CLIMATE CHANGE TOOLKIT FOR TEACHERS

LESOTHO METEOROLOGICAL SERVICES

MINISTRY OF ENERGY AND METEOROLOGY

AUGUST 2015

THIS DOCUMENT IS DEVELOPED BY THE MINISTRY OF ENERGY AND METEOROLOGY - LESOTHO METEOROLOGICAL SERVICES, IN COLLABORATION WITH THE MINISTRY OF EDUCATION AND TRAINING - NATIONAL CURRICULUM DEVELOPMENT CENTRE

Funded by the Government of Lesotho and Global Environment Facility (GEF)

PREFACE

Climate change is a global phenomenon that threatens the very existence of humankind the world over. It is emerging as a key challenge on the global effort to achieve sustainable development. The linkage of climate change to poverty reduction, food security and overall development goals highlights its significance. Lesotho faces serious economic and social climate change related challenges. It has been identified as one of those countries most vulnerable to climate change worldwide. Predictions from several global circulation models (GCM) for the years, 2030, 2050 and 2075 derived from climate change scenarios suggest that there will be warmer future climatic conditions with lower precipitation.

Climate change is expected to impact on human health and other economic sectors through multiple pathways. It would result in reduced agricultural production through a shift and potential shortening of the growing period, cause malnutrition and thus affect child growth. As such, it is critical to pursue appropriate adaptation strategies, to cope with extreme events in order to protect human lives and property.

Solving the problem of climate change requires the world to agree tackling issues of climate change collectively including behaviour change. This can only happen depending on our understanding, which in turn depends on the knowledge of facts and their implications.

The impetus for writing this book was to advance our understanding of the atmospheric science and help to elucidate the fundamentals of teaching and learning about climate change. The intent was to provide a basic understanding of the subject matter so that teachers could meaningfully understand and teach climate change.

Although this book has been written using materials collected from many international climate change sources, the intention is for the local cases to be compared with cases around the world with a view of informing the teaching and learning of climate change in a wider context. The book provides concrete examples of measures taking placing in Lesotho and in other parts of the world.

The book contains wealth of information on basics principles of climate change. It provides background information on Earth's climate system, global warming, the scientific principles that govern climate, climate variability and climate change, adaptation and mitigation. Also covered are national policies of relevance to climate change in Lesotho.

Lesotho Meteorological Services (LMS)

ACKNOWLEDGEMENTS

We have immense pleasure in successful completion of this book entitled "**climate change education toolkit**" for Lesotho. We would like to express our heartfelt gratitude to all those who have contributed to the development of this toolkit. We are indebted to all those who did their best to bring their inputs and suggestions, that enabled us to complete this work.

The success and final outcome of this book required a lot of guidance and assistance from many people. We would like to acknowledge with much appreciation the critical role of Lesotho Meteorological Services Officials. A special vote of thanks goes to National Curriculum Development Centre Officials and Teachers who despite their congested schedules rendered their support during the development of this toolkit.

Completion of this toolkit was possible through concerted efforts from all those who rendered their support, your efforts and contributions are greatly appreciated.

LIST OF ACRONYMS

Abbreviation	Name in full
CDM	Clean Development Mechanism
CITES	Convention on International Trade in Endangered Species of Flora and Fauna
DMA	Disaster Management Authority
HFCs	Hydro-fluorocarbons
HSSP	National Health Sector Strategic Plan
ICSU	The International Council of Scientific Unions
INDC	Intended Nationally Determined Contributions
IPCC	Intergovernmental Panel on Climate Change
JI	Joint Implementation
NAP	National Action Plan
NAPA	National Adaptation Plan of Action
NEAP	National Environment Action Plan
NSDP	National Strategic Development Plan
PFCs	Per-fluorocarbons
SNC	Second National Communication
TNA	Technology Needs Assessment Report
UNCCD	United Nations Convention to Combat Desertification
UNEP	The United Nations Environment Programme
UNFCBD	United Nations Convention on Biological Diversity
UNFCCC	United Nations Framework Convention on Climate Change
WCC	World Climate Conference
WMO	World Meteorological Organisation

Table of Contents

1 INTRODUCTION

1.1 Definition of weather

Weather is defined as the state of the atmosphere at a particular time, as defined by the various meteorological elements[1] as defined in Box 1.

Weather is generally described in short time frames - minutes, hours, days, and weeks. Almost all weather phenomena occur in the troposphere, which is the lower part of the atmosphere.

Box 1: Meteorological Elements

Element	***Description***	***How it is measured***	***Units of measurement***
Precipitation	*Moisture from the sky e.g. rain, snow etc.*	*By a Rain Gauge*	*Millimetres (mm.)*
Temperature	*How hot or cold it is*	*By Thermometers, found inside a Stevenson Screen*	*Degrees celsius (°C)*
Wind Speed	*How fast the wind is blowing*	*By an Anemometer*	*Knots, or by the Beaufort Scale*
Wind Direction	*Where the wind is blowing **from***	*By a Wind Vane*	*Points of the compass (north, north-west etc), or bearing in degrees*
Humidity	*The amount of water vapour in the air*	*By a Hygrometer (wet and Dry Bulb Thermometers)*	*Relative Humidity (% of water vapour that can be held by the air at the actual temperature)*
Air Pressure	*The "weight" of the air pushing on the surface of the Earth*	*By a Barometer*	*Hectopascals (hPa) / millibars (mb)*
Cloud Cover	*The amount of cloud in*	*It is observed by a*	*Oktas - eighths of the sky*

[1] *World Meteorological Organization: International Meteorological Vocabulary No. 182*

	the sky	*meteorological observer*	
Visibility	*How far you can see*	*It is observed by a meteorological observer*	*Kilometres*
Sunshine	*The hours of sunshine*	*By a Sunshine Recorder*	*Hours and minutes*

1.2 Definition of climate

Climate is defined as the average weather over a long period of time (at least 30 years) of a certain place.

WMO defines climate as the synthesis of weather conditions in a given area characterized by the long-term statistics (mean values, variances, and probability of extreme values) of the meteorological elements in that area.[2]

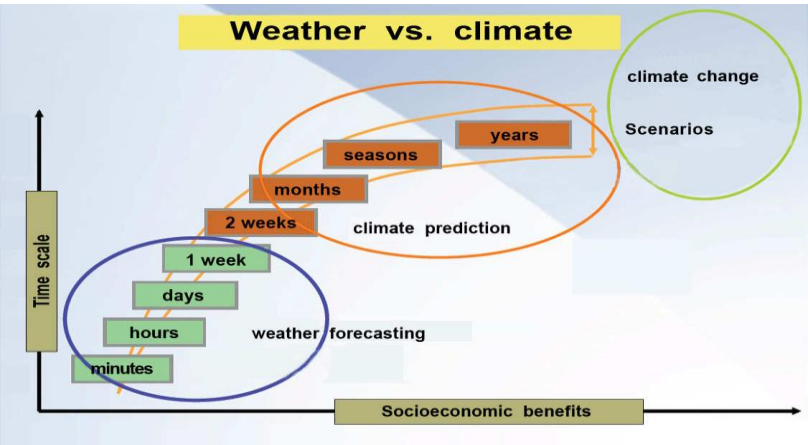


Fig.1.1 Differences between weather and climate

1.3 The climate system

The climate system is defined by the dynamics and interactions of five major components: atmosphere, hydrosphere, cryosphere, lithosphere(land surface), and biosphere. Climate system dynamics are driven by both internal and external forcing, such as volcaniceruptions, solar

[2] *World Meteorological Organization: International Meteorological Vocabulary No. 182*

variations, or human-induced modifications to the planetary radiative balance, for instance via anthropogenic emissions of greenhouse gases and/or land-use changes.

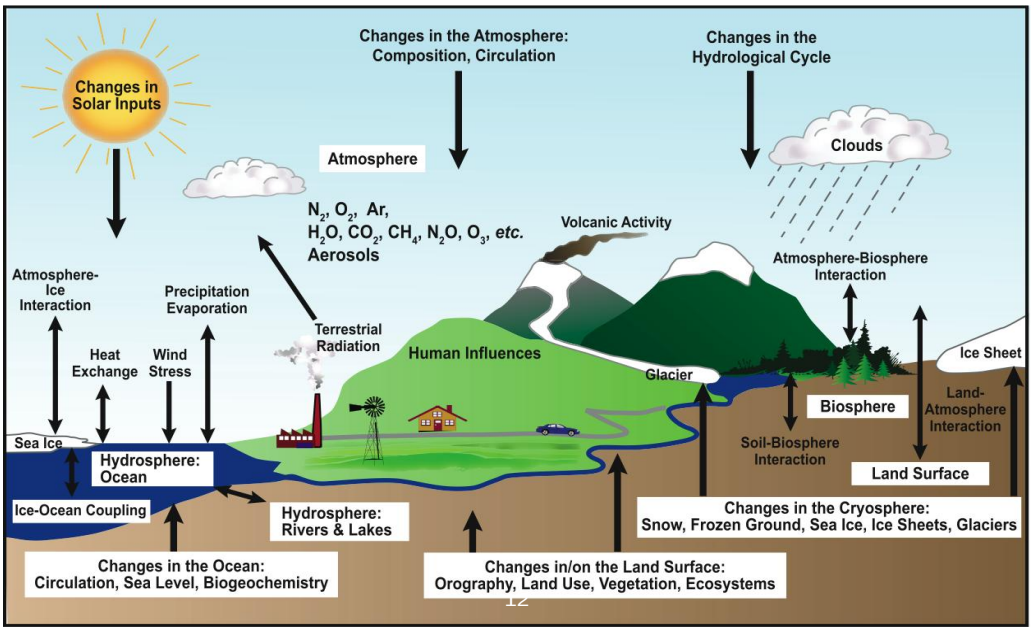


Fig.1.2: Schematic view of the components of the climate system and of their potential changes

The components of the climate system consist of the atmosphere, the hydrosphere (comprising the liquid water distributed on and beneath the Earth's surface, as well as the cryosphere, i.e. the snow and ice on and beneath the surface), the surface lithosphere (comprising the rock, soil and sediment of the Earth's surface), and the biosphere (comprising Earth's plant and animal life and man), which, under the effects of the solar radiation received by the Earth, determines the climate of the Earth. The climate system components have been summarised in Table 1 below.

Table 1: Components of the climate system

Components	Description
Atmosphere	The gaseous envelop surrounding the earth
Hydrosphere	Comprising the liquid water distributed on and beneath the Earth's surface.
Cryosphere	Snow and ice on and beneath the surface.
Lithosphere	Comprising the rock, soil and sediment of the Earth's surface.
Biosphere	Comprising Earth's plant and animal life and man.

Climate essentially relates to the varying states of the atmosphere only, the other parts of the climate system also have a significant role in forming climate, through their interactions with the atmosphere[3].

1.4 The atmosphere

Atmosphere is the unstable and rapidly changing part of the system where all weather patterns occur. The Earth's dry atmosphere is composed mainly of nitrogen (N_2, 78.1% volume mixing ratio), oxygen (O_2, 20.9% volume mixing ratio, argon (Ar, 0.93% volume mixing ratio) and trace gases less than 0.1% (IPCC, 2007)

1.4.1 Layers of the atmosphere

The atmosphere consists of different layers with reference to height, temperature and composition. These are: troposphere, stratosphere, mesosphere and thermosphere.

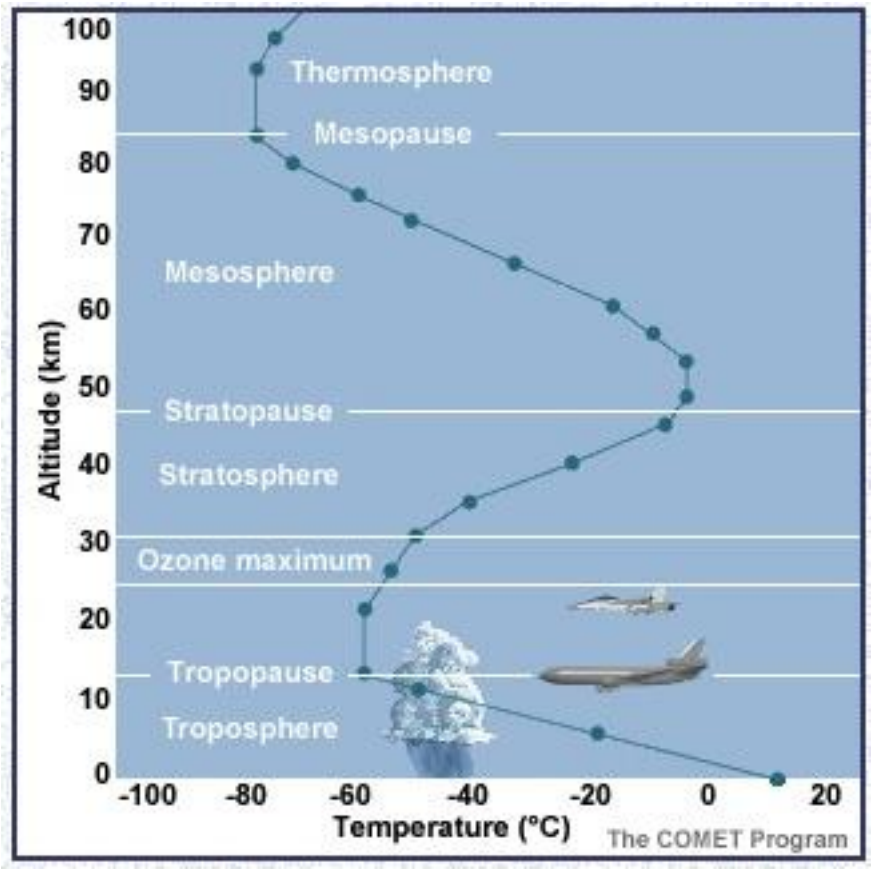


Fig.1.3: The schematic vertical profile of the atmosphere

[3] *World Meteorological Organization: International Meteorological Vocabulary No. 182*

Troposphere

This is the layer where all weather related activities occur, at an altitude of about 10 km from the earth's surface. In this area the temperature decreases with height until tropopause. The tropopause separates the troposphere and above layer stratosphere.

Stratosphere

In the stratosphere the temperature profile increases with height immediately after the tropopause until at an altitude of about 50km, the stratopause level.

Mesosphere

Above the stratopause, temperature decreases strongly with height in the mesosphere, until the mesopause is reached at an altitude of about 80 km.

Thermosphere

Above the mesopause, temperature increases with height in the thermosphere and above until to the sun.

Table 2: The summary of the structure of the atmosphere

Atmospheric layer	Temperature range	Vertical distance	Chemical composition
Troposphere	Decreases (18 to -60)	0 to 10Km	Oxygen, nitrogen, trace gases
Stratosphere	Increases (-60 to -10)	10 to 48km	stratospheric ozone
Mesosphere	Decreases (0 to -80)	48 - 84km	atomic oxygen, molecular oxygen, atomic nitrogen, molecular nitrogen, helium, and hydrogen.
Thermosphere	Increases (-80 to above)	84km and above	Helium, hydrogen

2 GLOBAL WARMING (GW)

2.1 Definition of GW

The increase of the earth's average surface temperature due to the increase of greenhouse gases which trap heat that would otherwise escape from the earth.

(http://www.nmsea.org/Curriculum/Primer/Global_Warming/fossil_fuels_and_global_warming.htm)

2.2 Causes of GW (Introduction to GHGs)

As reflected in the definition of GW above, the cause of GW is the increased levels of GHGs in the atmosphere see Fig. 2.1. These gases are listed in Table 3 below

Box 2: Definition of GHGs and GHG Effect

Greenhouse Gases (GHG): *Those gaseous constituents of the atmosphere (both Natural and anthropogenic) that absorb and emit radiation at the specific wavelengths within the spectrum of infra-red radiation emitted by the earth's surface, the atmosphere and the clouds. This property causes the greenhouse effect. –IPCC 2007*

Greenhouse Effect: *The process in which the absorption of infrared radiation by the atmosphere warms the earth. The GHGs in the atmosphere are <0.1% of the total amount of gas in the atmosphere and yet they are what make the planet habitable. Without the 0.1% of GHGs, the average temperature of the planet would be $<0^0$C.These gases accumulate in the atmosphere causing concentrations to increase with time. Changing the atmospheric abundance or properties of these gases and particles can lead to a warming or cooling of the climate system.–IPCC, 2007*

Enhanced greenhouse effect: *The warming of the Earth's mean global surface temperature as a result of increased human induced emissions of greenhouse gases is termed the* ***anthropogenically/ enhanced greenhouse effect.***

Table 3: List of GHGs (IPCC, 2007)

Name of Greenhouse Gases	Chemical Symbol
Water vapour	(H_2O)
Carbon dioxide	(CO_2)
Nitrous oxide	(N_2O)
Methane	(CH_4)

Ozone	(O_3)
Hydro-fluorocarbons	(HFCs)
Per-fluorocarbons	(PFCs)
Sulphurhexafloride	(SF_6)

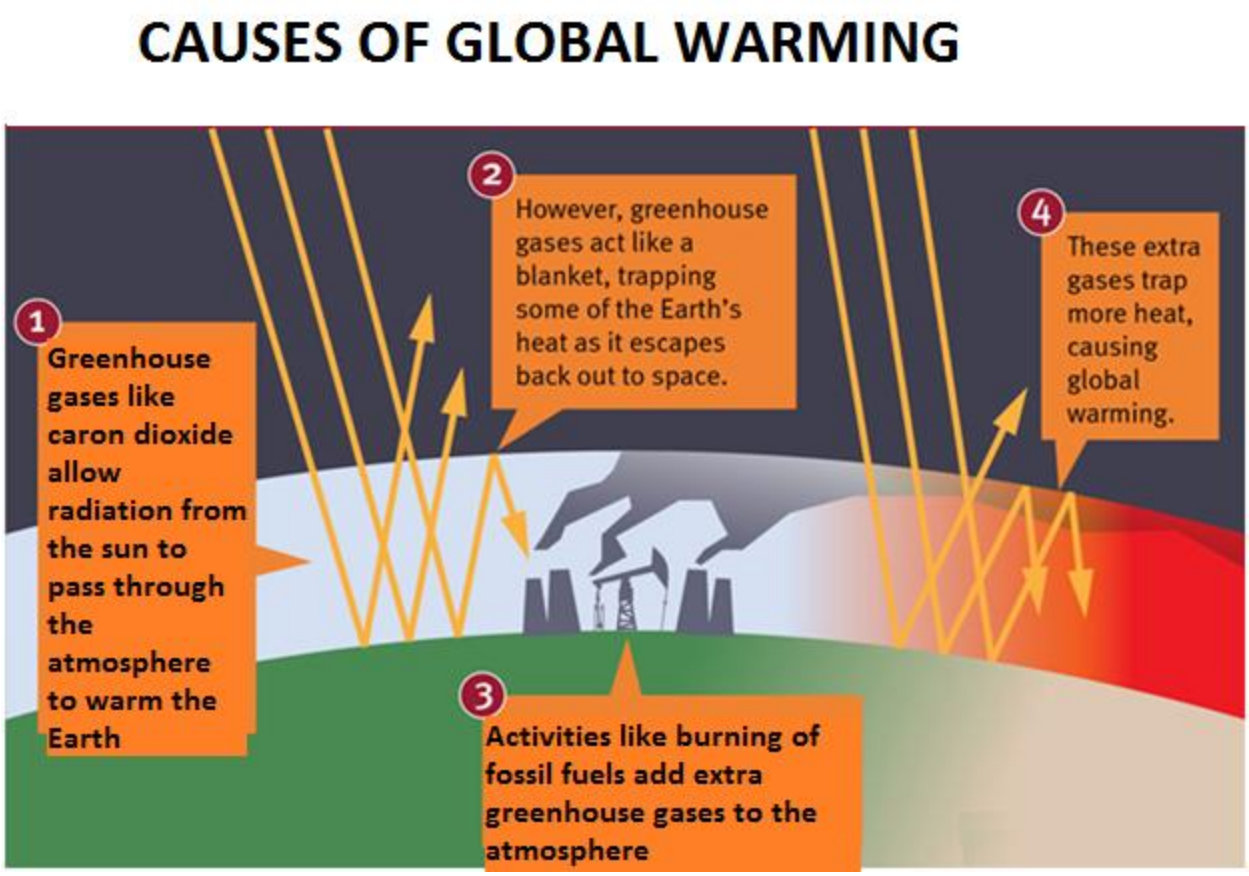


Fig.2.1 Causes of Global Warming

2.3 Properties of GHGs (How do GHGs differ from other gases)

A greenhouse gas is one that is able to absorb infra-red radiation. Only molecules that have at least three atoms can absorb infrared radiation such as H_2O, CO_2 and SF_6.

Mononuclear diatomic molecules such as N_2 and O_2 neither absorb nor emit infra-red radiation, as there is no net change in the dipole moment of these molecules.

2.3.1 Sources of GHGs (Where do GHGs come from?):

There are two ways that the greenhouse gases enter the atmosphere, namely; natural processes and human activities.

2.3.1.1 Natural sources:

Table 4: Natural Sources of Emissions

Greenhouse Gas	Source
Carbon dioxide (CO2)	Decomposition (28.56%), Ocean release (42.8%), Respiration (28.56%) Volcanoes (0.03%).
Methane (CH4)	Wet lands (78%) Termites (12%) Oceans (10%)
Nitrous Oxide (N2O)	Soils under natural vegetation (60%) Oceans (35%) Atmospheric chemical reactions (5%)
Water vapour (H2O)	Evaporation from seas Lakes Rivers Moist earth

2.3.1.2 Anthropogenic Emissions (Human induced Emissions)

Table 5: Emissions from human activity

Greenhouse Gases	Sources
Carbon dioxide (CO_2):	Industrial process (4%) Deforestation (9%) Burning of fossil fuel (87%)
Methane (CH_4):	Intensive livestock farming and fossil fuel production (60%) Landfills and waste (16%)

		Biomass burning (11%) Flooding rice agriculture (9%) Bio-fuel (4%).
Nitrous oxide (N_2O):		Agriculture, fossil fuel use and industrial process (77%) Biomass burning (10%) Atmospheric deposition (9%) Human sewage (3%)
Fluorinated Gases (PFCs, HFCs, and SF_6):	HFCs(91%)	Refrigerators, Air-conditioners Foams and aerosols cans.
	PFCs(6%)	Created during process of aluminum and semi-conductors
	SF_6(3%)	Electric power industry Magnesium production

2.3.2 Emissions per Sector

Table 6: sectors' specific emissions

Sector that contribute to GHG emission globally		
	SECTORS	SOURCES OF EMISSIONS
SECTORS THAT CONTRIBUTE TO GHG EMISSION GLOBALLY – IPCC 2014	Energy (35%),	Use of coal-fired power plants use of petrol and diesel by road transportation, etc.
	Agriculture forests and other land uses(24%)	Deforestation, Use of synthetic fertilizer, nitrogen from animal wastes, Enteric fermentation from animal manure and manure management, etc.

	Industry (21%)	Electricity use, etc.
	Transport (14%)	electricity, hydrogen and liquid biofuels, etc.
	Building (6%)	Electricity use, etc.
Sectors that contribute to GHG emission in Lesotho		
GHG EMISSION IN LESOTHO – SNC 2013	Agriculture (63%)	Use of synthetic fertilizer, nitrogen from animal wastes, nitrogen from increased biological N-fixation and crop residues Enteric fermentation from animal manure and manure management Anaerobic decomposition of manure also produces some CH_4, etc.
	Energy (31%)	Residential fuel combustion, use of petrol and diesel by road transportation. Residential emissions emanate from the use of coal, Liquid Petroleum Gas (LPG) and paraffin, etc.
	Waste Management (6%)	emissions from domestic, commercial and industrial waste, etc.

The climate system behaves in a certain way at a certain temperature. A change in global temperature will change the behavior of the climate system. Increase in global temperature (global warming) will cause change in behavior of the climate system leading to climate change.

3 CLIMATE CHANGE (CC)

3.1 DEFINITION OF CLIMATE CHANGE

Climate change refers to a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer (World Meteorological Organisation).

Climate change can simply be understood as being a cause and effect chain that begins from natural and human activities (such as emissions of greenhouse) gases and results in changes to the environment and the climate. It happens if the variability of the climate system changes in a significant way.

3.2 CAUSES OF CLIMATE CHANGE

The earth's climate is dynamic and always changing through a natural cycle. What the world is more worried about is that the changes that are occurring today have been speeded up because of man's activities. These changes are being studied by scientists all over the world who are finding evidence from tree rings, pollen samples, ice cores, and sea sediments. The causes of climate change can be divided into two categories - those that are due to natural causes and those that are created by man.

3.2.1 Natural causes of climate change

Table 7 and Box 3 present and explain the natural causes of climate change.

Table 7: Causes of climate change

Natural Cause	Explanation
Continental drift	The continental drift has an impact on the climate because it changes the physical features of the landmass, their position and the position of water bodies. The separation of the landmasses changed the flow of ocean currents and winds, which affected the climate.
Volcanoes	When a volcano erupts it throws out large volumes of sulphur dioxide (SO_2), water vapour, dust, and ash into the atmosphere. The gases and dust particles partially block the incoming rays of the sun, leading to cooling. Sulphur dioxide combines with water to form tiny droplets of Sulphuric acid. These droplets are so small that many of them can stay aloft for several years.
Aerosols	Aerosols are very small particles present in the atmosphere, which vary in size and chemical composition. Their net effect depends on the size and composition of the aerosol itself.
Ocean currents	The oceans covers about 71% of the Earth and absorb about twice as much of the sun's radiation as the atmosphere or the land surface.

Much of the heat that escapes from the oceans is in the form of water vapour, the most abundant greenhouse gas on Earth. Water vapor also contributes to the formation of clouds, which shade the surface and have a net cooling effect.

Box 3: Natural causes

There are a number of natural factors responsible for climate change. Some of the more prominent ones are continental drift, volcanoes, ocean currents, change in solar circle, the earth's tilt, and comets and meteorites. Let's look at them in a little detail.

- ***Continental drift***

The continents that we are familiar with today were formed when the landmass began gradually drifting apart, millions of years back. This drift also had an impact on the climate because it changed the physical features of the landmass, their position and the position of water bodies. The separation of the landmasses changed the flow of ocean currents and winds, which affected the climate. This drift of the continents continues even today; the Himalayan range is rising by about 1 mm every year because the Indian land mass is moving towards the Asian land mass, slowly but steadily.

- ***Volcanoes***

When a volcano erupts it throws out large volumes of sulphur dioxide (SO_2), water vapour, dust, and ash into the atmosphere. Although the volcanic activity may last only a few days, yet the large volumes of gases and ash can influence climatic patterns for years. Millions of tonnes of sulphur dioxide gas can reach the upper levels of the atmosphere (called the stratosphere) from a major eruption. The gases and dust particles partially block the incoming rays of the sun, leading to cooling. Sulphur dioxide combines with water to form tiny droplets of sulphuric acid. These droplets are so small that many of them can stay aloft for several years.

- ***Aerosols***

Aerosols are very small particles present in the atmosphere, which vary in size and chemical composition. Natural aerosols include mineral dust released from the surface, sea salt aerosols, biogenic emissions from the land and oceans and sulphate and dust aerosols produced by volcanic eruptions. Aerosols have a complex effect on climate. Their net radiative forcing effect depends on the size and composition of the aerosol itself, which determines to what extent it is able to absorb or scatter incoming solar and outgoing long wave radiation from the Earth's surface – hence determining the aerosol's influence on the Earth's energy balance. Aerosols are also known to affect the properties of clouds, such as the size of water droplets and possibly the thickness of clouds. It is believed that, overall, aerosols act to cool the climate system and so oppose, to some extent, the warming caused by greenhouse gases.

- ***Ocean currents***

The oceans are a major component of the climate system. They cover about 71% of the Earth

and absorb about twice as much of the sun's radiation as the atmosphere or the land surface. Ocean currents move vast amounts of heat across the planet - roughly the same amount as the atmosphere does. But the oceans are surrounded by land masses, so heat transport through the water is through channels.

Ocean currents have been known to change direction or slow down. Much of the heat that escapes from the oceans is in the form of water vapour, the most abundant greenhouse gas on Earth. Yet, water vapour also contributes to the formation of clouds, which shade the surface and have a net cooling effect. Any or all of these phenomena can have an impact on the climate, as is believed to have happened at the end of the last Ice Age, about 14,000 years ago.

3.2.2 Human causes

Humans affect the components of the climate system in various ways. **Agriculture, deforestation, urbanization** and **other forms of land cover change** alter the proportion of incoming solar radiation that is reflected back to space, thus affecting the energy balance and hence the temperature and dynamics of the climate system. **Land use change** also affects the carbon cycle, which in turn affects the state of the climate system.

All this has contributed to a rise in greenhouse gases in the atmosphere. Fossil fuels such as oil, coal and natural gas supply most of the energy needed to run vehicles, generate electricity for industries, households, etc. The concentration of these gases results in the intensification of the greenhouse effect, which over time warms the mean global surface temperature. The relationship between a gas atmospheric concentration and its influence on the energy budget is known as **radiative forcing**. Information on GHGs can be found in the previous chapter (Global Warming).

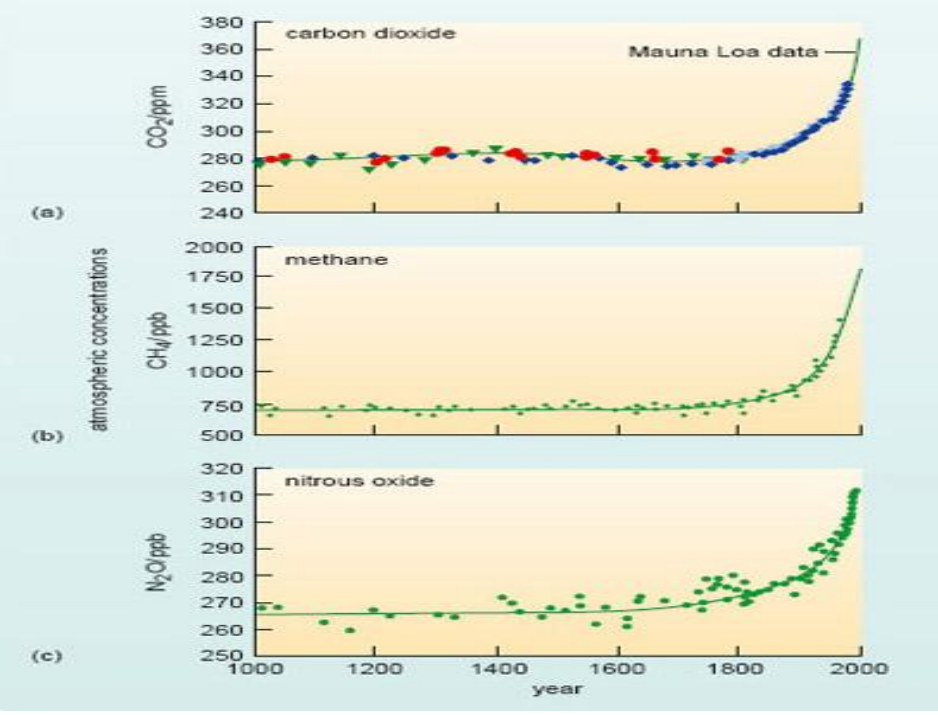


Fig.3.1: Changes in atmospheric concentration of molecules of major GHGs with time

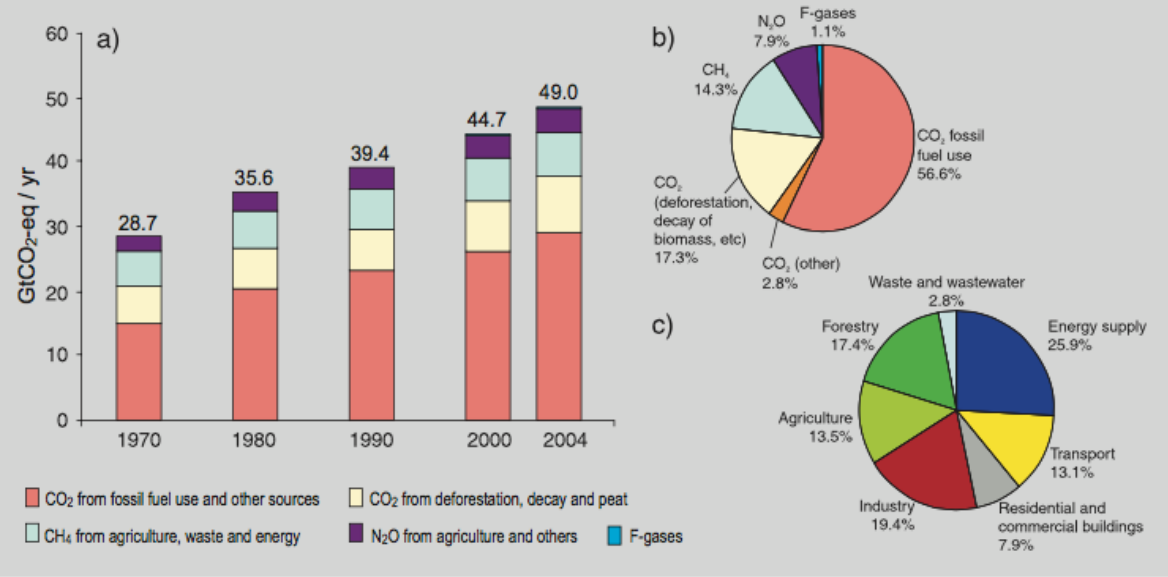


Fig.3.2: Global Anthropogenic emissions. Source: IPCC

The above figure Fig. 3.2 presents a) Global annual emissions of anthropogenic GHGs from 1970 to 2004.5 (b) Share of different anthropogenic GHGs in total emissions in 2004 in terms of carbon dioxide equivalents (CO2-eq). (c) Share of different sectors in total anthropogenic GHG emissions in 2004 in terms of CO2-eq. (Forestry includes deforestation.)

Box 4: Human or Anthropogenic Causes of Climate Change

Many human activities result in the emission of greenhouse gases, which are responsible for the anthropogenically enhanced greenhouse effect. Examples of greenhouse gases emitted by human activities include carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF6) and nitrogen trifluoride (NF3). These activities include, among others, ***the burning of fossil fuels (coal, oil and gas), clearing of forests, and agricultural practices*** *that lead to increased GHG concentration in the atmosphere.*

Further reading
United Nations Institute for Training and Research (UNITAR) 2014 MDP/UNITAR
http://www.unitar.org/mdp

3.3 Observed and expected changes

3.3.1 Observed Global changes

Observations of the climate system are based on direct measurements and remote sensing from satellites and other platforms. Global-scale observations from the instrumental era began in the mid-19th century for temperature and other variables, with more comprehensive and diverse sets of observations available for the period 1950 onwards.

Each of the last three decades has been successively warmer at the Earth's surface than any preceding decade since 1850. The globally averaged combined land and ocean surface

temperature data as calculated by a linear trend, show a warming of 0.85 [0.65 to 1.06] °C3, over the period 1880 to 2012, when multiple independently produced datasets exist. The total increase between the average of the 1850–1900 period and the 2003–2012 period is 0.78 [0.72 to 0.85] °C, based on the single longest dataset available4, AR5. It is virtually certain that globally the troposphere has warmed since the mid-20th century. More complete observations allow greater confidence in estimates of tropospheric temperature changes in the extra-tropical Northern Hemisphere than elsewhere, AR5.

Changes in the frequency and intensity of many extreme weather and climate events have been observed since about 1950. It is very likely that the number of cold days and nights has decreased and the number of warm days and nights has increased on the global scale. These changes have been detected in most countries and some of the regions.

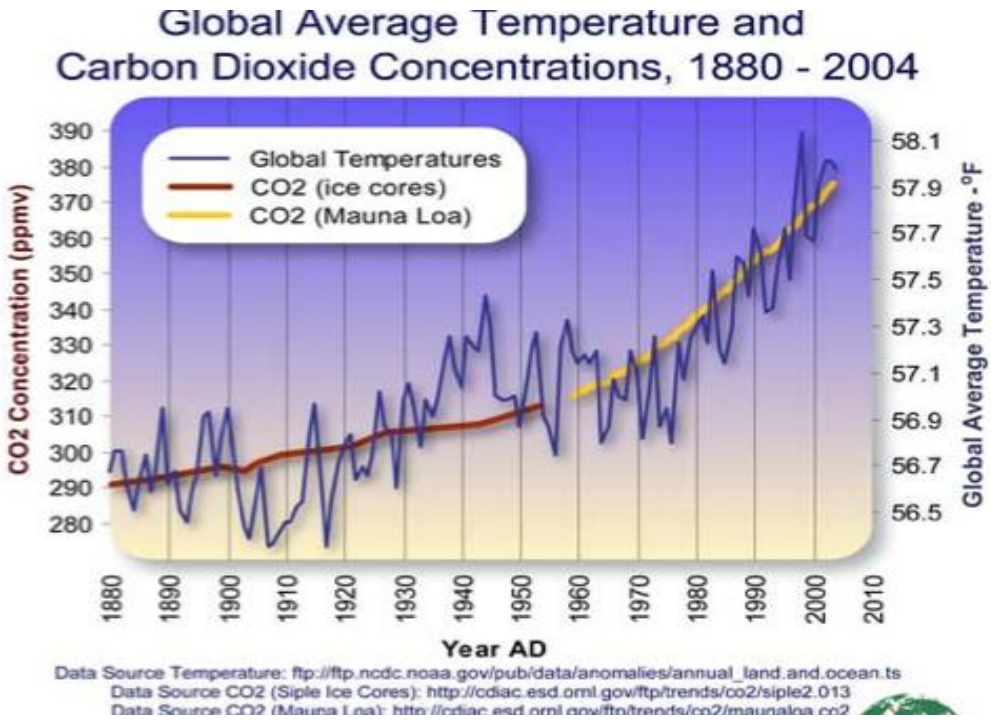


Fig.3.3: Increased concentration of carbon dioxide in the atmosphere is related to higher observed temperatures

These temperature changes since the middle of the 20thcentury can only be explained by scientists with reference to the increased emissions of greenhouse gases due to anthropogenic activity since the (Western) industrial revolution.

The findings of the latest reports are of even more concern. The Emissions Gap Report of 2012 of the United Nations Environment Programme (UNEP) confirms the increasing trend of global greenhouse gas emissions as well as the growth of energy production and conversion in the share of total greenhouse gas emissions. See Figure below.

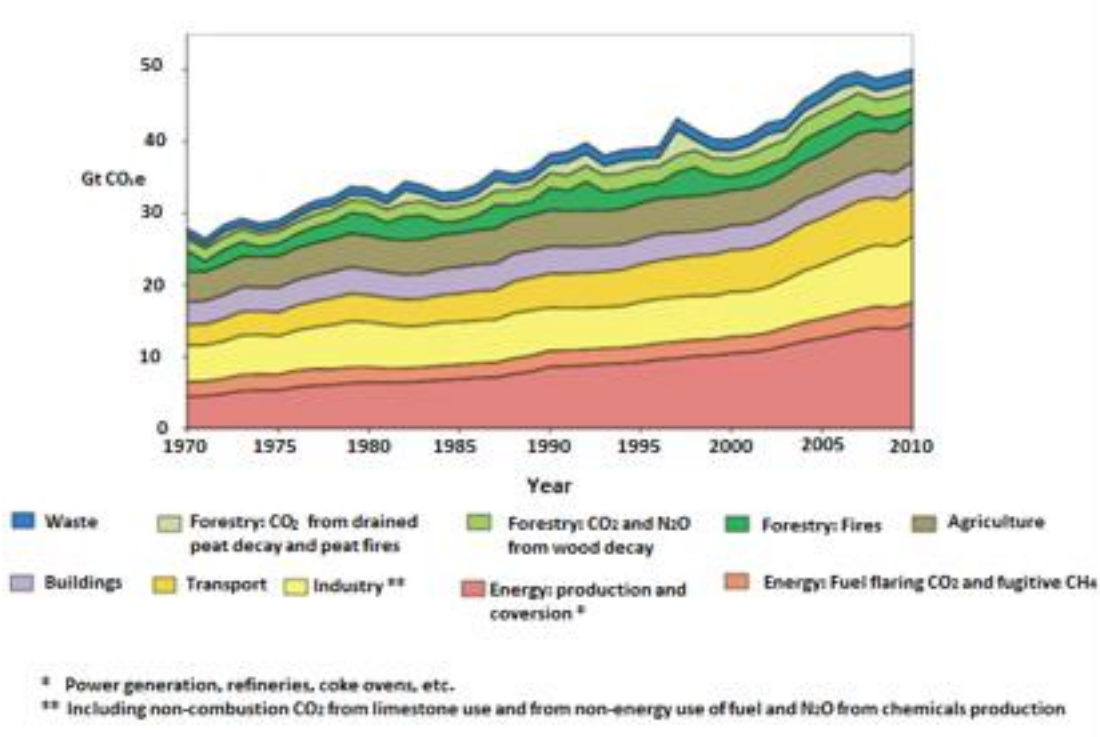


Fig.3.4: trend in global greenhouse gas emissions 1970-2010 by sector[4].

The most widely observed environmental changes that have been observed during the past decade which may be attributable to anthropogenically enhanced climate change and are hence considered to be the **effects** of climate change, include, inter alia:

- *Temperature Rise;*
- *Sea level rise;*
- *Melting of snow and ice;*
- *Changes in precipitation;*
- *Change in the frequency and/or intensity of extreme weather events;*
- *Changes to ecosystems and biodiversity patterns.*

Whilst *these* are examples of the effects of climate change, the **impacts** of climate change refer to how these effects induce **risk and vulnerabilities**, affecting global societies and economies.

[4]*Source: UNEP 2012. The Emissions Gap Report 2012. United Nations Environment Programme (UNEP), Nairobi:*

Box 5: Effects of Climate Change

The warming of the climate system is 'unequivocally' happening, as stated by the IPCC's Fifth Assessment Report. Data showing global average surface and ocean temperatures indicate a warming trend during the past century, as does the increasingly rapid retreat of glaicers and shortening of snow seasons as shown by historical satellite images. Rising of global sea levels are also observed and its impact already being felt particularly by many island states such as the Maldives.

Temperature Rise

Of the 10 years from 2001 to 2011, 9 are among the 12 warmest since records began in 1800, with 2010 and 2005 probably being the warmest. Global average surface temperature observations show a significant increase during recent decades, although this temperature rise has been most marked in the northern Polar Regions (the Arctic) due to various feedback mechanisms which have amplified the warming effect. In the Northern Hemisphere, 1983–2012 was likely the warmest 30-year period of the last 1400 year (IPCC, 2013).

1.2 Sea Level Rise

There is plenty of evidence that shows that large changes in global sea level have occurred during the Earth's history. For example, during the last interglacial period (129,000 to 116,000 years ago), the average sea level was at least 5 m higher than it is today (IPCC, 2013). When ice cover was at its maximum towards the end of the ice age, some 18,000 years ago, sea level was over 100m lower than today, sufficient, for instance, for Britain to be joined to the continent of Europe.

1.3 Melting of Snow and Ice

Decreases in the thickness and extent of snow and sea ice are also consistent with what would be expected as a result of the observed global temperature rise over past decades (as confirmed by climate modeling studies). Over the last two decades, the Greenland and Antarctic ice sheets have been losing mass, glaciers have continued to shrink almost worldwide, and both the Arctic sea ice and the Northern Hemisphere's spring snow cover have continued to decrease in extent. According to the IPCC, the average rate of ice loss from glaciers around the world, excluding glaciers on the periphery of the ice sheets, was very likely 226 [91 to 361] Gtyrover the period 1971 to 2009, and very likely 275 [140 to 410] Gtyrover the period 1993 to 2009 (IPCC, 2013).

1.4 Precipitation

From 1901 to 2010 precipitation (rain, sleet and snow) increased significantly in parts of the Americas, northern Europe, and northern and central Asia, but declined in the Sahel, the Meditteranean, southern Africa, and parts of southern Asia (Fig. 18).

1.5 Extreme Weather Events

More intense and longer droughts have been reported over wider areas since the 1970s, particularly in the tropics and subtropics, although the quality of the databases and the difficulty in defining drought is causing recent debate in this area. Increased drying linked with higher temperatures and decreased precipitation has contributed to higher frequencies of drought conditions such as in the Sahel region of Africa. The IPCC has concluded that it is likely that the area affected by drought has increased since 1970s in many global regions, although this result has low confidence partly due to the difficulty in defining drought. Drought conditions can severely impact agricultural productivity, affecting the livelihoods of those who live there. It is not yet certain that these changes in precipitation trends are attributable to anthropogenically enhanced climate change, but it is certain that the climate of some vulnerable areas is changing and the likelihood and severity of extreme events such as drought are increasing.

3.3.2 Observed changes in Lesotho

- Temperature rise

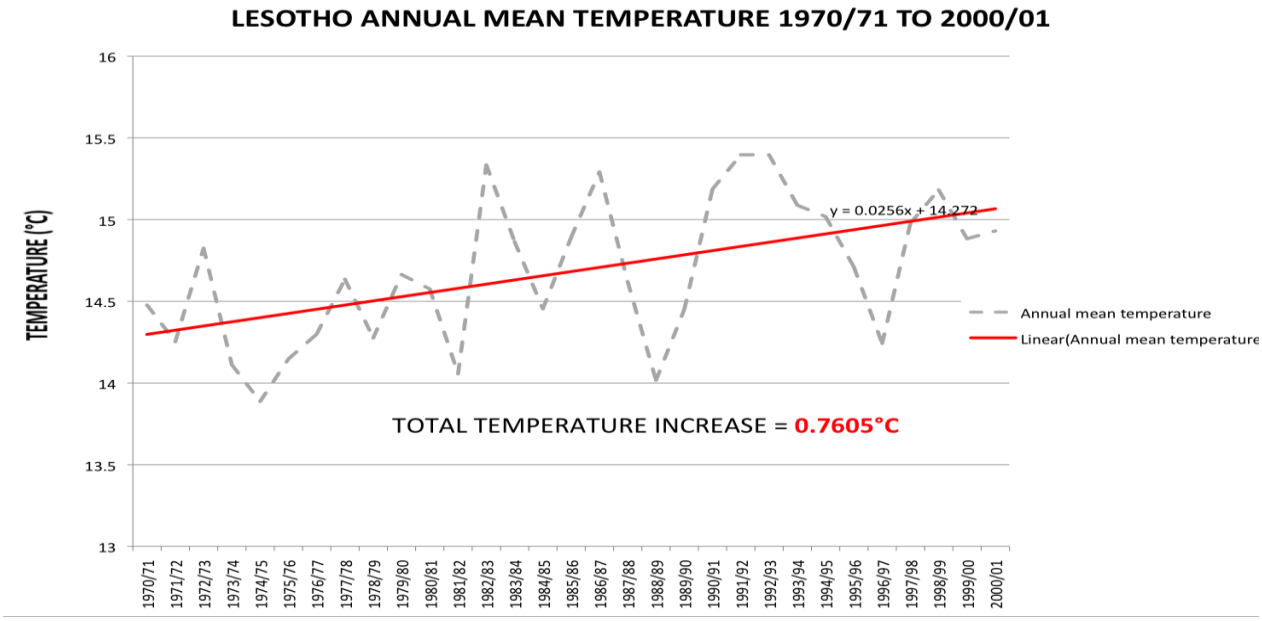


Fig 3.5: Lesotho annual mean temperature 1970/71 to 2000/01

- Increase of rainfall at some places and decrease in other places
- Increase in the frequency of Extreme Weather Events e.g. Snowfall, Extreme and prolonged droughts, increased frequency of droughts

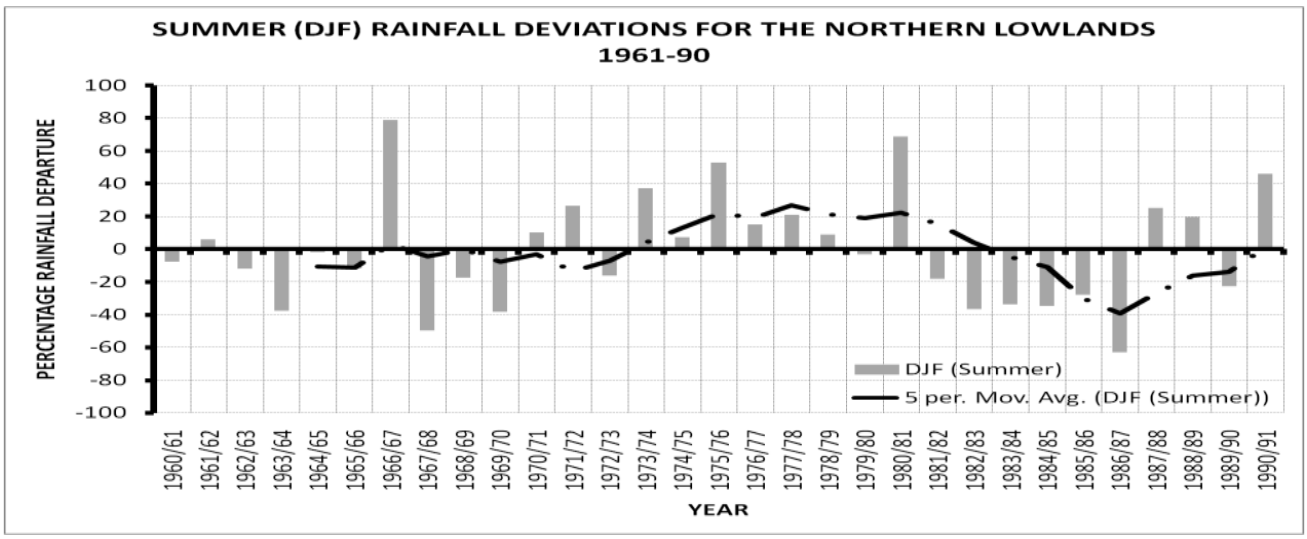


Fig.3.6: Summer rainfall deviations for the Northern Lowlands

3.4 Expected changes

3.4.1 Local (Lesotho)

According to Fig. 3.7 below, temperature are expected to continue increasing. Autumn (MAM) and summer (DJF) are generally not expected to change in the future. Spring (SON) rainfall is expected to increase slightly while Winter (JJA) is expected to decrease significantly Fig.3.8 below.

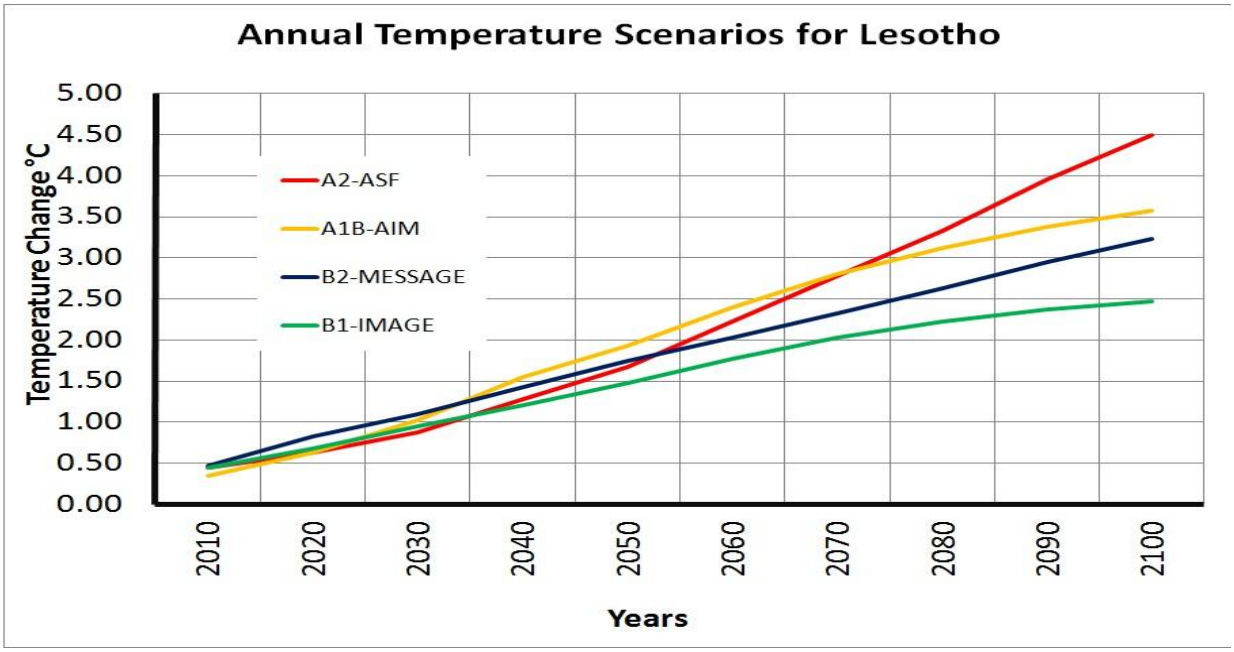


Fig.3.7: Projected annual temperature over Lesotho

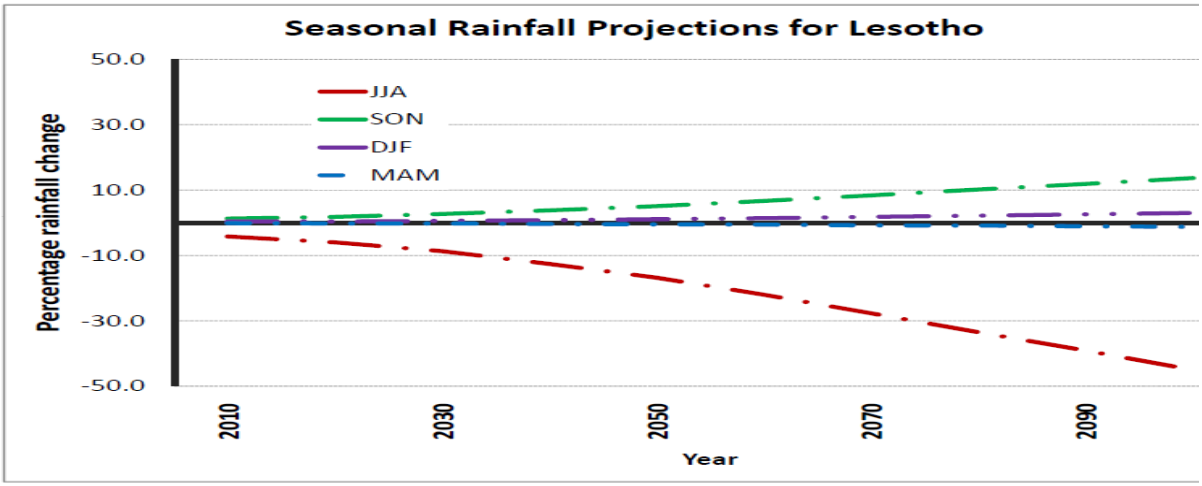


Fig. 3.8: Projected Seasonal Rainfall Change over Lesotho

3.5 Impacts of CC

3.5.1 Global impacts

Projected impacts include changes that will affect:

- Global mean surface temperatures;
- Water cycle;
- Global mean sea levels;
- Global food security and human health;
- Ecosystems and patterns of biodiversity;
- Freshwater supply;
- Ocean Acidification.

Table 8 below summarises the impacts of climate change on some selected sectors

Table 8: Examples of major impacts on selected sectors[5]

Examples of major projected impacts on selected sectors				
Climate Driven Phenomena	**Agriculture, Forestry and Ecosystem**	**Water Resources**	**Human Health**	**Industry, Settlements and Society**
Temperature Change **Over most land areas, warmer and fewer cold days and nights, warmer and more frequent hot days and nights**	Increased yields in colder environments Decreased yield in warmer environments Increased insect outbreaks	Effects on water resources relying on snow melt Effects on some water supply	Reduced human mortality from decreased cold exposure	Reduced energy demand for heating and increased demand for cooling Declining air quality in cities Reduced disruption to transport due to snow and frost Effects on winter tourism
Heat Waves/ Warm spells **Frequency increases over most land areas**	Reduced yields in warmer region due to heat stress Wildfire danger increases	Increased water demand Water quality problems e.g. algal blooms	Increased risk of heat-related mortality, especially for the elderly, chronically sick, very young and socially isolated	Reduction in quality of life for people in warm areas without appropriate housing Impacts on elderly, very young and poor

[5] *The table has been extracted from AR4 Synthesis Report of the Intergovernmental Panel on Climate Change 4th Assessment Report (2007); as cited and published by UNEP/Grid Arendal, Climate in Peril*

Heavy Precipitation Events **Frequency increases over most land areas**	Damage crops Soil erosion Inability to cultivate land due to waterlogging	Adverse effects on quality of surface and groundwater Contamination of water supply Water stress may be relieved	Increased risk of deaths, injuries, infectious, respiratory and skin diseases	Disruption of settlements, commerce, transport and societies due to flooding Pressures on urban and rural infrastructures Loss of property
Drought **Affected areas increase**	Land degradation Crop damage and failure Increased livestock deaths Increased risk of wildfire	More widespread water stress	Increased risk of malnutrition Increased risk of water and food-borne diseases	Water shortages for settlements, industry and societies Reduced hydropower generation potentials
Cyclones and storm surges **Frequency increases**	Damage to crops Windthrow (Uprooting) of trees Damage to coral reefs	Power outages cause disruption of public water supply	Increased risk of deaths, injuries, of water and food-borne diseases Posttraumatic stress disorders	Withdrawal of risk coverage in vulnerable areas by private insurance Potential for population migrations Loss of property
Sea level rise **Increased incidences of extreme high sea-level**	Salinisation of irrigation water, estuaries and freshwater systems	Decreased freshwater availability due to salt water intrusion	Increased risk of deaths and injuries by drowning in foods Migration-related health effects	Cost of coastal protection versus costs of land use protection Potential for movement of populations and infrastructure

Source: extracted from AR4 Synthesis Report of the Intergovernmental Panel on Climate Change 4th Assessment Report (2007); as cited and published by UNEP/Grid Arendal, 'Climate in Peril

3.5.2 Local impacts (Lesotho)

3.5.2.1 Observed impacts

Lesotho is categorized as one of the countries that are highly vulnerable to the impact of climate change, deserving special attention. Lesotho manifests several of the specified conditions since it is a country prone to natural disasters, liable to drought and desertification, and is mountainous, with a

largely fragile ecosystem. The country experiences frequent droughts that result in poor harvests and large livestock losses to rural farmers, exacerbating poverty and suffering. Heavy snowfalls, strong winds and floods that pose devastating social impacts also affect Lesotho. These adverse climatic conditions undermine the economic development of the country and the well-being of the nation.

Table 9: List of Vulnerable Sectors and Associated Climate Change Impacts in Lesotho

Vulnerable Sectors	Impacts
Water Resources	Ground water resources are reduced by shortened rainfall season. This will cause • Inadequate annual recharge of aquifers, lower water tables and drying up of springs. • Drying up of wetlands in the mountains, affecting reliability of perennial streams.
Agriculture	• Reduced rainfall and frequent drought reduce crop production. • Drought and high temperatures exacerbate incidences of diseases and pests. • Resultant crop failures lead to famine and food shortages.
Forestry	• Rural communities depend on biomass fuels as a major energy source. • The resilience and regenerative capacity of forest resources are negatively affected by extreme climatic conditions. • Decreasing forestry resources reduces the stability of energy supplies for both cooking and heating.
Livestock and Rangelands	Livestock production is deteriorating due to degradation of rangelands. The net effects are: • Higher livestock mortality rates and lower quality of livestock products. • Extreme weather conditions increase disease and pest incidences.
Culture	• Natural heritage and culture of the Basotho is closely linked to the environment. Their housing, clothing, medicine and other traditions are affected by climate change
Health	• Frequent droughts result in lack of water availability and reduced water quality. • The resultant disease outbreaks are compounded by famine and malnutrition
Energy	• Climate Change induced droughts reduces hydro-power generation • Decreasing forestry resources reduces the stability of energy supplies for both cooking and heating.
Soils	• Climate change negatively affects soil cover (range and forest resources). • Incidences of drought and flooding increase soil erosion, desertification and

	land degradation and reduce soil fertility.

Source: (Lesotho Meteorological Services, 2007)

Box 6: Assessed Damages and Losses due to heavy rains of 2010/2011 - case of Lesotho

The total value of the disaster effects was calculated at M462.7 million (US$66.1 million), which is equivalent to 3.2% of country's Gross Domestic Product (GDP) and 5.2 of Gross Fixed Capital Formation (table 1). Most of the flood damage was sustained by the road transport sector (M80.3 million or 33% of the total), followed – in order of decreasing importance – by livestock (M44.8 million or 19%), education (M28.3 million or 12%), and housing (M22.4 million or 9%). Considering the losses in production and higher costs of services, the sector of agriculture crops was the most affected (M103.6 million or 47% of the total), followed by road transport (M57.4 million or 26%), livestock (M29.8 million or 13%) and commerce (M20.5 million or 9%) (figure 2). These sectors are crucial to the livelihoods of the poor in Lesotho, and the impact of the events has increased the vulnerabilities of large portions of the population.

4 REDUCING GREENHOUSE GASES (MITIGATION)

4.1 Definition of Mitigation

An anthropogenic intervention to reduce the anthropogenic forcing of the climate system; it includes strategies to reduce greenhouse gas sources and emissions and enhancing greenhouse gas sinks.

Mitigation actions seek to reduce the extent of climate change by reducing GHG emissions or increasing their removal from the atmosphere.

4.2 Lesotho's mitigation efforts

Mitigation actions can be economy-wide, or can involve one or more sectors, such as energy, transport, buildings, industry, agriculture, forestry and waste management. There are a variety of mitigation approaches; selecting which measures to apply and when is a national implementation decision, which will factor national circumstances, availability of technology and financial resources, mitigation potential and policy implementation issues. The table below summarises the proposed mitigation options for Lesotho with targets.

Table 10: Summary of mitigation option per sector

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

Agriculture	• Irrigation efficiency • Substitution of traditional varieties by • Improved crop and livestock varieties • Minimum tillage • Ammonium of straw for animal feed • Biogas digester	
Waste	• Recycling of waste; • Composting of waste; • Incineration; • Methane Recovery.	• The projected waste potential in 2020 is estimated at 205 000 t/a of which 40,000 t/a can be reduced, 45000t/a re-used, 55000t/a recycled and 65000t/a disposed
Forestry and Rangelands	Building capacity in sustainable forest management and forest monitoring. • *afforestation/reforestation projects to rehabilitation of degraded lands*	
Transport	• Import controls in favour of low-emission vehicles • Encourage public transport and modal shift (bicycles) • Introduction of national vehicle emission standards	

Source: (Lesotho Meteorological Services, 2013)

4.3 Carbon Trading Mechanisms

In an effort to overcome the financial constraints for the implementation of mitigation options, several market based carbon-trading mechanisms were created. These mechanisms were Kyoto protocol mechanisms and non-Kyoto. The Kyoto protocol mechanisms are:

1. the Clean Development Mechanism (CDM)
2. Joint Implementation (JI)
3. International Emissions Trading.

4.3.1 The Clean Development Mechanism (CDM)

The CDM is a project-based mechanism that facilitates cooperative action between countries that have a cap on emissions and those that do not. It allows *greenhouse gas* emission reduction projects to take place in countries that have no emission targets under the *United Nations Framework Convention on Climate Change (UNFCCC) Kyoto Protocol*, yet are signatories.

Benefits of CDM projects include investment in climate change mitigation projects in developing countries, transfer or diffusion of technology in the host countries, as well as improvement in the livelihood of communities through the creation of employment or increased economic activity. Basotho have reaped the above benefits through the

implementation of the CDM project activity titled *"Efficient Wood Fuel Stove-Cooking Sets"*.

5 REDUCING CLIMATE CHANGE IMPACTS (ADAPTATION)

5.1.1 Definition

According to Intergovernmental Panel on Climate Change (IPCC), Climate Change Adaptation can be defined as an adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities.

UNFCCC defines Adaptation as "Actions taken to help communities and ecosystems to cope with changing climate conditions."

5.1.2 Adaptation responses

Climate change adaptation can better be understood as a process through which countries and communities become better able to manage the impacts of climate change. Adaptation by its definition seeks to manage uncertainty/risk, reduce vulnerabilities and build resilience for communities at risk.

Adaptation responses can be broken down into several sub-categories describing the adaptation triggers, timing, and systems involved.

- Autonomous adaptation is triggered by ecological changes in natural systems and by market or welfare changes in human systems, rather than being a conscious response to climate change.
- Planned adaptation, on the other hand, is the result of a deliberate policy decision, based on an awareness that conditions have changed or are about to change.
- Anticipatory adaptation takes place before impacts are apparent, whereas reactive adaptation occurs after the initial impacts of climate change have become manifest.

Adaptation is a cross cutting issue with co-benefits across many different sectors. Figure 11 below illustrates adaptation strategies that can increase the resilience of local livelihoods and conserve the ecosystems. These measures can positively contribute to reduce the impacts of climate change.

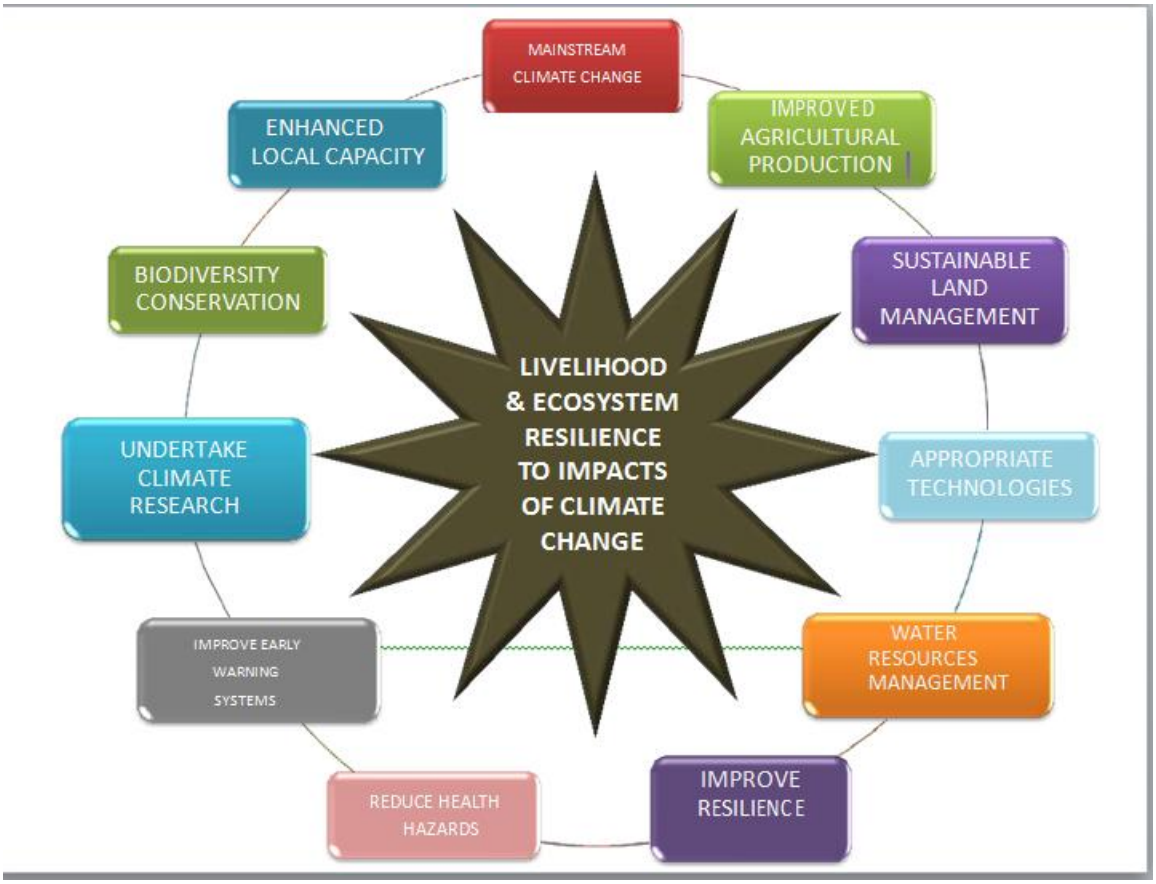


Fig.5.1: Adaptation strategies aimed at increasing the resilience of livelihoods and conserve ecosystems

5.1.3 How can Lesotho adapt?

Lesotho's communities heavily rely on natural resources. Their ability to adapt to the future risk of climate variability and change is therefore one of the greatest challenges especially to food security (LMS, 2013). Climate change could exacerbate the vulnerability of communities since their coping strategies are limited by the lack of knowledge and resources. The table below gives some examples of possible adaptation measures responding to different climate-related stresses in Lesotho, ranging from communities to the national level.

Table 11: Adaptation strategies aimed at increasing the resilience of livelihoods and conserve ecosystems

Climatic Stresses	Impact	Current Adaptation measure	Proposed Future adaptation Measure
CROP SECTOR			
Drought	• Delays in ploughing • Stagnated Crop Growth • An increase in disease and insects pests • Famine and food shortage	• Use of fertilizers and lime • Use of drought resistant cultivars • Construction of irrigation tanks • Conservation Agriculture	• Introduce improved drought resistant crop varieties • Promote use of irrigation technologies • Improve efficiency of irrigation equipment • Improve of early warning systems

Climatic Stresses	Impact	Current Adaptation measure	Proposed Future adaptation Measure
		• Short lived reservoirs • Conservative irrigation	• Increase cooperation amongst all stakeholders • Improve market potential • Construct of earth and check dams including spring tanks • Promote climate smart agriculture (CSA)
High Temperatures andHeat waves	• Crops wilt • High soil moisture loss	• Application of herbicides • Timing of planting • Construction of irrigation tanks • Conservation agriculture	• Promotion of crop diversification • Use of irrigation technologies
Strong winds and duststorms	• High loss of moisture • Soil erosion increased	• tree planting • Rehabilitate gullied areas • Planting cover crops	• Land reclamation and gully rehabilitation • Wind breaks • Covers crops
Early and late Frost	*1.* Plants wilt • Poor harvest	• Short season cultivars • Early planting	• Promotion of use of short season cultivars • Promotion of small-scale cash crops • Early planting
Floods and hail	• Heavy soil erosion • Damage to crops • Water logging	• Hail shields • Diversion furrows	• Promotion of use of hail shields • Construction of diversion furrows and terraces
HEALTH SECTOR			
Drought	• Poor water quality • Famine (malnutrition) • Disease outbreaks	• Introduction of water purification programmes • Promotion of use of sanitary services	• Promotion of water purification programmes
Heat waves	• Diseases (heat stroke) • Increase level of discomfort • Multiplication of bacteria	• Stay in shady areas	• Improve house ventilation
Wind storms	• Increase in air-borne diseases	• Wind breakers	• Cover water storage containers
Severe Cold temperatures	• Increase incidences of colds and influenza	• Use of traditional herbal practices & Influenza vaccines • Reliance on biomass fuels for heating	• Promote conservation and regeneration of biodiversity • Promote use of renewable energy technologies for heating and cooking
CULTURE SECTOR			
Drought	• Extinction of indigenous medicinal plants and herbs • Migration of rare wild	• Policy reform through Environment Act 2008 • Protection and	• Establishment of botanical gardens

Climatic Stresses	Impact	Current Adaptation measure	Proposed Future adaptation Measure
	animals • Increased incidences of alien species • Decline in biodiversity	conservation of plants	
RANGE AND LIVESOCK SUB-SECTORS			
Drought	• Poor rangelands • Increased livestock mortality/death • Water sources dry up • Poor quality of livestock and livestock products(wool, mohair and hides) • Increased soil erosion and gully formations	• Construction of conservation dams • Plant fodder to feed animals • Promote communal grazing system • Registration of livestock	• Rear well bred animals to withstand extreme weather (drought tolerant breeds) • Promotion of rangelands sharing within communities • Improve animal nutrition • Planting fodder to feed animals
High temperatures	• Increased incidence of animal disease • Wild fires	• Use of veterinary services • Anti-fire awareness campaigns	• Promote use of fire breaks • Increase public awareness on fire hazards and management
Extreme cold spells and heavy snowfall in winter	• Shrinkage of grazing land due to snowfall • Increased livestock mortality	• Provision of animal feeds (crop residues)	• Introduction of dairy livestock breed that would not heavily rely on rangelands • Planting animal feeds
ENERGY SECTORS			
Drought	• Water shortages and reduced hydropower generation	• Formulation of energy policy	• Development and promotion of renewable energy technologies (wind, solar, biogas)
SOILS AND FORESTRY			
Intense drought	• Poor soil fertility • Deforestation	• Reforestation • Community and individual tree nurseries • Adoption of soil conservation practices e.g. agroforestry, • contour cropping, terracing and others	• Reforestation of multi-purpose trees • Introduction of grafted trees and varieties
Extremely high temperatures in summer	• Forest fires • Increase in tree bugs and diseases • Increased soil moisture loss	• Reforestation	• Regenerating damaged areas with different tree species • Fire prevention • Capacity building and policy reform
Heavy floods	• Increased soil sedimentation • Increased gully formation	• Construction of silt traps and diversion furrows • Construction of waterways	• Promote land management practices and use land reclamation techniques. • Construction of water conservation and collection dams • Promote biological erosion measures: planting trees and

Climatic Stresses	Impact	Current Adaptation measure	Proposed Future adaptation Measure
			grasses
Strong winds	• Dust storms • Increased soil erosion	• Forestry and rangelands conservation programmes • Grazing associations and livestock improvement • programmes being practiced	• Intensify afforestation programmees • Use conservation agriculture with soil cover crops • Increase use Land reclamation programmes
WATER SECTOR			
Shortened rainfall season	• Underground water not adequately recharged • Water sources dry up	• Rainwater harvesting from roof-tops • Development of well fields for water supply	• Build small dams • Drilling boreholes • Promotion of rain water harvesting • Increase coverage of well fields • Rehabilitation of boreholes
Drought	• Decline in water availability • Stagnant water causes diseases • Poor water quality • Outbreak of water borne diseases e.g. cholera	• Conserve water sources • Water rationing • Encourage communities to protect natural springs and • Wetlands Rehabilitation	• Demand management and leak detection • Promotion of water recycling and procurement of requisite equipment e.g. water testing kits • Conservation of wetlands and mountain sponges • Dredging of existing ponds and water collection points that have been silted over the years
Floods	• Outbreak of water borne diseases e.g. typhoid	• Use domestic water purification systems	• Intensify investments in purification technologies

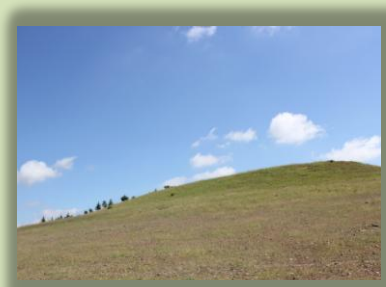
SECTORS	INTERVENTION	AFTER INTERVENTION
AGRICULTURE Introduction of resilient crops varieties		
RANGELANDS Rehabilitation of rangelands – stone packing eroded		
WATER Water harvesting		
WATER Construction of earth dams for irrigation		
RANGELANDS Brush control – restoration of rangelands through removal of alien species		

Fig.5.4 Examples of Adaptation interventions in Lesotho

Box 7: Tšana-Talana Community Council (E06)

This area has continuously experienced severe droughts; frequent hailstorms; high temperatures in summer; and strong wind. Torrential rain events are also sometimes experienced.

- *Recurrent droughts have led to drastic decline in agricultural production, drying up of natural water sources, and degradation of rangeland resources.*
- *Heavy rainfall exacerbates the problem of soil erosion in the area where desertification (i.e. a loss of vegetation cover and soil erosion) is already a widespread threat.*

In integrating climate change adaptation into the Council's development plan, Tšana-Talana Community Council has identified protection of water sources such as wetlands as one of the most important adaptation measures.

The Council has planned to work with the relevant government departments to implement relevant legislation and demarcate and protect all important natural areas within the Community Council.

The plan highlights rangeland management activities as vital adaptation interventions.

- *In particular activities such as removal of invasive species and reseeding of exposed areas with grasses are integrated with rangeland management practices to be carried out.*
- *Promoting production of fodder crops by livestock farmers to provide supplementary feed is promoted as a strategy to reduce livestock pressure on grazing areas.*
- *Measures to control soil erosion, such as planting grasses and trees, construction of small retaining dams and terraces, implementing rehabilitation initiatives such as stone packing, and planting indigenous grasses are some of the activities highlighted in the plan.*

The Council also recognizes that it has a vital role to play in planning and coordinating developments in the area, such as road constructions and allocation of land for housing, to avoid negative environmental consequences such as erosion. (Source LMS, 2011)

Box 8: Impacts and proposed adaptation interventions for Qibing Community Council
Qibing Community Council (E07)

Challenges associated with climate variability and change that are being experienced locally include long and recurrent spells of drought, extreme temperatures (i.e. very high temperatures in summer and very low temperatures in winter), unseasonal snowfall, and erratic rainfalls. In response to these challenges the Qibing Community Council has developed a plan that aims to address environmental problems and strengthen livelihood strategies for the communities.

Projects identified include:

- *Soil erosion control*
- *Improvement of agricultural production*
- *Diversification of livelihood strategies*
- *Education of communities on issues of climate change*
- *Protection of wetlands and other important water sources*

- *The Council has recognized that soil erosion has worsened in recent times due to very heavy rainfall. The Council's adaptation plan therefore includes expanding the catchment management initiatives through planting trees and grasses. Donga/gully rehabilitation through construction of*

silt traps.

- *The adaptation plan maps activities that aim at protecting wetlands and other water sources, for example by developing grazing plans that will ensure grazing in wetlands areas is avoided or controlled.*
- *Water scarcity is one of the greatest challenges in this Council. Simple and affordable water harvesting techniques such as rain water harvesting from roofs are therefore to be widely promoted across the area.*
- *Improvement of agricultural production to improve food security focus on promotion of conservation agriculture and use of keyhole gardening for vegetable production.*
- *The adaptation plan recognizes the importance of diversifying livelihood strategies not only to mitigate the risks involved in farming, but also taking into account that not all households are able to farm and meet their food security needs.*
- *Finally, the Council recognizes the need to liaise with the relevant Government Departments and Civil Society Organizations to educate the communities about the impacts of climate change and adaptation opportunities*

6 HISTORY AND DEVELOPMENT OF THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE (UNFCCC) AND THE KYOTO PROTOCOL

6.1 Background to the climate negotiations

In 1979, the First World Climate Conference identified climate change as an urgent world problem and issued a declaration calling on governments to anticipate and guard against potential climate hazards. A World Climate Programme was set up, steered by the World Meteorological Organisation (WMO), the United Nations Environment Programme (UNEP) and the International Council of Scientific Unions (ICSU). Several intergovernmental conferences on climate change followed.

Box 9: World Meteorological Organisation (WMO) at a glance

The World Meteorological Organization (WMO) is a specialized agency of the United Nations. *It is the UN system's authoritative voice on the state and behaviour of the Earth's atmosphere, its interaction with the oceans, the climate it produces and the resulting distribution of water resources.*

WMO has a membership of 191 Member States and Territories *(on 1 January 2013). It originated from the International Meteorological Organization (IMO), which was founded in 1873. Established in 1950, WMO became the specialized agency of the United Nations in 1951 for meteorology (weather and climate), operational hydrology and related geophysical sciences.*

Further Reading about WMO

1. WMO website: https://www.wmo.int/pages/about/index_en.html

2. WMO, 2009. World Meteorological Organization at a glance. Geneva, Switzerland. Available online: https://www.wmo.int/pages/about/documents/WMO990.pdf

In 1988, the Toronto Conference on the Changing Atmosphere advanced public debate when more than 340 participants from 46 countries all recommended developing a comprehensive global framework convention to protect the atmosphere. Following a proposal by Malta, the United Nations General Assembly addressed climate change for the first time by adopting Resolution 43/53. This recognised that "climate change is a common concern of mankind, since climate is an essential condition which sustains life on earth", and determined that "necessary and timely action should be taken to deal with climate change within a global framework" The WMO and UNEP established the Intergovernmental Panel on Climate Change, (IPCC), to assess the magnitude and timing of changes, estimate their impacts and present strategies for how to respond.

Box 10: Intergovernmental Panel on Climate Change (IPCC) at a glance

The Intergovernmental Panel on Climate Change (IPCC) is the leading international body for the assessment of climate change. The IPCC is a scientific body under the auspices of the United Nations (UN).

The Objective of the IPCC

To provide the world with a clear scientific view on the current state of knowledge in climate change and its potential environmental and socio-economic impacts.

Goals of the IPCC

The IPCC has three (3) goals as listed below:

1. *Assess available scientific information on climate change*
2. *Assess the environmental and socio-economic impacts of climate change*
3. *Formulate response strategies*

IPCC Working Groups

The IPCC is currently organized into three Working Groups and a Task Force.

1. *Working Group I deals with "The Physical Science Basis of Climate Change",*
2. *Working Group II with "Climate Change Impacts, Adaptation and Vulnerability"*
3. *Working Group III with "Mitigation of Climate Change".*

The main objective of the Task Force on National Greenhouse Gas Inventories is to develop and refine a methodology for the calculation and reporting of national GHG emissions and removals.

IPCC Reports

The IPCC has now completed five assessments of climate change published every 5-6 years, the first and latest being published in 1990 and 20014. These reports are commonly known as Assessment Reports (AR)

Report	*Abbreviation*	*Year of publication*
Firth Assessment Report	*AR5*	*2013*
Fourth Assessment Report	*AR4*	*2007*
Third Assessment Report	*TAR*	*2001*
Second Assessment Report	*SAR*	*1996*
First Assessment Report	*FAR*	*1990*

Further Reading about IPCC

1. *WMO website: https://www.wmo.int/pages/themes/climate/international_ipcc.php*
2. *IPCC website: http://www.ipcc.ch/organization/organization.shtml*

http://www.ipcc.ch/publications_and_data/publications_and_data_reports.shtml#1

6.2 History of climate negotiations

1992, countries joined an international treaty, the United Nations Framework Convention on Climate Change, to cooperatively consider what they could do to limit average global temperature increases and the resulting climate change, and to cope with whatever impacts were, by then, inevitable.

Box 11: United Nations Framework Convention on Climate Change (UNFCCC) at a glance

The United Nations Framework Convention on Climate Change (UNFCCC) is an international environmental treaty (also known as a multilateral environmental agreement) that was opened for signature at the Earth Summit held in Rio de Janeiro, Brazil, in 1992 and came into force in 1994. 194 countries signed the UNFCCC showing near universal agreement that there is a problem and that action is required against climate change.

The Objective of the UNFCCC

The ultimate objective of the Convention is to stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.

The United Nations Framework Convention on Climate Change is an international treaty joined by countries to:

- *Cooperatively consider what they could do to limit average global temperature increases and the resulting climate change, and to cope with inevitable impacts.*
- *Formulate response strategies and policies (under both mitigation and adaptation)*
- *Review of implementation decisions or response strategies*
    - *Mitigation*
    - *Adaptation*
    - *Finance e.g. Green climate fund*
    - *Technology development and transfer*
    - *Capacity building*

Legal nature of the UNFCCC

The treaty itself is not legally binding as it does not set mandatory limits on greenhouse gas emissions for individual countries and doesn't contain any enforcement mechanisms.

Further Reading on UNFCCC

1. *WMO website: https://www.wmo.int/pages/themes/climate/international_unfccc.ph*
2. *UNFCCC website: http://unfccc.int/essential_background/items/6031.php*
3. *UN, 1992. United Nations Framework Conversion on Climate Change.*

By 1995, countries realized that emission reductions provisions in the Convention were inadequate. They launched negotiations to strengthen the global response to climate change, and, two years later, adopted the Kyoto Protocol, in Kyoto, Japan.

Box 12: Kyoto Protocol (KP) at a Glance

The Kyoto Protocol legally binds developed countries to emission reduction targets by 5% of their 1990 levels from 2008 to 2012. This period (2008 - 2012) is called first commitment period. The second commitment period began on 1 January 2013 and will end in 2020. The protocol entered into force in February 2005. There are now 195 Parties to the Convention and 192 Parties to the Kyoto Protocol.

Further Reading on KP
http://unfccc.int/essential_background/kyoto_protocol/items/6034.php

Why climate change international agreements are needed?

Countries in the world generate different levels of GHG emissions, historically and actually, from different kinds of activities. Thus, a global approach to a global problem involves careful consideration of the differences in contribution, in circumstance, and in capacity to make these changes.

Climate change international agreements are the first steps towards implementation of an international response strategy to combat climate change.

Cooperation by all nations is essential. The global nature of the sources and impact, the fact that as countries develop their potential emissions also increase, and the unbalanced negative impacts on the most poor and vulnerable, requires full cooperation by all countries in order to achieve effective and enduring results. Subsequently, all nations need to reorient their economies and practices, both to reduce their carbon emissions, and to strengthen resilience to the inevitable impacts of climate change.

Definition of terms	
Conference of the Parties (COP)	The COP is the supreme decision-making body of the Convention. Parties meet annually since 1995. The first COP (COP1) was held was held in 1995 at Berlin, Germany.
Conference of the Parties serving as the meeting of the Parties (CMP)	CMP is the Conference of the Parties that are also parties to the KP. Parties meet annually since 2005. The first CMP (CMP1) was held in 2005 at Montreal, Canada

6.2.1 Climate Change's essential background time line

Table 12 provides time line detailing the international response to climate change

Table 12: Summary of the international response to climate change

Year	Event
1979	The first World Climate Conference (WCC) sponsored by WMO takes place.
1988	The Intergovernmental Panel on Climate Change (IPCC) is set up
1990	IPCC's first assessment report released. IPCC and second World Climate Conference call for a global treaty on climate change. United Nations General Assembly negotiations on a framework convention begin.
1991	First meeting of the Intergovernmental Negotiating Committee (INC) takes place
1992	The INC adopts UNFCCC text. At the Earth Summit in Rio, the UNFCCC is opened for signature along with its sister Rio Conventions, UNCBD and UNCCD.
1994	UNFCCC enters into force
1995	The first Conference of the Parties (COP 1) takes place in Berlin
1996	The UNFCCC Secretariat is set up to support action under the Convention IPCC publishes its Second Assessment Report (SAR)
1997	Kyoto Protocol (KP) formally adopted in December at COP3
2001	Release of IPCC's Third Assessment Report. Bonn Agreements adopted, based on the Buenos Aires Plan of Action of 1998. **Marrakesh Accords** adopted at COP7, detailing rules for implementation of Kyoto Protocol, setting up new funding and planning instruments for adaptation, and establishing a technology transfer framework.
2004	Russia ratifies KP in November
2005	Entry into force of the Kyoto Protocol. The first Meeting of the Parties to the Kyoto Protocol (MOP 1) takes place in Montreal. In accordance with Kyoto Protocol requirements, Parties launched negotiations on the next phase of the KP under the **Ad Hoc Working Group on Further Commitments for Annex I Parties under the Kyoto Protocol (AWG-KP).** What was to become the Nairobi Work Programme on Adaptation (it would receive its name in 2006, one year later) is accepted and agreed on
2007	IPCC's Fourth Assessment Report released. Climate science entered into popular consciousness. At COP13, Parties agreed on the Bali Road Map, which charted the way towards a post-2012 outcome in two work streams: the AWG-KP, and another under the Convention, known as **the Ad-Hoc Working Group on Long-Term Cooperative Action Under the Convention**.
2009	Copenhagen Accord drafted at COP15 in Copenhagen. This was taken note of by the COP. Countries later submitted emissions reductions pledges or mitigation action pledges, all non-binding.

2010	Cancun Agreements drafted and largely accepted by the COP, at COP16
2011	The Durban Platform for Enhanced Action drafted and accepted by the COP, at COP17.
2012	The Doha Amendment to the Kyoto Protocol is adopted by the CMP at CMP8. Several decisions taken opening a gateway to greater ambition and action on all levels.
2013	Key decisions adopted at COP19/CMP9 include decisions on further advancing the Durban Platform, the Green Climate Fund and Long-Term Finance, the Warsaw Framework for REDD Plus and the Warsaw International Mechanism for Loss and Damage.
2014	During COP20 Parties agreed on Lima call for climate action. Other outcomes of the meeting include Lima work programme on Gender, and launching of Lima Ministerial Declaration on education and awareness raising

Further Reading

- *UNFCCC website: http://unfccc.int/essential_background/items/6031.php http://unfccc.int/bodies/body/6383.php*

6.2.2 Lesotho's efforts

1992; Lesotho was one of the countries that signed the UNFCCC at the

Earth Summit in Rio de Janeiro in 1992.

1995: Ratified UNFCCC through the focal point, the Lesotho Meteorological

Services (LMS)

2000: Ratified Kyoto Protocol

6.2.2.1 Lesotho published the following documents

2000: First National Communication to the Conference of the Parties to the UNFCCC

2002: Technology Needs Assessment Report

2007: National Adaptation Plan of Action (NAPA)

2012: Stakeholder Capacity Development Needs Assessment in Climate Change Adaptation

2013: Second National Communication

2015: Lesotho climate change baseline report

2015: Intended Nationally Determined Contributions (INDC)

7 LESOTHO GOVERNMENT POLICIES AND PLANS RELATED TO CLIMATE CHANGE

7.1 OVERVIEW

In response to environmental concerns, the country has ratified a number of multi-lateral environmental agreements, conventions and protocols such as: United Nations Convention on Biological Diversity (UNCBD); United Nations Framework Convention on Climate Change (UNFCCC), Convention on Wetlands of international importance especially as waterfowl habit (RAMSAR); Convention on International Trade in Endangered Species of Flora and Fauna (CITES); United Nations Convention to Combat Desertification (UNCCD), Montreal Protocol for the Protection of the Ozone Layer, Cartagena Protocol on Bio-safety and Basel Convention on Trans-boundary movement of hazardous wastes and their disposal.

Climate change derives its mandate from the Constitution of Lesotho, section 36, which states that:"Lesotho shall adopt policies designed to protect and enhance the natural and cultural environment of Lesotho for the benefit of both present and future generations and shall endeavour to ensure to all citizens a sound and safe environment adequate for their health and well-being''.

7.2 NATIONAL POLICIES AND PLANS

Lesotho during the past decade embarked on developing policies and plans that focus on the attainment of sustainable economic growth and development. Lesotho developed a national policy, Vision 2020 that provides a long-term perspective within which short to medium term plans could be made. The vision statement states that by year 2020, "Lesotho shall have a well managed environment" and the statement forms pillar five of the Vision 2020. Nonetheless, the Vision does not make reference to climate change.

In an effort of attaining the Vision 2020, the National Strategic Development Plan (NSDP) 2012/13-2016/17 was developed in 2012.The NSDP provides guidance on how the country can drastically transform its economy in a sustainable manner. The NSDP has a chapter on "reverse environmental degradation and adapt to climate change", as one of the national priorities. This chapter advocates for building a climate resilient nation and promotion of the green economy, which can be attained through:

Undertaking or reviewing vulnerability assessments and review sector plans and programmes to improve mainstreaming of climate change

Consolidating the national climate change policy and adaptation strategy, agenda and investment programme

- *Upgrading standards for infrastructure development to climate-proof investments*
- *Developing mechanisms to improve access to climate change adaptation technology and use*
- *Promoting cost-effective and clean energy generation*

- *Promoting foreign and domestic investment in the production and use of environment friendly technology*
- *Promoting research and private participation in "green" technology development*
- *Exploring options for carbon trading and tapping different international funds*

7.3 SECTORAL POLICIES AND PLANS

In an effort to achieve accelerated and sustainable socio-economic growth and a friendly environment, Lesotho is concerting efforts at all levels by adopting a number of sectoral policies that also address climate change issues. They include the following:

7.3.1 Finance Sector

The guiding plan that governs the Lesotho finance sector is the Financial Sector Development Strategy 2010 – 2014 whose primary objective is to facilitate, coordinate and allocate financial resources for proper implementation of development activities in the country. The financial sector plays a pivotal role in achieving sustained growth and providing a basis for achievement of green growth in the face of climate change.

7.3.2 Environmental Sector

In 1998, Lesotho adopted the National Environment Policy (NEP) which is a harmonized version of the National Environment Action Plan (NEAP) and National Action Plan (NAP). The main aim of the NEP is to "ensure the protection and conservation of the environment with a view to achieving sustainable development for Lesotho". To enforce this Policy, the Environment Act 2008 was enacted.

In 2009, the Environmental Education Strategy was developed. The strategy echoes the importance of environmental education in achieving sustainable development in Lesotho.

7.3.3 Disaster Management Sector

The National Disaster Risk Reduction Policy was developed in 2007, by the Prime Minister's Office, Department of Disaster Management Authority (DMA). It sets out strategies necessary to enhance capacities required for reducing risks and building community resilience to disasters in Lesotho.

7.3.4 Energy Sector

Lesotho has developed the Energy Policy 2015 – 2025 which stipulates that "energy shall be universally accessible and affordable in a sustainable manner, with minimal negative impact on the environment." There is also the Draft Renewable Energy Policy 2013, whose aim is to create a progressive, long-term policy framework that would promote use of locally available renewable energy sources (e.g. Solar, Hydro and Wind) in Lesotho.

7.3.5 Land Management Sector

The land management sector is governed by the legal frameworks and policies such as:

- ***National Range Resources Management Policy, 2014*** *- The policy provides the legal framework for supporting sustainable rangelands management in the country. It advocates for establishment of multi-level institutional arrangements necessary to enable the implementation of sustainable land management practices within the country and reverse land degradation.*

- ***National Rangelands Action Plan, 2015*** *– The Action plan seeks to identify strategic actions that are necessary to implement the National Range Resources management Policy.*

- ***National Forestry Policy, 2008 –*** *The policy calls for sustainable forest management and associated socio-economic dimensions, including enhanced stakeholder participation in the forestry sector.*

- ***UNCCD Lesotho National Action Programme, 2015 –*** *The programme deals with diversification of livelihoods base and generation of income from Sustainable Land Management including reduction of environmental and socio-economic vulnerability of affected populations to drought, climate change and climate variability.*

7.3.6 Agriculture Sector

The policy framework that governs the agricultural sector in Lesotho is provided for by a number of policies and strategies including the Agriculture Sector Strategy 2003,the National Conservation Agriculture Strategy Framework 2012 – 2017, Lesotho Food Security Policy 2005 and the resultant National Action Plan for Food Security 2007 – 2017 which is meant to implement the Food Security Policy. These policies and strategies are aimed at improving income distribution and increasing the share of agriculture in the national GDP. They also promote conservation agriculture as a strategy that can ensure improvement of soil fertility and maintenance of soil moisture, ensure minimal soil disturbance hence promote microbial activity and help control soil erosion which is one of the major threats to the sector.

7.3.7 Water Sector

The management of water resources in Lesotho is guided by the Water and Sanitation Policy (2007) and its implementation is facilitated by the Long Term Water and Sanitation Strategy (2014). The strategy sets pathways for implementing the Water and Sanitation Policy as well as the Water Act (2008), by establishing enabling institutional mechanisms and setting clear goals to be achieved by 2020. The National Wetlands Conservation Strategy 2013/14 – 2017/18 provides guidance on how to achieve the coordinated management of rangelands and wetlands ecosystems within the framework of catchment management; while promoting conservation and sustainable utilization of the ecological infrastructure.

7.3.8 Health Sector

The sector is governed by the 2012 National Health Policy which guides the implementation of interventions in the health sector. The plan is implemented by the National Health Sector Strategic Plan (HSSP) 2012/13 – 2016/17 which is a successor plan to the 2000 – 2010 HSSP. The aim of the strategy is to achieve among others a "healthy population, living a quality and productive life" which will be attained by significantly reducing morbidity, mortality and inequality in accessing health care services.

7.3.9 Transport Sector

In order to have an overarching policy for the Transport Sector, the Ministry of Public Works and Transport developed the Transport Sector Policy in 2006. This policy states that "the Government will provide an enabling environment for efficient, cost effective and safe transport, within Lesotho, regionally and internationally, to facilitate the sustainable development of the economy, social services and of the population in general". It also calls for rationalization where necessary and upgrading or extending where justified, transport infrastructure in accordance with the planning for the integrated transport system.

7.3.10 Gender Sector

The Gender and Development Policy was developed in2014. The overall goal of the Policy is to take gender concerns into account in all national and sectoral policies, programmes, budgets and plans in order to achieve gender equality in the development process. The Policy advocates for development and implementation of gender sensitive sectoral policies and strategies of all critical areas identified by Beijing Platform for Action.

7.3.11 Climate Change

Although there are a number of policies and plans in place, an overarching policy on climate change is yet to be developed to guide implementation and coordination of climate change initiatives in the country. The Lesotho climate change Policy has to create an enabling environment for the implementation of appropriate actions aimed at addressing climate change in particular adaptation and mitigation.

7.3.12 Mainstreaming Climate Change

The need to integrate climate change into development planning and in decision-making processes has become increasingly apparent with the general recognition of the linkages between development and climate change (LMS, 2015). Integrating or mainstreaming, climate change considerations into national and sectoral decision-making processes is therefore critical to meeting different challenges. Mainstreaming of climate change into

national and or sectoral plans and policies is crucial to ensure long-term sustainability of actions taken in the country. This may call for the review of existing strategies and policies.