Lesotho National Adaptation Plan

Lesotho NAP Team

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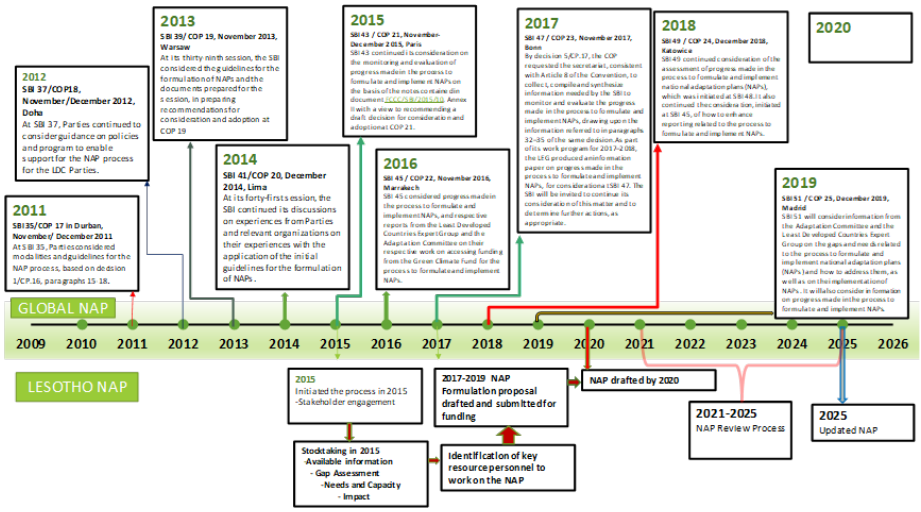
Contents

Chapter 1

Preliminaries

1.1 The process to formulate the NAP



ABOUT LESOTHO Geographically, Lesotho is located in the south eastern part of Southern Africa; at approximately 28°S and 31°S Latitude and 27°E and 30°E Longitude (LMS 2017). It occupies a land area of 30,355 km2, a north-south extent of about 230 km and a maximum width of about 210 km, with elevation ranging from 1,388 m to 3,482 m. Lesotho is a landlocked country surrounded by the Republic of South Africa (LMS 2017). Lesotho has a continental temperate climate characterized by four distinct seasons: spring, summer, autumn and winter (LMS 2017); its temperate climate with sub-alpine characteristics distinguishes it from other southern African countries (NAP Stocktaking Report 2015). The average temperature ranges between -10°C in winter and 30°C in summer (LMS 2017). The country receives most

of its highly-variable rainfall between the months of October to April, with an average of 700 mm per annum (LMS 2017): the lowest average annual rainfall occurs in the Senqu River Valley (450 mm) and the highest in the north-eastern mountain zone (1,200mm) (LMS 2017).

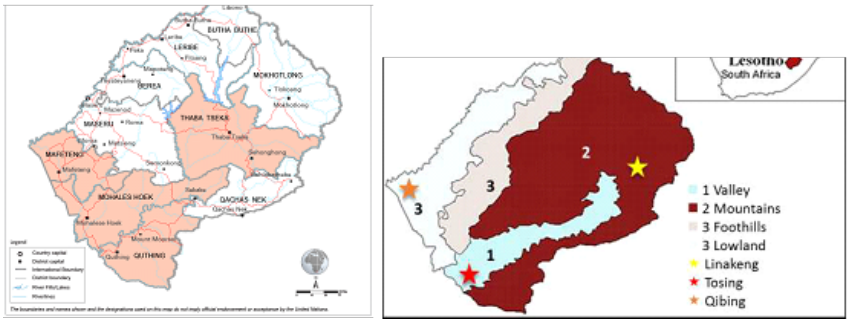


Figure 1.1: Figure: Climate Change Vulnerability Zones in Lesotho (Source: Matarira et al, 2013; Gwimbie et al, 2011): Zone 1: The Southern Lowlands and Senqu River Valley – inhabited by small scale livestock and subsistence farmers, most vulnerable; Zone 2: The Mountains – mountainous with minimal cultivation land, second most vulnerable; Zone 3: The (Western) Lowlands and Foothills – combination of urban and farming areas, prone to drought, least vulnerable.

Lesotho is generally characterized by unemployment, poverty, food insecurity, lack of infrastructure, as well as high population pressure on arable land and natural resources (LMS 2017). Climate change is already affecting Lesotho's climatic patterns with resultant substantial environmental and socio-economic loss, particularly because of its mountainous topography and socio-economic conditions (LMS 2017). Challenges related to climate change include (LMS 2017): spatial and temporal variability of rainfall; increased frequency and magnitude of floods and droughts; intense rainfall associated with flash floods, soil erosion and high sediment loads in rivers; strong winds associated with destruction of infrastructure such as houses and power lines; pasture degradation and desertification; shrinkage of habitats, and decrease in the number of plant species and wildlife; snowfall, which occurs annually over the mountains and on average once every three years in the lowlands, associated with extremely low temperatures, loss of livestock, hampered movement and access to essential services.

Chapter 2

Introduction

The increasing rate of global warming over the Southern African region has resulted in continuous experience of climate variability. In congruence with studies done by the Intergovernmental Panel on Climate Change (IPCC 2014) and scenarios projected by the Lesotho Meteorological Services (LMS 2017), climate change is already affecting Lesotho's climatic patterns with resultant substantial environmental and socio-economic loss, particularly because of its mountainous topography and socio-economic conditions. According to Lesotho Meteorological Services (LMS 2017) rainfall is highly variable both temporally and spatially, thus droughts and floods are common occurrences. High intensity rainfall often produces flash floods that accelerate soil erosion leading to high sediment loads in rivers. Snowfall occurs annually over the mountains and on average once every three years in the lowlands causing serious problems, not only resulting in extremely low temperatures but in restrictions on movement and access to essential services as well as the mountain communities including loss of livestock. Strong winds are common, causing destruction of infrastructure such as houses and power lines .Droughts alone are estimated to reduce total GDP by 1% - 4%, while soil erosion (40 million tons lost per year) has been estimated to reduce agricultural GDP by 2%-3% (around 1% of total GDP) (LMS 2000, LMS 2017). Lesotho's population is made up of one homogeneous ethnic grouping (Basotho), and is estimated to be 2 million with ran estimation of 80% of the population reside in rural areas (FAO 2018). A significant portion (49.2%) of the population in Lesotho lives under the poverty line which makes them more vulnerable to climate change since they do not have sufficient incomes to prepare and protect themselves from the adverse effects of climate change (UNDP 2020). This means that the majority of Lesotho's population does not have adequate adaptive capacity and resilience to climate change. In an effort to bring transformational change in country's capacity to address the impacts of climate change the nation has adopted a number of strategic instruments such as the National Strategic Resilience Framework (2017-2030) and Climate Change policy (2017 – 2027) and National Early Warning Strategic Action Plan,

(2020). However, despite initiatives taken towards being more resilient to natural hazards and in reducing disaster risk, climate change is posing real time and potential challenges to the country's natural resources dependent livelihoods (Draft National Disaster Risk Management Strategy and Action Plan 2020). Therefore, integrating climate change information into development planning and decision making can improve adaptive capacity and resilience. There is a need for powerful adaptation policies and programmes with implementing capacity across all systems.

It is widely agreed that adaptation strategies (Cancun Adaptation Framework (2010), World Economic Forum Davos 2020) could fuel reduction in harmful effects of climate change in the Least Developed Countries such as Lesotho. Sustainability in adaptation interventions will translate to contextually socio-economically and environmentally feasible development pathways. Countries stand to lose the hard won sustainable development gains if they do not build the resilience of people, places, ecosystems, and economies to the impacts of climate change. Therefore, the NAP process is highly essential for Lesotho given the prevailing climate change related challenges that are facing the country, and which are clear and detrimental impacts on its people, ecosystems and economy. During the launch of the NAP Lesotho (2015), it was strongly emphasised that the NAP process will help to identify a NAP roadmap for Lesotho, facilitating the coordination of all the existing adaptation projects and initiatives, and the formulation of new concepts which will be further developed into bankable projects to reduce vulnerability, build capacity and mainstream adaptation into all systems and sectors specific development plans. NAP will clearly identify and prioritise the key adaptation measures required to address the country's peculiar adaptation needs, and the processes to ensure that these measures are mainstreamed into the national planning and development processes and programmes across systems and sectors. The Lesotho National Climate Change Policy (2017-2027) sets the basis for addressing one of its core pillars, "adaptation and climate risk reduction", noting that adaptation to climate change is of utmost importance to ensure socio-economic and environmental systems function and development, and to avoid loss and damage. It points out that adaptation in sectors such as water, agriculture and food systems, early warning, energy, land use, health and biodiversity, among others, are key to paving the way to a climate resilient pathway. Prior to the initiative on NAP development, Lesotho developed a number of documents and programmes in relation to adaptation interventions. The documents include the NAPA (2007) and NDC (2015). However, with the NAPA gaps were identified and these are sectoral and zone based (concentration in southern districts of Lesotho) characterised with fragmental approaches (different implementing strategies from individually implementing entities) which poses a high probability for maladaptation. Moreover, it had limitations in terms of trans- regional adaptation capacity and multi sectoral connectivity in a long term timeframe. Therefore, the NAP process will address these shortfalls identified and work towards a more systematic approach with interconnectedness within bio-physical and socio economic development spheres. Consequently, the experience potentially leverages Lesotho

in a good position to develop the NAP process. Therefore, in the NAP process Lesotho adopts a "systems" rather than "sectoral" approach as it provides a more integrative and holistic understanding that better underpins required and effective adaptation strategies. While the National Adaptation Programme of Action(2007) identified the country's "urgent and immediate" priority needs for adaptation, the NAP process extends this to cover adaptation measures that the country needs to focus on for its medium- and long-term priorities for adapting to climate change and defines clear actions to develop the necessary capacities and systems and to operationalise necessary actions needed to make adaptation an integral part of a country's development planning, decision making and budgeting.

Chapter 3

Framework for the NAP

Lesotho's geographical characteristics and prevailing socioeconomic conditions among the majority of its rural population make it one of the most vulnerable countries to the impacts of climate change . Climate change is affecting Lesotho in many ways. Recurrent and devastating droughts and high temperatures cause food insecurity which affects hundreds of thousands of people through reduced agricultural yields as a consequence of low soil moisture, higher livestock mortality, increased food prices for both human and livestock consumption, and reduction in the effectiveness of traditional farming practices. Drought lowers hydroelectric power production and increases water insecurity particularly in the lowlands where about two-thirds of the national population reside.

The effects of the droughts are compounded by degraded soils, rangelands and wetlands, decreasing availability of agricultural land, reduced availability and quality of potable water for humans, livestock and wildlife, and biome shifts. Higher temperatures are increasing human and livestock susceptibility to heat stress, exacerbating the incidences of pests and diseases, and contributing to crop failures through crop wilting. On the other hand, intense rainfall and runoff, floods, hail and heavy snowfalls destroy crops and infrastructure such as roads, bridges and power lines, enhance soil erosion and land degradation which result in turbid rivers and compromised ecosystem services, and increase susceptibility to water-borne diseases. Both droughts and floods directly result in loss of human lives, and also kill livestock and wildlife. Increasing rainfall variability, shorter rainfall seasons and late onset of rainy seasons contribute to reduced crop and pasture yields, unreliable water supply and hydropower generation, reduced availability of groundwater due to inadequate recharge, and more broadly to degraded ecosystem services. All these changes, among others, are depressing economic activities, with significant impact on national GDP, and diminishing the wellbeing particularly of the large population of rural dwellers whose livelihoods depend on the rangelands, wetlands, indigenous plant and animal species, and ecotourism, as well as the urban poor who contend with

unemployment and inequality.

The National Adaptation Planning process which was initiated during the seventeenth session of the Conference of the Parties (COP) to the United Nations Framework Convention on Climate Change (UNFCCC) is today an essential component of planning at all levels because climate change is an issue that has to be addressed over the long-term. The process enables developing and least developed country (LDC) parties to assess their vulnerabilities, mainstream climate change risks, and to address adaptation across all key sectors that are impacted by climate change (LEG, 2012). Further, it is essential that developing country and LDC parties integrate adaptation planning in the broader context of sustainable development planning because climate change risks disproportionately magnify development challenges in these countries as compared to developed countries (LEG, 2012). The national adaptation plan (NAP) process was, therefore, established by the COP as a pathway by which effective adaptation planning in LDCs and other developing countries can be facilitated. The Government of Lesotho embarked upon the National Adaptation Plan (NAP) process to adopt a medium-term approach for reducing vulnerability to climate change impacts, and to facilitate the integration of climate change adaptation into ongoing planning processes at national and subnational levels.

The agreed objectives of the national adaptation plan process are (LDC-EG, 2012): (a) To reduce vulnerability to the impacts of climate change, by building adaptive capacity and resilience; (b) To facilitate the integration of climate change adaptation, in a coherent manner, into relevant new and existing policies, programmes and activities, in particular development planning processes and strategies, within all relevant sectors and at different levels, as appropriate.

The implementation of the NAP process is intended to:

- build on existing CCA planning processes and initiatives in order to provide continuity with previous planning efforts;
- build on past implementation successes;
- eliminate duplication of effort; and
- avoid repetition of implementation failures.

3.1 Essential functions of the NAP process

The NAP for Lesotho will serve the following functions:

1. Provide a pivotal framework for mainstreaming and coordination of adaptation efforts at national and sub-national levels and across systems and sectors in support of the core pillar “adaptation and climate risk reduction” as outlined in the National Climate Change Policy 2017-2027, and to interface with regional and international mechanisms.

2. Support adaptation planning and implementation at all levels through the collection, compilation, processing and dissemination of data, information and knowledge on climate change and national development. The various government agencies will contribute to this effort through their respective mandates and in association with local and international development partners including the private sector.
3. Identify and address capacity gaps and needs to ensure that adaptation strategies are properly designed and implemented.
4. Assess climate-development linkages and needs to support the integration of climate change adaptation into national and sub-national development and sectoral planning and in support of the 22 policy statements in the National Climate Change Policy.
5. Provide analyses of national and sub-national climate data, assess vulnerabilities to climate change, and identify appropriate adaptation options at scale. This will require the cooperation of all devolved units of governance down to the community and urban councils and coordination to ensure that the different data streams are in standardised formats that allows for integration and comparison. The NAP secretariat would provide these standards.
6. Support decision-making on adaptation investments and development planning through appraisals of adaptation options.
7. Promote and facilitate the prioritisation of climate change adaptation in national planning.
8. Facilitate the implementation of adaptation at all levels through its mainstreaming into policies, projects and programmes and to maximise on synergies.
9. Provide a framework for monitoring, review and updating of adaptation plans over time, ensure progress and effectiveness of adaptation efforts, and outline how gaps are being addressed.
10. Coordinate reporting and outreach on the NAP process to national and international stakeholders and formally on progress to the UNFCCC.

3.2 The NAP as the umbrella programme for adaptation

There are several development programmes and activities that are taking place in Lesotho at national and sub-national levels under national government ministries and parastatals or through bilateral arrangements and partnerships with private sector entities, which need to be buttressed to be resilient to the impacts of climate changes in order to be able to effectively contribute to targeted development outcomes. Among many others, these include: Ministry of Finance “Millennium Challenge Account Lesotho Project” which has implemented projects in urban and rural water supplies and health and now targets a second phase focusing on health, job skills, land, and the regulatory envi-

ronment; Ministry of Energy and Meteorology "Sustainable Energy for All" project from household to national level and across rural and urban areas; Ministry of Water – has several ongoing projects such as the Lesotho Water Sector Improvement Phase II to supply water to the Lowlands (Maseru, Roma, Morija, Mazenod, Teyateyaneng) and stand-alone solutions to villages; Ministry of Health – Lesotho Nutrition and Health System Strengthening Project, which recognises climate change but does not tie in its impacts to its health services delivery, and; several programmes implemented bilaterally between the government and international donor or investment agencies.

The Ministry of Social Development is implementing the Community Development Model as a sustainable intervention to build the capacities of communities to graduate from poverty and social assistance programs through livelihoods establishment, though this effort is constrained by financial resources which could potentially be leveraged through linking with livelihoods-related projects that are under different ministries and programmes. The Climate Finance Facility Project seeks to crowd in private sector investment by de-risking and increasing the bankability of climate projects. Further, while the country is committed to ensuring full and productive employment and decent work for all including women, youth and people with disabilities, climate impacts on its various systems are undermining the efforts to achieve these objectives (Lesotho VNR 2019). However, the involvement of these different actors and the private sector, are sector- and project-constrained, and gendered aspects are not clearly staged.

Given its cross-cutting nature which includes, inter alia, considerations of adaptive capacity and resilience at systems level while considering also the individual, institutional, and systemic factors, and its mainstreaming into governance and development planning structures, the NAP offers an appropriate umbrella under which national programmes for adaptation can be jointly framed, coordinated and implemented. The NAP will present an aggregate national adaptation plan that will link to appropriate local, subnational, national, and sectoral activities and action plans, maximise on efficiencies, minimise duplication of efforts, and leverage on cost constraints to programme implementation. The NAP process shall also add value to past and current activities by identifying capacity gaps, especially for the design and implementation of medium-term climate change adaptation priorities, as well as by accessing opportunities for international funding to develop more effective climate responsive planning and budgeting. The Lesotho NAP coalesces all the discrete climate change adaptation plans and programmes that are or shall be implemented in the country. It comprises of collated, synthesised and analysed data of climate change trends and its impacts, aggregated from local level and downscaled from regional analyses, as well as related peculiar vulnerabilities at scale within and across regions and systems, and identifies gaps and capacity needs that should be addressed. This information will be used to identify and prioritise adaptation options, and to put in place plans to implement the proposed adaptation options, as well as how to finance them. Finally, a monitoring and evaluation framework is determined for the different programmes to track progress and to make adjustments where

necessary. Periodic updates (every four years) shall be undertaken to ensure that the NAP is responsive to new and emerging needs and offers an effective mechanism for climate change adaptation at scale.

3.3 Coherence with national development context, SDGs, Sendai and other relevant frameworks

The Lesotho Vision 2020 which was adopted in 2004 is anchored on seven pillars of development, namely; democracy, unity, peace, education and training, economic growth, management of the environment, and advancement in technology. It recognized that "poor land use management as well as climate change and a general degradation of the environment have led to aridity and barrenness of the land with an unmistakable signs of the onset of desertification". The vision statement highlights a "healthy and well-developed human resource base", a "strong economy", a "well-managed environment", and "well-established technology" which all broadly speak to the goals of the NAP process as well. The Coalition Agreement of 2015 outlines 12 specific commitments, of which 7 are directly pertinent to climate change adaptation and resilience building, and these include: growing the economy faster through…effective use of natural resources, infrastructure development and retaining within the country a greater proportions of earnings from natural resources (B1); enhancing the strategic management of natural resources through creating a Ministry of Water (B2); growing the private sector and promoting the tourism industry (B4); promoting food security and commercial agriculture (B5); supporting Small, Micro and Medium Enterprises (SMMEs) through appropriate regulatory policies and access to finance (B6); reducing poverty and inequality, and improving access to effective social services for its citizens (B8) and; addressing the needs of vulnerable populations including orphans, children, young people, women, the elderly and people with disabilities (B9).

Lesotho developed the National Climate Change Policy 2017-2027, providing the basis for the development of other national strategies and plans. For example, the National Strategic Development Plan (NSDP II) 2018/19-2022/23 recognizes that climate change is a challenge that needs to be responded to in a strategic manner using appropriate approaches because it contributes to lower land quality, heightens extreme weather conditions (e.g. recurrent droughts, heavy rain falls and floods, strong winds, early/late frosts, hail, snow storms) which sometimes lead to emergency relief efforts that divert much needed finances from development projects, and has significant adverse consequences for agriculture, food security, poverty and vulnerability. It is viewed as "the greatest threat to Lesotho's developmental progress" . The NSDP II, which is also aligned with the African Union Agenda 2063 and Regional Indicative Strategic

Development Plan, is implementing the final years of the goals set out in Vision 2020, and also operationalizes the Sustainable Development Goals (SDG) 2030 agenda. On the other hand, the National Resilience Strategic Framework 2017-2030 and the Disaster Risk Management Bill 2020 aligns with the Sendai Framework. Lesotho is therefore well placed to enact and mainstream a NAP to operationalize its approach to adaptation to climate change and to monitor progress towards desired outcomes.

Chapter 4

Approach/Methodologies

4.1 Guiding principles

The guiding principles are drawn from a number of documents, including: The Constitution of Lesotho, Lesotho Vision 2020, The National Strategic Develop Plan II 2018-2023, the National Communications to UNFCCC, and the principles outlined in the UNFCCC 'Technical guidelines for the national adaptation plan process'.

```
library(flextable)
```

```
## Warning: package 'flextable' was built under R version 4.0.5
```

```
library(magrittr)
```

```
## Warning: package 'magrittr' was built under R version 4.0.5
```

```
principles<-readxl::read_excel("Tables_from_NAP.xlsx",
    sheet = "nap_principles")
t1<-flextable(principles,col_keys = names(principles),
  cwidth = 3,
  cheight = 0.01,
  defaults = list(),
   theme_booktabs())
t2<-fontsize(t1,part = 'all', size = 8)
t3<-border_outer(t2,part = 'all', border = NULL)
t4<-border_inner(t3,part = 'all', border = NULL)
t4
```

a. A country-driven approach.	Country-driven approaches inspire ownership and ensure that plans, programmes and activities are aligned with national priorities.
b. Equality, justice, and transparency	Lesotho's Constitution states that it shall adopt policies aimed at promoting a society based on equality and justice for all its citizens, and that the State shall take appropriate measures in order to promote equality of opportunity for the disadvantaged groups in the society to enable them to participate fully in all spheres of public life. Transparency is an important principle of good governance and promotes public and private sector participation in development projects.
c. Protection and sound management of the environment	Article 36 of the Constitution of Lesotho states that it "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 assure to all citizens a sound and safe environment adequate for their health and well-being".
d. Gender and social inclusion, and particular consideration of marginalized groups such as women	Lesotho's NSDP II mainstreams Climate Change, Environment, Gender and Social Inclusion across all sectors, recognising that these are crucial for the realization of inclusive growth.
e. Contribution to sustainable development	Sustainable development serves to meet the country's needs today without compromising the ability of future generations to meet their needs. Lesotho, in its Vision 2020, lays a very strong emphasis on sustainable development, and is implementing the UN Sustainable Development Goals which have been domesticated in the National Strategic Development Plan II. Development gains are threatened by high vulnerability to global warming and the impacts of climate change, so adaptation planning and implementation of planned adaptation measures are important the country is to remain on the development pathway.
f. A participatory NAP process involving stakeholders	Stakeholder participation is necessary for buy-in, ownership, involvement in, and support of planned activities. Lesotho aims to strengthen & promote private sector and civil society participation in managing development, and to ensure the equal participation of men and women and vulnerable groups in economic opportunities, participation in policy making, and other decision-making structures.
g. A multidisciplinary and complementary NAP approach, building upon relevant existing plans and programmes	Multidisciplinary and complementary approaches are important in the NAP approach because the issue of adaptation is itself multidisciplinary and cross-cutting. The country has mainstreamed climate change issues in its development plans because it has implications for employment creation and economic growth since its impact on various economic sectors such as agriculture, health and nutrition, tourism and natural resources has been well established.
h. Incorporation of science, technology and indigenous technical knowledge (ITK)	It is important to incorporate and to build capacity, through a gender-sensitive lens, in this area that is cross-cutting in climate change adaptation. New knowledge from assessments and emerging science, as well as the results and lessons learned from implemented adaptation measures, are important, iterated inputs to the NAP process.

a. A country-driven approach.	Country-driven approaches inspire ownership and ensure that plans, programmes and activities are aligned with national priorities.
i. Education and training	The priority projects identified in the NAP contain various activities that are related to building capacity to address climate change, such as improving institutional and human resource capacity, strengthening early warning systems including data and modelling capacity, improving climate change education and awareness, and developing and/or strengthening policy frameworks to address climate change – all of which are strongly emphasized in the country's development plans.
j. Mainstreaming of climate change adaptation across all sectors	Lesotho's NSDP II mainstreams Climate Change, Environment, Gender and Social Inclusion across all sectors, recognising that these are crucial for the realization of inclusive growth.
k. Cost-effectiveness	This is important as the country can make savings that can go a long way to expand or scale up its programmes and frees finances for other programmes and activities.
l. Simplicity, and flexibility of procedures based on the country's circumstances	Simplicity is important where actions are planned in multidisciplinary and multi-institutional/multi-agency contexts coupled with strong involvement of the public and private sector, communities and individuals. Flexibility is important, as adjustments can be made to improve different aspects of implemented programmes.
m. Alignment with the GCF country programme.	This alignment is important in order to improve access to funds such as the Green Climate Fund. Such alignment would include coherency with the national climate change policy and related strategies and plans, coherence with existing policies, capacity of the executing entity to deliver, and stakeholder consultations and engagement.

4.2 Guidelines used

The main guidelines used included:

- The Technical Guidelines for the National Adaptation Plan Process, UNFCCC – this was used as the primary document for framing of the structure and content of the NAP. It also requires that the NAP process: follows a country-driven, fully transparent, approach; is based on and guided by the best available science and, as appropriate, traditional and indigenous knowledge; and facilitates country-owned, country-driven action and not be prescriptive, nor result in the duplication of efforts undertaken in-country.
- National Climate Change Policy 2017-2027
- Lesotho National Communications to the Conference of Parties of the UNFCCC
- Lesotho Vision 2020
- The National Strategic Develop Plan II 2018-2023

- Lesotho's Nationally Determined Contribution 2017
- National Adaptation Plan of Action 2007
- NAP Stocktaking Report 2015.
- Lesotho Resilience Strategic Framework 2017
- Guidelines for integration of climate change into National , Sectoral and Local Policies, Strategies and Development Plans 2018

In addition, and following the experiences gathered from the implementation of the NAPA process, the Technical Guidelines recommend: * using locally defined criteria for ranking vulnerabilities and prioritizing project activities, which will build confidence and buy-in across all stakeholders; * using available data and assessments as a basis for more comprehensive assessments; and * engaging national experts, as this will also enhance the experience and capacity of the country. * Using findings from past and ongoing projects midterm reviews

These were supported with emerging new data from the published literature. The assessment of these documents together included:

a. Process of identification/stocktaking of desirable and available information

b. Climate and socio-economic data and information

ii. Current assessments: Exploring possibilities for further assessments
iii. Policies, strategies, plans
iv. Existing initiatives on adaptation

b. Resource mobilization for the process.

4.3 A systems approach to adaptation

Systems are complex, and each system interacts to various degrees with other related systems. Sectoral interventions have not been as successful as desired because they do not take into account the interactions of system components, including the fact that the mandate to manage some components of the system may lie in a different sector, and hence come under a different institutional mandate whose primary goal is not necessarily in tandem with those of another sector, and more often than not, there is very little synergy between sectoral programmes.

Urban areas, for example, are complex since many social, physical and economic systems meet and interact, with many of these extending well beyond its spatial boundaries, e.g. water and power supply systems, while other linkages may be transboundary. It is important, therefore, that National Adaptation Plans capture these systems and their interlinkages, scale and stakeholder diversity,

so that appropriate and synergistic adaptation measures can be devised and implemented. Thus, the NAP process uses a systems approach which facilitates the integration of climate change adaptation, in a coherent manner, into relevant new and existing policies, programmes and activities, in particular development planning processes and strategies, within all relevant sectors and at different levels, as appropriate.

The framework to guide the assessment of vulnerabilities and risks included:

i. Conceptual framework of vulnerability and risk at various levels: national, system level, local level, etc.
ii. Boundary conditions for the assessment using the period 1971-2000 for baseline climate
iii. Focus on key systems/sectors
iv. Synergy with SDGs, Sendai Framework for DRR, and other relevant regional and national frameworks.

4.4 Other unique considerations

The emergence of the COVID-19 pandemic in early 2020 disrupted, globally, established societal structures and ways of doing things, and has had devastating impacts on human health, stressed health systems and severely disrupted national economies. A UNDP 2020 study "Assessment of the Socio-Economic Impact of COVID-19 on the Kingdom of Lesotho" highlights the high levels of vulnerabilities of individuals, families, and the whole economy with projected overall negative GDP growth for 2021, and the gaps in health systems and infrastructure. This Open NAP initiative has been developed with some steps of the NAP process being omitted, in particular; it has not been possible to apply and get GCF readiness funding, and extensive consultations with stakeholders have not been undertaken because of personnel unavailability due to lockdowns, and challenges of mounting online surveys and poor internet access as well. It is hoped that the situation will normalise soon and the GCF funding can then be used to continue this process and to produce the next NAP.

4.5 Road Map

This particular process was initiated in 2015 with a stakeholder engagement workshop (Figure 1). During the same year, stocktaking was undertaken to assess the available information on climate change, its impacts, vulnerability of people and ecosystems, and adaptation to climate change impacts. A gap assessment relating to these aspects was undertaken, along with assessment of the needs and capacity to adapt. Key resource persons were identified to work on the NAP from 2017 through to 2021, the target year for having the draft NAP in place.

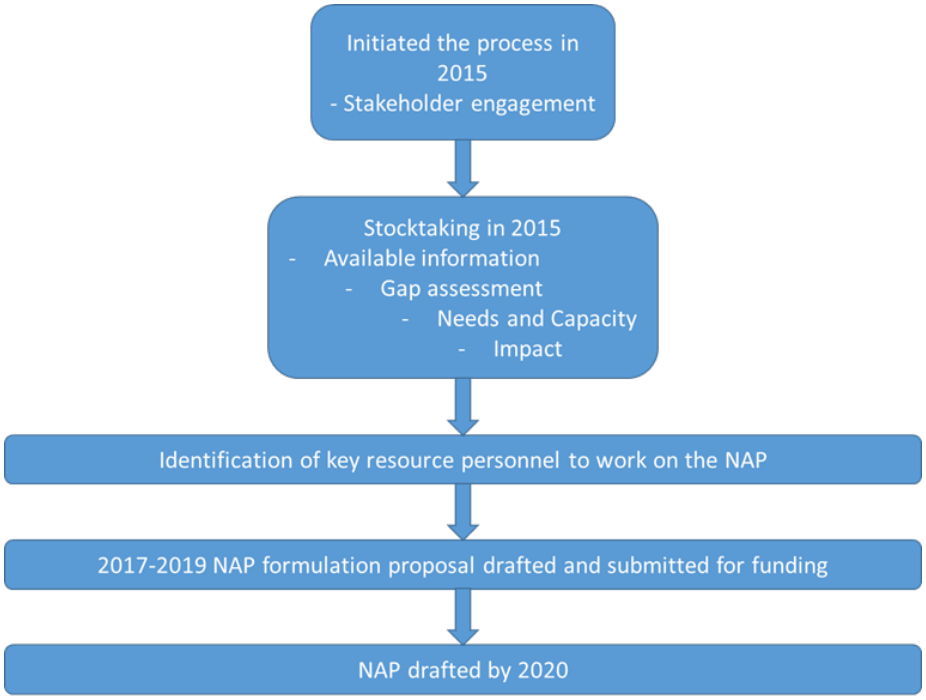


Figure 4.1: Figure 1: NAP roadmap.

Chapter 5

National context

5.1 National circumstances

Environment: The land area of Lesotho is dominated by rugged topography of the Maloti and Drakensberg mountain ranges. The land area comprises of 10.1 percent of arable land, 65.9 percent of permanent pasture, 1.63 percent tree cover, and 22 percent being other (bare rock and build up areas). The forests, though small in areal coverage and under threat from deforestation, are a very important resource to rural communities by providing fuelwood, construction materials, medicines, forage and shelter (LMS 2000). Ecologically, Lesotho is divided into four agroecological zones namely; lowlands (17% of total area), foothills (15%), mountains (59%), and the Senqu River Valley (SRV) (9%). The country's steep topography dictates in part the economic activities, which are largely confined to the lowlands, the foothills, and the Senqu River Valley, while the mountainous areas are suitable only for grazing and water resource development like hydropower for which it has a high potential (LMS 2000). Environmental degradation including severe soil erosion are impediments to crop production (LMS 2000). Soil erosion and desertification have been aggravated by recurrent droughts, rapid population growth and increasing pressure on natural resources, as well as unsustainable land and natural resource management practices. Loss of ground cover on the highland rangelands due to overstocking has resulted in excessive water runoff during mountain storms, leading to flash flooding and sheet and gully erosion, which is leading to loss of limited agricultural land. It is estimated that 4.5 million tons of soil is lost through soil erosion per year, thus reducing the productive capacity of the country's croplands and rangelands and impacting on biodiversity by changing and reducing habitat for wild species. For the period 2005 to 2010, the energy sector was the highest emitter of GHGs, followed by Agriculture, Forestry and Other Land Use (AFOLU), Waste and Industrial Processes and Product Use (IPPU) (LMS, 2020).

Climate: Lesotho has four distinct climatic seasons over a 12-month period, namely; Summer (December, January and February), Autumn (March, April and May), Winter (June, July and August) and Spring (September, October and November). Maximum and minimum temperatures recorded at various locations show wide variations on annual, monthly and diurnal time scales. Mean temperatures vary from 10.9°C to 27.6°C during the summer (DJF) season with January being the hottest month. In winter (JJA), mean minimum temperatures vary between 0.1°C to 17.3°C with July being the coldest month. Annual mean temperatures are highly variable from year to year with an increasing trend. The country's mean annual temperatures have increased by 0.76° C between 1970-2001 . During summer, prevailing wind directions are from the north and east, shifting to the south and west in winter (Sene et al. 1998). In the highlands, temperatures regularly drop to below zero and some areas may experience ground frost for up to 200 days per year (Sene et al. 1998). Lesotho experiences one rainfall season which spans the months of October through April of the following year with December to February being peak rainfall months. More than 80% of the annual rainfall is received during the rainy season, which varies from 450 mm in the low-lying regions in the southwest to about 1200 mm in the northeast highlands where snowfall, which has a water equivalent depth usually less than 10% of the average rainfall, is also highest in winter especially in June and July (Sene et al. 1998). The winter months are characterized by occurrence of significant amounts of snowfall on annual basis in the high-lying areas and occasionally in the low-lying areas once every 3 years (NAPA, 2007). Droughts occur three years out of every 10, heavy frosts are frequent and heavy unseasonable rains also occur from time to time resulting in serious periodic falls in agricultural output (NAP Stocktaking Report 2015).

Political: Lesotho is a sovereign democratic kingdom that is led by the King as the constitutional monarch and head of state (Lesotho Constitution, Chapter I). There are three arms of government, namely, the Legislature, the Executive, and the Judiciary. The Legislature has a system of government in which the legislature consists of two houses; the Upper House or Senate, and the Lower House or National Assembly. The Senate comprises of 22 principal chiefs, who are members by heredity rights and 11 other members, nominated by the King (Lesotho Constitution, Chapter VI). The National Assembly comprises of one hundred and twenty elected members. The succession of the King is determined by the College of Chiefs who designates the king's successor in accordance with the customary laws of the country (Lesotho Constitution, Chapter V). Lesotho is a member of the United Nations, the Commonwealth of Nations, the African Union, and the Southern African Development Community (SADC).

Legislative: The National Climate-Change Policy 2017-2027 sets the climate change agenda in Lesotho. The policy is aligned to the Vision 2020 and the National Strategic Development Plan. It sets the context to inform adaptation strategies to mitigate climate change impacts (World Bank, 2018). The 2017 National Climate Change Policy Implementation Strategy is an implementation framework of the National Climate Change Policy. The wider legal, regulatory

and institutional framework is discussed in more detail in sections 4.2 and 4.3.

Social: The population of Lesotho was estimated at 2,008,801 in 2016, with an annual population growth rate of 0.08% (Census, 2016) while current (2020) estimates place it at 2,147,418 with over 70 percent of people residing in rural areas. Women make up 51.1 percent of the population, with youth (those between 15 to 35 years) comprising nearly 39.6 percent (50.7 percent male and female 49.3 percent) of the total population. According to the 2016 population census, the distribution of the population in the four ecological zones is: 62% in the lowlands; 9.7% in the foothills; 19.6% in the mountains, and; 8.7% in the Senqu River Valley. Majority of the population is concentrated in the lowlands resulting in very high population densities. The country's population is mainly distributed across the rural, urban, and the peri-urban areas. The country with Human Development Index of 0.527 is ranked 165/189 , indicating a low human development. The population in severe multidimensional poverty is 5%, but 28.6% are vulnerable to it (OPHI-UNDP 2020). On the Global Needs assessment (GNA) Vulnerability Index, Lesotho is ranked 2/3 and on the GNA Crisis Index it scores 3/3, indicating a high vulnerability. In terms of population growth rate trends, the growth rate was 2.6% in 1986, 1.5% in 1996, 0.08% in 2006, and 0.68 in 2016: this erratic change in the country's population growth is attributed to the impacts of the HIV and AIDS pandemic on the population (Census, 2016). After Eswatini, as at 2018, Lesotho had the second highest HIV prevalence rate at 23.6% globally (UNAIDS, 2019). The report estimated 340,000 people were living with HIV while 6,100 died from AIDS-related illnesses in 2018 in the country.

Economic: Lesotho's economy is intricately linked to its regional and international partners. Its economy is primarily based on four sectors, namely: water, manufacturing, mining and agriculture (LMS 2017). Other significant contributors to the economy are: Customs Duties from the Southern African Customs Union (SACU); benefits accruing from other regional and international trade agreements and protocols; and individual remittances from Basotho working in South Africa. Thus, Lesotho is a low-income country with a small domestic market and private sector. The government is the main driver of economic activities estimated to account for 60% of the national Gross Domestic Product (United Nations, 2020). For instance, in 2018/2019 financial year recoveries by the government in textile and mining (diamond) sectors resulted in 3% growth of the GDP (United Nations, 2020). Lesotho's major natural resource is water. In January 1998, the government completed a major hydropower facility – which was part of the Lesotho Highlands Water Project (LHWP). LHWP is a multistage infrastructure project to transfer water from water rich-highlands of Lesotho and to enhance water security against future potential vulnerabilities (World Bank, 2016). The facility has permitted sale of water to South Africa and generated royalties that have earned the country significant income (Government of Lesotho). Indeed, it is Lesotho's largest source of foreign income (NAP Stocktaking Report 2015). In 2018 and 2019, Lesotho's economy contracted due to the volatility of Southern African Customs Union (SACU) re-

ceipts to which the country is a member. SACU receipts account for about half of total Lesotho government revenue (Lesotho economy, 2020). The coronavirus pandemic has further slowed the economic resurgence and necessitated external emergency funding. For instance, through its rapid credit facility (RCF), the International Monetary Fund (IMF) approved a US$49.1m disbursement to Lesotho in early August 2020 to mitigate the pandemic's impacts on the economy (Lesotho Economy, 2020). Real GDP growth rate is estimated to have contracted by 1.2% and 0.4% in 2018 and 2019 and it is projected to average 0.6% between 2019–2023 (World Bank 2021). However, in the medium-term, economic growth is expected to be boosted by construction-related projects including the second phase of the Lesotho Highlands Water Project (LHWP II) and the Lesotho Lowlands Water Development Projects (LLWDP -I and-II). The water and electricity subsectors are expected to be boosted by green energy projects, while the tertiary sector is envisaged to be supported inter alia by government initiatives to reinforce financial inclusion (World Bank 2021).

```
library(flextable)
library(magrittr)
sectorg<-readxl::read_excel("Tables_from_NAP.xlsx",
    sheet = "sector_growth")
```

```
## New names:
## * `` -> ...1
```

```
t1<-flextable(sectorg,col_keys = names(sectorg),
  cwidth = 3,
  cheight = 0.01,
  defaults = list(),
   theme_booktabs())
t2<-fontsize(t1,part = 'all', size = 8)
t3<-border_outer(t2,part = 'all', border = NULL)
t4<-border_inner(t3,part = 'all', border = NULL)
t5<-bold(t4,part='header')
t6<-bold(t5,i=c(1,2,3,4,9,18))
t6<-set_caption(t6, caption = "Table 1: Fiscal Year Real Sector Growth Rates (percent)
t6
```

...1	19/20	
GDP at constant market prices, %age growth	-2.4	

...1	**19/20**	
GDP at constant basic prices, %age growth	**-1.3**	
Agriculture, forestry and fishing	**16.4**	
Growing of crops; market gardening; horticulture	**14.1**	
Farming of animals (incl. fishing)	11.7	
Forestry	-2.4	
Fishing and aquaculture	0.6	
Industry	-2.5	
Mining and quarrying	**2.4**	
Manufacturing	-2.9	
Food products and beverages	6.2	
Textiles, clothing, footwear and leather	-5.3	
Other manufacturing	6.8	
Electricity supply	-2.6	
Water and sewerage; waste collection	4.1	
Construction	-8.9	
Services	-2.2	
Wholesale and retail trade; repair of motor vehicles	**-7.9**	
Transportation and storage	-14.5	
Accommodation and food service activities	-13.5	
Information and communication	1.8	
Financial and insurance activities	6.8	
Financial service activities, except insurance	7.0	
Insurance and pension funding	5.6	
Activities auxiliary to financial services	4.9	
Real estate activities	-0.5	
Professional and support service activities	-5.5	
Administrative and support service activities	-9.3	
Government sector	-0.9	
Public administration and defense; compulsory social security	-0.8	

...1	19/20
Education	0.2
Human health and social work activities	-2.0
Other service activities	-2.6
Taxes on products, net of subsides	-10.9

OR

```
library(flextable)
library(magrittr)
sectorg2<-readxl::read_excel("Tables_from_NAP.xlsx",
    sheet = "sector_growth2")
```

```
## New names:
## * `` -> ...1
```

```
t1<-flextable(sectorg2,col_keys = names(sectorg2),
  cwidth = 3,
  cheight = 0.01,
  defaults = list(),
   theme_booktabs())
t2<-fontsize(t1,part = 'all', size = 8)
t3<-border_outer(t2,part = 'all', border = NULL)
t4<-border_inner(t3,part = 'all', border = NULL)
t5<-bold(t4,part='header')
t6<-bold(t5,i=c(1,2,3,4,9,18))
t6<-set_caption(t6, caption = "Table 1: Calendar Year Real Sector Growth Rates (percent
t6
```

...1	2019
GDP at constant market prices, %age growth	**-0.400**
GDP at constant basic prices, %age growth	**0.300**
Agriculture, forestry and fishing	**6.100**
Growing of crops; market gardening; horticulture	**-21.400**
Farming of animals (incl. fishing)	15.200

...1	2019	
Forestry	-3.000	
Fishing and aquaculture	1.100	
Industry	-1.300	
Mining and quarrying	**-0.700**	
Manufacturing	0.700	
Food products and beverages	20.100	
Textiles, clothing, footwear and leather	-3.000	
Other manufacturing	11.200	
Electricity supply	-9.300	
Water and sewerage; waste collection	-2.100	
Construction	-3.700	
Services	0.600	
Wholesale and retail trade; repair of motor vehicles	**-3.700**	
Transportation and storage	-0.100	
Accommodation and food service activities	-4.300	
Information and communication	4.700	
Financial and insurance activities	7.900	
Financial service activities, except insurance	8.100	
Insurance and pension funding	7.400	
Activities auxiliary to financial services	6.400	
Real estate activities	0.600	
Professional and support service activities	-2.800	
Administrative and support service activities	-8.300	
Government sector	0.600	
Public administration and defense; compulsory social security	0.300	
Education	0.004	
Human health and social work activities	2.800	
Other service activities	3.300	
Taxes on products, net of subsides	-5.700	

Over 70 percent of the country's population lives in rural areas and depends, directly or indirectly, on agriculture for employment and livelihood. Over half (57.1%) of the country's population lives below the poverty line (LMS 2017). UNDP (2019) states that in 2014, 8.5% of the country's population was in severe multidimensional poverty while 24.4%, and 59.7% were vulnerable to multidimensional poverty and below the income poverty line, respectively. There is also high unemployment rate in Lesotho. In 2017, the unemployment rate was estimated at 27.25% while 50% of the entire population remained in poverty (Hapazari, 2019). Besides farming and animal husbandry, other sources of employment include small-scale industries such as clothing, footwear, textiles, food processing and construction. Migrant labour is another source of employment where a large portion of the adult male workforce are employed in the South African mines. Majority of the poor reside in the rural areas. The challenges of poverty and high unemployment among the communities are exacerbated by among other things, rugged terrain, limited production, over-reliance on South Africa, and adverse climate of extreme cold winters and very hot summers (Hapazari, 2019).

Technological: Environmentally sound technologies and knowhow are imperative assets for developing countries to enable them implement measures to mitigate the adverse effects of climate change, as recognized by the United Nations Framework Convention on Climate Change (UNFCCC). The UNFCCC also calls for all practicable steps to be taken to promote, facilitate and finance, as appropriate, the transfer of, or access to, these technologies and knowhow. While Lesotho has embarked on the identification, assessment and development of technologies that promote sustainable development without contributing significantly to greenhouse gas emissions, and adaptation to climate change, the barriers to the transfer of these environmentally sound technologies (ESTs) has been found to be insurmountable in some sectors of the economy (Mhlanga 2004; LMS 2017), and some external support is required to hasten climate resilience building actions across all sectors (LMS 2017).

5.2 Legal frameworks

The NAP aligns with the goals and objectives of the National Climate Change Policy 2017-2027 (NCCP) which sets the climate change agenda in Lesotho. The National Climate Change Policy has articulated Lesotho's aspirations on matters concerning climate change mitigation and adaptation as indicated by its 22 policy statements. To effectively implement the policy, a National Climate Change Implementation Strategy (NCCPIS) has also been developed. The 2017 NCCPIS is a five-year implementation framework of the National Climate Change Policy. The strategy establishes action guidelines for mainstreaming climate change into key socio-economic sectoral plans and programmes while safeguarding environmental integrity and sustainable development in Lesotho.

The National Strategic Development Plan 2018/19 – 2022/23 (NSDPII) is a national policy document and it also serves as a reference for the country's sectoral plans in order to enhance and uplift Basotho's social well-being. NSDP II has identified climate change as one of the major domestic threats to developmental progress. NSDP II also takes cognizance of the importance of mainstreaming of climate change adaptation and mitigation in all socio-economic sectors as these are crucial for economic growth, thereby setting the basis upon which the NAP process can be mainstreamed. .

The NCCP policy statements are:

1. Strengthen climate early warning systems and improve climatic information, including research and systematic observations;
2. Enhance the resilience of water resources by promoting integrated catchment management, ensuring access, supply and sanitation;
3. Promote climate-smart agriculture and food security systems;
4. Develop renewable energy sources and increase energy efficiency;
5. Promote climate resilience in mining;
6. Promote climate resilience and reduce greenhouse gas emissions in manufacturing;
7. Climate proof and increase efficiency of the tourism sector;
8. Enhance best practice for forestry and rangelands to mitigate and adapt to climate change;
9. Increase the resilience of environment, ecosystems and biodiversity;
10. Address climate change impacts on human health;
11. Promote low-carbon and climate resilient transport systems;
12. Climate proof human settlements and infrastructure;
13. Enhance the resilience of natural and cultural heritage;
14. Promote agro – ecological/district/local level approach to addressing climate change;
15. Strengthen climate change governance frameworks;
16. Promote participation of gender, youth, and vulnerable groups;
17. Promote participation of the civil society;
18. Promote participation of the private sector;
19. Implement education, training, public awareness and communication programmes;
20. Promote research and development, innovation and technology transfer;
21. Mobilize financial resources; and
22. Enhance social security/ protection by managing climate induced migration.

There are a number of other frameworks in place (Table 2) to help domesticate the climate change adaptation process. Notwithstanding development of these policies, climate change adaptation and mitigation has not been adequately integrated in sectoral policies and plans. Some of the relevant policies and

strategies that should be reviewed and brought into line with the NCCP 2017-2027, with cross-cutting inclusion of climate change adaptation and mitigation, gender and social inclusion, and environment include those listed in table 2:

```
library(flextable)
library(magrittr)
policies<-readxl::read_excel("Tables_from_NAP.xlsx",
    sheet = "adapt_policies")
t1<-flextable(policies,col_keys = names(policies),
  cwidth = 3,
  cheight = 0.01,
  defaults = list(),
   theme_booktabs())
t2<-fontsize(t1,part = 'all', size = 8)
t3<-border_outer(t2,part = 'all', border = NULL)
t4<-border_inner(t3,part = 'all', border = NULL)
t5<-bold(t4,part='header')
t6<-set_caption(t5, "Table 2: Policies/Strategies/plans relevant for adaptation")
t6
```

Table 5.3: Table 2: Policies/Strate
tion

Act	Policy	St
Environment Act 2008	National Environment Policy 1998	Ag
	Lesotho Food Security Policy 2005	En
	Transport Policy 2006	Lo
	Water and Sanitation Policy 2007	
	National Disaster Risk Reduction Policy 2007	
	National Forestry Policy 2008	
	Draft Renewable Energy Policy 2013	
	National Conservation Agriculture Strategy Framework 2012 – 2017	
	National Range Resources Management Policy 2014	

Act	Policy	Strategy
	National Health Policy 2017	
	National Gender Policy 2018 – 2023	
	Draft Soil and Water Conservation Policy 2021	

```
library(flextable)
library(magrittr)
spolicies<-readxl::read_excel("Tables_from_NAP.xlsx",
    sheet = "sectoral_policies")
```

```
## New names:
## * `` -> ...1
```

```
t1<-flextable(spolicies,col_keys = names(spolicies),
  cwidth = 3,
  cheight = 0.01,
  defaults = list(),
   theme_booktabs())
t2<-fontsize(t1,part = 'all', size = 8)
t3<-border_outer(t2,part = 'all', border = NULL)
t4<-border_inner(t3,part = 'all', border = NULL)
t5<-bold(t4,part='header')
t6<-set_caption(t5, "Table 3: National/sectoral policies, strategies and plans relevant for adapt
t6
```

Table 5.4: Table 3: National/sectoral policies, s
relevant for adaptation

...1	Title/type	Year
Climate	National Climate Change Policy	2017-2027
	National Climate Change Policy 2017-2027 Implementation Strategy	2017

...1	Title/type	Ye
	Second National Communication	20
	Third National Communication	20
	National Adaptation Programme of Action (NAPA)	20
	Nationally Determined Contribution	20
Environment	National Forestry Policy	20
	National Environment Policy	19
	National Range Resource Management Policy	20
	Plant Protection Policy For	20

...1	Title/type	Year
	Lesotho	
	National Seed Policy	2006
	Draft Soil and Water Conservation Policy	2021
	Biodiversity Strategy and Action Plan	2000
	Draft National Biodiversity Strategic Plan	2020
	Lesotho National Action Programme in Natural Resource Management, Combating Desertification and Mitigating the Effects of Drought National Range Action Plan	2015
Agriculture	National Conservation Agriculture Strategy Framework	2012-2017
	Agriculture Sector Strategy	2003
	Strategic Plan for Agriculture and Rural Statistics for Lesotho	2019/20 – 2023/2
	Country Strategic Opportunities Programme	2020 - 2025

...1	Title/type	Ye
Energy	Lesotho Energy Policy	20
	Renewable Energy Policy	20
Health	National Health Policy	20
	Lesotho Food and Nutrition Strategy and Costed Action Plan	20
	National Health Strategic Plan	20
Infrastructure	Transport Policy	20
	Long Term Water and Sanitation Strategy	20
Economic	National Strategic Development Plan	20
Land	The Land Act	20

...1	Title/type	Year
Water	Water and Sanitation Policy	2007
Education	Environmental Education Strategy	2014
Social/	Gender and Development Policy	2018 - 2030
Cultural		

Sources: https://climate-laws.org/cclow/legislation_and_policies?q=lesotho; NDC_Lesotho (2017)

5.3 Institutional arrangements for climate change adaptation

The Ministry of Energy and Meteorology (MEM) through LMS is charged with the responsibility of monitoring and reporting on weather, climate and climate change issues. In addition, MEM ensures that the country adheres and implements commitments under the UNFCCC and the Paris Agreement. A National Climate Change Committee (NCCC) was formally established in 2013 to effectively coordinate climate change issues in the country. The committee serves as an advisory body to MEM. Other major responsibilities of the MEM include implementation of the Vienna Convention and Montreal Protocol on Substances that deplete the ozone layer; and provision of support to other Multilateral Environmental Agreements (MEAs).

The successful implementation of National Climate Change Policy is much dependent on active support and effective participation of all stakeholders as stipulated in the National Climate Change Policy and its Implementation Strategy . Proper coordination and mainstreaming of climate change activities into different sectors of the economy is key to addressing the issues of working in silos by various departments, institutions and organizations; a state that could

lead to disharmony between different actors and undermine its effectiveness and efficiency. It is against this background that the NCCPIS calls for the establishment of an institutional framework and set up that will be effective in implementing the Policy (see below).

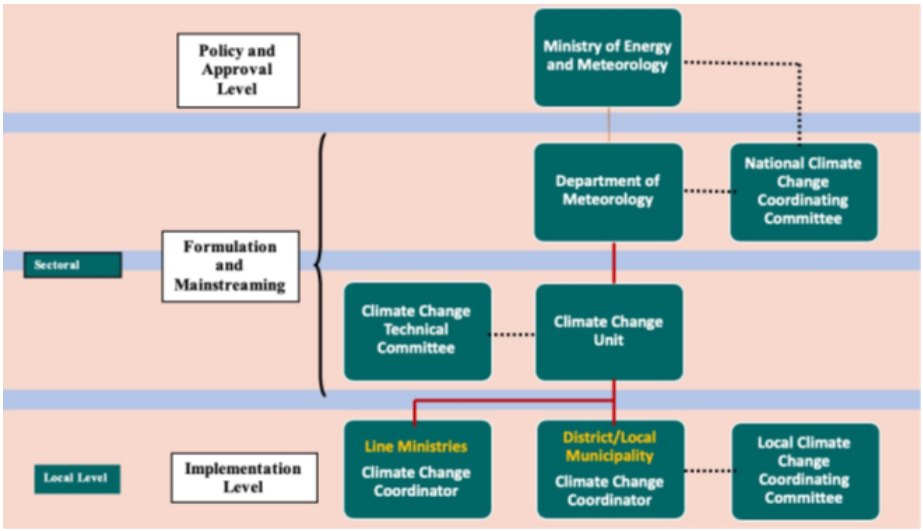


Figure 5.1: Figure 2. Proposed institutional arrangement. Source: National Climate Change Policy Implementation Strategy (2017)

Chapter 6

Vision, goals and objectives of the NAP

6.1 Vision for Adaptation for the Country

The vision is to have a well-adapted Lesotho that achieves its medium to long-term sustainable development objectives in the context of a changing climate.

6.2 Goals and Objectives of the NAP

The main goals and objectives of the Lesotho NAP, in line with the National Climate Change Policy, are: Goals

- Reverse environmental degradation and adapt to climate change
- All stakeholders address climate change impacts and their causes through the identification, mainstreaming and implementation of appropriate adaptation and mitigation measures, while promoting sustainable development. Objectives
- Promote climate-resilient, social, economic and environmental development that is compatible with, and mainstreamed into, national development planning and national budget-setting processes;
- Explore low-carbon development opportunities, nationally and internationally, in order to promote the sustainable use of resources and
- Strengthen a framework that promotes efficient climate change governance, strong international cooperation, capacity building, research and systematic observations, clean technology development, transfer and use, education, training and public awareness and financing in a way that also

benefits the most vulnerable through the implementation arrangements to be defined in the NAP.

Chapter 7

Climate change adaptation assessment

7.1 Observed climate impacts

The general aspects of the climate and environment of Lesotho have been covered in sections 1 and 4.1 above. In this section, emphasis is on the impacts of observed climate on the identified systems, for which the impacts of climate extreme events are summarised in Table 4 below. The southern lowland areas are dry and particularly threatened by drought while mountain and foothill areas are vulnerable to frost, snow, and hail. During the period 1979 to 1996 the country experienced the highest incidences of drought in almost 100 years. The longest drought in the country's 200-year record of climate monitoring lasted from April 1991 to October 1995 and was related to severe reductions in food production that ranged from 50-75% (Rook, 2005; NDC, 2017). A more recent drought that occurred in 2015/16 drought was the worst experienced in Lesotho in 35 years and resulted in US$82 million (3.6% of GDP in 2016) being mobilized to respond to it. It affected 979,000 people and left around 709,000 people food-insecure, resulted in a 66% reduction in cereal production and 58% increase in food price, and increased the need for external food supply.

Recurrent droughts in 2017/2018, 2018/2019 and 2019/2020 led to three back-to-back failed harvests. In 2019, production of major cereals decreased by more than 60 % compared to 2018, including a 78 % decrease for maize, 61 % for wheat, and 93 % for sorghum. This followed a poor 2017/2018 season. As a result, more than 500,000 people were left food-insecure in 2019. In response to the humanitarian crisis brought about by the recurrent droughts, the Government of Lesotho developed a Drought Response and Resilience Plan which required US$83.2 million. In support of the Drought Response and Resilience Plan, a Flash Appeal was implemented. Under the Flash Appeal, 261,000 peo-

ple were targeted with life-saving interventions between November 2019 and April 2020.

```
library(flextable)
library(magrittr)
hazards<-readxl::read_excel("Tables_from_NAP.xlsx",
    sheet = "cc_hazards")
t1<-flextable(hazards,col_keys = names(hazards),
  cwidth = 3,
  cheight = 0.01,
  defaults = list(),
   theme_booktabs())
t2<-fontsize(t1,part = 'all', size = 8)
t3<-border_outer(t2,part = 'all', border = NULL)
t4<-border_inner(t3,part = 'all', border = NULL)
t5<-bold(t4,part='header')
t6<-set_caption(t5, "Table 4: Examples of notable past extreme climate events, impacts
t6
```

Table 7.1: Table 4: Examples of
events, impacts and impacted syste

Hazard	**Event date**	**Im**
Heavy rains	2021	-F
		-C
Drought	2017 – 2020	- 5
		- I th
Flash floods	2018	- I
		- I
		31
		- I

Hazard	Event date	Impacts
		- Damaged crops
Drought	2015 - 2016	- Worst experienc
		- Drought respons 2016)
		- Affected 979,00 insecure
		- 66% reduction i prices
		- Increase in the
Torrential rains	2010/2011	- Heaviest rains s
		- Lost 3.2% of 20
		- Between 2,000
		- 74,912 hectares subsistence agric
		- 806 hectares of were partially des
		- 44,00 domestic ill
		- +50,000 more p
Dry spell	1991 – 1996	The longest drou
		Reductions in foo
Drought	1979 – 1996	- Period with high years

Hazard	Event date	In

Yields vary significantly, depending on the amount of rainfall, but are generally low, contributing to widespread poverty in rural areas (World Bank 2018). Maize yields have fallen from 1,400 kg per hectare in the mid-1970s to 450-500 kg per hectare in the past decade (LMS 2000; LMS 2013; Dejene et al., 2011). Though Lesotho maize yield fluctuated substantially in recent years, it tended to decrease through 1971 - 2020 period ending at 0.88 tonnes per ha in 2020 (ref). On the other hand, river floods, high runoff from hillslopes, and rock slides in 2010/11 that were caused by a series of heavy rains accompanied by strong winds and localized hailstorms affected 500,000 people (28% of the country's population), displaced 3,360 people, and severely damaged crops, washed away fields, damaged transport infrastructure, affected or destroyed many houses, and increased food insecurity (World Bank 2019). In 2018 floods killed 12 people, 7 children were injured, more than 1 400 people and 315 households were displaced, public infrastructure worth USD 4 million and crops worth USD 1,5 million were damaged. Amidst the Covid 19 pandemic in January 2021, the country was hit by heavy rains which led to the declaration of a six-months state of emergency (GoL, 2021). The heavy rains caused havoc to water sources, infrastructure, property, washed away crop fields and damaged graveyards. Due to the destroyed road infrastructure including bridges most of Basotho were left stranded and unable to access essential services. The cost of responding to the heavy rains was estimated at USD 2.8 million which is 2.3 percent of the budget (World Bank, 2021). These impacts are occurring in a country where more than 75% of the population living in rural areas experiences water shortages (Ministry of Energy, Meteorology and Water Affairs 2013) which exacerbates vulnerability to droughts and floods. The changing climate has, therefore, already drastically affected the principal crops of maize, sorghum, and wheat, which are planted on nearly 85 percent of the cultivated area while livestock which contributes 30 percent of total agricultural output are threatened by drought and rangeland degradation (Gwimbi et al. 2012). Lesotho's crop production is dominated by maize which accounted for 63% of the area planted in 1995/96 (LMS 2000). These changes are occurring against a backdrop of decreasing hectarage of land under cultivation, from 450,000 hectares in 1960, down to between 136,500 and 300,500 hectares in the 1990s and increasing dependency on food imports to satisfy local demand (LMS 2000).

7.2 Projected future climate

The most recently developed climate change projections by the Lesotho Meteorological Services use a set of scenarios called Representative Concentration Pathways (RCPs). There are four pathways under RCPs namely: RCP8.5, RCP6, RCP4.5 and RCP2.6. The pathways describe different climate futures, all of which are considered possible depending on the volume of greenhouse gases (GHG) emitted in the years to come. RCP2.6, RCP4.5, RCP6, and RCP8.5 are labelled after a possible range of radiative forcing values in the year 2100 (2.6, 4.5, 6, and 8.5 W/m2, respectively). The projected change in the annual average surface maximum (TX) and minimum temperatures (TN) projected over Lesotho are shown in Figures 3 (a) and (b) respectively. The plotted changes are for the time periods 2011-2040 (near-future), 2041-2070 (mid-future) and 2071-2100 (distant-future) relative to the reference period 1971-2000 (baseline period). The projected changes reflect a gradual increase in the annual average surface maximum temperature (TX) and minimum temperatures (TN) for Lesotho during the 21st century (LMS, 2018). The figures further portray that the gradual increase in temperatures under both RCP4.5 and RCP8.5 is consistent among all grid points. These projections are consistent with other model outputs which indicate temperature rises (Gwimbi et al 2012, Mokoena 2012, LMS 2013 and World Bank 2016). It is projected that temperatures in Lesotho will increase, above the historical average of 12.7°C, by 0.8°C to 2.9°C for the period 2030 to 2050 depending on the scenario (World Bank, 2016). Based on PRECIS driven by an ensemble GCM model data, it was noted that all the models project an increase in temperature of 3.5-4.0° with the highlands getting up to 4.5° for the 2070-2099 horizon (Mokoena 2012).

Figure 3: Summary of multi-model projections of change in a) surface maximum temperature (TX) and b) surface minimum temperature (TN) Source: LMS 2020

Unlike for temperature, where models show a general degree of agreement about future regional changes, different models may have the same region becoming wetter or much drier in a warming world. Disagreements between the models in future precipitation changes in some regions does not mean that the models are useless for this purpose. LMS's predictions show annual precipitation (prcptot) decrease over the North-Eastern Mountains which becomes more intense and spatially pronounced towards the end of the 21st century under both RCP45 and RCP85 scenarios (figure 4). This agrees with other models such as the CSIRO and MIROC models (Gwimbi et al. 2012) which show that rainfall will decline by 2050, with significant decline in the lowlands, foothills, and southern Senqu Valley (CSIRO model) or the whole country (MIROC model). It is projected that the highlands will experience a decrease in the frequency of severe snowfalls and the number of frost days (Morris, 2017). The declining rainfall trend will continue through to the 2070-2099 period (PRECIS ensemble) with 30-40% decrease in winter rainfall, but no significant change for summer rainfall relative to the reference period (1961-1990) (Mokoena 2012). However, Kalognomou et

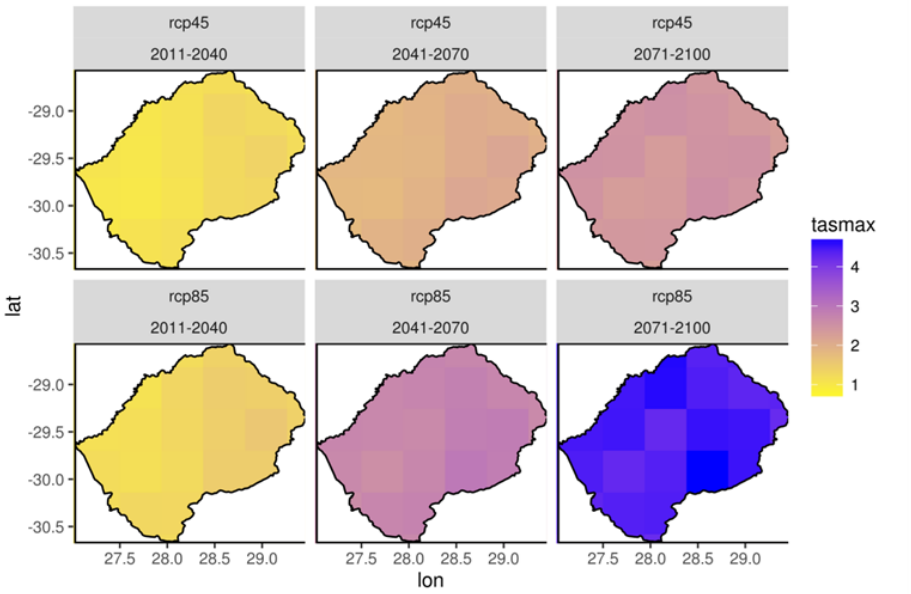


Figure 7.1: surface maximum temperature (TX) change

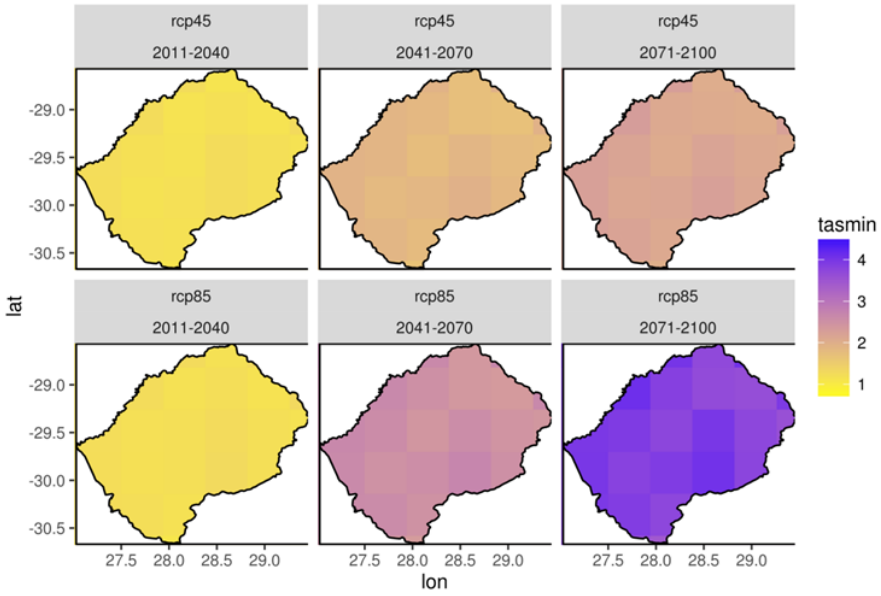
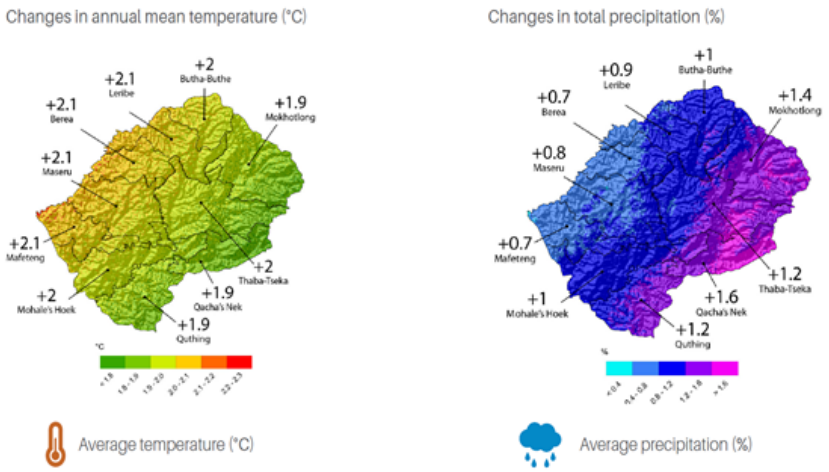


Figure 7.2: surface minimum temperature (TN) change

al. (2013) used the CORDEX models to simulate rainfall and noted that higher rainfall results occurred over the Lesotho Highlands and Drakensburg areas. The density of station data in Lesotho is low and this affected the performance of the variable-resolution atmospheric model CCAM which drastically overestimated rainfall totals, far in excess of CRU and TRMM observations, as well as area-averaged intra-annual rainfall cycles simulated for the country (Dedekind et al. 2015). Apart from the wet bias over Lesotho the simulations have a high spatial correlation to the observations (higher than for the annual rainfall totals). The largest overestimations occur over Lesotho and are attributed to its steep and complex topography (Kalognomou et al. 2013; Dedekind et al. 2015); however, the CCAM-NCEP simulations have skill in representing inter-annual variability of summer rainfall over the Lesotho region and can therefore be used to project future climate (Dedekind et al. 2015).



Source: Reliefweb

Sub-regional climate change projections for the near future (2020 to 2040) that encompass the three climate change vulnerability zones in the country (Zone 1: The Southern Lowlands and Senqu River Valley; Zone 2: The Mountains, and; Zone 3: The (Western) Lowlands and Foothills) provide more granular information on the projected climate (INR 2014, INR 2015a.b) and comparison is shown in Table 3 below. In terms of mean annual temperatures (maximum and minimum), these will increase more or less uniformly in all the three zones, but the effect will be most pronounced in Zone 2 because of the steep topography and changes to the temperature lapse rate with altitude, which will result in stronger biome shifts in this zone compared to the others. Likewise, the number of hot days >32°C in a year will increase and will particularly affect cropping seasons in the foothills and the relatively lower lands in Zones 1 and 3 and will be accompanied by fewer frost days, but some models show exception in Zone 1. The mean dry spell duration is expected to increase in winter by 6 to 7 days

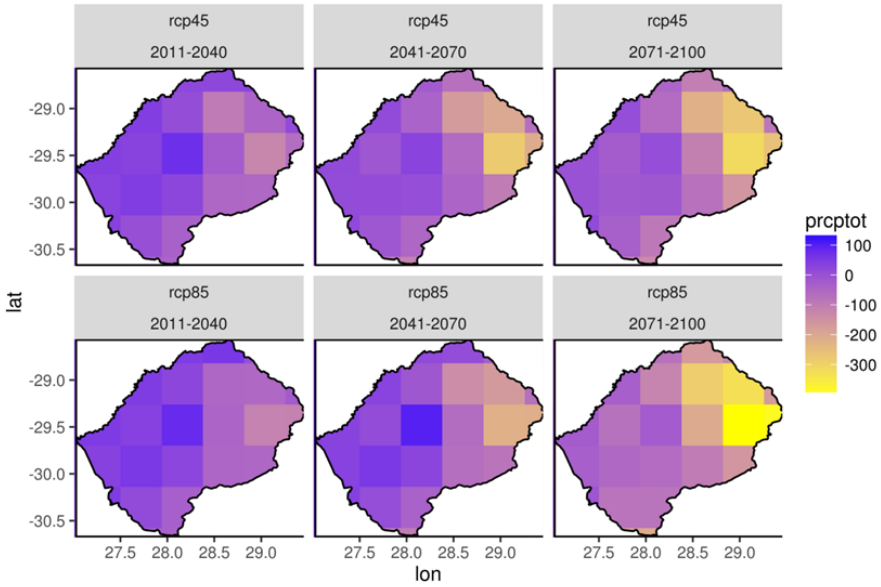


Figure 7.3: Figure 4: Summary of the projected changes in total precipitation (PR, in mm) relative to the reference period (1971-2000) over Lesotho

in all zones, but is expected to decrease slightly during the summer rainfall months. In terms of total monthly rainfall, amplified variability is expected in all zones with more precipitation (up to 36% in zone 3) during the summer months, and significantly reduced precipitation (up to 100% for zones 1 and 3) in the drier winter months.

```
library(flextable)
library(magrittr)
reg_proj<-readxl::read_excel("Tables_from_NAP.xlsx",
    sheet = "regional_proj")
```

```
## New names:
## * `` -> ...1
```

```
t1<-flextable(reg_proj,col_keys = names(reg_proj),
  cwidth = 3,
  cheight = 0.01,
  defaults = list(),
   theme_booktabs())
t2<-fontsize(t1,part = 'all', size = 8)
t3<-border_outer(t2,part = 'all', border = NULL)
t4<-border_inner(t3,part = 'all', border = NULL)
t5<-bold(t4,part='header')
t6<-set_caption(t5, "Table 5: Sub-regional climate change projections for Lesotho, 202
t6
```

Table 7.2: Table 5: Sub-regional
Lesotho, 2020-2040

...1	Zone 1: The Southern Lowlands and Senqu River Valley – Tosing Community Council (INR 2015a)	Zo C
Total Monthly	Increase in monthly rainfall in the summer seasons of up to 22%, particularly in December and January (up to 22mm per month).	Pr (D (u
Rainfall		
	Uncharacteristically, there is also a large 22% increase projected for March (up to 23mm).	
		Le (1
	There is a general decrease expected in winter, especially in June of up to 100% (up to 21mm). This demonstrates a polarisation of seasonal rainfall patterns.	

...1	Zone 1: The Southern Lowlands and Senqu River Valley – Tosing Community Council (INR 2015a)	Zone 3: The (We Community Cou
		In general, an inc (spring and summ months.
Max. Daily	Although there are large variations in projections, it is evident that there is a likely decrease in June of up to 58% (up to 7mm) and a likely increase in October and December of up to 45% and 32% respectively (up to 10mm and 9mm).	Large variations i there is a distinct
Rainfall		June (up to 7mm
	Interestingly, there is a large projection that there will be a decrease in November rainfall.	
		Patterns in the in
		(spring and autur predication can b
Count of Wet	Clear increase of wet days in the spring months (September and October) by up to a ¼ of a day. A decrease in wet days in winter, however not very significant due to the current lack of wet days in winter months.	No data available
Days (95th		
percentile)	Trends for the rest of the year vary greatly and thus no clear projection can be made.	
Avg. Max	All year-round increase expected, between 0.5°C and 2.3°C.	All year-round inc
Temp.		
	Greatest increase expected in September (spring), followed by February (end of summer). Demonstrating a shift in seasons due to the sooner onset of spring but a longer summer period.	
		Greatest increase
	Summer months that already have relatively high temperatures are expected to increase more than winter temperatures.	September (sprin Demonstrating s
		due to the sooner
		Summer months
		have relatively hi more than winter

...1	Zone 1: The Southern Lowlands and Senqu River Valley – Tosing Community Council (INR 2015a)	Zo C
Avg. Min.	All year-round increase expected, between 0.6°C and 2.3°C.	Pr 2.
Temp.		
	Greatest increase expected in September, followed by October, January and February (cropping season).	
		G Fe
	This replicates the average maximum temperature trends.	
		Th
		te
Count of Hot	All year round increase projected, except in June and July where no change is evident.	Al
Days (>32°C)		
	Large changes in the number of hot days expected, up to 4.8 days in January and 3.7 days in December (summer).	
		La
	Cropping season expected to have between 1.5 and 4.5 more hot days per month.	6 Fe
		su
		Cu ho
Mean Dry	Increase of dry spell duration of by up to 7.4 days in June (winter), closely followed by a significant increase evident in the other dry, winter months.	In 6
Spell Duration		ar

...1	Zone 1: The Southern Lowlands and Senqu River Valley – Tosing Community Council (INR 2015a)	Zone 3: The (We Community Cou
	Decrease of duration by up to 2.4 days in the wet season (January), followed by small decreases in the other wet, summer months.	
		Little change (slig expected in the s
Count of Frost	All year round decrease of frost days, by up to 1 day in winter (July). This followed by the other winter months were a decrease of 0.6 and 0.9 days is expected.	All year round de winter (July). This
Days (<0°C)		other winter mont expected.
	However, some models show an increase in days, even in the winter months and particularly in the spring months and start of the cropping season (September-November).	
		This is most likely
		to the general inc

7.3 Assessment by key systems

There are a number of key systems in Lesotho (Table 6 below on Lesotho Systems). Each of these are addressed below and interlinkages between them are explored. Some of the text is adapted from Lesotho NAPA but also includes other sources (GFDRR (2019). ThinkHazard! Lesotho. Index for Risk Management (2019); INFORM 2019 Risk Index: Lesotho. Ministry of Natural Resources. Lesotho's National Adaptation Programme of Action on Climate Change (2007); USAID (2016) Climate Change Risk Profile: Southern Africa, and as indicated below.

The Lesotho National Development Plan (NSDPII) outlines four key priority areas: Promoting Inclusive and Sustainable Economic Growth and Private Sector –led job Creation; Strengthening Human Capital (through developing human capabilities in Health, Education, Nutrition and Social Protection); Building Enabling Infrastructure, and; Strengthening governance and accountability systems. Mainstreamed across these four priority areas are Climate Change, Environment, and Gender.

```
library(flextable)
library(magrittr)
SDG<-readxl::read_excel("Tables_from_NAP.xlsx",
    sheet = "SDG_iFrame")
t1<-flextable(SDG,col_keys = names(SDG),
  cwidth = 3,
  cheight = 0.01,
  defaults = list(),
   theme_booktabs())
t2<-fontsize(t1,part = 'all', size = 8)
t3<-border_outer(t2,part = 'all', border = NULL)
t4<-border_inner(t3,part = 'all', border = NULL)
t5<-bold(t4,part='header')
t6<-set_caption(t5, "Table 6: Systems affected by climate change and its impacts, mappe
t6
```

Identified Systems	**Key System Stressors/Weaknesses**	**K**
Food		
Crop Production	Rainfall variability	Li
	Drought	R
	Heavy rains	W
	Frost, snow and hail	E
	High temperatures	W
	Strong winds	M
	Land degradation	S
	Soil erosion	H
	Weak extension systems	
	Poor marketing and access to markets	

Identified Systems	Key System Stressors/Weaknesses	Key Interacting/
Horticulture and cash crops	Floods	Crop production
	Droughts	Livestock produc
	Rainfall variability	Rangelands
	Hail	Water resources
	High temperatures	Energy
	Long dry spells	Water
	Rangeland fires	Manufacturing ar
	Water scarcity	Social-Cultural
	Soil erosion and land degradation	Health
Livestock Production	Droughts	Rangelands
	Heavy rains	Water resources
	Disease	Energy
	Rangeland degradation	Water
	Low water availability	Manufacturing ar
	Heat	Social-Cultural
	Cold	Health
	Poor pastures	
	Soil erosion	
Fisheries	Low diversity of fish species	Water resources
	Reducing amount of water in rivers	Manufacturing ar
	Higher water temperatures	Ecosystems and
	Dams impeding fish migration and spawning	Social-Cultural
		Health

Identified Systems	**Key System Stressors/Weaknesses**	**K**
		To
Manufacturing and Trade	Susceptibility of main commodity market to water availability (clothing, water trade, wool, horticulture and cash crops)	W
	A net food importing economy	H
	Heavy rainfall and flooding impacts on infrastructure and properties	Tr
		Er
		Sc
Water Resources		
	Drought	Al
	High temperatures	W
	Floods	Er
	Heavy rains and reduced water quality	Hu
	Rainfall variability and water stress	M
	Drying highland wetlands	Fi
	Reduced groundwater availability	Cr
	Insufficient storage and reticulation infrastructure	Li
		To
		H
Wetlands	Drought	W
	Land degradation	Ec
	Loss of biodiversity	Sc
		To
Critical Infrastructure		

Identified Systems	Key System Stressors/Weaknesses	Key Interacting/
Transport	Inadequate road and rail infrastructure	Energy
	Poor transport infrastructure in the remote highlands	Water resources
	Poor condition of transport infrastructure	Manufacturing an
	Destruction by floods	Human settlemer
Energy		
Energy System	Rainfall variability	Alpine (Mountain
	Drought	Water resources
	High temperatures	Manufacturing an
	Strong winds	Cities and Humar
	Low access to electricity	Commercial agric
	Reduced availability of biomass fuels for rural population	Health
	High dependency on imported fossil fuels	Transport
		Ecosystems and
Ecosystems		
Rangelands	Drought	Water resources
	Heat stress	Manufacturing an
	Low water availability	Ecosystems and
	Overstocking	Social-Cultural
	Poor rangeland management	Health
	Changes in vegetation cover	
	Soil erosion	
	Lowered soil quality	
	Acidic soils	

Identified Systems	**Key System Stressors/Weaknesses**	**K**
	Poor grass cover	
	Invasive species	
Forests	Drought	W
	Forest fires	E
	Over-exploitation	E
	Soil erosion	S
	Reduced biomass production	T
Ecosystems and Biodiversity	Drought	C
	Desertification	L
	Population pressure	W
	Bush fires	F
	Soil degradation	R
	Over-exploitation of resources	F
		W
		M
		S
Alpine (Mountain) system	Drought	W
	High temperatures	E
	Rainfall variability	S
	Soil erosion	T
Tourism	Degrading ecosystem and biodiversity	A
	Increasing variability in snowfall patterns	E
		S

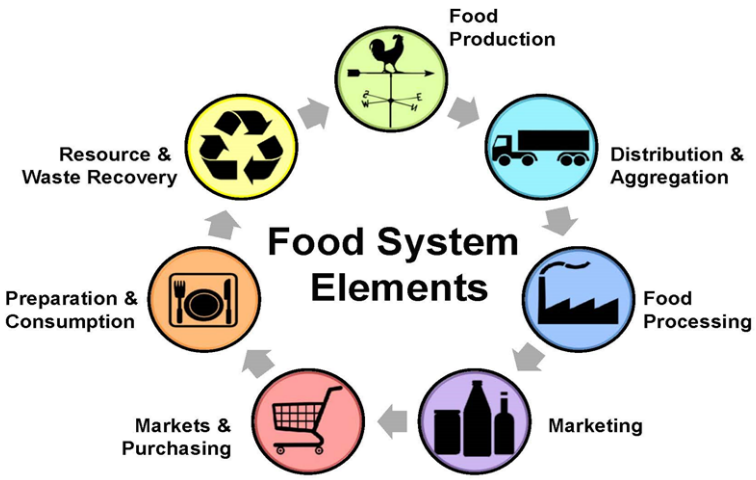
Identified Systems	Key System Stressors/Weaknesses	Key Interacting/
Human Settlements and living space	Inadequate transport, water supply and power distribution infrastructure networks	Water resources
	Susceptibility to heavy rains and floods	Energy
	Heat stress (lowlands)	Crop production
	Cold stress (highlands)	Livestock produc
	Inadequate housing planning capacity	Transport
	Low access to basic services for water supply, sanitation, drainage, roads and electricity	Manufacturing an
		Health
Social-Cultural System	Over-exploitation of natural resource for housing, clothing, medicine, energy, livelihoods	Ecosystems and
	Socio-cultural importance of livestock ownership	Forestry
	Chronic poverty	Crop production
	Low adaptive capacities	Livestock produc
		Fisheries
		Rangelands
		Water resources
		Energy
		Tourism
		Cities and humar
		Health
Health System	Food insecurity	Crop production
	Water insecurity	Livestock produc

Identified Systems	**Key System Stressors/Weaknesses**	**K**
	Lack of access to basic services infrastructure	S
	Waterborne diseases associated with heavy rains and flooding	
	Heat stress	
	Cold stress	
	Nutritional deficiencies	
	Increased susceptibility and risk to diseases due to HIV/AIDS	
Knowledge and Information System	Unsatisfactory education outcomes particularly in rural areas	
	Low access to post-primary education for the poor	
	Poor public awareness and education services	
Governance System		P
		L
		M
Cross-Cutting		

Identified Systems	Key System Stressors/Weaknesses	Key Interacting/

7.3.1 Food system

According to the Food and Agricultural Organization (FAO 2018) food systems cover a range of actors and their interlinked value-adding activities involved in the production, processing, distribution, consumption and disposal of food products that originate from agriculture, forestry or fisheries, and parts of the broader economic, societal and natural environments in which they are entrenched. The food system is composed of sub-systems such as farming system, input supply system, etc. and interacts with other key systems such as energy system, trade system and health system. In this section different elements of the food systems will be covered.

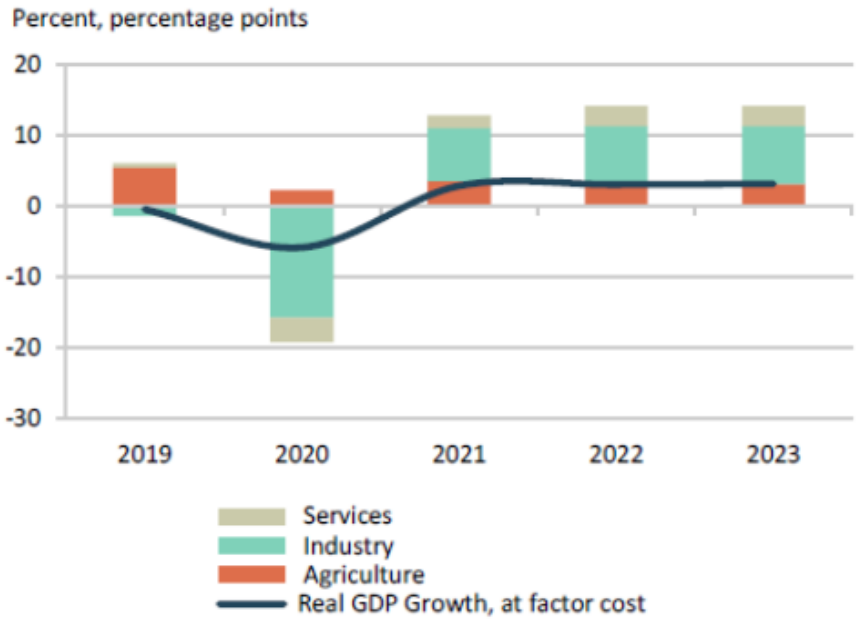


Source:

7.3.1.1 Crop Production

Lesotho's agriculture is predominantly rain fed (LMS 2000, World Bank 2016). Drought, frost, snow, hail, heavy and/or continuous rains, late onset of the rainy season and extreme temperatures are hazards to crop cultivation and fruit quality and quantity which is also affected by strong winds. Grains are the most important crops in terms of area allocated to their production in Lesotho. The average area allocated to grain production is about 75 percent of the total arable land in Lesotho. Major grains that are grown in Lesotho include maize,

wheat, pulses and sorghum. Most crops are grown in summer while wheat is grown in winter in the lowlands. Crop production is characterised by a high proportion of subsistence farming with most production being kept for home consumption making the country a net food importing country (less than 30% of food are produced locally). According to the International Fund for Agricultural Development (IFAD), declining agricultural production is caused by severe land degradation, reliance on rainfed agriculture, weak extension systems, sub-standard marketing infrastructure, poor access to markets for small producers, insecure land tenure , and unfavourable weather conditions. Though the government of Lesotho has undertaken numerous reforms since the structural adjustment years there has not been a major transformation in crop production in the country. At the local scale, farmers operate in a range of multiple and unique bio-physical and agronomic conditions, offering prospects for identification of local agronomic management alternatives and/or locally relevant adaptation strategies (Zinyengere et al. 2014).



Source

Source: World Development Indicators (WDI)

Generally, maize yield is projected to decrease as rainfall decreases and temperatures increase though sorghum yield could increase in some zones due to its drought tolerance and maize could gain a foothold in some of the highland regions where temperatures will be warm enough to support maize production (Gwimbi et al. 2012, LMS 2020). Using an ensemble of nine CMIP3 models, a baseline of 1961-2000, and future (2046-2065) climate scenarios based on SRES

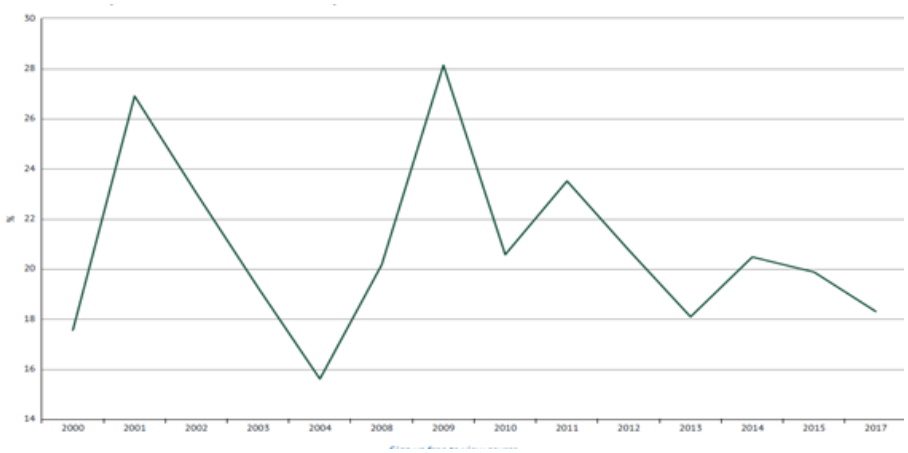


Figure 7.4: Figure 7: Lesotho - Food imports as a share of merchandise imports.

B1 and AS, Zinyengere et al. (2014) observed that crop yields are expected to increase on average (maize (+8%) and sorghum (+51%) in Mohale's Hoek, a highland region that is historically prone to cold related crop yield losses. This result is contrary to those by Malebajoa (2010) and Gwimbi et al. (2013) which suggest a 25% decline in maize yields and 10-25% decline in sorghum yields in Mohale's Hoek by 2050. Zinyengere et al. (2014) note that the results of the latter two studies agree with large scale-low spatial resolution studies in the region which are commonly used for national and regional projections, and point out to the fact that finer resolution projections are required in order to ensure that suitable (rather than maladaptive) strategies for adapting crop production to climate changes are implemented.

7.3.1.2 Horticulture and cash crops

Floods and droughts have resulted in severe loss to agricultural crop and livestock resulting in food insecurity implications. The economic impact depends on the extent of the variability and extreme events, but droughts alone are estimated to reduce total GDP by 1% - 4%, while soil erosion has been estimated to reduce agricultural GDP by 2%-3% (around 1% of total GDP). Even normal variability has a negative economic impact due to the sensitivity of agricultural output to climate. These all equate to a high current vulnerability and economic cost that must tackled. In view of the sensitivity of agricultural production to climate, Lesotho has scaled up efforts to transform the agricultural sector. Horticultural farming is getting an increasing focus after the implementation of the World Bank-supported Private Sector Competitiveness (PSC) Project. The project has two sub-components: the production of vegetables and the production of fruit trees, specifically apples and cherries. Two South African

companies, Alpha Farms and Denmar estates, have partnered with farmers in Lesotho to produce for the Lesotho, South Africa and EU markets. Due to the country's elevation, good soil, and abundance of water, the quality of the produce is good, and the fruits ripen earlier than in other countries in the southern hemisphere, offering an opportunity to supply the regional market early in the season. In addition, Lesotho's climate is good for mushroom farming, and the kind of mushroom produced in Lesotho is in high demand in South Africa, Botswana and other southern African countries. Medicinal cannabis farming has also provided impetus for growth of agricultural sector.

7.3.1.3 Livestock Production

Livestock farming is one of the most traditional economy of Basotho. It is based on the favourable ecological conditions in the country, particularly the large area covered by the Foothills and the Mountains that is best suited for extensive livestock. Common livestock includes cattle, goats and sheep which contribute more than 6% to GDP and over 80 of the agriculture sector contribution to GDP. The production of livestock and their general health is highly exposed to current and future changes in climate given their sole dependence on ecological resources for survival. Already, there is recorded evidence of declining livestock herd sizes due to the recurring droughts, stock theft and disease outbreaks. The available statistics on livestock show a 25% decrease in herd sizes for cattle, while for sheep and goats there is a 9 % decrease between 2010 and 2015. The current rangeland and water availability for livestock is poor and livestock condition has deteriorated with reported drought related deaths in the districts visited especially in Quthing, Mohale's Hoek, and Butha-Buthe with over 20% of communities reporting, in other districts about 5-15% of communities indicated livestock death. Reduced quality and quantity of livestock products can occur due to heat stress, cold stress, drought and shortage of feedstuff and livestock deaths, resulting in reduced numbers, can be occasioned by heavy rains, heat and cold spells and heavy snow, and climate-sensitive diseases. Through the Wool and Mohair promotion project (WAMPP) whose main goal is to boost resilience to the adverse effect of climate change and economic shocks among poor rural people across the country is establishing a sustainable system of communal grazing and rangeland management. This initiative will build climate change resilience of those involved in the rangeland sector. It will also improve livestock production and management.

7.3.1.4 Fisheries

In Lesotho, fish farming plays a very important role in the development of the fisheries industries, and the potential for aquaculture development has increased as a result of the current and planned water development projects such as the Lesotho Highlands Water Project Phase I and II, respectively . Two fish farming

zones are recognised; the Lowlands and the Highlands. In the highlands the cool climatic conditions are suitable for production of high quality trout and salmon which are exported to South Africa and Japan . The diversity of fish in Lesotho is low, consisting only of 17 species (ACP Fish 2013). The indigenous species with potential for developing capture fisheries are: yellowfish species, mudfish, mud mullet and sharp tooth catfish while exotic species of fish (rainbow trout, brown trout, common carp, largemouth bass and bluegill sunfish) have been introduced with the main objective of increasing productivity in fish farming (ACP Fish 2013). Subsistence fishery activity in the Mohale catchment is minimal compared to the Katse catchment. The migration of mainly cyprinid fishes has been hampered by as much as 90% because of the establishment of many dams which act as barriers to their migration in the Orange/Senqu river (Schrijvershof 2015). Two trout farms, Katse Fish Farm (KFF) and Highlands Trout (HT), operate at Katse Dam. KFF is licensed to produce 1,200 tonnes/annum, whereas HT is licensed to produce 2,500 tonnes/annum. KFF exports primarily to food service outlets in Southern Africa. HT exports primarily to Japan. It is noted, however, that neither the national fisheries legislation, nor the LHWP fishing regulations support establishment of a commercial fishery. As the climate changes, the quantities and quality of fish can be reduced under drought and increased water temperature conditions.

7.3.1.5 Manufacturing and Trade System

Commodity market in Lesotho is dominated by clothing market (40 percent of total exports), water and wool. These products make the most contribution to GDP. Another important commodity is the importation of cereal to supplement domestic crop production. As a net food importing economy the cereal market largely depends on neighbouring market for stocking. Climate change events affect trade and industrial activities in many ways. For instance, during the 2010/2011 heavy rainfall there were evidence of physical damages to industrial properties (roofs and ceilings). The floods impeded access to sources of goods due to breakdown in road networks. Future increases in temperature and extreme events will impact negatively on commerce.

The IMPACT Model was parameterized by the Second Shared Socioeconomic Pathway (SSP2), a conservative scenario that is typically considered "business-as-usual". A positive value for net trade indicates greater exports than imports while a negative value for net trade indicates greater imports than exports. Ideally, countries strive to have positive net trade of key agricultural commodities. Measured in tonnes/ha. Source: CCAFS

7.3.2 Water Resources

The water resources system comprises of many interdependent components which include sources, treatment and storage, transmission and distribution

Figure 7.5: Figure 8: The impact of climate change on net trade in Lesotho (2020-2050).

as depicted in figure 9… below.

7.3.2.1 Wetlands

The eastern alpine areas of Lesotho support a network of unique high altitude bogs and sponges, a system of wetlands found nowhere else in the world. These high-altitude wetland systems include hydrophilous, aquatic and semi-aquatic communities, with a high proportion of endemic species. The wetland systems also play a crucial role in the hydrological cycle. Particularly, their retention and slow release of water, these high-altitude wetlands help stabilise the stream flow, attenuate flooding, reduce sedimentation loads and absorption of nutrients. Currently, these highland wetlands are drying up, affecting the reliability of perennial streams, while projected future increases in temperature and reduction in precipitation are likely to affect the wetland biodiversity significantly. Conservation and rehabilitation of degraded highland wetlands is therefore critical.

7.3.2.2 Water Resources and Supply

Rainfall together with winter snowfalls provides an estimated 5.5 billion cubic metres of water annually and renewable groundwater resources of some 340 million cubic metres per year. In Lesotho, quantity and quality of water is intricately linked with climate and a number of other systems. In particular, shortages and reduced quality of water may occur due to high temperatures and drought or due to heavy rains. Urban water supply in Lesotho depends entirely on the Senqu/Orange River basin. Water stress by 2019 (1700m3 per

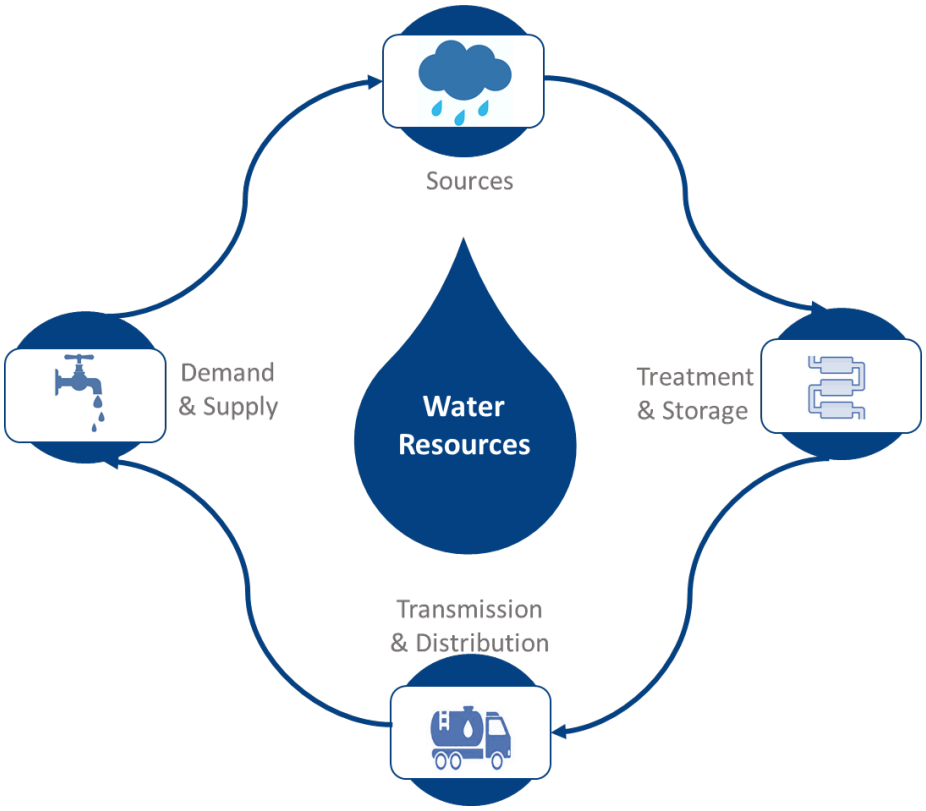


Figure 7.6: Figure 9: Components of the water resources system

capita per year), water scarcity by 2062 (1000m3 per capita per year) is projected (INC report on the results of the "Calibrated and Verified Water Balance Model (CLIRUN)" projecting future yields of water over Lesotho), with several potential consequences, including: water scarcity for livestock and households; ecological disaster such as the drying up of highland wetlands; closure of many water-based economic and social activities; dry springs and wells, lower water tables and higher borehole costs, and reduced yields of many water sources that will particularly affect rural populations who mainly depend on ground water (LMS 2000).

The 2016 World Bank report 'Lesotho Water Security and Climate Change Assessment' evaluates the vulnerabilities, challenges and opportunities in the country's water management system. This detailed study of the vulnerabilities of Lesotho's water management system to climate change was undertaken using the WEAP model and included 121 downscaled Global Climate Model (GCM) projections of future climate over two possible water demand scenarios, for a total of 244 scenarios up to the year 2050 (World Bank 2016). The projections show an increase in temperature and decrease in winter rainfall in the north which will impact on the water balance of runoff, soil moisture, water in reservoirs, and lead to salinization of shallow aquifers as well as changes in stream flow, dam water levels and wetlands capacity. These climate-induced changes in the resource will also have far reaching transboundary effects as the country is a regionally important water tower whose supply zone extends through to South Africa, Namibia and Botswana (NDC 2017). The landmark Lesotho Highlands Water Project (LHWP) generates hydropower and enables the transfer of water from the highlands to Lesotho's urban areas as well as for export to Gauteng in South Africa (World Bank 2016). Royalties earned from the export of water have become the largest single source of non-tax revenue in the country, contributing 10% to the overall Gross Domestic Product (GDP), and the launch of the LHWP Phase II has reinforced the crucial role of this lucrative commodity in Lesotho's economy (LMS 2017). Simulations show that continued development of existing water infrastructure is critical to improving the reliability and resilience of the domestic and industrial sectors. Unless sufficient surface storage and reticulation infrastructure are developed, the projected lower runoff could influence future re-negotiations and reviews of the Lesotho Highlands Water Project (LHWP) (INC Report). Exploring interconnections between water resources developed through the LHWP, as well as the Metolong Dam and water supply programme implemented under the Lesotho Lowlands Water Supply Scheme (LLWSS) and linking these to address domestic and industrial demands in the lowlands could help improve the resilience of the existing system. Furthermore, the implementation of additional phases of the (LHWP II) will increase transfer capacity as well as acting as a major job creator in the construction sector.

7.3.3 Critical Infrastructure

Critical infrastructure is the body of systems, networks and assets that are essential for continued operations required to ensure the security of a given nation, its economy, and the public's health and/or safety. In Lesotho critical infrastructure comprises of the transport system, electric power generation and transmission infrastructure, water supply systems and telecommunication networks. This section will only cover the transport system, the other components of critical infrastructure will be covered under the energy, water and knowledge and information systems respectively.

Transport system in Lesotho is dominated by road as the main mode with limited air and rail transport services. Private sector operators predominantly provide road freight services. The only rail services available on a regular basis is a freight line from the Maseru Railway station to Bloemfontein. Lack of good road network planning/investment constrains growth, especially for the isolated highland areas. Currently, road network is mostly concentrated in the lowlands and foothills, constituting 25 percent of the country's total area. In the remote highlands a network of bridle paths, footbridges and river crossings provide limited and sometimes difficult access to main roads for the rural population. Arterial roads connect all districts in Lesotho to nine border crossing points with South Africa, but relatively fewer rural roads connect villages and towns within mountain districts of Thaba Tseka, Mokhotlong, Qacha's Nek, and Quthing that constitute the remaining 75 percent of Lesotho's territory. The mining and tourism sectors in the Mokhotlong district offer the best economic potential but are constrained by the very poor condition of district's road infrastructure, although a few bridges have been built recently. Majority of Lesotho's unpaved road network remains in poor condition due to inadequate levels of maintenance and limited absorbing capacity of the local contractors. The rugged highland areas covering three-quarters of Lesotho's land area continue to challenge the expansion of road infrastructure, as well as the maintenance of the existing network. Road institutions continue to experience institutional capacity constraints despite years of reform. There are also high fatality rates in densely populated districts and high road accident incidence in the mountainous terrains. These challenges and the impact of climate on road infrastructure requires that future investment in the road and transport system should consider climate change in the design of transport infrastructure.

7.3.4 Energy System

Sources of energy in Lesotho include hydropower, fossil and other renewable sources. The country is renowned for an abundant supply of unspoilt and unexploited water resources, capturing approximately 50% of Southern Africa's total catchment run-off, therefore, hydropower contributes to most of its electricity needs. Lesotho's main power generator is the Lesotho Highlands Development

Authority (LHDA). LHDA supplies energy to Lesotho Electricity Company, a monopoly transmitter responsible for distributing and supplying electricity to the consumer (BOS 2020). Lesotho Electricity Company had a customer base of approximately 260,000 in 2019/2020 (BOS 2020). Additionally, Lesotho also receives some of its power from neighbouring countries such as South Africa and Mozambique, however, as of 2019 only 44.6% of Lesotho's population had access to electricity (World Bank 2021). The country also relies heavily on biomass fuels to meet its major rural population basic needs of cooking and heating space. The country does not have any proven fossil fuels sources, hence it does not produce any crude oil, consequently, there is a huge dependency on imported fossil fuels. In the rural household sector, almost 90% of the energy is derived from biomass sources (shrubs, firewood, crop residues and dung) (Mhlanga 2004). Reduction of water levels in hydropower dams is a highly likely scenario as a consequence of high and rising temperatures, strong winds and more frequent and severe droughts. Widely ranging weather and climate situations also impact the transmission and distribution of power and the transfer of fuels. This is particularly true in the case of transmission lines that extend over long distances and get exposed to strong winds, land movements and erosion processes. Land-based transfers of petroleum products are similarly exposed.

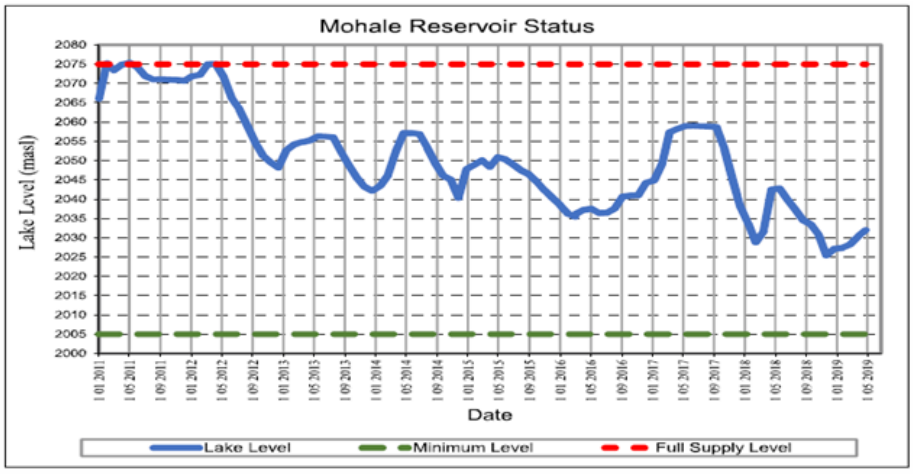


Figure 7.7: Figure 10: Drought impact on Mohale dam reservoir, 2001 – 2019.

Source:

Owing to its abundant water resources and topography, high wind speeds as well as extensive annual solar radiation, the country has a huge potential for generation of clean renewable energy (NDC 2017). As echoed in the Lesotho Energy Policy 2015 and the Draft Lesotho Renewable Energy Policy 2013, the sector is geared towards harnessing the potential of these resources in advancing sustainable universal energy accessibility and affordability, reducing Greenhouse

Gases (GHG) emissions and mitigating the negative impacts of climate change in Lesotho (NDC 2017).

7.3.5 Ecosystems and biodiversity

Lesotho has two distinct grassland type ecosystems: the highveld and the mountain grassland ecosystem, each with unique features of montane, afro-montane and alpine vegetation; minor ecosystems within the major ecosystem are the unique alpine wetlands, bogs and tarns and patches of woody vegetation . The water resource base plays a critical role in supporting ecosystems integrity, while land use and land cover change is an important factor in determining the vulnerability of ecosystems and landscapes to degradation and environmental change. Furthermore, land use and land cover changes influence carbon fluxes and greenhouse gas (GHG) emissions which directly alter atmospheric composition and radiative forcing properties; they also change land-surface characteristics and, indirectly, climatic processes. Protected areas in Lesotho are the Sehlabathebe National Park, the Ts'ehlanyane National Park, the Bokong Nature Reserve and the Masitise Nature Reserve, while the Lets'a-la-Letsie wetland (source of the Quthing River, a major tributary of Senqu river) in the Quthing district is listed as a Ramsar site, wetland of international significance. These cover only a small portion of the country's land area, and overall, the country's natural ecosystems and habitats are over-exploited. The decrease of land quality, such as through poor rangeland use and management, results in the decrease in productivity which has an effect on the livelihoods of people in terms of food insecurity, poverty and migration. Overgrazing of the rangelands has led to decrease in diversity of species and invasion of non-palatable species, while over harvesting of medicinal plants and animals, poor agricultural practices such ploughing on marginal and sloping lands, use of and loss of genetic resources in favour of foreign hybrid varieties and breeds and misguided biological diversity conservation are some of the activities that are causing biodiversity loss in the country. Aquatic and terrestrial biodiversity loss, which has already 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, may be exacerbated or improve depending on species response to the warming (LMS 2000). Insect and pest populations are expected to increase but the extent to which they may be controlled naturally is not known (Mhlanga 2004).

7.3.5.1 Rangelands

Lesotho's land surface area is roughly 30,055 km2 (3 million hectares), of which about 60% are rangelands, and the predominant vegetation types are Hyparrhenia, Eragrostis/Aristida, Themeda, Festuca, Chrysocoma/Artemisia, Leu-

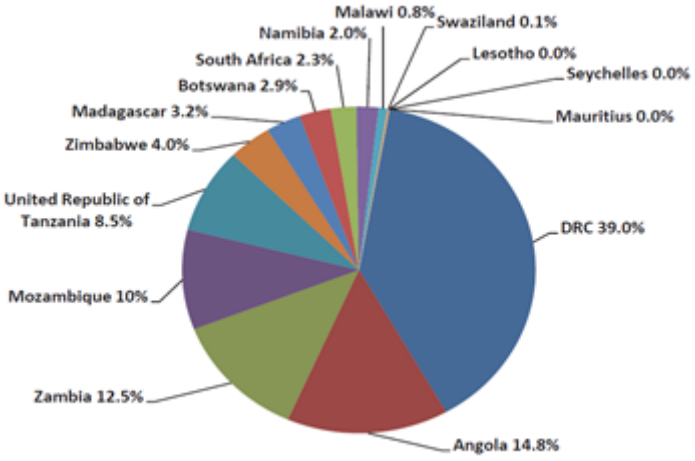
cosidea, Rhus and Merxmuellera. Rangelands are very important regionally and globally as a major source of clean water, bio-resources and as a life form support for a variety of plants, animals and humans. Changes in vegetation cover, soil stability, type and duration of rainfall are among important factors responsible for soil erosion which is the most significant form of land degradation in Lesotho. Overuse of arable land and limited vegetation cover has resulted in loss of nutrients and most of the lowland soils are acidic and generally infertile. The degradation of Lesotho's rangelands is resulting in habitat changes for both micro- and macro-flora and fauna, and has the net effect of reduced livestock production, quality of livestock products and increased livestock mortality rate. Higher 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 the levels that were recorded in the late 1990s, putting the country's ecosystem and economy under heavier stress (LMS 2000), while extreme weather conditions are conducive for disease and pest incidences. One model (SPUR model shows that the country is likely to lose a lot of its nutritious climax grass species and gain a lot of hardy and less nutritious varieties as a consequence of reduced and delayed rainfall under climate change, while at the same time facing the pressure of overstocking in the extensive communal grazing systems, and increasing rangeland degradation – all these together will reduce productivity in the important livestock sector, lower farmer incomes, and increase meat imports to meet demand (LMS 2000).

The understanding of challenges that the rangeland and livestock production systems face in adapting to a changing climate, should be underlined by identification and prior understanding of some of the impacts that climate change pose on these systems. An increase in annual mean temperature change from 2010 to 2100 has been predicted to be in the region of 1-2°C by 2050 and 2.5 – 3.5°C by 2080. Expected frequent warming and fire due to prolonged droughts is very likely to reduce carbon stocks. High temperatures and greater dry spell duration have potential to increase vegetation flammability resulting in extensive rangeland fires which would alter biodiversity by its effects on soil organic matter and soil fertility in grasslands (Rice et al., 1998) and could lead to species changes such as dominance of fire-tolerant species e.g. Themida triandra and resprouting karroo bushes. The temperature increase will more likely impact negatively on grass layer cover on rangeland and crop residues, which are important sources of feed in the country. Anticipated climate change combined with other drivers of change is likely to intensify water scarcity for humans and livestock in Lesotho, particularly during the winter months (JJA) but while less than 10% decrease is expected in rainfall in the other months of the year, variability is expected to increase and is likely to result in reduction in cover and forage productivity. Climate change could increase the frequency with which species across a wide range of taxa are able to spread outside their home range (Karl et al., 2009) and is likely to increase opportunities for invasive species because of their adaptability to disturbances. In Lesotho, where the major land use practice on rangelands is grazing, loss of vegetation will result in poor an-

imal production and aggravated land degradation. Thus, land use and land cover change is an important factor in determining the vulnerability of ecosystems and landscapes to degradation and environmental change. Furthermore, land use and land cover changes influence carbon fluxes and greenhouse gas (GHG) emissions which directly alter atmospheric composition and radiative forcing properties; they also change land-surface characteristics and, indirectly, climatic processes.

7.3.5.2 Forests

Increased temperatures and levels of atmospheric carbon dioxide as well as changes in rainfall, and frequency and severity of extreme weather events are already having notable impacts on the condition of forests (Maile, 1990), even though the forest cover is very low as a percentage of total area of the country and tends to be limited to short patches under escarpments and to some river valleys in the mountains (Mhlanga, 2004). In the northern region of Lesotho, projected decrease in rainfall during the winter season and concomitant forest fires will present a major risk for forests as most of Lesotho's plantations are concentrated in that region. In the south, predicted increases in rainfall during the seasons of spring and autumn may be sufficient to compensate for increased evapo-transpiration, and there may be no major threat to the existence of forests.



Source: FAO, 2010

Though of low occurrence, indigenous forests are an important resource to rural communities as they provide fuelwood, construction materials, forage for livestock, medicines and shelter, and their use was unsustainable (Mhlanga 2004). Their use was recognized as being unsustainable a few decades ago, and this led to the government-led initiative of planting trees in the lowlands and foothills

simultaneously with soil conservation programmes from the early 1970s; of the more than 10,000 hectares were planted, only 60% of this was known to be currently stocked by the turn of the century (Mhlanga 2004).

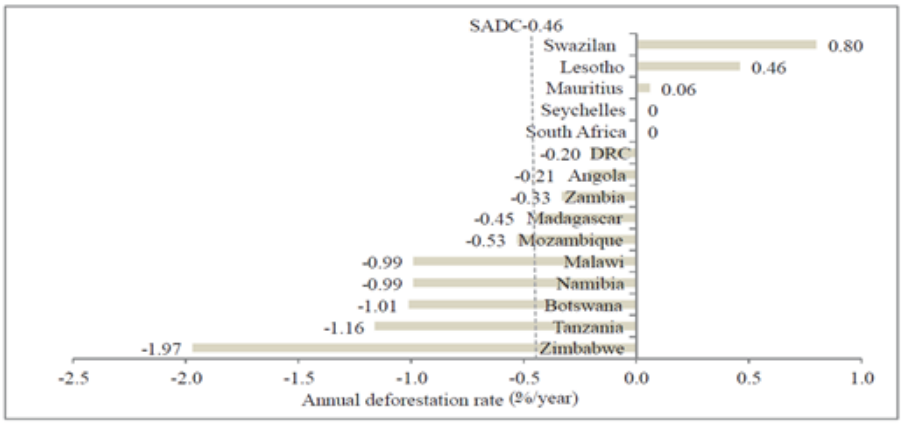


Figure 7.8: Figure 11: Annual rate of deforestation, SADC countries, 2005–2010

Projections by the Holdridge Life Zone Classification model and the Forest Gap model suggest that indicate that there could be widespread occurrence of sub-tropical dry forest and temperate moist forest cover under climate change, with benefits to afforestation programmes and biomass production in the country (LMS 2000).

7.3.5.3 Alpine (Mountain)

The alpine (mountain) system which comprises the Maloti-Drakensberg mountain range covers 59% of the land area of Lesotho, to the east and north. Its rugged topography and cool climate gives it an aesthetic value that is particularly important to the tourism industry. Many unique species of plants occur within it, and it is a regional hot spot for plant diversity. Lesotho's highlands host ubiquitous wetlands and provides water, resources for traditional medicine and cultural activities, grazing land for the vast majority of the country's livestock during the summer months, and supplies water to the dam (Bisaro et al. 2020). The country constitutes one of Southern Africa's principal water catchment areas, capturing around 50% of the total catchment run-off, and its water resource base plays a critical role in advancing socio–economic development and supporting ecosystems integrity (NDC 2017).

7.3.5.4 Tourism

Lesotho has a viable and growing tourism market that depends on its unique ecosystem and biodiversity. Lesotho is not only mountainous but also has an authentic and unique culture to other African cultures has abundant water resources, and a growing institution. Mountains, valleys, and rivers provide memorable scenery for tourists. The tourism sector in Lesotho currently employs 34,000 Basotho representing 6% of the workforce. The country relies on a good climatic condition to attract tourist in the region. Tourism resources such as snow is particularly vulnerable to the consequences of climate change, notably through rising temperatures and alterations in natural precipitation patterns. For example, the Afriski mountain ski resort in the Lesotho Highlands is facing the challenges of a changing climate. Future climate variability is likely to impact significantly on the sector with attendant impact on job creation, infrastructural development and rural development.

7.3.6 Settlements and Living Spaces

Human settlement in Lesotho includes a systemic (regularized) settlement and unregularized zones (hamlets, villages, towns, cities) that are linked with one another by trade and other complex system of human interactions. These settlements are interposed with roads, and infrastructure networks. Lesotho faces major challenges in terms of capacity for planning and development within the housing sector and as a result, a large number of the houses are built within the informal sector (UN Habitat 2015). This is driven by numerous factors, including the absence of a Ministry of Housing for the country, and has resulted in housing acquiring lesser priority and minimal national budget. Budget constraints in the sector highly impact on the quality of infrastructure and as a result, basic service delivery infrastructure for water supply, sanitation, drainage, roads and electricity are absent in some households (Morgan-Jarvis 2018).

7.3.7 Social-Cultural

The natural heritage and culture of the Basotho is closely linked to the environment and hence their housing, clothing, medicine and other traditions are affected by climate change; the relationship between these are nuanced and are not clearly outlined in terms of projected impacts on ecosystem goods and services. It is also common knowledge that the rearing and ownership of livestock, which is the pride and wealth of the Basotho, is supported entirely by the rangelands. Across a greater interior from the mountain region to the Senqu River valley communities live under chronic poverty with survivalist livelihoods. Most communities are more vulnerable to climate change since they do not have sufficient capacities to outlive the consequences of climate change and variability (NAPA 2007). Despite this, Lesotho has a solid foundation for community-based

climate change adaptation based on its preservation of its longstanding social ecology (Palframan 2015), even though the present climatic trends have severely dented the culture of Basotho people (LMS 2000). Some of the projected future conditions such as would lead to changes in biodiversity that could lead to improvements in traditional medicine, may be favourable to cultural restoration (LMS 2000). Further, increased biomass due to forest expansion may reduce the use of dung and paraffin as energy sources, and improved production of sorghum and beans is likely once more to lead to higher consumption of these nutritionally rich crops, provided there are technological improvements on the processing side (LMS 2000). Thus, for the communities, adaptation is interwoven with many other priorities and, as such, experts/specialist should take this into account to ensure that they do not work in isolation or at cross-purposes with community aspirations (Palframan 2015).

7.3.8 Health System

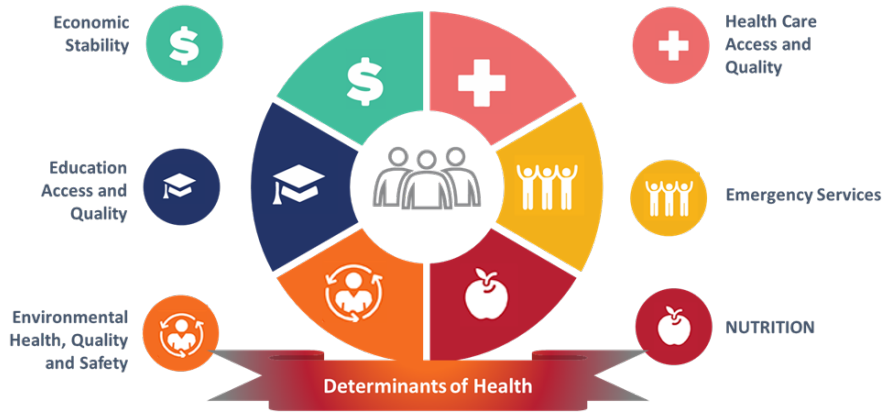


Figure 7.9: Figure 12: Components of the health system

The dynamics of disease patterns especially those influenced by climate are very complex, in part because the effects of climate change on health depend on what happens in other sectors of the economy like agriculture, and this makes prediction difficult (SNC 2013). However, warming climate could lead to a number of outcomes with health consequences: invasions by tropical diseases; increases in the incidence of respiratory tract infections like tuberculosis, and waterborne diseases like typhoid; exacerbated acute respiratory infections during severe winter conditions particularly in those rural areas where poverty is very severe and energy resources very scarce (LMS 2000). Drought diminishes dietary diversity and reduces overall food consumption and may therefore lead to micronutrient deficiencies. While Lesotho lies outside of the current malaria zone the Fourth Assessment Report of the IPCC anticipates expansion of the zone deep into southern Africa (SNC 2013). Countries within the 'Meningitis Belt' in semi-arid

sub-Saharan Africa experience the highest endemicity and epidemic frequency of meningococcal meningitis in Africa. The spatial distribution, intensity and seasonality of meningococcal (epidemic) meningitis appear to be strongly linked to climatic and environmental factors, particularly drought, although the causal mechanism is not clear (Confalonieri, U. et al., 2007). In 2010 meningitis was one of the top five causes of adult mortality (Health Statistics, 2010/11). Climate variability may also interact with other background stresses and additional vulnerabilities such as immuno-compromised populations (e.g. with HIV/AIDS) and conflict and war in the future, resulting in increased susceptibility and risk of other infectious diseases (e.g., cholera) and malnutrition (Boko, M. et al., 2007).

The delivery of health services in Lesotho is done at three levels: primary, secondary, and tertiary. In total, there are 286 health facilities in Lesotho. Of these, 265 are primary health care centres, 20 are general district hospitals, and one is classified as a tertiary/referral hospital. Non-Governmental Organisations (NGOs) provide additional health care services in the form of counselling centres, HIV testing clinics and reproductive health services (Government of Lesotho 2013). Lesotho is experiencing an increasing double burden of diseases characterized by an increase in the burden of non-communicable diseases as well as a high burden of communicable diseases. A resilient health system will require global and national efforts, mobilising all health actors (state and non-state), having a strong regulatory and policy framework to guide actions and accountability and maintain a dedicated and committed health workforce. Since the linkages between human health and the climate have so far not been developed in Lesotho, a rational approach to human health impacts assessment for climate change should emphasize continuing study and monitoring of human disease in relation to climate and environmental factors and should acknowledge a range of possible outcomes (Ministry of Natural Resources, 2000).

7.3.9 Knowledge and Information System

Education and training, along with advancement in technology, and management of the environment, are three of the seven pillars of development as specified in the Lesotho Vision 2020. The NSDP II notes that while the country has made significant progress on overall literacy, only over half of women and 40 percent of men attended at least some secondary school and only 9 percent of women and 8 percent of men have more than secondary education. Thus, while expenditure on education is one of the highest relative to GDP, the country's education outcomes are noted to have been unsatisfactory, and challenges faced included: the efficiency and effectiveness of public spending in education, skills mismatch, shortage of critical skills such as entrepreneurship skills, medicine, engineering and management skills. Educational outcomes have not changed that much in rural areas, and access to post-primary education remains a challenge for the poor (World Bank 2015). The National Climate Change Policy

outlines the following as important to manage climate risks: * Educational options: Awareness raising & integrating into education; knowledge sharing & learning platforms. * Informational options: Hazard and vulnerability mapping; early warning and response systems. * Behavioural options: Migration; soil and water conservation; changed cropping, livestock and aquaculture practices.

Poor public awareness and education services undermine adaptation efforts, and it is important that climate change education is mainstreamed into curricula at primary, secondary and tertiary levels and also targets the private sector. More generally, as recognised in the NCCP, capacity building is needed at community, district, national and regional levels across all sectors in order to be able to collect and analyse the diverse sets of data and information that relate to climate change and to respond appropriately to the climatic changes and their impacts. The integration of ICT will be useful for monitoring, information exchange and public awareness raising.

7.3.10 Governance System

Different institutions are mandated to undertake different actions that feed into adaptive capacity and resilience. There is always the potential for such inevitable institutional composition to create silos and inertia in responding to climate crises. For instance, responsibilities for disaster risk reduction are shared between stakeholders and governments at different levels. Current institutional arrangement for the management of climate change risk needs to be enhanced to ensure proper linkages and cross-collaboration in the design and implementation of actions. It is also important to ensure continued capacity building in areas that might need some staff development. Governance and institutional barriers limit adaptive capacity by exacerbating drivers of vulnerability as well as impeding action, decision-making, and the flow of resources to where they are needed.

Chapter 8

National adaptation priorities

8.1 Key risks and adaptation options

The key risks and adaptation options are presented based on analysis and summary of past and current data and reports up to 2020. The risk levels are divided into three temporal periods: near future (2011 - 2040 which is the period for which most of the granular [sub-regional] climate projections are based; mid-future (MF – covering the period 2041-2070) and far future (FF – the period 2071 to 2100). Risk level is assigned based on the criteria outlined below and expert judgment as presented in the reports in the framework outlined in the NAP technical guidelines report. It is evident that there are inadequately projected risks, particularly beyond 2040 for most of the systems/sectors and how this gap can be addressed is outlined in section 8 of this report.

Risk assessment criteria (scores are provided in brackets, with a possible highest score of 24, and ranked as follows: high (20 or more; medium (15-19), low (14 and below):
The probability of a given climate hazard – The general probability for change in a climate hazard (such as temperature or extreme precipitation events) occurring.

- **High** probability of the climate hazard occurring (3);
- **Medium** probability of the climate hazard occurring (2);
- **Low** probability of the climate hazard occurring (1).

The likelihood of impact occurrence – The likelihood that a change in a given climate hazard (e.g. temperature rise) will result in a particular impact (e.g. material failure). Examples of likelihood categories include:

- **Virtually certain/already occurring** – Nearly certain likelihood of the impact occurring over the life of the infrastructure, and/or the climate hazard may already be impacting infrastructure (3);
- ___High ___likelihood of the impact occurring over the life of the infrastructure (2);
- **Moderate** likelihood of the impact occurring over the life of the infrastructure (1);
- **Low** likelihood of the impact occurring over the life of the infrastructure (0).

The magnitude of the consequence – The combined impacts, should a given hazard occur, taking into account such factors as:

- **Internal operations**, including the scope and duration of service interruptions, reputational risk, and the potential to encounter regulatory problems (1 - low to 3 – high);
- **Capital and operating costs**, including all capital and operating costs to the stakeholder and revenue implications caused by the climate change impact; (1 - low to 3 – high);
- **Number of people impacted**, including considerations related to any impacts on vulnerable populations (including, but not limited to seniors, low-income communities, mentally or physically disabled citizens, homebound residents, and children); (1 - low to 3 – high);
- **Public health**, including worker safety; (1 - low to 3 – high);
- **Economy**, including any impacts to the city's economy, the price of services to customers, and clean-up costs incurred by the public; (1 - low to 3 – high);
- **Environment**, including the release of toxic materials and impacts on biodiversity, the state's ecosystems, and historic sites. (1 - low to 3 – high).

```
library(flextable)
library(magrittr)
proj_cc<-readxl::read_excel("Tables_from_NAP.xlsx",
    sheet = "projected_cc")
```

```
## New names:
## * Risk -> Risk...6
## * Risk -> Risk...7
## * Risk -> Risk...8
```

```
t1<-flextable(proj_cc,col_keys = names(proj_cc),
  cwidth = 3,
  cheight = 0.01,
```

```
  defaults = list(),
   theme_booktabs())
t2<-fontsize(t1,part = 'all', size = 8)
t3<-border_outer(t2,part = 'all', border = NULL)
t4<-border_inner(t3,part = 'all', border = NULL)
t5<-bold(t4,part='header')
t6<-set_caption(t5, "Table 5: Projected climate changes and impacts. NF - near future (2011-2040)
t6
```

Parameter	Hazard/	Impacts
	Threat	
Below normal rainfall	Drought	Food insecurity
		Low soil moisture
		Reduction in agri
		Reduction in lives
		Introduction of ne locusts)
		Shortage of wate
		Degraded soils, r
		Loss of soil fertilit
		Soil cover change negatively
		Extinction of flora
		Increased food pr consumption
		Limited availabilit
		Reduced hydropo
		Reduced econom

Parameter	**Hazard/**	**In**
	Biodiversity loss	Bi
		R
		R
	Land degradation	D
		Lo
		Se ne
		Tu
		C
		Im te
		D
		D
Above normal rainfall	Floods, storms, Intense runoff,	D

Parameter	Hazard/	Impacts
	Hail	Killed animals
		Destroyed infrast bridges)
		Loss of lives and missing
		Soil erosion and
		Waterborne disea
		Land use-change
		Reduced eco-tou
High rainfall variability	Dry spells	Limits cultivable a
	Flash floods Shorter rainfall seasons,	Limits duration of
	Late onset of rainy season	Unreliable water
		Exacerbate land
		Shrinking of rang
		Lower crop and p
		Inadequate annu
		Lower water table
		Drying up of mou perennial streams
		Reduced hydropo
Storm	Strong wind	Damage to prope and power lines
		Uprooting of trees
		Transmission of a

Parameter	**Hazard/**	**In**
		In
		In
Low temperatures	Snow/ Frost	In le
		H
		R
		R
		D
		R
High temperatures	Heat wave	R re
		H
		Hi pe
		In
		C
		C
		D st

Parameter	Hazard/	Impacts
	Wildfires	Destruction of cro
		Air pollution
	Biome shifts	Change in ecosys mammals, birds a
		Change to the ec
	Biodiversity loss	Biome shifts
		Reduced ecosyst
I'd expect the south western parts of the country to register high temperatures		

(Primary sources: LMS 2000; NDC_Lesotho (2017); NAPA Lesotho 2017; Lesotho Systems February 2015 m.map; NAP Stocktaking Report 2015); LMS 2021. Secondary sources: Kleine, Buck and Eastaugh, 2010, adapted from Spittlehouse and Stewart, 2003 and Kalame et al., 2009

From the risks related to projected climate changes, it is clear that Lesotho must put in place adaptation options that deal with the following climate change clusters in order of priority:

1. **Rainfall extremes – droughts and floods, and rainfall variability, including impacts of tropical cyclone activity.** These adversely impact the following systems' components: Crop production; Livestock production; Horticulture and cash crops; Ecosystems and biodiversity; Rangelands, Alpine (Mountain), Wetlands, Fisheries, Manufacturing and trade; Social-Cultural; Water resources and supply; Energy; Health; Knowledge

and information; Human settlements and living spaces; Tourism. Adaptation options to address these are in the immediate, medium and long-term timeframes.

2. **Temperature extremes – Heat and Cold Stress, and changes in rainfall patterns between and within seasons.** These will have impacts on the following systems' components: Crop production; Livestock production; Horticulture and cash crops; Ecosystems and biodiversity; Rangelands, Alpine (Mountain), Fisheries, Manufacturing and trade; Social-Cultural; Water resources and supply; Energy; Health; Knowledge and information; Cities and human settlements; Tourism. Adaptation options to address these are in the immediate, medium and long-term timeframes.
3. **Progressively rising minimum and maximum temperatures, increased duration of number of hot days and dry spells.** These will have impacts on the following systems' components: Crop production; Livestock production; Commercial agriculture; Ecosystems and biodiversity; Rangelands, Alpine (Mountain), Wetlands, Fisheries, Horticulture and cash crops; Social-Cultural; Water resources and supply; Energy; Health; Knowledge and information; Cities and human settlements; Tourism. Adaptation options to address these are in the medium and long-term timeframes.

8.2 Ranking adaptation actions

The adaptation options listed below have been ranked using multi-criteria analysis, that is partly modified from Sinay and Carter (2020) to make it simple for a large group of diverse stakeholders to come to consensus easily on the priority adaptation actions which will be unpacked in the project development plans. The adaptation options are clustered under over-arching adaptation themes which are the most likely to generate synergistic and wide-reaching co-benefits for the country as a whole. The project development plans will take into consideration other specific criteria that will assess aspects such as alignment with SDGs, Sendai Framework and Country GCF programmes, and inclusion of cross-cutting factors such as gender, vulnerable groups, policy and legislative reforms, and knowledge and capacity building at individual, community, institutional and systemic levels. These aspects align well with the five broad strategy clusters of the NSDP II, namely;

- Accelerated, Shared and Sustainable Economic Growth
- Human Development and Social protection
- Good Governance
- Environment, Natural Resources and Climate Change
- Cross cutting issues: integration of population, gender, youth and other vulnerable populations.

These considerations have been taken into account in the development of the Environment, Natural Resources and Climate Change Chapter which is included in the Public Sector Investment Plan attached to the NSDP, addressing and integrating environment and climate issues into development under five strategic objectives: Integrated Land and Water Resources Management; A Climate-Resilient Nation; A Green Economy; Delivery of Environmental Services and Environmental Health, and; Strategic Environment and Climate Governance.

Criteria:

```
library(flextable)
library(magrittr)
criteria<-readxl::read_excel("Tables_from_NAP.xlsx",
    sheet = "ranking_criteria")
t1<-flextable(criteria,col_keys = names(criteria),
  cwidth = 3,
  cheight = 0.01,
  defaults = list(),
   theme_booktabs())
t2<-fontsize(t1,part = 'all', size = 8)
t3<-border_outer(t2,part = 'all', border = NULL)
t4<-border_inner(t3,part = 'all', border = NULL)
t5<-bold(t4,part='header')
t6<-bold(t5,j=1)
t6<-set_caption(t6, "Table 5: Projected climate changes and impacts. NF - near future (2011-2040)
t6
```

Table 8.2: Table 5: P
– near future (2011-20
future (2071-2100)

Criteria	Indicator	States/Score
Uncertainty	Scenario	1.5ºC
		3ºC
		5ºC
Costs	Costs	Low
		Moderate
		High
Decision-Making time horizons	Timing	Urgent

Criteria	Indicator	St
		C
		In
Co-benefits	Natural Systems	Lo
		M
		Hi
	Human Systems	Lo
		M
		Hi
Positive Systems Synergies	Positive impacts	Lo
		M
		Hi
Negative Systems Synergies	Negative impacts	Lo
		M
		Hi

Adaptation Options – Ranked:

1. Ensure sustainable water supplies for multiple uses through: integrated catchment management and protection of key water towers and associated river basins, restoration and rehabilitation of degraded lands including wetlands in mountain areas and flood prone areas in the lowlands. Establish a national integrated water resource management framework that incorporates community-based catchment monitoring and management, building appropriate capacity where needed, and revise the water-related and water-reliant policies and strategies to underpin these measures. Promote water recycling activities and to a large extent dredge some existing ponds and dams to collect and conserve water
2. Upscaling interventions that combat land degradation and soil erosion by implementing land rehabilitation programmes incorporating integrated approaches to Sustainable Land Use Planning and Management, promotion of nature-positive land use practices and improvement of legislation addressing range management and the conservation of genetic resources.

3. Promote climate-smart agriculture and innovations in post-harvest storage and food processing, including: implementing conservation agriculture, improved land management e.g. erosion control and soil protection and agroforestry practices; expanding irrigation and enhancing water use efficiency; crop and livestock diversification, adjustment of planting dates and crop variety informed by integrated climate forecasts; crop relocation; promotion of drought-tolerant and heat-tolerant crop varieties and hardy livestock, and; build the capacity of smallholder farmers to adopt climate resilient agronomic practices.
4. Devise and implement a multi-hazard forecasting and early warning system to support systems planning, monitoring and disaster preparedness and facilitate inclusive participation, access, sharing and information exchange using well documented and advertised channels of communication. Add a sentence to address issues of sustainability.
5. Support and implement programmes for alternative livelihoods in order to reduce unsustainable resource use that contributes to loss of biodiversity, including: strengthening and stabilizing rural livelihoods through diverse adaptation interventions including ecotourism and aquaculture.
6. Preserve natural forest and expand afforestation and forest regeneration programmes to maintain biodiversity and ecosystems and conserve genetic resources, including: protection and conservation of indigenous and endangered species and promotion of drought tolerant and fast growing tree species; development and maintenance of a frequent forest inventory system to facilitate monitoring of forest status and strengthening the implementation of the national Community-Based Forest Resources Management Programme; enhanced regulatory protections for floral and faunal species potentially at risk due to climate changes; and prevention of wildfires.
7. Protect and conserve grasslands and rangelands.
8. Improve access to sufficient and safe water supplies for various purposes by: promoting appropriately scaled multi-purpose water reservoirs and expanding rainwater harvesting and water storage facilities and connected infrastructure across the public and private sector domains, down to the household level, and; construct boreholes where plausible with supporting storages and reticulated water supply systems at village level for better access to clean drinking water. Grow awareness of, encourage and build capacity at scale in: water conservation, including re-use, recycling and irrigation efficiency; protection of natural and artificial wells; surface runoff control and managed aquifer recharge.
9. Climate proof supply distribution systems (water/power), waste management systems (sanitation) and transport systems (roads, bridges).
10. Diversify the energy mix by implementing renewable energy (solar/wind) projects in addition to multi-purpose dams for hydropower, and promote use of efficient bioenergy technologies, supporting these with appropriate guiding policies, regulatory framework/legislation and capacity building.
11. Strengthen the capacity of the health system to prepare for and respond

to disasters, including: construction and equipping of more health centres in order to improve access to health facilities within a walking distance of 8 km; support programmes for preventing and controlling climate induced diseases; enhance public awareness about water, sanitation and hygiene practices; enhance health surveillance, and; build capacity to diagnose, prevent and control climate-induced diseases such as diarrheal diseases and malnutrition.

12. Develop and implement climate related building codes/standards and revise existing building and construction standards in line with climate change.

Some already identified priority activities that can be developed into comprehensive adaptation plans for GCF funding and implementation are outlined below.

a. Key Priority activities

```
library(flextable)
library(magrittr)
priority<-readxl::read_excel("Tables_from_NAP.xlsx",
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t1<-flextable(priority,col_keys = names(priority),
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  cheight = 0.01,
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t3<-border_outer(t2,part = 'all', border = NULL)
t4<-border_inner(t3,part = 'all', border = NULL)
t5<-bold(t4,part='header')
t5
```

Key systems	Interventions
Livestock production, Rangelands, Water resources and supply, Crop production, Social-Cultural	Improve Resilience of Livestock Production Systems Under Extreme Climatic Conditions in Various Livelihood Zones in Lesotho
	Promoting Sustainable Crop Based Livelihood Systems in Foothills, Lowlands and the Senqu River Valley
Governance, Knowledge and information, Social-Cultural, and cross-cutting	Capacity Building and Policy Reform to Integrate Climate Change in Sectoral Development Plans
	Improvement of an Early Warning System Against Climate Induced Disasters and Hazards
Water resources and supply, Social-Cultural, Health	Securing Village Water Supply for Communities in the Southern Lowlands

Key systems	Interventions
Ecosystems and biodiversity, Rangelands, Wetlands, Alpine (Mountain), Water resources and supply	Management and Reclamation of Degraded and Eroded Land in the Flood Prone Areas (Pilot Project for Western Lowlands)
	Conservation and Rehabilitation of Degraded Wetlands in the Mountain Areas of Lesotho
Energy, Cities and human settlements, Manufacturing and trade, Social-Cultural	Promote Wind, Solar and Biogas Energy Use as a Supplement to Hydropower Energy
Tourism, Alpine (Mountain), Wetlands	Strengthening and stabilizing eco-tourism based rural livelihoods
Manufacturing and Trade, Horticulture and cash crops, Social-Cultural	Improvement of community food security through the promotion of food processing and preservation technologies
	Stabilizing community livelihoods which are adversely affected by climate change through improvement of small-scale industries

Source: Adapted/updated from NAPA, NDC, other national strategies and the analysis in formulating this NAP

Other adaptation projects are proposed in the "Lesotho Water Security and Climate Change Assessment Report" (World Bank 2016):

Improve Data Monitoring and Management. Data limitations will undermine Lesotho's ability to monitor predictions and respond to changes in climate. Design and implementation of an optimized hydrometeorological network would enhance the capacity of Lesotho to prepare for and respond to potential future changes in climate. Detailed agricultural data and information about the economic uses and value of water were not readily available. These limitations led to a more cursory evaluation of the agricultural sector and the omission of a more formal economic analysis.

Continued Capacity Enhancement. The tools and analysis required to support the planning for robust climate adaptation necessitate sustained capacity development. The nature of the analysis here provided support to the first iteration of an interactive participatory process. The time required to develop the tools and capacity needed provides a foundation, but should be further developed and integrated into government planning processes.

Economic Evaluation. The climate modelling and RDM framework illustrates important decision pathways for future development in Lesotho. The cost and valuation data required to support a cost-benefit analysis across the wide range of climate conditions would also support an important economic evaluation of different adaptation options. These data could be incorporated into the current RDM analysis to evaluate the economic robustness of the different adaptations.

Extending Adaptation Analysis. Using the existing data and tools to undertake additional iterations of the vulnerability and adaptation analysis up to the end of the 21st century would increase the scientific rigor. The analysis would enhance the capacity to evaluate climate risks and weigh different trade-offs. Further adaptation of the WEAP model to a shorter time step, such as one day, would enable the evaluation of operational strategies for water allocation among competing uses, such as water deliveries and timing for domestic and agricultural use, as well as hydropower generation. Extending the geographic scope of the model to demand areas in South Africa that rely on water imported from Lesotho would also produce a more complete understanding of vulnerabilities and trade-offs.

Lowlands Water Supply Scheme. Continued development of the LLWSS is critical to improving the reliability and resilience of the domestic and industrial sectors. Exploring interconnections between the developed water resources through LHWP and linking these to address domestic and industrial demands in the lowlands could help improve the resilience of the existing system. Such integrated planning could also help to manage the associated political economy between perceived national benefits and the development of water transfer projects.

Agriculture Sector Assessment. The results highlight the need for a more thorough assessment of the risks and opportunities for Lesotho's agricultural sector of potential changes in climate. An evaluation of the implications of increasing atmospheric carbon dioxide (CO2) concentrations, together with rising temperatures and water stress on agricultural productivity, should be further elaborated. A better understanding of these dynamics could help develop agricultural strategies suited for the unique climatic changes under way in Lesotho. This information could help direct a program to incorporate the traits of such plans into desirable crop production cultivars to improve yield.

Chapter 9

Implementation strategy (including costs)

9.1 Projects for implementation and guidelines

```
library(flextable)
library(magrittr)
programs<-readxl::read_excel("Tables_from_NAP.xlsx",
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t4<-border_inner(t3,part = 'all', border = NULL)
t5<-bold(t4,part='header')
t6<-set_caption(t5, "Table 6: Existing country programmes for climate change adaptation")
t6
```

Project/ Programme Name	Objectives	Fu
FP098: DBSA Climate Finance Facility	The programme will de-risk and increase the bankability of climate projects in order to crowd in private sector investment	G
National framework for leapfrogging to Energy Efficient Appliances and	The project will reduce strain on the electricity grid and ability to extend the electricity grid, increase disposable income for households (reduced electricity bill), and potentially reduce GHG emissions	G
Equipment in Lesotho (Refrigerators and Distribution Transformers)		
through regulatory and financing mechanism		
NDA Strengthening and Country Programming support for Lesotho through DBSA	It seeks, among others, to improve national resilience to climate change and promote green growth.	G
Increasing Agricultural and Ecosystem Resilience through Ecosystem-based Adaptation Agroforestry	The project will support some of the most climate vulnerable communities in the region	G
	to improve the sustainability and resilience of farming systems, and increase household	
	food security and adaptive capacity.	
Regeneration of Livelihoods and Landscapes (ROLL) Project	The project will promote an integrated landscape approach to reduce land degradation through sustainable land and water management, land restoration at large scale, sustainable livestock management and agricultural practices, and strengthening local and institutional capacities.	G
Promoting Conservation, Sustainable Utilization and Fair and Equitable Benefit-sharing from Lesotho's Medicinal and Ornamental Plants for Improved livelihoods	To promote conservation, sustainable use and improved access and benefit-sharing from ABS products derived from selected Medicinal Plants in selected Highlands and Foothill areas of Lesotho	G
Climate Change Adaptation for Sustainable Rural Water Supply in Lowlands Lesotho	To improve the livelihoods of the communities of South Western Lowlands facing challenges caused by climate change through better water resource management	Le
Strengthening Climate Services in Lesotho for Climate Resilient Development and Adaptation to Climate Change	To strengthen early warning in Lesotho to effectively address adaptation to climate change	Le
Development of Cornerstone Public Policies and Institutional Capacities to Accelerate Sustainable Energy for All (SE4A) Progress	To catalyse investments in renewable energy-based mini-grids and Energy Centres to reduce GHG emissions and contribute to the achievement of Lesotho's Vision 2020 and SE4All goals.	G
Adaptation of Small-scale Agriculture (LASAP)	To increase the resilience of small-scale agriculture to climate change impacts by promoting climate-proofed investments for agriculture-based development, as well as by enhancing the resilience of agricultural productivity under increased climate variability	Le
Strengthening Capacity for Climate Change Adaptation through Support to Integrated Watershed Management Programme in Lesotho	to implement sustainable land and water management practices (SLM/W) and resource conservation measures in selected watersheds to reduce vulnerability and enhance adaptive capacity at community level	Le