, and an improvement of facilities and equipment. However, out of a staff complement of 51 technicians and 9 professional meteorologists, only two have post-graduate qualifications, a situation which has serious implications for skill levels. The institution currently operates a network of over 105 meteorological stations. These include 6 synoptic stations, 28 climatological stations, and 73 rainfall stations. Plans are underway to convert 40 of the latter into climatological stations by year 2003. Weather forecasting is carried out with the support of satellite-derived data at the weather office located at the Moshoeshoe I International Airport, 20 kms south of Maseru.

327. To handle climate change responsibilities, the LMS is broadly divided into 4 distinctive functions as shown on diagram 2: (a) weather and atmosphere whose main climate change responsibility is daily weather forecasts, monitoring of atmospheric pollution, and computing an inventory of GHG emissions; (b) climatology which keeps the country's climate data bank for the creation of future climate change scenarios; (c) climate change research and applications whose main responsibility is the assessment of climate change on various sectors of the economy; and (d) environment which concentrates on thematic climate issues that directly affect the environment such as droughts and desertification. At the present moment, however, some of the functions specified on this diagram tend to be diffuse due to the thin spread of professional personnel. The plan is to develop these functions into fully-fledged divisions in future.

Diagram 2: Responsibilities of LMS Divisions in Climate Change Action Plan



328. LMS has designed a programme which promotes an understanding of the interplay between meteorology and socio-economic development amongst people at all levels. This is done through public awareness campaigns which combine pitso (village assemblies) with twice-daily radio news bulletins, radio features, a topical monthly news bulletin, talk shops, workshops and seminars. The number and frequency of data requests from the public and consultations with the same have been increasing gradually. Capacity constraints have been addressed by constituting a steering committee of stakeholders, and by drawing upon the professional expertise of an interdisciplinary study team and consultants. There are also strong backup services from relevant international organizations.

The Ministry of Agriculture, Cooperatives and Land Reclamation

329. The Ministry of Agriculture, Cooperatives and Land Reclamation (MACLR) is one of the key ministries in the implementation of the national climate change action plan. Its activities are mainly geared towards reducing the agricultural sector's direct contribution to the country's vulnerability, and on increasing the country's adaptation to the negative impacts of climate change. MACLR is divided into a number of specialised departments the most relevant of which are Conservation, Forestry, and Land use Planning; Livestock Services; Crops; and Research. The main thrust of activities centres around soil conservation and environmental rehabilitation, conducting adaptive research, and reducing vulnerability by improving the sector's productivity.

330. The critical importance of MACLR lies in the fact that the majority of the population derive their livelihood directly from agriculture, a sector that is critically dependent on climate. Like many ministries, MACLR suffers a lot of capacity constraints. There is presently a lot of donor involvement in capacity building programmes with the hope that there will be visible improvements in service delivery. The Ministry has gone a long way in decentralizing its activities to the districts and lower levels. There is also a growing cooperation with NGOs, CBOs, and the private sector. This cooperation, together with the liberalisation of agricultural commodity markets and privatization and commercialisation of some of the productive activities which were state dominated, will lead to a relaxation of some of the capacity constraints that are currently facing this MACLR.

Other Institutions

331. There are many other government and non-government agencies which play a critical role in climate change action planning and programming in the country. The Ministry of Health and Social Welfare has been monitoring health impacts for a long time. Its database has been very useful in programme targeting. The Ministries of Local Government and Home Affairs are the main avenues through which climate change issues are taken to the people. Admittedly, more coordination with this Ministry will be necessary for the future success of this strategy. The Ministries of Finance and Development Planning are responsible for drawing up national plans and allocating resources to the same. They have in recent years taken climate change issues to the top of the development agenda by emphasizing sustainable human development as the major goal of the country's development endeavour. A number of parastatals, NGOs, CBOs, and private sector companies and individuals (eg waste scavengers) have recognised roles in the climate change action plan.

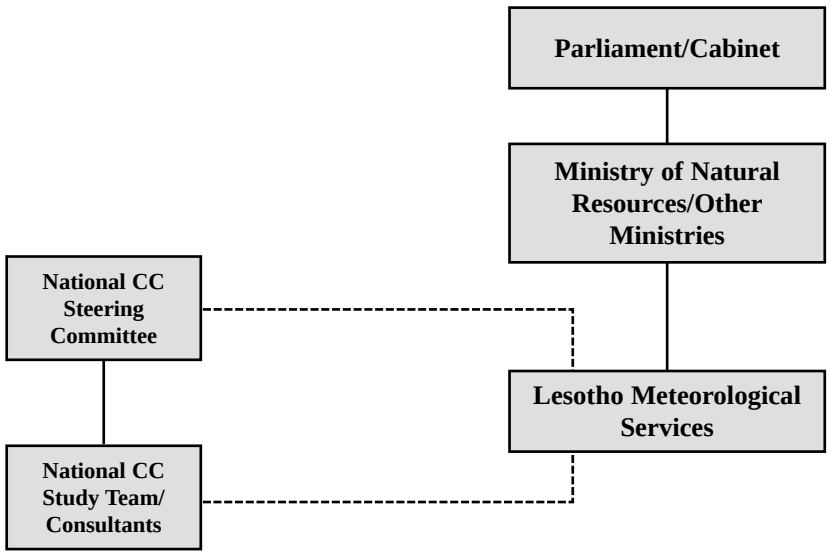
The Programming Framework

332. The above sections showed that there are a number of institutions whose role is essential for the successful planning and implementation of national policies, strategies and programmes on climate change. In order to ensure consistency in policies and strategies, the Lesotho Meteorological Services has been identified as a focal point for the following:

- Coordination of baseline studies and all climate change documentation;
- Coordination of the formulation of overall climate change policies;
- Coordination of the formulation of specific climate change programmes and activities; and
- Mobilizing resources to fund climate change activities and programmes.

Diagram 3 Climate Change Action Plan: The Programming Framework

Diagram 3: The Programming Framework for Climate Change Action Plan



333. Despite the fact that climate change action plans are expected to dovetail into existing national policies and programmes, it became evident at inception that LMS could not on its own efficiently carry out these functions. A National Climate Change Steering Committee (NCCSC) has been constituted to

assist in this mammoth task. This is a stakeholders forum that consists of representatives of major Governmental agencies, non-governmental organizations, training and research institutions, and the private sector. Chaired by LMS, the main task of NCCSC is to provide guidance on a number of issues relating to national policies on various aspects of climate change, to consider a national climate change programme of action; to make periodic reviews of progress at the implementation of the same; and to consider technical reports that are prepared by the National Climate Change Study Team (NCCST) and consultants.

334. Another body that has a critical role in building capacity within LMS is the National Climate Change Study Team (NCCST), a grouping of specialists and distinguished individuals and consultants who are working on specific technical programmes and assignments that provide guidance and form a basis for policy and programme formulation. The team has been appointed by and reports to the NCCSC through the LMS. Depending on the decisions of the NCCSC, those programmes that have been approved will either be passed on to stakeholders for implementation, sometimes with funding allocation from the Committee, or be passed on, through the LMS, to relevant ministries for presentation to the Cabinet either as a policy recommendation or as draft legislation to be submitted for to Parliament for approval. The process is vividly illustrated on Diagram 3.

Research and Systematic Observation

335. Other than in the agricultural sector, there is very little official systematic research that is conducted in the country. There is, however, a lot of systematic data capturing in various sectors of the economy in the areas of hydrology and meteorology, national accounts, financial indicators, health and education statistics, etc. Most of this is coordinated by the Bureau of Statistics and the Central Bank of Lesotho which maintain quite elaborate databases. There are also periodic surveys and studies that are commissioned for specific purposes. The LHWP has been very instrumental in this respect.

336. The mandate to conduct and coordinate all agricultural research lies with the Agricultural Research Division (ARD) of the Department of Field Services (DFS) in MACLR, an institution which was established as a research station in 1952. ARD currently runs 10 research stations and sub-stations, distributed across the major agro-ecological zones. Research activities are concentrated in the main research station in Maseru which has laboratories and physical infrastructure to conduct adaptive crop production research and livestock breeding. The other stations are mainly used for demonstration trials and extension activities. However, it has not been easy to sustain activities and adequate levels of communication at the latter stations because of staff, transport, and budgetary constraints.

337. The current focus of agricultural research is on:

- increasing farm incomes by reducing production unit costs, introducing high-value crops and high-yielding crop varieties, and by disseminating cultivation practices that are more economical and environmentally acceptable;
- providing technological inputs and new agronomy practices that can overcome drudgery;
- providing technological packages for the intensification and diversification of the production of basic grains, vegetables, and high-value crops; and
- introducing production practices (particularly in the area of livestock), crop varieties, and technologies that protect and enhance the productivity of the natural resource base.

338. Despite limitations in institutional capacity and funding, a number of agro-technologies have been developed over the years. These are well-documented and will provide a good base for the screening of appropriate crops. ARD has made significant technological breakthroughs in pinto beans, leafy green vegetables, and drought resistant and quick maturity cereals. A number of these have already been adopted by farmers.

339. In its future activities, ARD intends to concentrate on technological adaptation as opposed to technological generation. In this regard, ARD has opened a number of collaborative efforts with a number of international institutions. These are listed on table 49. For crops which are seen to have high growth potential and for which there are markets, ARD will shift away from applied research towards adaptation to local conditions. Tried and tested technologies will be moved rapidly into commercial production. Experience has shown that ARD can transform some of the traditional products into high-value products for specialized markets. A good example is the promotion of dehulled sorghum in the southern districts. This, however, needs good and better extension and management than what is currently available for simple traditional crops.

Table 49 ARD Collaborative Efforts by Area of Cooperation

Area of Collaboration	International Institution
Groundnut production, pulses, maize and wheat, sorghum and millet improvement programme, crop management research	Southern African Development Community (SADC).
Sorghum Improvement	International Cereal Research Institute for Semi-Arid Tropics (ICRISAT)
Beans and Groundnuts	Centro International de Agricultura Tropical (CIAT)
Institutional management capacity building	International Service for National Agricultural Research (ISNAR)
Crop storage and processing, farm structures, mechanization and energy.	Agricultural Operations Technology (AGROTEC)
Wheat and Maize improvement	Centro International de Mejoramiento de Maizy Trigo (CIMMYT)
Library Information	Centre Technique de Cooperation Agricole at Rurale (CTA)

Source: Agricultural Research Division.

Education, Training and Public Awareness

340. There has been growing interest in climate change related fields of study in Lesotho in the past one or two decades of education. The National University of Lesotho has expanded its curricula to include a wide range of environmental sciences and agriculture. The Faculty of Health Sciences has also been commissioned in Maseru, with a mandate to train students in a wide range of health sciences up to technician level. Donor-supported scholarships have also been generally available for long-term training abroad. The problem has been to introduce climate change issues at primary and secondary schools because of the short supply of qualified teachers for that level. The second problem is that, like all sectors of the economy, it has been very difficult to retain trained manpower in climate change fields of study because of uncompetitive remuneration packages and poor working environments. Lesotho has lost a lot of trained manpower to the RSA where incentives are much higher.

341. A number of short-term training and on-the-job training courses have been organized for both LMS staff and those from other stakeholders. Results from inventory studies indicate that these have produced positive results. However, a lot of training support will be necessary to take the subject of climate change to a broader spectrum of field agents both at the national and local levels. Lesotho is fortunate to have a well accepted traditional public awareness forum, the pitso or village assembly. This is a gathering that is organized with the assistance and full participation of both official and traditional leaders. Attendance in these fora is generally good. A number of agencies in climate change related fields have used this forum to pass messages to the grassroots levels. In addition to district-level workshops that have been held for officials and traditional leaders, LMS would like to use appropriate institutions to take messages down to those levels. This will entail additional financial resources and greater coordination.

342. Although LMS has utilised, albeit to a limited extent, electronic media and a newsletter in its awareness campaigns, it is clear that capacity-building is necessary in that direction. There are a lot of out-sourcing possibilities, provided resources are available. The aim is to develop focussed massages that will be directed to various categories of people, with translations into the local language.

Monitoring and Evaluation

343. The implementation of the climate change action plan draws together stakeholders from a wide spectrum with different and sometimes conflicting interests and persuasions. At the national level, LMS has been mandated to coordinate the plans and actions of these stakeholders and harmonise their interests. At the international level, LMS has an obligation, in accordance with Article 12 of the UNFCCC, to compile regular reports to the COP on progress in the implementation of the national action plan. This entails a lot of cooperation from stakeholders which can only be solicited through their meaningful participation in the formulation, monitoring and evaluation of policies and programmes in their domains. The first part has already been achieved. The national action plan on climate change has been drawn up with very active stakeholder participation. It has been fully integrated with national plans, policies, and programmes. Agency responsibilities have been clearly elaborated in these plans. This includes reporting responsibilities as shown on table 50.

344. Reporting agencies will submit their reports to the LMS which in turn will compile a communication report to be submitted to the COP. For this purpose, a number of indicators and areas of their utilisation have been isolated. Because of capacity constraints in various agencies, LMS will be expected to provide periodic institutional strengthening through the NCCST or consultants. These will design reporting formats to facilitate comparisons over time, and to facilitate easy utilisation. A number of workshops will also be held for those who will be directly involved in progress monitoring. There will also be regular workshops to review and evaluate progress in each of the areas of the action plan. In fact, each draft communication report, like the current report, will be submitted to a workshop of stakeholders for discussion, and comments emerging therein will be incorporated before presentation to the Conference of Parties.

Table 50 Indicators for Monitoring Under Climate Change Action Plan:

Type of Data	Reporting Institution	Utilisation
Socio-economic		
National accounts, population, employment trends, financial and monetary sector trends	Bureau of Statistics Ministry of Labour and Employment Employment Bureau of Africa Ltd.	Assessments of overall macro-economic performance, growth impacts, and financial resources availability.
Consumer indices, incomes and expenditure data, entitlements, incidence of poverty	Bureau of Statistics	Assessment of threats to family well-being, targeting of poverty alleviation programmes.
GHG Inventory/Climatology		
Level of emissions by GHG gas type	Lesotho Meteorological Services	Assessment of global warming potential; review of climate change policies.
Rainfall, temperatures, wind, and snow records	Lesotho Meteorological Services	Long-term weather forecasts and analysis of vulnerability; forecasts of disaster occurrences.
Agriculture		
Area planted and area harvested	Ministry of Agriculture	Assessment of agro-ecological conditions.
Agricultural production, yields, and prices.	Ministry of Agriculture	Assessment of household food security, targeting of relief programmes.
Water and Sanitation		
Water resources inventory, coverage statistics	Department of Water Affairs, Department of Rural Water Supplies, and Water and Sewerage Authority	Long-term water supply demand forecasts, assessment of water stress conditions, assessment of development needs and investment requirements, assessments of compliance with WHO standards and impact on health indicators.
Water quality and yields	Department of Water Affairs, Department of Rural Water Supplies, and Water and Sewerage Authority.	Assessments of compliance with WHO standards.
Health		
Disease and malnutrition patterns and trends	Ministry of Health and the Food and Nutrition Coordination Office	Assessment of impacts of disasters, assessment of community health condition
Energy		
Imports – fosil fuels and other petroleum products and electricity, energy consumption patterns	Department of Energy, Lesotho Electricity Corporation, Bureau of Statistics	Assessment of consumption structure, projections of future demand structure.
Rangeland		
Vegetation cover, species composition, carrying capacities, livestock populations	Range Management Division, Department of Livestock Services	Assessment of pressure on rangeland resources and on biodiversity, assessment of destocking programmes.
Rangeland productivity, tion livestock productivity, live-stock incomes and productivity	Range Management Division, Department of Livestock Services.	Assessment of the state of the range and impact of adapta- options, impact on household food security and welfare.
Forestry		
Area planted, area stocked	Forestry Division	Assessment of adaptation options in soil protection and biomas energy supply.

Appendix 1 Sectoral Report for Energy

SECTORAL REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (Gg)							
GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_X	CO	NMVOC	SO_2
Total Energy	**635.99**	**7.63**	**0.10**	**4.92**	**137.08**	**17.57**	**0.00**
A Fuel Combustion Activities (Sectoral Approach)	**635.99**	**7.63**	**0.10**	4.92	**137.08**	**17.57**	**0.00**
1 Energy Industries	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
a Public Electricity and Heat Production							
b Petroleum Refining							
c Manufacture of Solid Fuels and Other Energy Industries							
2 Manufacturing Industries and Construction	**27.87**	**0.00**	**0.00**	**0.09**	**0.03**	**0.00**	**0.00**
a Iron and Steel							
b Non-Ferrous Metals							
c Chemicals							
d Pulp, Paper and Print							
e Food Processing, Beverages and Tobacco							
f Other (please specify)							
3 Transport	**220.69**	**0.05**	**0.00**	**2.10**	**17.70**	**3.33**	**0.00**
a Civil Aviation	0.25	0.00	0.00	0.00	0.00	0.00	
b Road Transportation	220.44	0.05	0.00	2.10	17.70	3.33	
c Railways	0.00	0.00	0.00	0.00	0.00	0.00	
d Navigation	0.00	0.00	0.00	0.00	0.00	0.00	
4 Other Sectors	**382.55**	**7.58**	**0.10**	**2.73**	**119.25**	**14.22**	**0.00**
a Commercial/Institutional	2.15	0.00	0.00	0.00	0.05	0.00	
b Residential	357.42	7.58	0.10	2.72	119.20	14.22	
c Agriculture/Forestry/Fishing	22.99	0.00	0.00	0.01	0.00	0.00	
5 Other (please specify)	**4.87**	**0.00**	**0.00**	**0.00**	**0.10**	**0.01**	
B Fugitive Emissions from Fuels	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
1 Solid Fuels	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
a Coal Mining		0.00					
b Solid Fuel Transformation							
c Other (please specify)							
2 Oil and Natural Gas	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
a Oil		0.00		0.00	0.00	0.00	0.00
b Natural Gas		0.00					

Appendix 2 Sectoral Report for Agriculture

SECTORAL REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (Gg)					
GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CH_4	N_2O	NO_x	CO	NMVOC
Total Agriculture	**37.31**	**0.50**	**0.13**	**6.73**	**0.00**
A Enteric Fermentation	**31.91**				
1 Cattle	18.58				
2 Buffalo	0.00				
3 Sheep	5.65				
4 Goats	3.75				
5 Camels and Llamas	0.00				
6 Horses	1.80				
7 Mules and Asses	1.46				
8 Swine	0.67				
9 Poultry	0.00				
10 Other (please specify)					
B Manure Management	**5.21**	**0.01**			
1 Cattle	0.58				
2 Buffalo	0.00				
3 Sheep	0.18				
4 Goats	0.13				
5 Camels and Llamas	0.00				
6 Horses	0.16				
7 Mules and Asses	0.13				
8 Swine	4.00				
9 Poultry	0.03				
10 Anaerobic		0.00			
11 Liquid Systems		0.00			
12 Solid Storage and Dry Lot		0.01			
13 Other (please specify)		0.00			
C Rice Cultivation	**0.00**				
1 Irrigated	0.00				
2 Rainfed	0.00				
3 Deep Water	0.00				
4 Other (please specify)					
D Agricultural Soils		**0.49**			
E Prescribed Burning of Savannas	**0.19**	**0.00**	**0.13**	**6.73**	
F Field Burning of Agricultural Residues (1)	**0.00**	**0.00**	**0.00**	**0.00**	
1 Cereals					
2 Pulse					
3 Tuber and Root					
4 Sugar Cane					
5 Other (please specify)					
G Other (please specify)					

SECTORAL REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES
(Gg)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO
Total Land-Use Change and Forestry	**1,260.57**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
A Changes in Forest and Other Woody Biomass Stocks	**0.00**	**-289.20**				
1 Tropical Forests						
2 Temperate Forests						
3 Boreal Forests						
4 Grasslands/Tundra						
5 Other (please specify)						
B Forest and Grassland Conversion	**1,630.20**		**0.00**	**0.00**	**0.00**	**0.00**
1 Tropical Forests	0.00					
2 Temperate Forests	0.00					
3 Boreal Forests	0.00					
4 Grasslands/Tundra	1,630.20					
5 Other (please specify)	0.00					
C Abandonment of Managed Lands		**-2,750.00**				
1 Tropical Forests		0.00				
2 Temperate Forests		-896.50				
3 Boreal Forests		0.00				
4 Grasslands/Tundra		-1,853.50				
5 Other (please specify)		0.00				
D CO2 Emissions and Removals from Soil	**2,669.57**	**0.00**				
E Other (please specify)						

Appendix 4 Sectoral Report for Waste

SECTORAL REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (Gg)						
GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
Total Waste	**0.00**	**1.27**	**0.09**			
A Solid Waste Disposal on Land	**0.00**	**1.27**	**0.00**			
1 Managed Waste Disposal on Land						
2 Unmanaged Waste Disposal Sites						
3 Other (please specify)						
B Wastewater Handling	**0.00**	**0.00**	**0.09**			
1 Industrial Wastewater		0.00				
2 Domestic and Commercial Wastewater		0.00	0.09			
3 Other (please specify)						
C Waste Incineration						
D Other (please specify)						

Appendix 5a Sectoral Report for Global Warming Potential for Different Gasses

SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (Gg)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	HFCs		PFCs		SF_6	
									P	A	P	A	P	A
Total National Emissions and Removals	**1,896.56**	**0.00**	**46.211**	**0.69**	**5.05**	**143.81**	**17.57**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
1 Energy	**635.99**	**0.00**	**7.63**	**0.10**	**4.92**	**137.08**	**17.57**	**0.00**						
A Fuel Combustion (Sectoral Approach)	635.99		7.63	0.10	4.92	137.08	17.57							
1 Energy Industries	0.00		0.00	0.00	0.00	0.00	0.00							
2 Manufacturing Industries and Construction	27.87		0.00	0.00	0.09	0.03	0.00							
3 Transport	220.69		0.05	0.00	2.10	17.70	3.33							
4 Other Sectors	382.55		7.58	0.10	2.73	119.25	14.22							
5 Other (please specify)	4.87		0.00	0.00	0.00	0.10	0.01							
B Fugitive Emissions from Fuels	0.00		0.00		0.00	0.00	0.00	0.00						
1 Solid Fuels			0.00											
2 Oil and Natural Gas			0.00		0.00	0.00	0.00	0.00						
2 Industrial Processes	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
A Mineral Products	0.00					0.00	0.00	0.00						
B Chemical Industry	0.00		0.00	0.00	0.00	0.00	0.00	0.00						
C Metal Production	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D Other Production	0.00				0.00	0.00	0.00	0.00						
E Production of Halocarbons and Sulphur Hexafluoride									0.00	0.00	0.00	0.00	0.00	0.00
F Consumption of Halocarbons and Sulphur Hexafluoride									0.00	0.00	0.00	0.00	0.00	0.00
G Other (please specify)	0.00		0.00	0.00	0.00	0.00	0.00	0.00				0.00		0.00

Appendix 5b continued Summary Report for National Greenhouse Gas Inventory

SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (Gg)															
GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	HFCs		PFCs		SF_6	
									P	A	P	A	P	A
3 Solvent and Other Product Use	**0.00**			**0.00**			**0.00**							
4 Agriculture			**37.31**	**0.50**	**0.13**	**6.73**								
A Enteric Fermentation			31.91											
B Manure Management			5.21	0.01										
C Rice Cultivation			0.00											
D Agricultural Soils				0.49										
E Prescribed Burning of Savannas			0.19	0.00	0.13	6.73								
F Field Burning of Agricultural residues			0.00	0.00	0.00	0.00								
G Other (please specify)			0.00	0.00										
5 Land-Use Change & Forestry	**1,260.57**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**								
A Changes in Forest and Other Woody Biomass Stocks	0.00	-289.20												
B Forest and Grassland Conversion	1,610.20		0.00	0.00	0.00	0.00								
C Abandonment of Managed Lands		-2,750.00												
D CO_2 Emissions and Removals From Soil	2,669.57	0.00												
E Other (please specify)	0.00	0.00	0.00	0.00	0.00	0.00								
6 Waste			**1.27**	**0.09**	**0.00**	**0.00**	**0.00**	**0.00**						
A Solid Waste Disposal on Land			1.27											
B Wastewater Handling			0.00	0.09										
C Waste Incineration														
D Other (please specify)			0.00	0.00										
7 Other (please specify)														

Appendix 5c Short Summary Report for National Greenhouse Gas Inventory

APPENDIX 5B SHORT SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES

SHORT SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (Gg)															
GREENHOUSE GAS SOURCE AND SINK CATEGORIES		CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	HFCs		PFCs		SF_6	
										P	A	P	A	P	A
Total National Emissions and Removals		**1,896.56**	**0.00**	**46.21**	**0.69**	**5.05**	**143.81**	**17.57**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
1 Energy	Reference Approach	**637.01**													
	Sectoral Approach(1)	**635.99**		**7.63**	**0.10**	**4.92**	**137.08**	**17.57**	**0.00**						
A Fuel Combustion		635.99		7.63	0.10	4.92	137.08	17.57							
B Fugitive Emissions from Fuels		0.00		0.00		0.00	0.00	0.00	0.00						
2 Industrial Processes		**0.00**		**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
3 Solvent and Other Product Use		**0.00**			**0.00**			**0.00**							
4 Agriculture				**37.31**	**0.50**	**0.13**	**6.73**								
5 Land-Use Change & Forestry		**1,260.57**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**								
6 Waste				**1.27**	**0.09**										
7 Other (please specify)		**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**						
Memo Items:															
International Bunkers		**0.00**		**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**						
Aviation		0.00		0.00	0.00	0.00	0.00	0.00	0.00						
CO_2 Emissions from Biomass		**0.00**													

Appendix 6 Integrated Climate Change Impact Assessment Matrix for Lesotho

IMPACT ON	WATER -	AGRIC +	RANGELANDS -	FORESTRY +	SOILS -	HEALTH -	BIO-DIVERSITY +	CULTURE -
WATER		+ improve quality of catchment area	- increase sedi-mentation -reduce water quality -destabilise stream and water flow	+ increase rainfall + improve catchment area	- catchment areas to deteriorate - poor recharge of underground aquivers		+ improve quality of catchments	- increased demand for water
AGRIC	-decrease water for irrigation -water for crop extra-ction to reduce		- decrease of humus	+ provides humus	- reduced yield - soil salinity increase	- manpower to be reduced	+ increase in variety of agric crops	- loss of native agric practices
RANGE	- wetlands to degrade -pastures to deteriorate - variety of endemic species to reduce	+ decrease animal pressure on rangelands		+ provides humus + provides alternative sources of fodder	- rangeland area decreases as pressure over rangelands intensifies		+provide alternative fodders + some land species will be used as fodder	- destruction of rangelands due to exacerbated deterioration
FOREST	- young plant survival to reduce	+ preserve forest reserves	- decrease moisture		- forest cover and reserves to decrease		+ increase forest reserves	+ decrease use of fuel wood + promote forestry conservation
SOILS	- increase soil erosion due to dryness	+ improve humus content + improve water holding capacity	- decrease humus - increases erosion	+ reduces soil erosion + increases humus			+ increase humus + decreases erosion	- udermine soil conservation- -increase erosion
HEALTH	-typhoid incidences to increase + prevent malaria -increase in gastro intestinal diseases	+ increase food security	-decrease wild vegetables -decrease traditio-nal medicines	+ increases source of traditional medicines + improves nutrition + improves air quality +improves fuel & heating	- less food		+ improve health +improve forest cover	- increase in in incidences of promiscuity resulting in STDs
BIO-DIV.	- disappearance of aquatic species + xerophyte species to increase - plant & animal varieties to reduce	+improve endemic species survival	-dominance of unpalatable species -reduction of live-stock - degradation of wetlands.	+ maintains balance among tree speices	- bio-diversity to decrease - reduction of endemic plant species	- bio-diversity to decrease		- reduce bio-diversity

"-" indicates a negative impact "+" indicates a positive impact

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