Technical Report on Climate Change Impacts, Risks and Vulnerabilities on Food Security and Livelihoods in the Lowlands and Mountains

Kingdom of Lesotho

Strengthening capacity for climate change adaptation in the agricultural sector

For the Food and Agriculture Organization of the United Nations (FAO) in partnership with the Lesotho Ministry of Forestry and Land Reclamation

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Executive Summary

Climate change is already impacting on Lesotho, and robust integrated policies, strategies and action plans are required to prepare the "Mountain Kingdom" for continuing changes in the future. This study forms part of a larger Programme aimed at strengthening technical and institutional capacity for climate change adaptation in the agricultural sector, thus reducing vulnerability of farming and rural communities to climate-related risks. In this report, we assess the climate change-related impacts and vulnerabilities on crop, livestock and forest-based livelihood systems in two southern lowland districts (Mohale's Hoek, Mafeteng) and a mountain district (Thaba Tseka) that are identified as being the most vulnerable by Lesotho's National Adaptation Programme of Action (NAPA, 2007).

Although climate change is a global problem, its impacts are felt disproportionately across the world, and usually more severely in less developed countries such as Lesotho. Lesotho is highly **exposed** to current climate variability and extreme climate events, which are expected to increase in frequency and intensity in the future, accompanied by gradual warming and changing rainfall patterns. Both the southern Lowlands and the Mountains experience recurring droughts, and rising temperatures will further reduce available soil moisture during times of inadequate rainfall. The biophysical features of the country, notably the high proportion of high-altitude (non-arable) rangeland, thin and highly erodible soils of varying fertility, and sub-optimal spatial and temporal distribution of rainfall, also make the country very **sensitive** to climate change and climatic events. The current and future **impacts** of climate are thus high, and this has been felt particularly strongly in the agricultural sector, where productivity has declined noticeably over the last 10 years. This has hindered concerted efforts at reducing chronic food insecurity amongst the poor.

Subsistence agriculture forms the backbone of the majority of the people's livelihoods. Over-reliance on rainfed crop production and lack of crop diversification, small sizes of farming units, high population pressure on arable land, and unsustainable grazing pressure aggravate the impacts of natural hazards. **Vulnerability**, defined as the combination of impacts and **adaptive capacity**, will thus depend largely on whether households possess the necessary social, human, financial and physical capital to effectively mitigate against the negative effects of climate change, or are able to grasp the opportunities arising.

In Lesotho, households are grouped into four categories describing their vulnerability or resilience to food shocks. Of these, the "very poor" and "poor" will have great difficulty in dealing with climate and food shocks. The most vulnerable households will also include those with weak social networks, female heads, high dependency ratios, high levels of illiteracy, those with little income and no assets, and those with exclusive dependencies in subsistence agriculture, especially maize mono-culture.

Nevertheless, gradual warming of this cool high-altitude country, combined with slightly higher rainfall could well provide opportunities for more productive and more diversified agriculture. Less severe cold stress (particularly in the Mountains), a longer growing season, the fertilization effect of rising atmospheric carbon dioxide (CO_2) and higher summer rainfall could combine to improve crop and rangeland productivity, and allow for new crops to be introduced.

We conclude that:

- ***Cross-sectoral integration*** between the natural resource-based sectors and the socio-economic sectors is imperative for the success of adaptation actions. Institutional cooperation needs to become more streamlined, so that programmes and projects are not implemented at cross purposes. Climate change considerations need to be integrated into all planning processes and staff capacitated to understand the issues and connections.
- ***High quality data*** collection, management, analysis and information dissemination is of critical importance. Strategies, policies and projects must be underpinned by objective evidence. Information must reach those who require it in a reliable and timely manner for effective decision-making.
- The strong ***links between climate, farming and poverty*** should be recognized. Poverty is the underlying stress which impedes people's ability to cope, adapt and change their livelihood strategies in response to changing conditions. Investments are required to gradually move out of subsistence mode into profitable mode and thus out of poverty. Climate change can exacerbate this poverty trap.
- ***Opportunities for agricultural production to increase*** under climate change should be identified and made a reality. This will require a strong focus on predicting and managing climate variability and risk, using all the knowledge and technology currently available, and improved through research and technology transfer. If Lesotho can "climate-proof" its agriculture, in the sense that variability does not time and again lead to food shortages but is incorporated into a modern and diverse food system, it could make substantial inroads into reducing food and human insecurity.
- "Climate-proofing" crop production can also be achieved through the ***development of water for irrigation***. Water harvesting can be relatively easy and inexpensive, and the topography over most of the country is ideal for gravity-fed irrigation and small hill-top reservoirs In addition, a range of formal small-scale irrigation schemes managed by local users would provide enough capacity for irrigated cropping to avert entire crop failure during drought years.

Contents

1.INTRODUCTION

Amongst the world's Least Developed Countries (LDCs), Lesotho ranks as one of the most vulnerable to climatic and other hazards and shocks. Agriculture is the most important contributor to the national economy, and provides livelihoods to a high proportion of the population. Agro-ecologically, the country is characterised by a low proportion of arable land, and high elevations, steep slopes and a thin topsoil layer over much of the area, resulting in high vulnerability to soil erosion and degradation.

Extreme weather conditions occur periodically (drought, frost, heavy rainfall). The lowland is the most populated and intensively cultivated zone, whereas the highlands are less suited to growing crops and support a livestock industry providing valuable exports (wool, mohair) as well as meat, milk and hides. The majority of farmers (90%) are smallholder (subsistence and small-scale), with some medium-scale commercial farms. Less than 1% of arable land is irrigated. Climate change, manifested as general warming, changes in precipitation patterns, and increasing climate variability and occurrence of extremes, would place increasing pressure on the socially and economically vulnerable peoples of Lesotho who depend on the land and vagaries of the weather for their livelihoods.

The Government of Lesotho has completed the Lesotho National Report on Climate Change (its First National Communication to the Conference of the Parties to the United Nations Framework Convention on Climate Change, 2000), and the National Adaptation Programme of Action (NAPA) on climate change under the UNFCCC (2007). The NAPA process identified eleven adaptation options, most of which address land and water management and agricultural production, following the finding that chronic food insecurity is likely to be further deepened through climate change.

The challenge now is to build on this work and develop implementable and effective adaptation programmes for the agricultural and forestry sector, accompanied by strengthened financial and institutional capacity to support such actions. This should strengthen the country's ability to achieve its Millennium Development Goals (MDGs) targets, particularly MGD1 (reducing poverty and hunger) and MDG7 (attaining environmental sustainability).

The goal of this study is to assess the climate change-related impacts and vulnerabilities on crop, livestock and forest-based livelihood systems in the drier Southern Lowlands and the Mountains Livelihood zones.

The key objectives are to:

- Conduct a literature review, including previous climate change assessments
- Interrogate available data sources
- Investigate the most up-to-date climate change scenarios and develop key scenarios to be used for this study
- Conduct a Risk & Vulnerability assessment for the Southern Lowlands and Mountains based on Livelihood systems
- Conclude with recommendations

1.1. Terms of Reference

This Report forms part of a larger Technical Cooperation Programme (TCP) which "promotes an integrated and community-based approach in addressing climate change risks through strengthening of technical and institutional capacity of key stakeholders at national and local levels and evaluating and prioritizing best practices focusing on selected areas of crops, livestock, forest-based livelihood system to reduce the vulnerability of farming and rural communities to climate change-related risks" (TCP Lesotho Tender Information document, 2009). OneWorld Sustainable Investments have been tasked with the first of three outputs, namely the assessment of climate change-related impacts and vulnerabilities on crop, livestock and forest-based livelihood systems in selected watershed/catchments, and a baseline study on climate-related vulnerabilities and adaptation practices. The project will be implemented in two southern lowland districts (Mohale's Hoek, Mafeteng) and a mountain district (Thaba Tseka) that are identified as being the most vulnerable by Lesotho's National Adaptation Programme of Action (NAPA, 2007).

Specifically, this report constitutes Activity 1.1 of Output 1: Assess and produce a technical report on climate change impacts, risks/vulnerabilities on food security and livelihood (considering climate change projections/scenarios) focusing on the major livelihood zones in the country (i.e. on the dryland and mountain areas).

2. LESOTHO NATIONAL CIRCUMSTANCES: OVERVIEW

2.1. PESTLE analysis

Political

Lesotho has a parliamentary constitutional monarchy as the government of the Kingdom of Lesotho (we use the short name Lesotho hereon). The King is the Head of State while the Prime Minister is the Head of Government. Lesotho was a British Protectorate from the mid 1800s until its independence in 1966. The country is administratively divided into 10 districts: Botha-Bothe, Leribe, Berea, Maseru, Mafeteng, Mohale's Hoek, Quthing, Thaba-Tseka, Mokhotlong and Qacha's Nek.

Government is run through an Executive Branch headed by the Prime Minister. Although the King is the Head of State, he does not have executive or legislative powers. According to the Constitution of Lesotho, land is owned by the people but held in trust by the King. Land rights are allocated by a system of local authorities working with the traditional chieftainship structures. Tenure rights are based on customary laws, but attempts to legislate a land reform bill have been ongoing for a number of years.

Economy

Lesotho is totally land locked by the Republic of South Africa (RSA). It has been categorized by the World Bank as a "Least Developed Country" with few natural resources of its own. Lesotho is thus heavily dependent on RSA for its income, which is repatriated through labour exported to South Africa's gold mines and other labour-intensive industries. However, about half of these jobs have been lost over the last 10 years. Moreover, water is exported to South Africa from the Lesotho Highlands Water Project (LHWP) earning the country approximately M325 million per annum (2008 figure). In addition, electricity sales (hydropower) to the Lesotho Electricity Company (LEC) amount to approx. M60 million and those to Eskom in RSA about M300 000 (2008). This, together with Lesotho‟s share in the South African Customs Union (SACU) accounts for the largest sources of income. Revenue from SACU contributed between 44 and 60% to government revenue over the last 10 years (56% in 2007/08) (Lesotho Statistical Yearbook, 2008).

The economy of Lesotho relies heavily on the services, manufacturing and industry sectors. Over the last 10 years, the contribution to GDP of mining, electricity, water and construction has increased from 22% to 32%, whereas the contribution by agriculture has decreased from 11% to 7% (Lesotho Statistical Yearbook, 2008). Exports include textile and clothing supported by

multilateral and bilateral agreement such as the AGOA agreement (in which Lesotho enjoys a 34% share of the North American markets), ceramics, footwear, and light manufactured goods. Some diamond mining occurs in the east at Letšeng la Terae and nearby Liqhobong. Up to 24 diamondiferous possible resources have been recently identified in Lesotho, increasing prospects for future generation of royalties and employment for the population.

Major imports include cereals, electric power (although substantial amounts are now generated at the 'Muela Hydropower Station), food, machinery, pharmaceuticals, liquid fuel products and a variety of manufactured goods.

In 2003, agriculture's contribution to total GDP was 15.7% (FAO statistics). This is declining and is now estimated at 7% by the World Bank (World Development Indicators, 2009). Average per capita GDP was $543, but agricultural per capita GDP was only $198. Agricultural imports are eleven times the agricultural exports. External agricultural assistance is low ($8.7 million).

Social

There are about 1.88 million (2006 population census) people in Lesotho, 60% of whom fall in the age category of 15-64 years of age (working age). Median age is about 21 years with a population growth rate of about 0.12%. This relatively low rate is attributed to the high prevalence rate (23%) and impact of HIV/AIDS in the country. The HIV/AIDS pandemic is of a mature pattern with a high case-fatality ratio resulting in large numbers of orphans and vulnerable children. Life expectancy at birth is 43, and the rate of childhood (under-five) mortality is 8% and has risen in the last few years (Lesotho National Population Census, 2006). About 35% of Lesotho's active male wage earners work in South Africa (but this figure is likely to have changed since the census date as a result of the global recession of 2008/09, with migrant workers retrenched in South Africa returning to Lesotho. About 25% of the population are urbanized, with an urbanization rate of about 3.5%. Approximately 38% of the rural population (58% of which are female) in the economically active population work in the agricultural sector.

The country has a moderate level of undernourishment (15%). However, for the poor sector of the population, food insecurity has become chronic, driven by drought-induced reductions in agricultural outputs, escalating food prices, and underlying structural poverty and a stagnant economy. Within SADC, Lesotho has the highest reliance on food aid (9.6% of total consumption).

The Human Development Index (HDI) for Lesotho is 0.549, which gives the country a rank of 138th out of 177 countries (UNDP Report 2007/08). This has declined from a peak achieved in 1995 (Fig. 1).

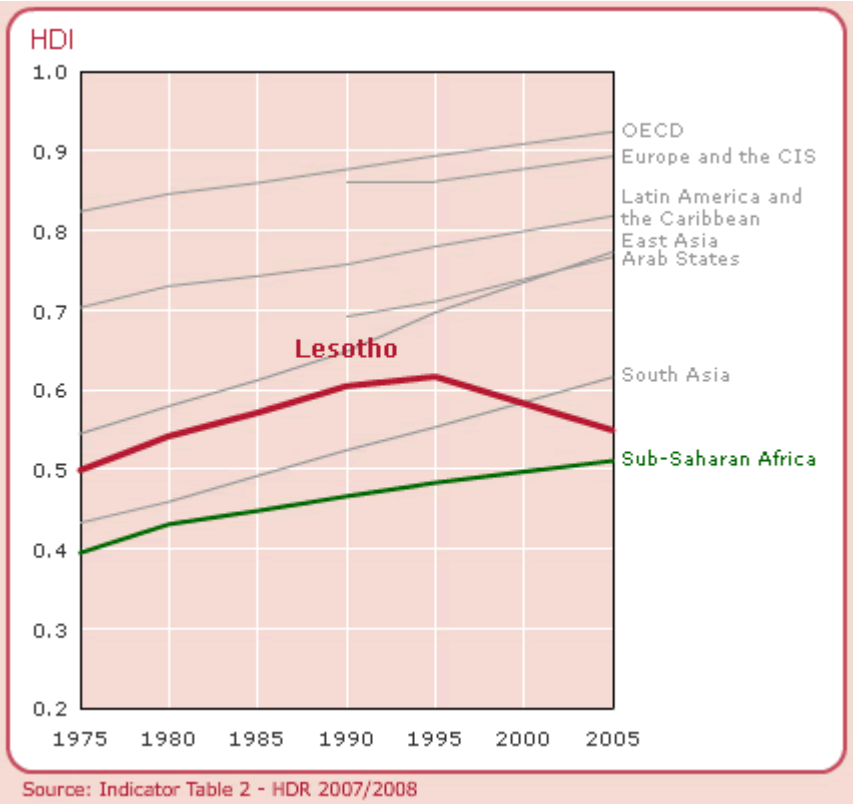


Fig. 1. Trend in HDI from 1975-2005 for Lesotho (source: UNDP Human Development Report Lesotho, 2007/08).

Technical

There is a mixed level of technology in the agricultural sector. For a subsistence economy, Lesotho is quite mechanized at animal traction level. Although most lands are still tilled by draught animals, croplands are increasingly being ploughed and crops planted using tractors, particularly in the main cropping areas of the lowlands (northern areas in particular) (FAO/WFP Special Report: Crop and Food Supply Assessment Mission to Lesotho, 2007) Although many farmers of the northern lowlands show interest in growing wheat as an alternative to maize, production is constrained by the shortage of combine harvesters.

The majority of farmers use on-farm produced, open pollinated seed varieties, whereas many farmers in the northern lowlands, and especially the commercial producers, utilize hybrid seeds. In general, the utilization of hybrid seed is related to the use of chemical fertilizer. This varies from district to district and farmers in high potential cereal production areas of the northern lowlands use more chemical fertilizers as compared to the low potential mountain areas of the south. The use of manure in the low productive areas of the south is also not significant. Non-use of chemical fertilizers is mainly due to the critical cash flow situation of most farm

households, and where low doses are used in an attempt to save, crop yields are poor on the infertile soils.

The transport infrastructure is growing steadily off a moderately low base, both in terms of the length of the road network (2370 km in 2006) and the proportion of roads that are paved (Lesotho Statistical Yearbook, 2008). The proportion of paved roads stood at approximately 57% for 2006 (Lesotho Statistical Yearbook, 2008) but has since risen due to ongoing construction. Road-building is expensive because of the steep terrain and deeply incised topography. The south-western mountains and Senqu River Valley (Mohale's Hoek and Quthing), as well as the north-eastern mountains (Mokhotlong) are not as well served with roads as the rest of the country (Lesotho Statistical Yearbook, 2008). Nevertheless, these districts have a reasonably high proportion of paved roads, with Botha Bothe (37%), Qacha's Nek (29%) and Thaba Tseka (1.4%) having low proportions of paved roads.

Being a landlocked country, there are no sea ports, but there is one international airport, two other airports and a number of airstrips. The communications infrastructure is of moderate extent and functionality, with gains being made in cell phone connectivity, but internet usage remaining very low.

Legal

A range of Acts, Strategies and Policies are in place for the regulation and development of the resources-based economic sectors (water, agriculture, livestock, forestry and conservation) – these are summarised in the following section (section 2.2).

The Lesotho Highlands Water Project treaty with RSA was negotiated to be to the mutual advantage of RSA and Lesotho, protecting the quality and quantity of water in the LHWP area. The LHWP is a trade for resources in which Lesotho receives income from the storage and diversion of water to the industrial and business region of South Africa (Gauteng). No water is currently stored and diverted for use in the agricultural sector in Lesotho. Lesotho is a member of the Orange-Senqu River Commission (ORASECOM).

Environment

Lesotho is a high-altitude country with difficult environmental conditions. Total land area is about 30,000 km^2 and only 9-12% of this is arable. Much of the remaining area is used as commonage. A combination of environmental management and socio-economic factors have over time caused significant biophysical degradation of both the arable and range lands. Population growth, a largely pastoral and agrarian society using poor land management practices, recurring droughts and high intensity rainfall, are leading to substantial land degradation, particularly in the south western lowland of Mafeteng and Mohale's Hoek districts, as well as sheet and rill erosion over most of the country. In response to this threat, Lesotho has

introduced one of the most advanced soil conservation programs in Africa. Measures like terracing, grass stripping and the construction of dams and diversion furrows are widely employed to cope with the severe erosion problems. There is also a growing acknowledgement that structures alone will not solve the problem, and that community and farmer participation is essential.

2.2. Legal and policy analysis

Lesotho's legal system is based on a complex dual practice of the English Common Law /Roman Dutch Law and Customary Laws. There is a judicial review of legislative acts in the High Court and Court of Appeal. Lesotho accepts the International Court of Justice. There are a number of subordinate courts, including resident magistrates courts, judicial commissioners courts and local courts which administer statutory laws. The Chieftainship administers customary laws.

The following summary of the legal and policy environment with respect to climate change is adapted from the RCCP Feasibility Review (OneWorld Sustainable Investments, 2007):

Strategic National Development Plans:

Lesotho's development plans are encapsulated in the following strategic documents: National Vision 2020 (2001-2003) and Poverty Reduction Strategy (2003).

In addition, Lesotho is striving to meet its goals in term of the Millennium Development Goals (MDGs), particularly MDG1 (reduce the number of hungry people by half) and MDG7 (attain environmental sustainability) by 2015, as agreed at the World Food Summit of 1996.

Relevant principal laws

Water Resources Act, 22 of 1978

The Act (13 articles) provides for the use and control, protection and conservation of water resources. The Act establishes a permit system, administered by the Water Officer, for all non-domestic water uses. It regulates servitudes, dispute settlement, the use of wells and boreholes, offences and penalties. The Act also prohibits pollution and empowers the minister to make further regulations concerning, inter alia, user associations, protected areas, inspections and water administration areas.

Environment Act, 2001

This Act makes provision for the establishment of the National Environment Council, the Lesotho Environment Authority, the National Environmental Fund

and the Environmental Tribunal and provides in general for the conservation and management of the environment of Lesotho.

The Act consists of 123 sections divided into 16 Parts. Part VIII on environmental management provides for a wide variety of matters such as identification and protection of hilly and mountainous areas, re-forestation and afforestation of hilly and mountainous areas, protection of rivers, river banks or wetlands, general and specific orders, for standards for the management of rivers, river banks, lakes, lake shore and wetlands, protection of forests, conservation of energy and planting of trees or woodlots, conservation of Biological Diversity and biological resources in situ and ex-situ, access to genetic resources of Lesotho, management of range lands, land use planning, protection of natural heritage sites, protection of natural environmental areas, protection of the ozone layer, management of dangerous materials and the management of (hazardous) waste. The Authority may issue to any person, in respect of a matter relating to the management of the environment and natural resources, an environmental restoration order pursuant to Part IX.

Forestry Act, 1998

This Act repeals previous laws relating to the planting and preservation of forests and provides for the regulation and control of forest produce and the sustained management of forests and forest reserves and other related matters. A principle objective of the Forestry Act of 1998 is to transfer management of the existing State Forest Reserves to local communities – as a way of encouraging sustained (and sustainable) management. However the Minister shall also have a right to reclaim the forest reserve if the agreement between the Minister and any entity to which the forest reserve had been transferred, is breached materially. This important policy initiative is a move towards decentralization as a means of improving and sustaining management.

It is important to note that forests provide the resources for fuelwood but may have a negative effect on local water resources if these forests are of sufficient size and position upstream of the water demand. Judicious management of forest resources is therefore required.

Land Act, 1979 (Act No. 17 of 1979)

The Act makes provision with respect to titles in land, the development of selected land and the resolution of disputes regarding land and various other matters relating to land. As a corollary to the principle that land in Lesotho is vested absolutely and irrevocably in the Basotho Nation and is held by the State, no person (other than the State) shall hold any title to land except as provided for under customary law or under this Act. This Act shall prevail where it is inconsistent with customary law. The power to grant titles to land, to grant or create servitudes, to revoke or derogate from an allocation made under Part II, to terminate or revoke a lease, license or servitude is vested in the King.

Disaster Management Act, 1997 (Act No. 2 of 1997)

"Disaster" means a progressive or sudden, widespread or localised, natural or man-made event including not only prevalent drought but also heavy snowfalls, severe frosts, hailstorms, tornadoes, landslides, mudslides, floods, serious widespread fires and major air or road traffic accidents. Sections of Part II provide for the declaration of the state of disaster by the Minister and concomitant emergency powers. The Disaster Management Authority, established under Part V, shall prepare a National Disaster Management Plan that the Minister shall submit to the Cabinet for approval. The plan shall cover requirements for disaster management, including mitigation, preparedness, response and recovery measures. Upon the declaration of a state of disaster and for its duration, the Prime Minister shall establish a National Disaster Relief Task Force which shall consist of Ministers directly involved with that disaster.

Relevant principal policies

With respect to agriculture and food security, the following policies have been developed:

Agricultural Sector Strategy (2003):

Six overall sectoral goals are identified. They are food security, poverty alleviation, sustainable environmental management and conservation, efficiency, improved income distribution and increasing share of agriculture in GDP.

A number of strategic principles are also identified throughout the text. Among the most important of these is the shift of government policy toward developing and relying on the private sector to provide the main driving force of development. The government complements this by playing a facilitatory role: making and implementing regulations where they are needed.

Two adjustment policies in particular are needed to help government in the transition from the old set of policies to the new one. The first is the liberalisation of trade and market regulations and second is the privatisation of state enterprises. These are explained and then strategy in individual sub-sectors is discussed. The sub-sectors chosen fall into three groups:

(i) The production sub sectors. These are crops (including field crops / grains; horticulture and special crops; seeds and irrigation); livestock (covering animal production and animal health) and subsistence production.

(i)i Cross cutting sectors which may be productive in themselves but also have implications for other sectors. These are marketing; health covering HIV/AIDS and nutrition; forestry conservation & range management; land use; land tenure; rural finance and investment.

(iii) Government services, covering extension and training as well as research.

Food Security Policy (2005):

The **goal** of the Food Security Policy is that by 2015, the numbers of people undernourished in Lesotho shall be half of the number undernourished in 1990. The GoL committed itself to this goal in 1996 at the World Food Summit, and this was reiterated in commitments made to the Millennium Development Targets in 2000.

The **main objective** of the food security policy is to:

Improve the *adequacy* and *stability* of access to food at household level.

Further objectives are to:

Improve the *utilisation* of food at household level

And

Improve *adequacy* and *stability* of food supplies at national level

These objectives shall be achieved through a number of strategies, which are as follows:

- Employment promotion to ensure sufficient and stable access to food;
- Effective monitoring of the impact of employment polices on food security;
- Promotion of agricultural and food production;
- Promotion of infrastructure and services to support livelihoods;
- Promotion of public transfers and social safety nets;
- Mainstreaming HIV/AIDS within the Food Security Policy to maximise the impact of policy measures on households affected by HIV and AIDS;
- Effective management of commercial food imports, food aid deliveries, and food stocks;
- Promotion of improved utilisation of food at household level.

The strategies shall be supported by:

- Improved food security and vulnerability information systems; and
- A strengthened institutional framework for implementing, monitoring and evaluating food security measures.

National Action Plan for Food Security (2006)

The National Action Programme for Food Security (NAPFS) is cast within the context of the PRS, the Agriculture Sector Strategy and the Food Security Policy, and has a 10-year horizon.

The **overall goal** of the Action Plan is to provide a Strategy and supporting programmes of food security interventions that can effectively address the needs of the resource-poor rural and peri-urban households whilst encouraging the commercialization of agricultural production and provision of support services in rural areas.

The Action Plan has five **major objectives**:

(a) to improve farm productivity, incomes and household food security through intensification, diversification and commercialisation of farming system and promoting marketable sales of agricultural produce;
(b) improve the nutritional and health status of the most vulnerable, and in particular those with HIV/AIDS;
(c) Improve the system of support services through public-private-civil society partnership;
(d) safeguard the long-term sustainability of the country's renewable resource base and protect the ecosystem;
(e) identify and promote policy dialogue.

The Action Plan comprises five **Programmes**:

(a) Programme 1: Commercial and Household Food Security with four sub-programmes - Conservation Agriculture-based Block Farming, Specialised Integrated Commercial Agriculture Production and Processing and Enabling and Supporting Rural Livelihoods;

(b) Programme 2: Watershed Protection and Management consisting of four sub-programmes - On-Farm Land Management, Communal Land Natural Resources Management, Range Management, Water Resources Management and Harvesting;

(c) Programme 3: Safety Nets and Social Protection with two sub-programmes - Public Works (emergency and long term) and Transfer (emergency and long term);

(d) Programme 4: Food Supply Stability and National Availability comprising three sub-programmes - Strategic Food Reserves, Commercial Food Imports and Food Deliveries;

(e) Programme 5: Cross-cutting to support Institutional framework, Food Security Information Systems and Monitoring and Evaluation.

Other relevant policies:

- Irrigation Policy (draft)
- Livestock Policy (1997)
- Forestry Policy (1996/97)
- Environmental Policy
- Range Management Regulation (1980)
- District Economic Strategies (2002-2005)

Climate change strategies and policies

Lesotho has met its obligations under the UNFCCC by submitting its First National Communication (2000), as well as a NAPA (2007). Although the Laws and Policies outlined above are closely aligned with climate change objectives and will assist the country in adapting to climate change and reducing greenhouse gas emissions, there is not yet a coordinated national climate change strategy in place. The danger is that sectoral initiatives will not be effective without overall integration into a coordinated national response, which in turn would leverage international funding for adaptation and mitigation.

National Adaptation Programme of Action (NAPA)

Lesotho NAPA on climate change under the UNFCCC was published on 1 January 2007. The NAPA process identified eleven adaptation options outlined below in their order of priority:

- Option 1: Improve resilience of livestock production systems under extreme climatic conditions in various livelihood zones in Lesotho;
- Option 2: Promoting sustainable crop-based livelihood systems in foothills, lowlands and the Senqu River Valley;
- Option 3: Capacity-building and policy reform to integrate climate change into Sectoral Development Plans;
- Option 4: Improvement of an early warning system against climate-induced disasters and hazards;
- Option 5: Securing village water supply for communities in the southern lowlands
- Option 6: Management and reclamation of degraded and eroded land in the flood-prone areas (pilot project for western lowlands);
- Option 7: Conservation and rehabilitation of degraded wetlands in the mountain areas of Lesotho;
- Option 8: Improvement of community food security through the promotion of food processing and preservation technologies;
- Option 9: Strengthening and stabilizing eco-tourism-based rural livelihoods;
- Option 10: Promote wind, solar and biogas energy as a supplement to hydropower energy and
- Option 11: Stabilizing community livelihoods which are adversely affected by climate change through improvement of small-scale industries.

NAPA Implementation Strategy

Implementation of NAPA will require active participation of all stakeholders, which include: government and line ministries, the private sector, vulnerable communities and NGOs. Assistance of international implementing agencies and co-operating partners is also critical for providing technical assistance to secure funding for the proposed project activities.

Barriers to implementation

- Insufficient financial resources to implement environmental activities;
- inadequate institutional and systemic capacity for climate change initiatives;
- shortage of human resources with requisite environmental expertise and skills in both community and institutional levels and
- lack of awareness on the impact of climate change in people's livelihoods.

In conclusion, enforcement of legislation remains weak and requires strengthening of institutional capacity at national, district and constituency level, particularly the latter.

2.3. The role of agriculture and forestry in the economy

This section draws on data sources from the United Nations Food and Agriculture (FAO) online databases, the Lesotho Food Security and Vulnerability Monitoring Report (LVAC, 2008), the Lesotho Bureau of Statistics online databases, and the Lesotho Climate Change Vulnerability Assessment Report (2000).

Sector overview

Although agriculture does not make a high contribution to the nation's Gross Domestic Product (GDP) (15.7% in 2003), some 80% of the people of Lesotho rely on agriculture in one way or another for their livelihoods. An underperforming agricultural sector thus has substantial economic ramifications, many indirectly through more extensive and deepening poverty levels. About half of the rural population are regarded as "very poor" or "poor" (LVAC, 2008). Dwindling job opportunities in South African mines and lack of formal job creation result in an ever-increasing sector of the population turning to agriculture in search of livelihoods.

Lesotho has a highly traditional agrarian structure. Almost 90% of the farmers operate on a small-scale or subsistence level, with the remaining

10% working medium-scale commercial farms. Communal land is allocated for crop farming or livestock grazing by the Chief and his structures.

The estimations of arable land vary between 9% and 12%. The lower estimate accounts for the amount of arable land that has been lost to soil erosion and land degradation, as well as urbanization over the last few decades. All the arable land is cultivated, and sometimes more due to encroachment onto marginal and fragile lands. About 70% of the land is used for pasture, and less than 1% is forest and woodland.

Crop farming

The primary crops grown include maize (which contributes 40% to the daily diet and occupies 60-65% of the planted area), sorghum (which is mainly used for brewing, feed and porridge, 10-20%), winter wheat (10%) and legumes, particularly beans (6%) and peas, which provide much-needed protein. Other minor crops include potatoes, vegetables (e.g. cabbage, spinach) and fruit, particularly peaches.

Yields are generally low, and substantially below their potential. Climatic variability, including erratic rainfall and recurrent droughts, have a large influence on year-on-year production (see Figs 2-3) and yield (Fig. 4), particularly over the last 10 years. .Additional factors include soil erosion, declining soil fertility, poor crop, livestock and range management practices, inappropriate past policies, weak extension services, and the impacts of HIV/AIDS. The declining yields, together with population growth, account for the increasing reliance on food imports and food aid, particularly the staples maize and wheat. Only about 14% of the country's food requirement is home grown.

Less than 1% of arable land is irrigated, and about 1.4% of renewable water resources are used for irrigation. Only 67 ha of the 2637 ha equipped for irrigation were still under operation by 1999 and still relied heavily on government and /or donor support, although the latter has declined in recent years. Approximately 175 ha of the total equipped area were small schemes (< 100 ha) and 2462 ha were large. The long-term irrigation potential in Lesotho is estimated at 12500 ha. It was estimated at 2520 ha for the foreseeable future in 1996, although this figure could be reduced by the high cost of irrigation development and thus limitations imposed by the market for high value crops. Other estimates of irrigation potential, considering only the available water resources and taking into account the reduced water availability due to the LHWP, reckon that a minimum of 3500 ha and up to 7000 ha could be brought under irrigation if the Senqu River potential is fully exploited.

It was announced by the government in early 2004 that an irrigation master plan is being developed to enable the networking of irrigation infrastructure throughout the country and that 59 irrigation sites in the foothills region are

meanwhile being surveyed for the possible installation of simple gravity irrigation systems. The Irrigation Policy is still in draft.

Livestock farming

The livestock industry (Fig. 5) relies strongly on sheep and goats which provide wool and mohair, respectively, for export, as well as meat. Other livestock include cattle (for meat, milk, draught, hides, and for cultural purposes), horses and donkeys (transport), and chickens (meat and eggs, low production). Hides supply a footwear industry, which is, however, in decline. The livestock industry is less directly sensitive to erratic climatic conditions, although indirectly via the quantity and quality of grazing. Poor rangeland management, overstocking and poor husbandry practices have led to poor and declining quality of animals and their products. The closure of the National Abattoir and Feedlot in 1997 has limited the meat market to local requirements. Milk is also produced mainly for home consumption, although some is processed by the Lesotho Dairy. Nevertheless, production and value of wool and mohair, one of the few export products, has risen well over the last decade (Fig. 6).

Forestry

The forestry sector is small and does not enjoy much scope for expansion. Indigenous trees and shrubs have been extensively utilised for fuel wood, and remaining patches are under heavy pressure, although more inaccessible than in the past. Government and private woodlots are found mainly in the Lowlands and Foothills, with very few in the Mountains. There has recently been a shift towards greater community involvement in forestry management.

Forest resources play a critical role in preventing soil erosion, protecting water resources, and providing firewood, building materials, forage and shelter. In 2005, about 8000 ha of forest existed, an increase from 5000 ha in 1990. The greatest rate of increase was between 1990 and 2000, followed by a decline in the rate of afforestation.

Future potential

The scope for increasing food production through area expansion is extremely limited. Increased irrigation would allow for intensification and diversification of the crop base, especially high value crops. This has been incorporated into agricultural policy.

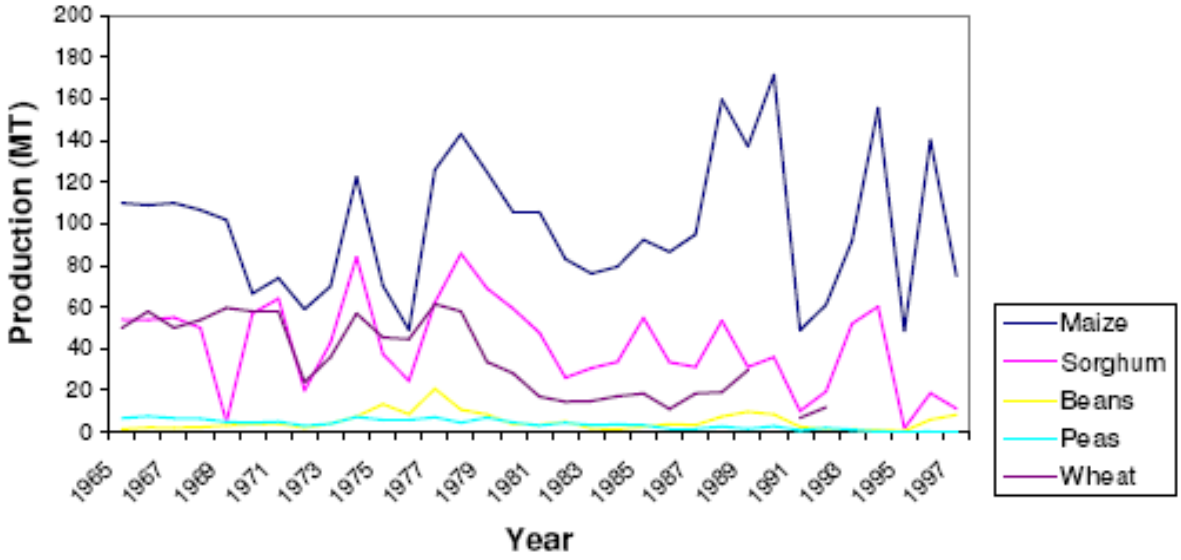
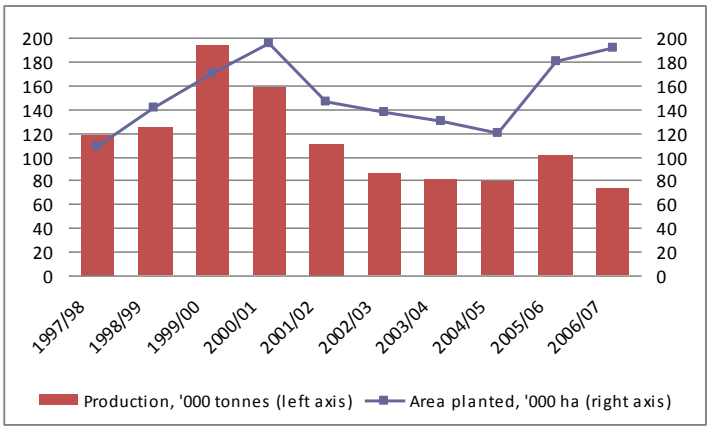


Fig. 2. Trends in the production of major crops for the period 1965–1997 (Lesotho Climate Change Vulnerability Assessment Report, 2000).

(a)



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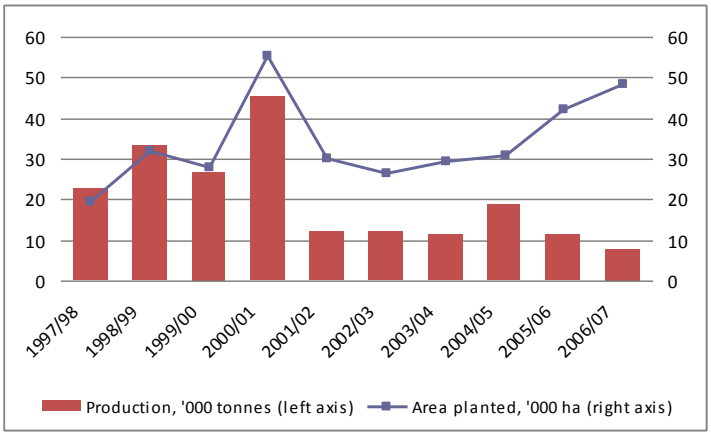

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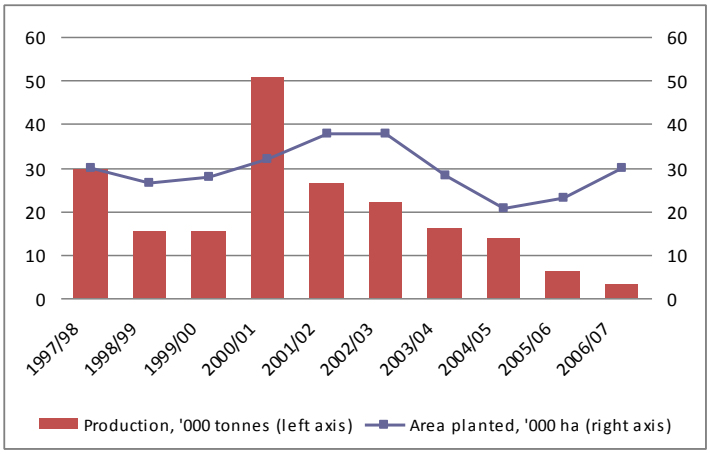


Fig. 3. Trends in the production and area planted for (a) maize, (b) sorghum, and (c) wheat for the period 1997/98 to 2006/07 (Bureau of Statistics Statistical Yearbook, 2008).

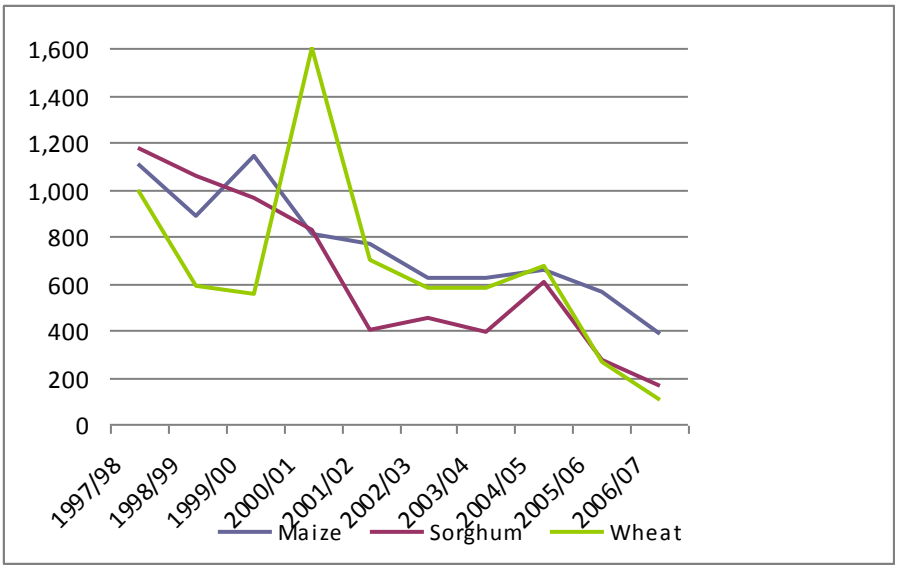


Fig. 4. Trends in the yield (kg/ha) of maize, sorghum and wheat for the period 1997/98 to 2006/07 (Bureau of Statistics Statistical Yearbook, 2008).

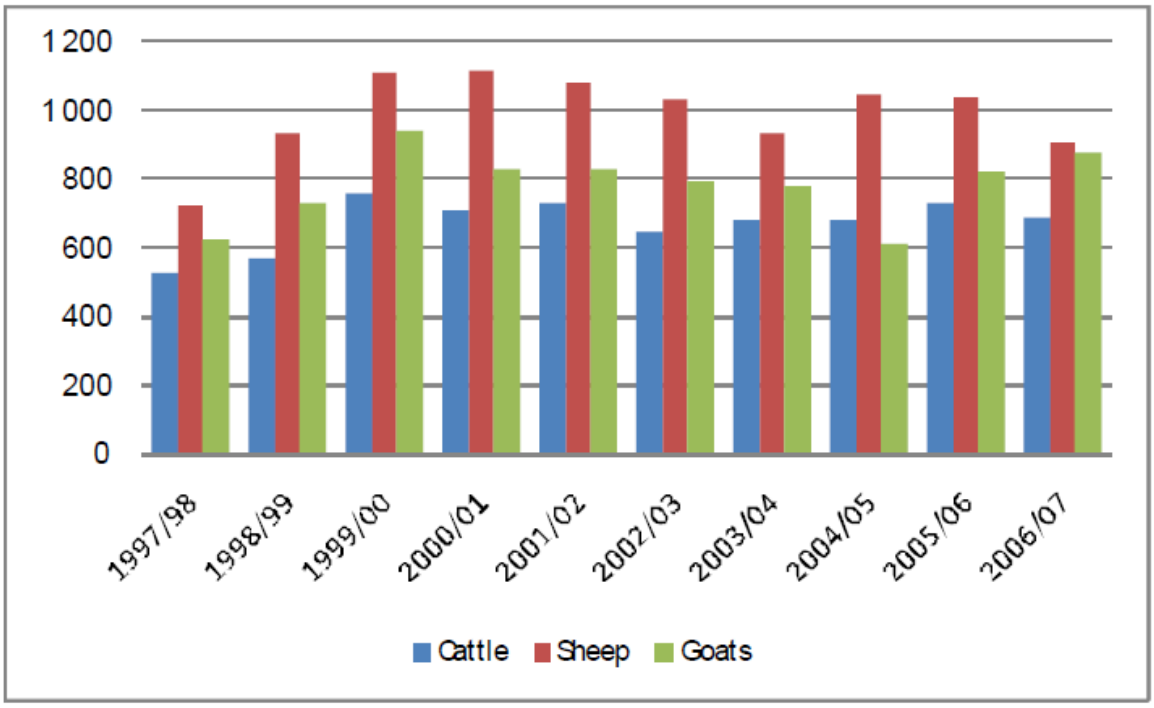
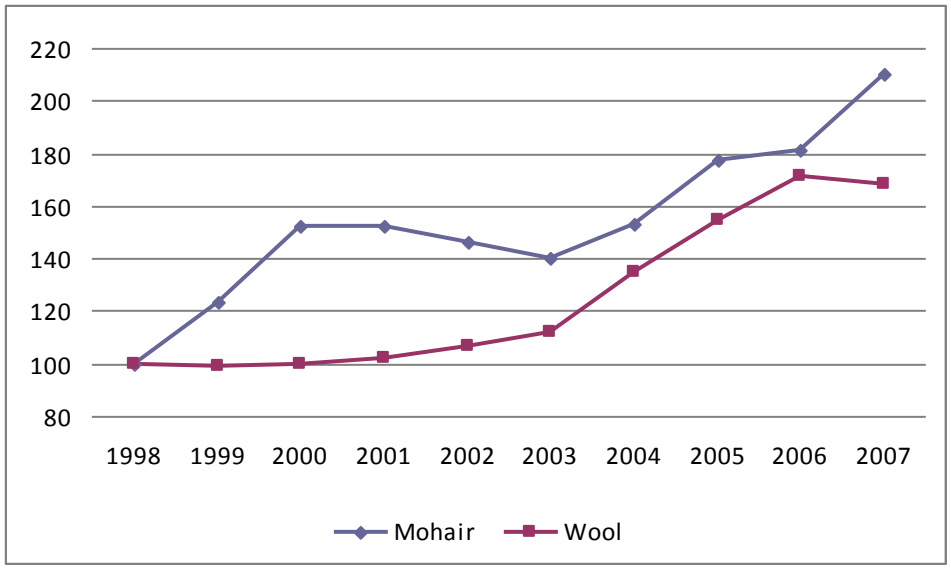


Fig. 5. Trends in the number of cattle, sheep and goats for the period 1997/98 to 2006/07 (Bureau of Statistics Statistical Yearbook, 2008).

(a)



(b)

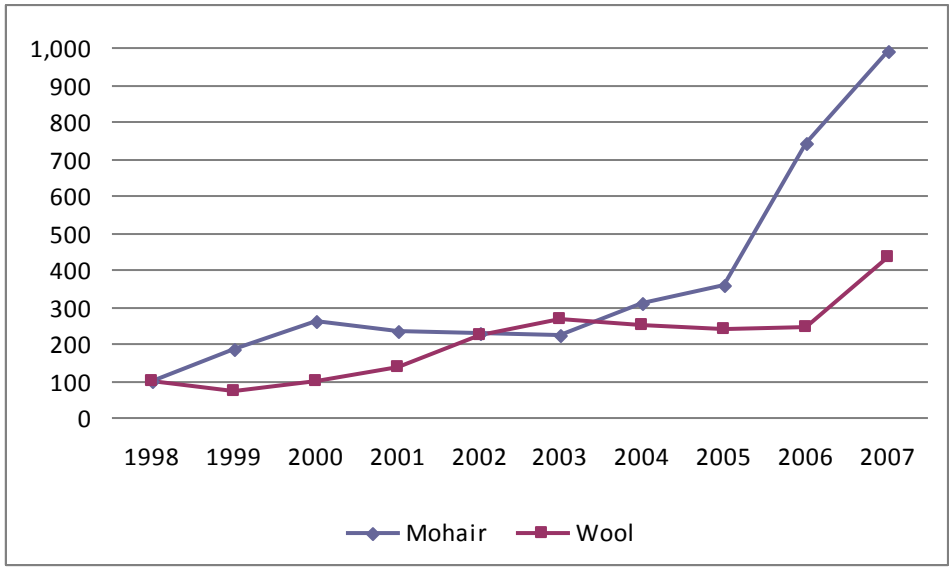


Fig. 6. Trends in (a) tonnes of wool and mohair, and (b) value (Maloti, thousands) of wool and mohair, relative to the baseline year 1998, for the period 1998 to 2007 (Bureau of Statistics Statistical Yearbook, 2008).

2.4. Historic view of climate vulnerability

Southern Africa has a long history of climate vulnerability. Events 200 years ago that are possibly climate-related still have their impact in Lesotho today. A summary of the climate influences follows in which a regional overview is given because of the available information but it is highly likely that, at

synoptic scales (1000 – 2000 km), the seasonal effects of climate are coherent across the region, i.e. drought is usually regional rather than confined to a specific locality.

Even before records were kept, droughts and floods have had significant impacts on Southern African societies (Ballard, 1986; Denbow, 1986; Vogel, 1989). Around AD 1200 to 1500, overgrazing and drought lead to the abandonment of settlements in the Kalahari (see Hall 1976). Speleothems, tree-ring records and oral histories indicate a number of devastating droughts in the 1700s and 1800s in Southern Africa (Holmgren et al., 1999; Hall, 1976; Dunwiddie and LaMarche, 1980, Vogel, 1989). Dry phases in the region in the first half of the 1700s could possibly be ascribed to the Little Ice Age when climates were generally cooler and dryer.

A long and deep drought during the early 1800s, which resulted in a substantial loss of grazing and water resources, lead to widespread famine and starvation. Around 1815 and lasting until the 1840s began the Lifaqane in Lesotho (also known as Difaqane in isiZulu), a period characterized by famine and fighting between nations and clans as the Zulu King Shaka set about uniting (and effecting control) of large areas of what is now KwaZulu Natal (Ballard, 1986). It is quite reasonable to expect that a sequence of volcanic eruptions in the early 1800s resulted in atmospheric cooling and a decade-long drought in Southern Africa, causing environmental degradation. Warfare is a common result, even today, of drought-induced famine among pastoral peoples.

Sulphuric acid layers in ice have been identified in the Antarctic for 1808, 1809 and 1815 (Robbock, 2002). The 1815 date is a consequence of the eruption of Tambora in Sumbawa, Indonesia, which injected huge amounts of sulphates into the atmosphere. Robbock (2002) speculates that the 1808-1809 event was at least as large as Tambora but the source has not been identified. Sulphates are known to increase albido of the upper atmosphere and reduce radiation loading at the earth's surface. The 1815 eruption was associated with reduced temperatures, drought and famine globally.

Vogel (1989) and Lindesay and Vogel (1990) indicate that large areas of southern Africa experienced dry conditions in 1826–7, 1832–5, 1848–51, 1858–60, 1861–3, 1877–81, 1884–6 and 1894–9, with the dry phases of the early 1850s, 1858–60, 1861–3 and 1894–9 affecting areas at least as far north as northern Botswana. Wetter phases affected much of the subcontinent in 1829–30, 1851–2, 1863–4, 1874–5, 1889––91 and 1899–1900, with widespread flooding in areas as far apart as central Botswana and the eastern Cape during the wet periods of 1874–5 and 1889–91. We expect that these conditions applied to Lesotho as well and indicate the climate-related stresses which have been prevalent in the country for a long time.

The people of Lesotho have, therefore, evolved within this climatic context and have developed a range of coping mechanisms which have served them well in the past. What has changed in recent times, however, is the increasing frequency, magnitude and duration of climatic shocks, leaving

little or no time to recover from the last event. Add to this the heightened competition for arable land due to population increase and migration to the lowlands, competition for land between crops and livestock, lack of resting of the land and progressive loss of vegetative cover, rapidly dwindling soil and water resources, few opportunities for off-farm income, and deepening poverty, and a picture emerges of increasing inability to deal with these shocks.

2.5. Human vulnerability: monitoring and initiatives

The vulnerability of Lesotho's population to various stress factors and especially to chronic food insecurity has come under close scrutiny over the last two decades, driven by increasing population pressure, decline in work opportunities in the South African mining sector, recurring droughts and failure to produce enough food locally, rapidly degrading soil resources on which most of the population depend in one way or another, and the HIV/AIDS epidemic. The close links between poverty and vulnerability are becoming increasingly obvious. People living in poverty are particularly vulnerable to climate risk and climate change. Poverty is often linked to a higher reliance on natural resources, thus making poor people more sensitive to changes in the environment. This, in turn, leads to degradation of natural resources, and a vicious circle of increasing vulnerability to climate variability and change.

The Government of Lesotho, NGOs and international donors have launched a range of programmes in an effort to understand the immediate and long-term underlying causes better, so that they can be addressed effectively. At government levels, the Food and Nutrition Coordinating Office (FNCO) is tasked with assessing food insecurity conditions and needs.

Some of the ongoing initiatives include the monitoring done by the Lesotho Vulnerability Assessment Committee (LVAC) which falls under the Disaster Management Authority of the Prime Minister's Office. The LVAC is mandated to provide information on vulnerable populations and provide recommendations to, for example the Ministry of Agriculture and Food Security, Ministry of Finance and Development Planning, the Ministry of Health and Social Welfare, international partners and local NGO's, on the appropriate responses. Since 2002, the LVAC has conducted three assessments. After the initial focus on emergency food needs, it became increasingly clear that responses to food crises need to go beyond short–term food aid needs to longer term livelihoods interventions (Livelihood Based Vulnerability Assessment (LBVA) and analysis). This grew out of the Livelihood zoning project conducted with the assistance of the Regional Hunger and Vulnerability Programme (RHVP).

Other players and initiatives include the FAO, CARE Lesotho, World Vision Lesotho, Lesotho Red Cross, Rural Self Help Development Association, the United Nations Office for the Coordination of Humanitarian Affairs (OCHA),

the United Nations Children's Fund (UNICEF), the United Nations Development Programme (UNDP), the World Food Programme, and the DfID-funded Livelihoods Recovery through Agriculture Programme (LRAP).

The Lesotho Bureau of Statistics (BOS) is conducting surveys based not only on administrative boundaries (districts, constituencies) but increasingly also on the six Livelihood zones. This is providing valuable data with which to integrate vulnerability into all other sectors. Better statistical data, analysis and dissemination of information to those who require it, in the right format, are essential for effective evidence-based policy decision making and crisis intervention.

3.METHODOLOGY

3.1. Approach

Frameworks and models for assessing the impact of climate change on natural and social systems have been evolving over the last two decades. Füssel and Klein (2006) provide a useful map outlining the evolution of assessment models, drawing in particular on the work of the IPCC. In their study, they identify four distinct models, each reflecting a more complex climate change vulnerability assessment that is a response to changing stakeholder needs: *impact assessments*; *first-generation vulnerability assessments* (which take into account non-climatic factors and their likely impacts on society, as well as the potential there is for adaptation); *second-generation vulnerability assessments* (focussing more on adaptive capacity); *adaptation policy assessments* (which aim specifically to address information needs of decision-makers). The selection of an appropriate model is largely dependent on the "decision context" (Füssel and Klein, 2006) i.e. what decisions need to be taken for what ends? There has also been a shift from considering vulnerability as an end point (i.e. vulnerability arises because of climate change), to vulnerability as a starting point (i.e. systems, sectors and groups are already vulnerable due to non-climatic factors, and climate change is an additional stressor). The latter is the approach that the OneWorld team has adopted in this project.

There has also been considerable development in the understanding of the concept "food security". From the initial definition based primarily on food production, this has evolved to include underlying socio-economic and environmental conditions and the concept of an integrated food system (Mano et al., 2007). Food systems encompass food activities (production, processing, distribution, preparation and consumption of food) and outcomes of these activities which contribute to the three components of food security - availability of food, access to food, and food utilisation. These are all informed by community and household livelihood systems. In this vulnerability assessment, we will employ a livelihoods-based understanding of food security, which includes acknowledgement of local coping mechanisms and thresholds.

3.2. First-to-fourth-order impacts

The phenomenon and impacts of climate change are wide-ranging and highly complex. It is common practice in climate change assessments to take a sectoral approach, but this invariably leads to lack of cross-sectoral integration, which is so critical when assessing economic and social system responses. We prefer to take a more hierarchical ("inverted pyramid")

approach to classifying climate impacts, starting with the basic climate parameters, and gradually scaling up to organism and system levels. We define the levels as follows:

1st order impacts: changes in atmospheric CO_2 concentration, temperature, rainfall parameters, humidity, wind and sunshine hours (basic meteorological conditions), as well as extreme climatic events

2nd order impacts: consequences of 1st order changes for agro-climatic conditions and agricultural resources (water/soil)

3rd order impacts: crop and livestock responses and effects on production

4th order impacts: rural economies and livelihoods – interaction with other stressors and drivers of change.

We have used this approach to provide a framework for the Risk and Vulnerability analysis.

3.3. Understanding risk and vulnerability

We start by examining the current climate of Lesotho (Chapter 4), as well as current impacts, risks and vulnerabilities associated with present-day climate and climate variability **(Situation Assessment)**, as linked to crop-, livestock- and forest-based livelihood systems in the two major livelihood zones (the Southern Lowlands and the Mountains) – Chapter 5. This involves an in-depth literature review of current climatic conditions, physical characteristics, the natural resource base (particularly soil and water), agro-ecological zones, crop and livestock types and production levels, marketing infrastructure, economic conditions as pertaining to agriculture, rural social systems (population structure, livelihood systems, poverty and food insecurity), and the primary current constraints on agriculture/livestock production and food security.

This is followed by an analysis of the complication arising from present and future climate change **(Complication Assessment)**, and includes a study of current climate change projections and scenarios (Chapter 6). Projections were sourced from various reputable international and regional sources to which OneWorld has established links. Both medium-term (2030-2040) and longer-term (2080-2100) timeframes were used, but with a primary focus on the former. These formed the basis for the development of two broad scenarios for climate change in Lesotho, and include both gradual changes in mean climate (warming combined with various annual rainfall outcomes), increased variability of rainfall, changes in seasonal rainfall patterns, and increased occurrence of extreme events. These scenarios informed the analysis of risk and vulnerability to climate change for agricultural livelihoods and food security (Chapter 7).

Risk is often defined as the likelihood of occurrence of a hazard x the potential consequences. However, this does not take into account underlying

adaptive capacity and farmer/household coping mechanisms. To address this, the concept of vulnerability is more often used in the climate change context. *Vulnerability* can be defined as the function of exposure to climate change (i.e. how much will the sector be exposed to climate change), the sensitivity to change (i.e. how much will the system react to climate change) – together they give an indication of *potential impact* - and the capacity of natural and human systems to adapt to that new climatic condition – called *adaptive capacity.* This is illustrated in Fig. 7:

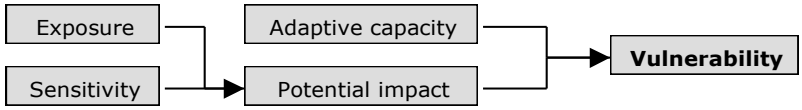


Fig. 7. Vulnerability and its components (Source: Adapted from D. Schroter and the ATEAM Consortium 2004. *Global change vulnerability – assessing the European human-environment system*. Potsdam Institute for Climate Impact Research. From Climate Change Risk and Vulnerability – Final Report 2005: Australian Greenhouse Office, p. Ix)

The assessment includes a sensitivity analysis of the major components of vulnerability in the two selected livelihood zones. The biophysical assessment is linked to current and projected socio-economic conditions, including population demographics, livelihood systems (including food systems) and community/household food security. This will identify the most vulnerable sectors of the population.

4. CLIMATE OF LESOTHO

4.1. Regional circulation as a driver of weather

Rainfall in Southern Africa is then driven by the regional expression of global atmospheric circulation systems. Mean circulation over southern Africa is anti-cyclonic throughout the year, meaning warm, dry descending air and is responsible for the general aridity in Southern Africa. Subtropical anticyclones (travelling and blocking) suppress the synoptic-scale cyclonic circulation, leading to dryer air over Lesotho. This pattern weakens during the summer when a heat driven low pressure system over the centre of the region helps suppress the anticyclonic circulation, enabling convection and thunderstorm activity.

A low pressure system can form over Botswana as part of the Congo Air Boundary (CAB), a zone of convergence of airstreams from the Atlantic and Indian Oceans (Tyson and Preston-Whyte, 2000, p.164). This system is associated with the ITCZ and when these troughs intensify or deepen and extend southwards, heavy rains form east of the trough in the easterlies. This system particularly influences periods of heavy, extended rainfall in Lesotho and may preferentially form during the La Niña phase of ENSO. Conversely, El Niño Southern Oscillation (ENSO) distorts the position of Botswana trough, pushing it out to the east and causing dry conditions over Lesotho. During the rainy season over the Southern Africa, easterly flows penetrate the interior, giving rise to orographically-forced rainfall along the eastern escarpment but also advecting moist air further into the interior where it enhances rainfall in the interior through convection.

During winter (June, July and August), anticyclonic flows are dominant in the interior and Lesotho experiences cool dry air. When this anticyclonic circulation strengthens, forced by steepening pressure gradients and also by an approaching trough or cold front from the south west (Atlantic), "berg winds" flowing downslope heat adiabatically, creating hot dry winds which favour wild fires. Rangeland fires therefore occur in the winter months when the dry senescent grass provides sufficient fuel conditions to carry the fire. These rangeland fires occur at a frequency of every one to two years, the current practice being an annual burn set by local people to encourage forage. A high frequency of fire has a negative effect on the sustainability of the grasslands and is a management problem for Lesotho government. Deep cold fronts can deposit significant amounts of snow on the high ground, sometimes isolating small outlying communities.

4.2. Climate of Lesotho

Precipitation in Lesotho is strongly controlled by topography. The highest mean annual rainfall occurs off the Lesotho escarpment in KwaZulu Natal > 1200 $mm.a^{-1}$ along the range between Cathedral Peak and Mont aux Sources – a function of the orographic forcing of rainfall (Schulze, 1979; Schulze et al., 1997). Within Lesotho, rainfall remains orographically controlled (see Schulze, 1979); Schulze et al., 1997). The strong rainshadow formed by the eastern escarpment results in a much lower rainfall of about 400 – 600 $mm.a^{-1}$ in the Senqu River valley while the remainder of Lesotho receives about 600 – 800 $mm.a^{-1}$ except in the north (Butha Buthe) where higher rainfalls of ~800 – 1000 $mm.a^{-1}$ occurs along the higher ground.

The lowest 10th percentile (1 year in 10 on average, or 10% probability of exceedance) mean rainfall drops from 600 – 800 $mm.a^{-1}$ in the east to 200 – 400 $mm.a^{-1}$ in the Senqu River valley, a rainfall which is quite low for Lesotho and is below the sustainable level for rainfed agriculture. The 10th percentile of maximum rainfall increases 800 – 1000 $mm.a^{-1}$ over most of the country. The area of maximum rainfall of over 1200 $mm.a^{-1}$ does not increase dramatically, however.

Variability of rainfall is fairly high running from 20 to more than 40% in the south, based on modelled the inter-annual coefficient of variation. Highest intensity rainfalls occur along the eastern escarpment. Thaba Tseka in the middle of the country appears to have the least reliable rainfall, being lower and warmer. The 10-year one day design rainfall is about 75 – 100 mm.

The high altitude means that Lesotho experiences some of the lowest temperatures in Southern Africa, especially along the mountain ridges and plateaus. Significant proportion of Lesotho experiences a mean annual temperature of <10°C. Mean daily maximum temperatures mostly do not exceed 22 - 25°C except in the south-west where temperatures can reach 27 - 30°C. Mean monthly temperatures of 7.5 - 10 °C are common in winter when snow is often to be found on the higher ground. Heavy snow falls have significant socio-economic effects by preventing communication in most outlying areas, necessitating air support from South Africa on occasion. Much of Lesotho has 8 – 12 occurrences per year where minimum temperatures drop below 0°C. Along the ridges and internal plateaus, temperatures can drop below -2.5°C a few times a year and temperatures below -7.5°C can occur. Extreme higher temperatures can occur up to 36 - 38°C.

Net primary productivity is low over most of Lesotho, likely because of the cooler temperatures and thinner soils on steep slopes. Areas of higher potential are restricted to small areas of lowland. Most of the country is climatically unsuitable for improved pasture, apart from the extensive areas of stony thins soils and steeper slopes.

The main climatic constraints to agricultural production are the high levels of variability, soil characteristics which combine with rainfall and evaporation to determine soil moisture, and the duration of the growing season (as

determined by the temperature regime, rainfall seasonality and the frost risk). The choice of crop, cultivar and planting date required careful consideration and is not always optimal for the conditions.

4.3. Climatological data and information

The Lesotho Meteorological Services (LMS) are mandated to "improve the livelihood of Basotho through effective application of the science of Meteorology and harmonization of their socio-economic activities with weather and climate."

The goals of the LMS are:

- To provide meteorological services that would contribute towards environmentally sound and sustainable socio-economic development of Lesotho
- To carry out observations of the atmosphere and weather elements at the earth's surface and developing a sound data bank and archiving system to create the National Climate Record.
- To implement on behalf of the Government of Lesotho, the international obligations on meteorology that Lesotho is signatory to.

The LMS provides daily, weekly and seasonal forecasts, as well as agro-meteorological services, amongst others. It has acted as the Focal Point for all climate change-related projects, with a Climate Change Secretariat, and with links to the WMO, IPCC and UNFCCC. It is relatively well staffed and hosts a quality web page.

The continued development and support of the LMS are central to a national climate change strategy. The country's capacity to adapt to changing climatic conditions and prepare for climate-related disasters would be severely compromised by a weak Meteorological Service.

Evidence-based decision making requires the best available (quality) information, which is determined by completeness, consistency, currency (dates), and good metadata. Effective information management rests on the clarification of policies around data ownership and custodianship, data sharing, data communication and processing, retrieval and dissemination. In the agricultural context, the seasonal forecasts could play a major role in adaptation efforts, but regional and national forecasts may not be reaching those who need the information for decision-making within acceptable time-frames and in a useful format (Ziervogel and Calder, 2003; Ziervogel, 2004).

5. LESOTHO LIVELIHOOD ZONES: SITUATION ASSESSMENT

Livelihood zone maps show the division of a country into homogeneous zones defined according to a livelihoods framework. Such a framework describes the different wealth groups in the region, the household activities at different periods in the annual cycle, the hazards (.e.g. events leading to failed crop or livestock production) that are experienced and the relative capacity of different types of households in different places to cope with these hazards. For example, one group of households will be left without any access to food should their crop fail, whereas another group of households will have alternative sources of food or cash or other valuable assets which can be used to purchase food. Livelihoods baseline information provides information on local livelihoods and coping strategies, which can be analysed in the face of current and future hazards to give an indication of relative levels of vulnerability and need for adaptation and/or assistance. This section will give a description of the Livelihood Zones of Lesotho, focusing in particular on the Lowlands and Mountains, and including the current social and natural capital which make up current agricultural potential, and the hazards imposed by the current climate on land-based livelihoods.

5.1. Overview of Livelihood Zoning

In 2002, the Lesotho Vulnerability Assessment Committee (LVAC) was established to perform a livelihood vulnerability analysis in the face of chronic food insecurity. For this purpose, Lesotho was divided into six Livelihood zones – this was done in collaboration with the RHVP. Four zones were identified broadly along the lines of the main agro-ecological zones, namely the Lowlands, the Foothills, the Senqu River Valley, and the Mountains. However, consideration of livelihood factors led to the further division of the Lowlands into the Northern and Southern Lowlands. In addition, a Peri-Urban Livelihood zone was also mapped out which has characteristics of both rural and urban livelihoods. The ten administrative districts are overlain with the livelihood zones according to Fig.8.

In 2003, the LVAC carried out a baseline survey in all six Livelihood zones. Three wealth groups were identified in each zone, namely “poor”, “middle” and “better off”, and a livelihood profile developed for each. This baseline was for a few years used for monitoring impacts of shocks such as low crop yields or high food prices. The lack of resolution in the large “poor” category resulted in the subsequent division of this group into “very poor” and “poor”, the former representing those households in desperate need of social protection programmes. A new baseline study was conducted in 2006 (baseline year 2004/05) for the four wealth groups, which included more

detailed analysis of household asset ownership, sources of food and sources of income. The LVAC is now able to present its results in terms of "expenditure deficits" and "food deficits":

"An ***expenditure deficit*** occurs when households can afford to purchase the balance of food required to make up 100% of energy requirements but cannot afford to purchase all items in the expenditure basket. (Note that the expenditure basket contains essential expenditure such as education, health, agriculture and livestock inputs, and grinding)."

"A ***food deficit*** occurs when households cannot afford to purchase the balance of food required to make up 100% of energy requirements, on top of not being able to afford anything in the expenditure basket."

Across all the livelihood zones, the poor are characterised by their lack of (or highly limited access to) surplus food or cash plus very limited ownership of livestock holdings and other capital assets. The "very poor" and "poor" households generally do not produce enough food to supply the household for the whole year (own production is only 20-30% of requirement), and rely on food purchases, labour exchange and food aid to meet their annual food requirements. They are thus more exposed to market price fluctuations of staple foods.

The "middle" and "better-off" wealth groups have variable but significant levels of surplus food and cash plus significant levels of livestock holdings and other stocks and capital assets – providing them with reserves with which to adsorb shocks to their livelihoods. The contribution of own crop and livestock production to total food intake increases with wealth. The "better-off" households cover about 80% of their food requirements from own production, and the "middle" wealth group about 60%. The food purchases by these groups are mainly for non-staples to complement their staple diet.

A comprehensive description of the six Livelihood Profiles is given in the Lesotho Livelihoods Profile Report (LVAC,2006).

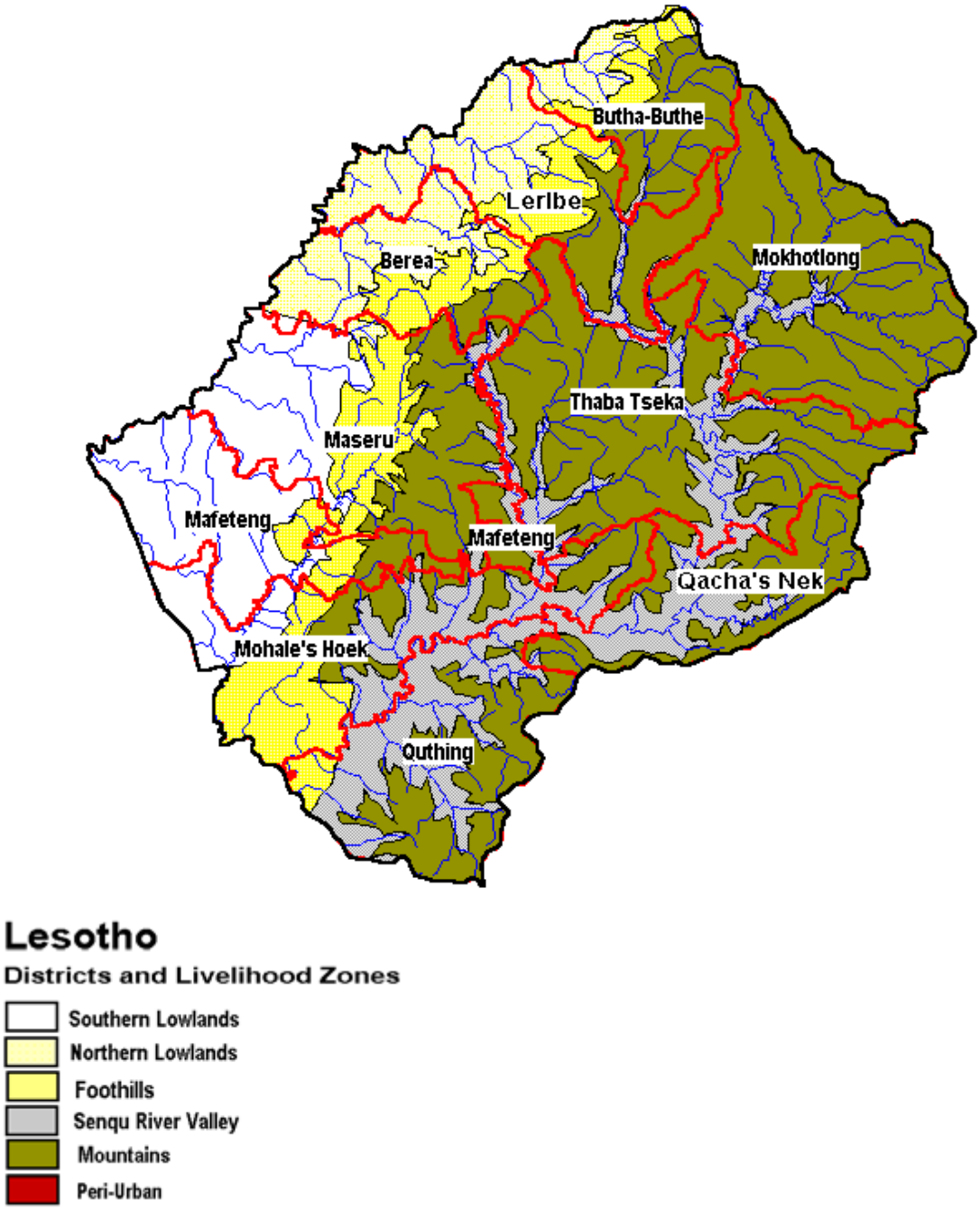


Fig. 8. Lesotho districts and Livelihood zones (source: LVAC 2003).

5.2. Southern Lowlands

Physical, climatic and natural resource characteristics

The Southern Lowlands occur along the south-western border, at elevations below 1800m. The topography is flat to gently rolling, rising gradually towards the Foothills. The soils are sandy with significant clay in places, relatively fertile (although not as fertile as those in the Northern Lowlands), but very fragile with high erodibility especially by wind and flowing water. The Southern Lowlands are one of the driest regions of Lesotho, with the district of Mohale's Hoek receiving only around 500mm rainfall per annum. It also experiences the highest summer temperatures. The Southern Lowlands are arable but less productive than other arable areas of Lesotho.

The summer rainfall period is from October to April, with the peak rainfall period from December to February. June is the driest month with little or no rainfall. This zone experiences a later start to the rainfall season than other zones, and erratic follow-up rains and uneven spread of rain through the season. The danger of rain falling at the wrong time or falling too hard or not falling at all when it is needed is always present even if total rainfall has been adequate. Distribution of water and reliability of rainfall are serious constraints on rainfed agricultural production. During the period 1995/96–2004/05, on average 17,000 ha of planted area failed annually in the Lowlands due to low and erratic rainfall.

The mean annual temperature in this zone is about 15.2°C. January is the hottest month with mean maximum temperatures reaching up to 32°C. Some of the hottest days in the country (up to 40°C) are measured here, especially in the Mohale's Hoek region. Mean minimum temperatures are lowest in June at around -1°C to -3°C but extremes can be much lower.

The annual mean evaporation for the lowlands is about 1600 mm. Evaporation is generally greater than rainfall over most of the year with the highest deficit experienced in summer.

Potential net primary production per hectare is reasonably good over the Lowlands. Based purely on average climate and soils, potential maize yields could reach 3-4 tonnes/ha. However, variability of maize yields are high compared to the rest of the country. Table 1 illustrates the high inter-annual variability of maize yields in the Southern Lowland districts of Mafeteng and Mohale's Hoek.

Table 1. Inter-annual variability of maize yields in Lesotho (LVAC, 2004)

Table 2

2003-2004 District Maize production Tonnes - compared to the Thirteen-year mean 89/90 to 01/02

District-level estimate of % deviation from 'normal ' summer production in 2003-2004

		District										
	Year	1	2	3	4	5	6	7	8	9	10	**Lesotho**
		Butha Buthe	Leribe	Berea	Maseru	Mafeteng	Mohale's Hoek	Quthing	Qacha's Nek	Mkhotlong	Thaba Tseka	Total
1	89/90	11689	34869	31893	28015	25616	10153	11100	2157	5669	10415	171576
2	90/91	2471	12964	7557	7085	6984	2820	2052	1764	2664	2557	48918
3	91/92	1521	14083	9068	7886	10932	4393	3012	1907	2865	5406	61073
4	92/93	9518	25629	11068	28346	1558	1124	609	2030	4034	7889	91805
5	93/94	5356	38137	26591	22517	15125	12646	6626	3437	6203	12424	149062
6	94/95	8213	15845	14301	8191	406	2011	1191	914	4375	7998	63445
7	95/96	8774	35828	29610	38579	26232	13060	5607	3065	12252	15482	188489
8	96/97	7500	23862	21003	32035	15869	16123	5294	3587	6376	10401	142050
9	97/98	8409	2399	20251	21404	7178	18753	6958	1474	13860	17993	118679
10	98/99	7125	31384	16801	27552	5746	9722	6495	1120	5990	12614	124549
11	99/00	11063	?	35622	26042	14492	7560	9527	3416	4638	10841	
12	00/01	4846	28167	28387	31586	19619	17919	7236	2871	8122	9436	158189
13	01/02	3220	31140	22964	19402	16386	5395	1668	2948	2931	5151	111205
14	**Sum**	**89705**	**294307**	**275116**	**298640**	**166143**	**121679**	**67375**	**30690**	**79979**	**128607**	**1429040**
15	13 year Mean	6900	24526	21163	22972	12780	9360	5183	2361	6152	9893	109926
16	Estimate 02/03	1900	9800	20100	12900	4300	3300	2600	900	1300	4300	61400
17	Estimate 03/04	2647	21683	8012	8383	14270	2904	954	75	1262	5413	65603
18	Forecast 03/04 as % of 13-year Mean	**38%**	**88%**	**38%**	**36%**	**112%**	**31%**	**18%**	**3%**	**21%**	**55%**	**60%**

Source:

1. **Lines 1-13 Lesotho Agricultural Situation report 2000/01 & 2001/02 MOAFS & BOS Lesotho**
2. **Line 16 - FAO/WFP CFSAM Estimates May 2003**
3. **Line 17 - BOS Crop Forecasts of Production 2003/04 12th May 2004**

Numerous streams and rivers drain across the landscape, some of which are perennial but others ephemeral or very low at times. Almost all crop production is rainfed. Reliance on groundwater is high at over 70-80%, provided mainly by boreholes, the balance being provided by surface water. Serious gulley erosion is a common feature of the landscape and has reduced the availability of arable soil and the soil fertility substantially. The remaining arable land in the country (about 9% of the country area, mostly in the Lowlands which produces 70% of agricultural output) is under severe pressure from further erosion due to climatic conditions combined with overgrazing, denudation resulting from the utilisation of woody shrubs and trees for firewood as well as conversion to fields, population increases, and growing encroachment of urban and peri-urban settlements and village livestock onto arable land.

Agricultural production

Lesotho's summer rainfall regime provides generally one growing season in the summer, although a slightly longer season in the Lowlands can support a second planting. The start of the planting season is in November/December. The timing and length of the growing season are constrained by the combination of low temperatures and lack of rainfall from late autumn to early spring, and the onset of the frost season in autumn.

The southern Lowlands zone is potentially productive, given a good rainfall season, but less productive than the northern Lowlands. Nevertheless, chronic food insecurity has occurred in the recent past. The main food crops

grown are maize, sorghum, beans (summer crops) and wheat (winter crop) – the latter mainly by wealthier households.

The "middle" and better-off" households generally own livestock (cattle, sheep, goats, pigs and chickens), whereas the poor sometimes own some pigs or chickens, or no animals. Ownership of livestock is a major determinant of wealth. The number of chickens has decreased substantially due to recurrent diseases. Horses and donkeys are kept primarily for transport purposes. Draught power is used extensively, but is being replaced by tractors where affordable. Stock theft is a major problem which the authorities seem unable to control. Livestock farmers are generally less satisfied with the conditions for livestock keeping in the Southern Lowlands (particularly in Mafeteng) compared to those in the Mountains (Appendix 1), citing weak extension services, lack of compensation for stock losses, and poor profitability as reasons.

The poorer households often lack inputs, labour and draught power, and are thus unable to cultivate much of their land. They often rent it out to wealthier farmers who use it for sharecropping. Sharecropping is a practice whereby one party provides the land (usually the poorer party) and the other (usually the wealthier party) provides the inputs and draught power. The latter only share food produced / proceeds with the former once all costs have been covered. Using this practice, the "middle" and "better-off" groups have access to more land, which enables them to produce enough food to meet 60-75% of the annual food requirements and sell some for cash income. Thus, land cultivated rather than available land creates the division between poor and wealthy. Nevertheless, household ownership of productive farm assets is higher in the southern Lowlands zone than in the Mountain zone (Appendix 1).

Farmers' perceptions of crop farming conditions are, however, negative, particularly in Mafeteng. This is owing to perceived low profitability, lack of protection of crops against animals, lack of compensation for crop failures, and poor government services (Appendix 1).

Infrastructure and marketing

Markets are generally small and not well developed except in the larger towns. Many households sell homestead vegetable produce, and common marketing arrangements are becoming popular in order to gain access to larger supermarkets in the main towns. Both commodity crops and livestock tend to be sold to passing traders. There are no formal livestock markets.

Prices of food staples e.g. maize, are fairly stable throughout the year, probably due to the informal trade routes to and from South Africa.

Livelihoods

The zone supports about 273,000 people at fairly high population density (see Appendix 1). Of the total population, 20% are estimated to be "very poor" and 33% "poor", giving a total of 53%. The "middle" wealth group make up 27%, and the "better-off" 20% of the population.

Levels of unemployment (2006 census) were about 20% for males, and 26% for females. The main sources of livelihood in this zone are: food crops, paid employment, livestock, and trade. The poor are highly dependant upon local wage employment as a source of income, but grow vegetables to supply their own needs. Amongst the "very poor" (LVAC, 2008), annual food energy is supplied by own production (20-35%), agricultural labour exchange (payment in kind) such as weeding and herding (10-15%), and food purchase (20–30%). Food aid contributes about 10-15% of total food access, and gifts from wealthier households often make up any shortfalls. For the "poor", "middle" and "better-off" groups, own production supplies about 40%, 60% or 75% to annual food requirements, respectively.

Casual labour contributes about 15-20% of the annual cash income of the "very poor", and self employment (e.g. brewing) contributes 20-30%. The "poor" group are similar but also receive some income from the sale of livestock (piglets) and petty trade. The main sources of income for the "middle" and "better-off" groups are salaried employment, remittances, livestock and a small amount from crop sales, as well as petty trade. Limited employment opportunities result in people moving outside the zone (often to Maseru or South Africa) in search of jobs.

Expenditure patterns show that the poorer households spend most of their income on food/beverages (since they don't produce enough food to meet their requirements), whereas the wealthier households spend more on farm inputs (to boost their main source of income) and social services.

Hazards

Most of the common hazards experienced are related to climatic extremes and unreliability. It has been said that Lesotho experiences a drought in three out of every ten years, but recently, the Southern Lowland zone has experienced drought almost every year. Not only total annual rainfall is below the long-term mean, but within-season rainfall variability is increasing, so that extended dry spells occur in the middle of the wet season. Crop yields have declined steeply. The poorer households are seriously affected through reduced crop production, reduced casual labour opportunities for both cash and in kind payment, and reduced gifts of food from wealthier households. Regional droughts also tend to increase the price of staple food, thus reducing the purchasing power of households.

Flooding occurs on occasion, resulting in waterlogging and crop losses. Swollen rivers prevent the movement of labour and of produce destined for

market, thus reducing income-earning opportunities. Heavy rainfall also results in serious soil erosion and land degradation, which diminishes the productive capacity of the land.

Hailstorms occur frequently and can destroy crops within hours. Strong winter winds and frost in winter are common and can cause serious damage if they arrive before all the crops have been harvested. The first and last days of frost are on average 18 May and 6 September, respectively (111 days of frost risk), but frosts do occur outside this window (April to October) and can result in a potential frost risk of 276 days.

5.3. Mountains

Physical, climatic and natural resource characteristics

This is the most extensive zone (59% of total land area), with an elevational range of 2000-3482 m. It is characterized by bare rock outcrops, deep river valleys and gorges, and a thin but rich soil horizon which is highly erodible.

The peak rainfall period is from December to February, with the lowest rainfall occurring in June. Annual rainfall is moderately high, reaching the highest recorded levels for Lesotho in the northern and eastern Escarpment. This zone experiences an earlier start to the rainfall season than other zones, but high variability of rainfall and periodic droughts reduce crop yields and cause crop failures. During the period 1995/96–2004/05, on average 9,000 ha of planted area failed annually in the Mountains due to low and erratic rainfall.

The start of the planting season is earlier in the Mountains (generally October) than in the Lowlands. The length of the growing season is constrained by low temperature (autumn to early spring) and the duration of the frost season, which is particularly long in the Mountains, where the first serious frost occurs around April.

Mean annual temperatures are quite low (7-10°C) in the Mountains, which limits the diversity of crops which can be grown. Maximum temperatures in summer reach 24°C in the Mountains, and heat stress is not a problem.

The annual mean evaporation for the Mountains is about 1400mm. Evaporation is generally greater than rainfall over most of the year (although the deficit is not as large as in the Southern Lowlands) with the deficit at its greatest in summer.

Potential net primary production per hectare is lower in the Mountains than the Lowlands due to the shorter season. Potential maize yields are 2-3 tonnes/ha, but variability of maize yield is high (Table 1).

This zone represents a vast catchment area, particularly for the Senqu River. The Lesotho Highlands Water Project is situated in this zone, with the water being used for hydropower and pumped into South Africa. However, all crop

farming is non-irrigated (rainfed). There is a much lower reliance on groundwater (only about 5%) than in the Lowlands, with springs providing a greater proportion of household water requirements. The steep slopes and thin soils overlaying rocks result in serious sheet erosion and loss of arable land. Overgrazing and the removal of shrubs for firewood increase the susceptibility of the land to erosion.

Agricultural production

The main food crops grown in this zone are maize, beans, potatoes (summer crops) and wheat and peas (winter crops). Maize and wheat have potentially good yields in the Mountains, but fail during some seasons. Sorghum is not well adapted to the colder climate and is grown only on a small scale.

All food produced is for own consumption, although bartering is practiced extensively. Inputs such as fertilizer and manure are used by wealthier farmers, but not by the poorer ones. Seed is saved from previous harvests and hybrid seed are not generally purchased. Access to land is not seen as a problem across all wealth groups. However, the wealthier farmers cultivate more land and often use sharecropping to increase access to fields.

The "poor" and "very poor" tend to grow mainly maize, whereas the "middle" and "better-off" farmers are more diversified, including wheat, potatoes, beans and peas. The poorer farmers often sell their maize in exchange for other foods. Wild foods (especially vegetables) are collected and eaten by households from all wealth groups, during the months of September to March. Since these consist mainly of leaves, they do not contribute significantly to total energy requirements.

A survey of farmers' perceptions of crop farming conditions indicates a low level of satisfaction, with farmers citing lack of compensation for crop failures as a particular reason (Appendix 1).

The mountain zone is suitable mainly for grazing and livestock /livestock products are the backbone of the economy. "Middle" and "better off" households tend to own large herds of sheep and goats (wool, mohair, meat), as well as some cattle for draught, meat and milk, and horses and donkeys for transport. The poorer households often do not own any livestock, save a few chickens. Draught power is extensively used for ploughing the fields, since the difficult mountain terrain is not suited to the use of tractors. Livestock diseases and stock theft result in significant losses, and have resulted in households owning fewer stock than previously. Livestock farmers are generally more satisfied with the conditions for livestock keeping in the Mountains compared to those in the Southern Lowlands (Appendix 1), citing lack of compensation for stock losses as a major problem.

Infrastructure and marketing

The rugged mountain terrain and sparse road infrastructure leads to isolation from services and markets in Lesotho and South Africa for all except wool and mohair, which have a formal marketing system. For food products, internal markets cater for local exchange and sales/purchases. However, the road system does not cover all mountain regions equally well, and there are major obstacles such as swollen rivers which can lead to communities being cut off at times. The rough roads require vehicles which are beyond the means of many traders, so that there is a strong reliance on horses and donkeys for transport.

This isolation also limits labour and market opportunities between this zone and neighbouring zones, resulting in a high risk of price manipulation by traders.

Food prices fluctuate during the year, going up during the "hungry season" and falling again during harvest season. Staple food is brought into the zone from outside markets (Maseru, Butha Buthe, South Africa) during the hungry season. Cheaper commodity imports from South Africa compete with local maize sales and thus negatively impact on larger producers, whilst on the other hand helping the poor to purchase food. Local livestock markets are not well developed and offer low prices, and farmers attempt to achieve higher prices by selling stock outside the zone (Maseru, South Africa).

Livelihoods

This zone is the least densely populated in the country, supporting about 290,000 people, of which 15% are regarded as "very poor" and 40% as "poor", a total of 55%. The "middle" wealth group account for 25% of the population, and the "better off" for 20%.

Livelihoods and income are based on livestock sales, crop sales, formal employment and casual labour. The "middle" and "better-off" groups earn a significant portion of their income from livestock and livestock products (wool, mohair). Remittances and salaried employment also contribute to the "middle" group's incomes. Amongst the "very poor" (LVAC, 2008), annual food energy is supplied by own crop production (10-20%), agricultural labour such as weeding (35-40%), and food purchase (20–25%). Casual labour contributes about 15-20% of the annual cash income, and domestic labour contributes 35-40%.

Expenditure patterns reveal that the poorer households in the Mountain zone spend most of their income on food/beverages (since they don't produce enough food to meet their requirements) and clothing/footwear, whereas the wealthier households spend more on social services and farm inputs such a fertilizer and livestock drugs (protecting their primary source of income).

Hazards

The most common hazards can be divided into climatic hazards and health hazards:

Climatic hazards in the mountains include droughts, hail storms and early/late frosts. The frequency and impact of drought appears to have increased over the last decade or two, attributable both to reductions in total annual rainfall, and in the erratic patterns of rainfall during the growing season. Since such a high proportion of food and income sources depend directly on crop and livestock production, the impacts of drought are compounded, particularly for the "very poor" and "poor". Opportunities for earning an income through agricultural labour, such as weeding, are reduced, so that the poor not only have to deal with their own crop failure, but also reduced cash for purchasing food.

Early or late frost, hail storms and strong winter winds are also fairly frequent and can cause devastation to maize and other crops.

Health hazards include crop and livestock pests and diseases. Inputs for pest and disease control are often too expensive, or not available in the remote areas of the mountains. Some animal diseases are a major problem and poorer households have reduced their stock (e.g. chickens) as a result of severe losses. It is not clear from the literature used whether there are any climatic linkages to crop and livestock pests and diseases.

6. FUTURE CLIMATE

6.1. History of climate change engagement

Lesotho signed the UNFCCC at the Earth Summit in Rio de Janeiro in 1992, and ratified it in 1995. Through the focal point, the Lesotho Meteorological Services (LMS), and assistance from United Nations Environment Programme (UNEP) and the Global Environment Facility (GEF), Lesotho set out to meet her obligations under the Convention by initiating the project *Lesotho: Enabling Activities for the Implementation of the UNFCCC*, the result of which was the submission of the First National Communication to the Conference of the Parties to the UNFCCC in April 2000. This document described national circumstances, assessed the country's greenhouse gas (GHG) emissions, vulnerability to the impacts of climate change, and various sectoral adaptation and mitigation strategies.

Subsequently, Lesotho as a Least Developed Country (LDC) developed its National Programme of Action on Climate Change (NAPA) which was submitted to the UNFCCC in January 2007. The country is currently preparing its Second National Communication to the UNFCCC.

6.2. Climate variability and climate change

With every 1°K increase in air temperature there is a 7% rise in atmospheric water vapour (as determined by the Clausius-Clapeyron equation). The increasing moisture content of the air must result in changing rainfall. Trenberth et al. (2003) describe how, with the increase in precipitable water, rainfall intensities increase faster than the average increase in specific humidity, therefore there will be a concomitant decrease in the frequencies of low intensity rainfall. The impact of these changes is that the frequency of intense rainfalls will increase and the duration between rainfall events will also increase (Trenberth et al., 2003). These projections appear to be supported by observed data, but not climate models (see Wentz et al., 2007).

In line with the expectations of Trenberth *et al*. (2003), there is already an apparent increase in intensity of rainfall experienced throughout the Highveld region of Southern Africa (Mason *et al*., 1999; Easterling *et al*., 2000; Groisman et al., 2005 and Kruger, 2006). As much of the rainfall in Lesotho comes from convection, these storms can be very intense, leading to local flash flooding, which is of importance to human security, and more importantly for agriculture, leads to increasing severity of erosion. The soils of Lesotho are probably its most precious resource and erosion is already a problem over much of the country. The highest erosion hazard (sheet erosion) exists over the higher altitude areas which includes the eastern

parts of Mokhotlong, Thaba Tseka and Qacha's Nek and the high ground in the east of Butha-Buthe, Leribe, Berea and Maseru districts. However, areas with deeper soils in the lowlands show the most visible effects (gulleys) of this permanent loss of Lesotho's heritage and productive resources.

The trend in the intensity of severe convective storms in South Africa has been a target of little research. Convective storms with super-cell characteristics have been thought not to be a feature of the southern African landscape, or are rare (Tyson, 1986). Recently, however, very severe thunderstorms (some centred in the Eastern Cape, close to Lesotho) have done a lot of damage and lead to loss of life. In 1998 and 1999, seven tornadoes and three powerful storms killed 50 people, caused 370+ injuries and resulted in financial losses of more than R100 million (Pyle, 2007). One tornado of intensity F4 on the Fujita-Pearson scale was recorded (less than 1.5% of all US tornadoes have this intensity and are characterized by wind speeds of 300-400 km/hr and are capable of devastating damage – the scale is ranked F0-F5). We could expect these events to occasionally affect the south-west portion of Lesotho. The only thing that can be said here is that we need more research insight into trends in the severity of severe convective storms.

6.3. Climate change projections

Our view of climate change in Lesotho is that these trends of increasing frequency and severity of extreme events will continue. In line with the expectations of Trenberth *et al*. (2003), there is already an apparent increase in intensity of rainfall experienced throughout the Highveld region of Southern Africa (Kruger, 2006). Thus we expect a future Lesotho climate that has more intense rainfalls, but with lengthening dry periods in between. The trend in increasing rainfall intensities as a response to global warming is one that was observed around the world more than a decade ago (Karl *et al*., 1995). In this respect, what is happening in Lesotho is supported by evidence elsewhere in the world. Notably, with these changes, there will likely be fewer days of the softer, more soaking rainfalls. This scenario will likely manifest already in the short- to medium-term, before any major shifts in background climate are experienced. It requires responses such as early warning systems, disaster reduction and mitigation actions, and other actions which provide resilience against climate risk, such as insurance and other financial mechanisms.

The above trends and projections are not well captured by climate models, and where they are addressed, they are characterised by high levels of uncertainty. Therefore, we also discuss the long-term changes in mean climatic conditions as captured in the models. These describe the gradual changes in background climate such as slow rates of warming that may ultimately require new behaviours and practices in human society. Suitable responses would include greater investment in research and technology transfer.

Global Circulation Models (GCMs) are used at larger spatial scale at fairly low resolution. For the development of regional climate change scenarios ("downscaled" from global scenarios) two techniques are commonly used: empirical downscaling and dynamic downscaling, both of which still use the GCM as a core factor and thus perpetuate the skill and credibility of the GCM in simulating the climate change signal.

For the purposes of this study, we assessed a range of modeling outputs for Lesotho, starting with the study undertaken during 1997/98 which was used for the Lesotho First Assessment Report and the NAPA, the latest IPCC Assessment (2007), and some recent preliminary simulations performed by the Climate Systems Analysis Group (CSAG) at the University of Cape Town (UCT). All these studies were based on GCMs. We then examined the latest regional downscaled model outputs by CSAG. It should be noted that the CSAG results are very preliminary and will only be used for indicative purposes.

GCM simulations of future climate

In the 1997/98 Lesotho studies used for the First National Communication and NAPA studies, GCM simulations of future (2030, 2050 and 2075 relative to 1961-1990) climate change scenarios were generated using six GCM models. The simulations projected a warmer future climate (increases of 1.0-1.8°C by 2050, or 1.5-3.8°C by 2075), lower precipitation during summer and spring, and a gradually increasing precipitation in autumn and winter. The latter would result in heavy snowfalls and strong winds.

The most recent (2009) climate change simulation results for Lesotho was provided by the LMS (Figs. 9 and 10). These show temperatures increasing by about 1.5-2.0°C by 2050, and by about 2.5-3.5°C by the 2080s. Winter rainfall shows strong decreases, with no change in summer and autumn rainfall, and gradually increasing spring rainfall.

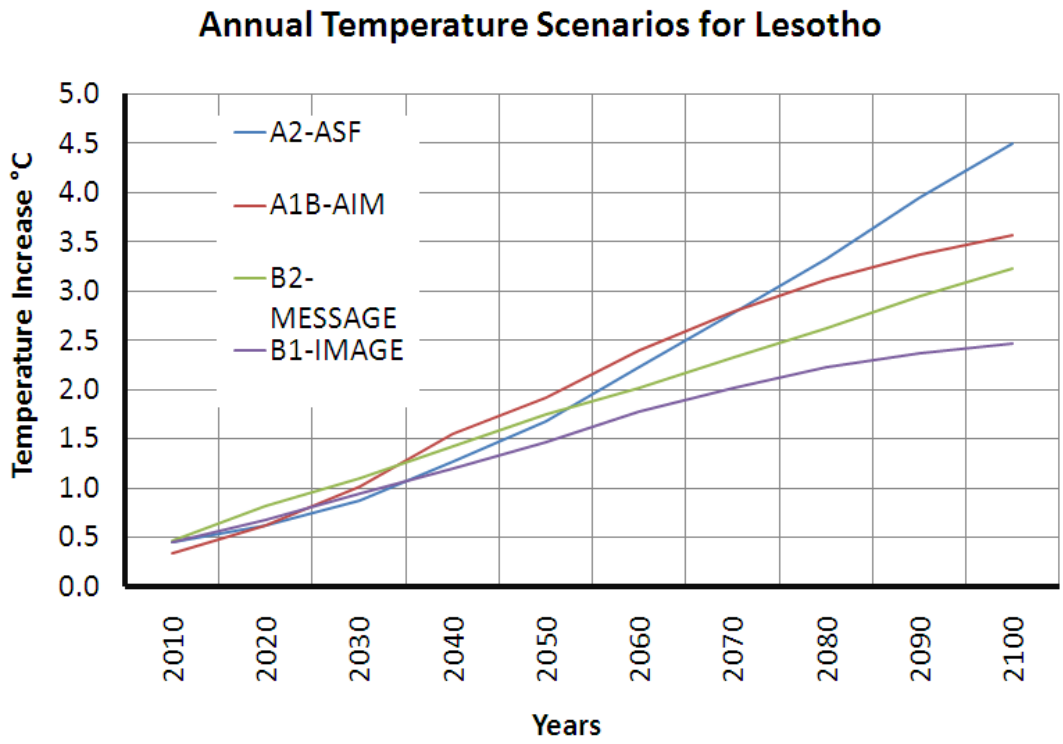


Fig. 9. Annual temperature scenarios for Lesotho (source: LMS).

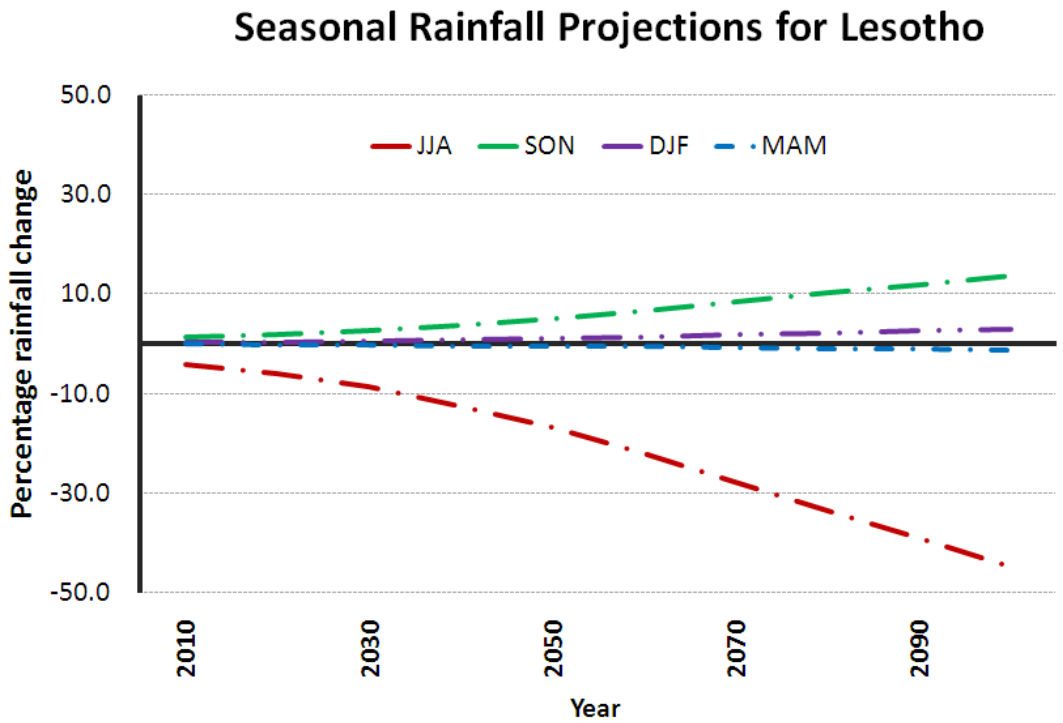


Fig. 10. Seasonal rainfall projections for Lesotho (source: LMS).

There has thus been a change in the direction of projected rainfall changes since the 1997/98 study, but the more recent results are in line with the simulation modeling performed as part of the IPCC Fourth Assessment Report (2007), which yielded regional projections of winter drying (good model agreement) and inconsistent results for summer rainfall, with no clear signal of direction of change (Fig. 11 from Boko et al., 2007).

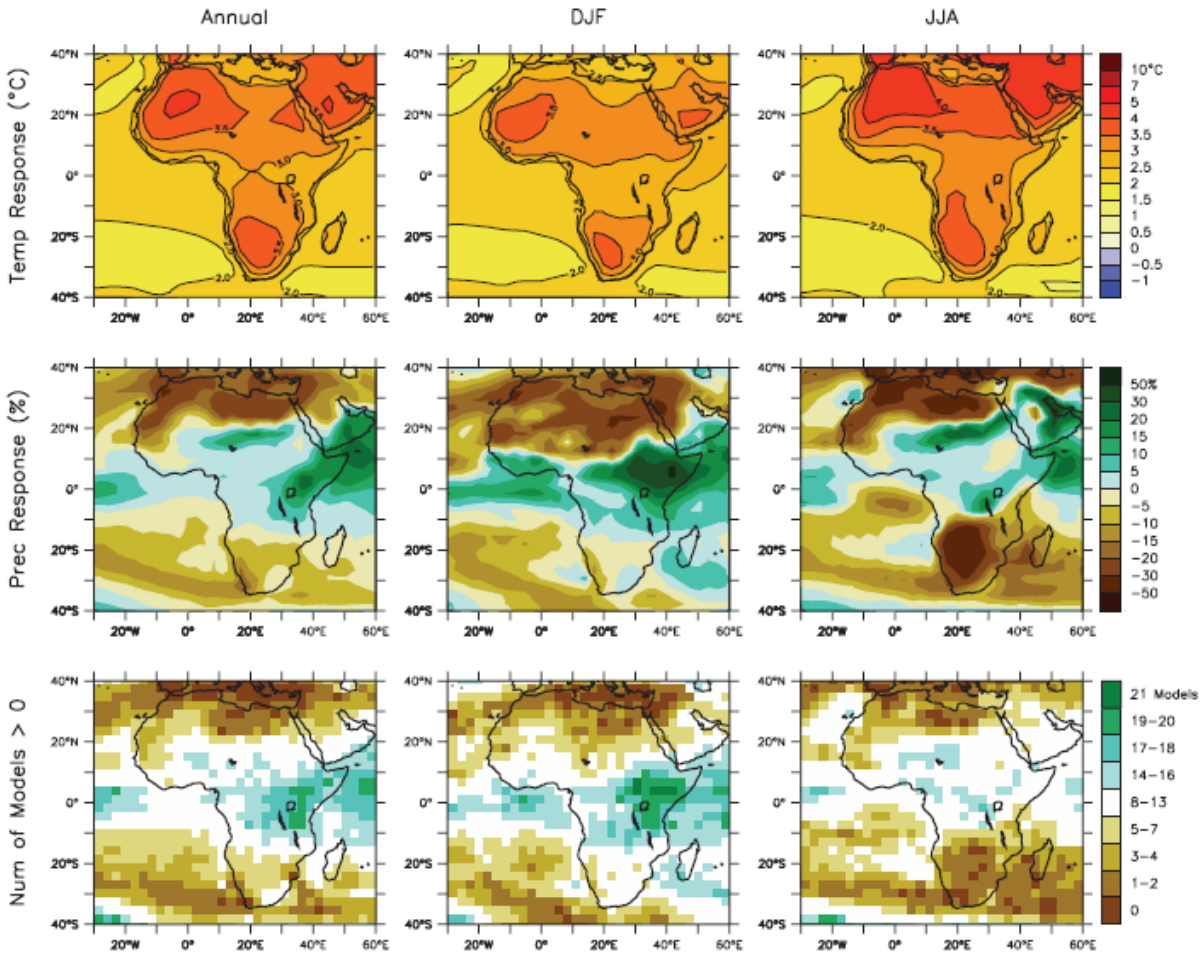


Figure 11.2. *Temperature and precipitation changes over Africa from the MMD-A1B simulations. Top row: Annual mean, DJF and JJA temperature change between 1980 to 1999 and 2080 to 2099, averaged over 21 models. Middle row: same as top, but for fractional change in precipitation. Bottom row: number of models out of 21 that project increases in precipitation.*

Fig. 11. Temperature and precipitation changes over Africa (source: Boko et al., 2007).

Climate change simulation results based on 15 GCMs from the World Climate Research Programme's (WCRP's) Coupled Model Intercomparison Project phase 3 (CMIP-3) multi-model dataset[1] were assessed by CSAG and downscaled for the periods 2046-2065 and 2080-2099 using the A2 SRES scenario (Figs 12-13). This dataset formed the basis for the Fourth Assessment Report of the IPCC (2007). The preliminary results presented here indicate temperature increases of approximately 2.0-2.5°C for 2046-2065, and of 3.5-4.0°C for 2080-2099 over Lesotho.

The direction of rainfall changes is not clear, with some models showing wetting and others drying in the Oct-Mar season, with a median result of slight drying (2046-2065) (Figs 14-15). The Apr-Sep season is shown to experience varying degrees of drying. For 2080-2099, these trends remain similar although intensifying, but the median result for Oct-Mar is a wetting.

1[1] *We acknowledge the modeling groups, the Program for Climate Model Diagnosis and Intercomparison (PCMDI) and the WCRP's Working Group on Coupled Modelling (WGCM) for their roles in making available the WCRP CMIP3 multi-model dataset. Support of this dataset is provided by the Office of Science, U.S. Department of Energy.*

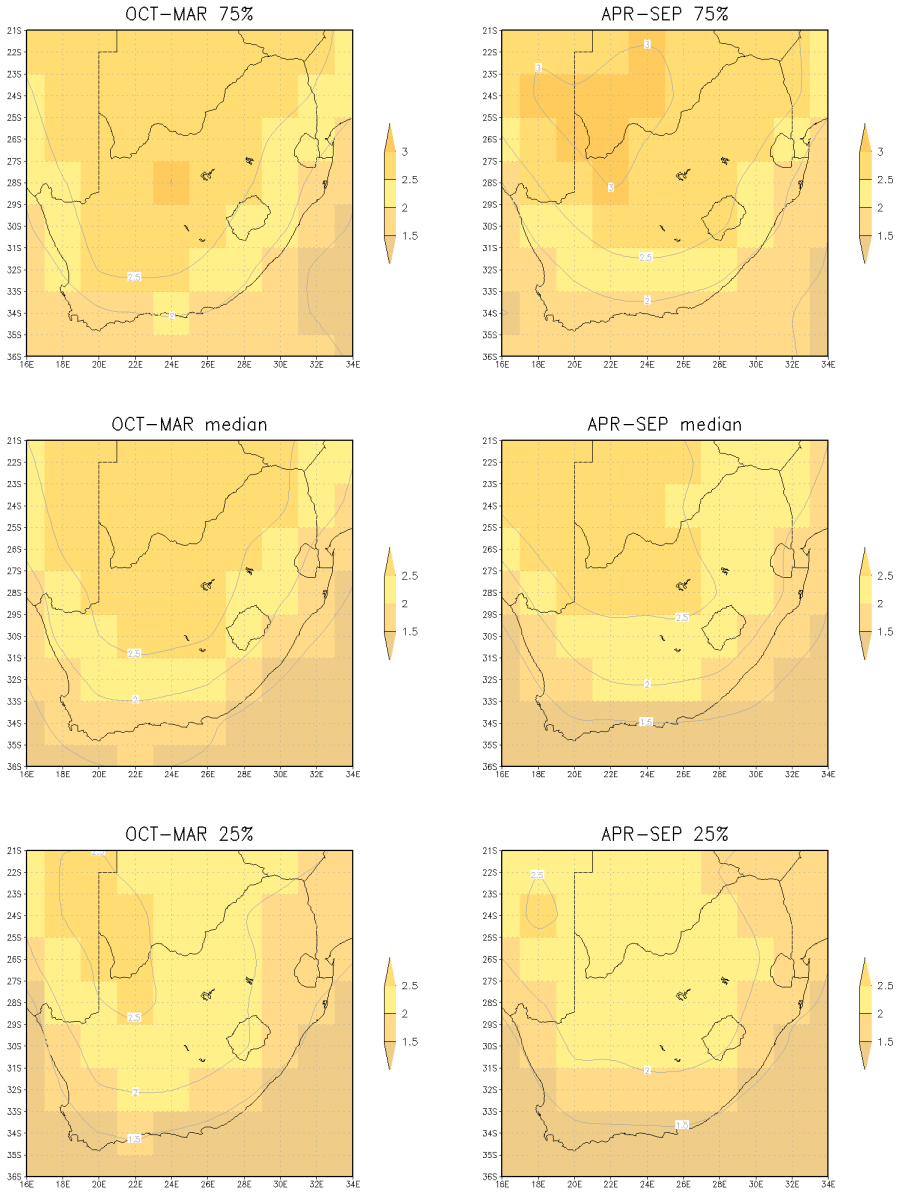


Fig. 12. Projected temperature change (ºC) from 15 GCMs of the CMIP-3 archive, for 2046-2065 based on the SRES A2 scenario for the summer and winter seasons (average for each 6 month period). The upper row shows the 75th percentile of the 15 models, the middle row is the median, and the lower row the 25th percentile. Source: B. Hewitson, pers. conf.

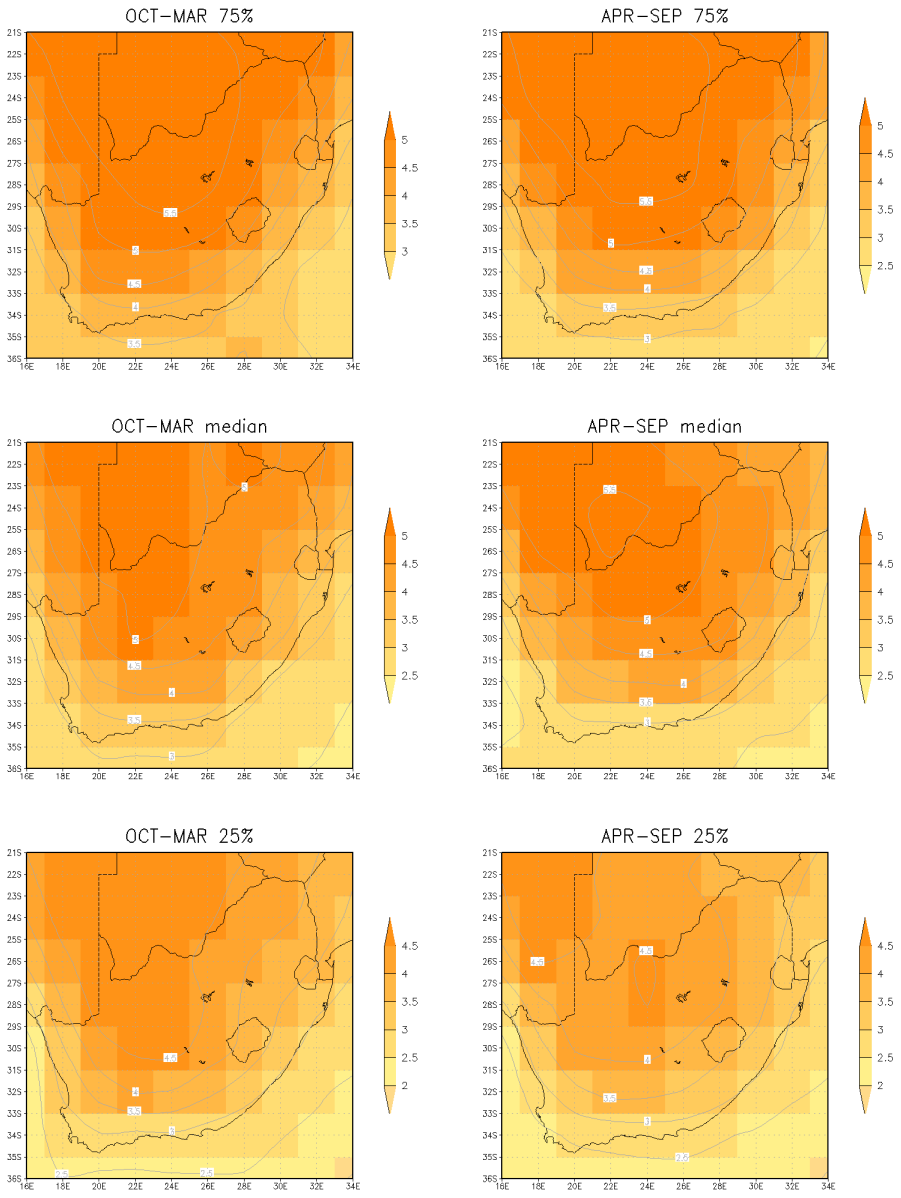


Fig. 13. Projected temperature change (ºC) from 15 GCMs of the CMIP-3 archive, for 2080-2099 based on the SRES A2 scenario for the summer and winter seasons (average for each 6 month period). The upper row shows the 75th percentile of the 15 models, the middle row is the median, and the lower row the 25th percentile. Source: B. Hewitson, pers. conf.

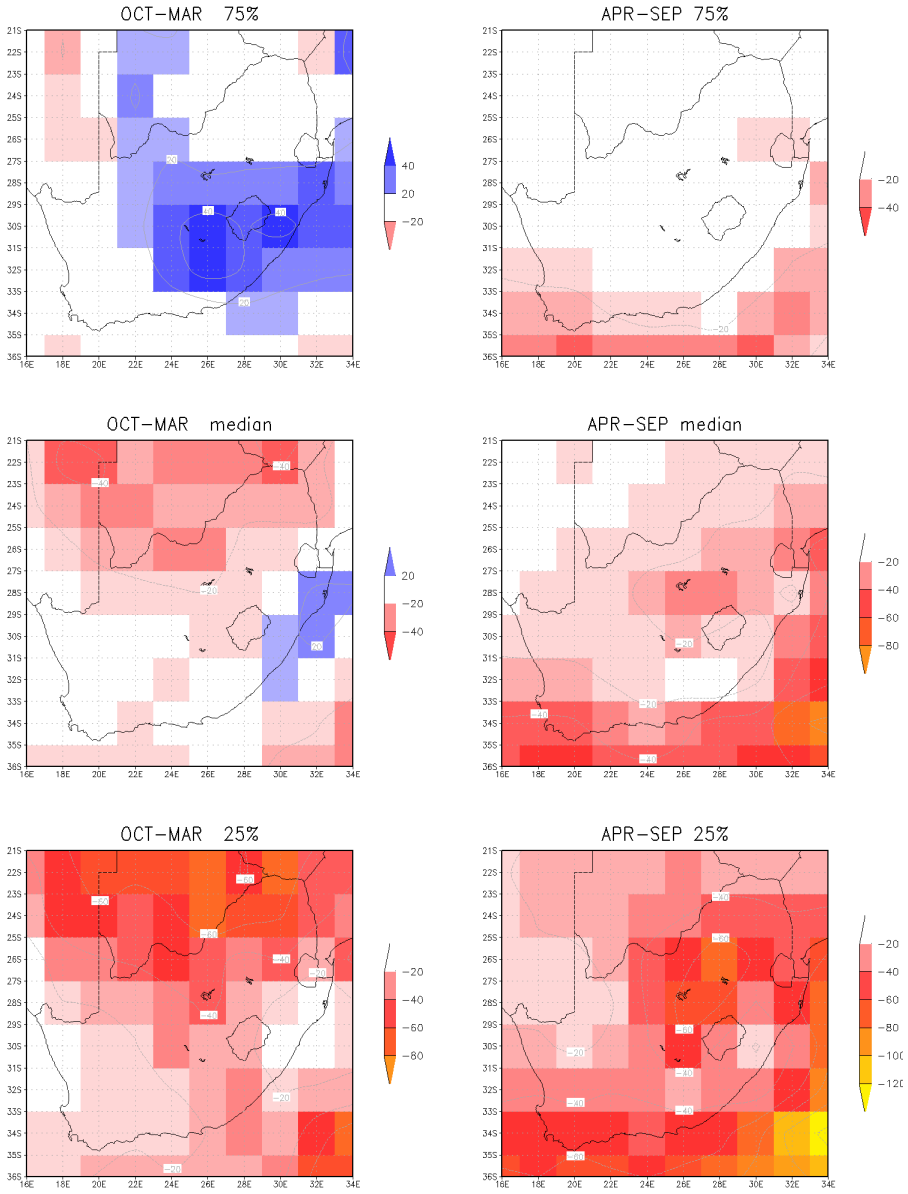


Fig. 14. Projected rainfall change (accumulated rainfall over 6 month, in mm) from 15 GCMs of the CMIP-3 archive, for 2046-2065 based on the SRES A2 scenario for the summer and winter seasons (average for each 6 month period). The upper row shows the 75th percentile of the 15 models, the middle row is the median, and the lower row the 25th percentile. Source: B. Hewitson, pers. conf.

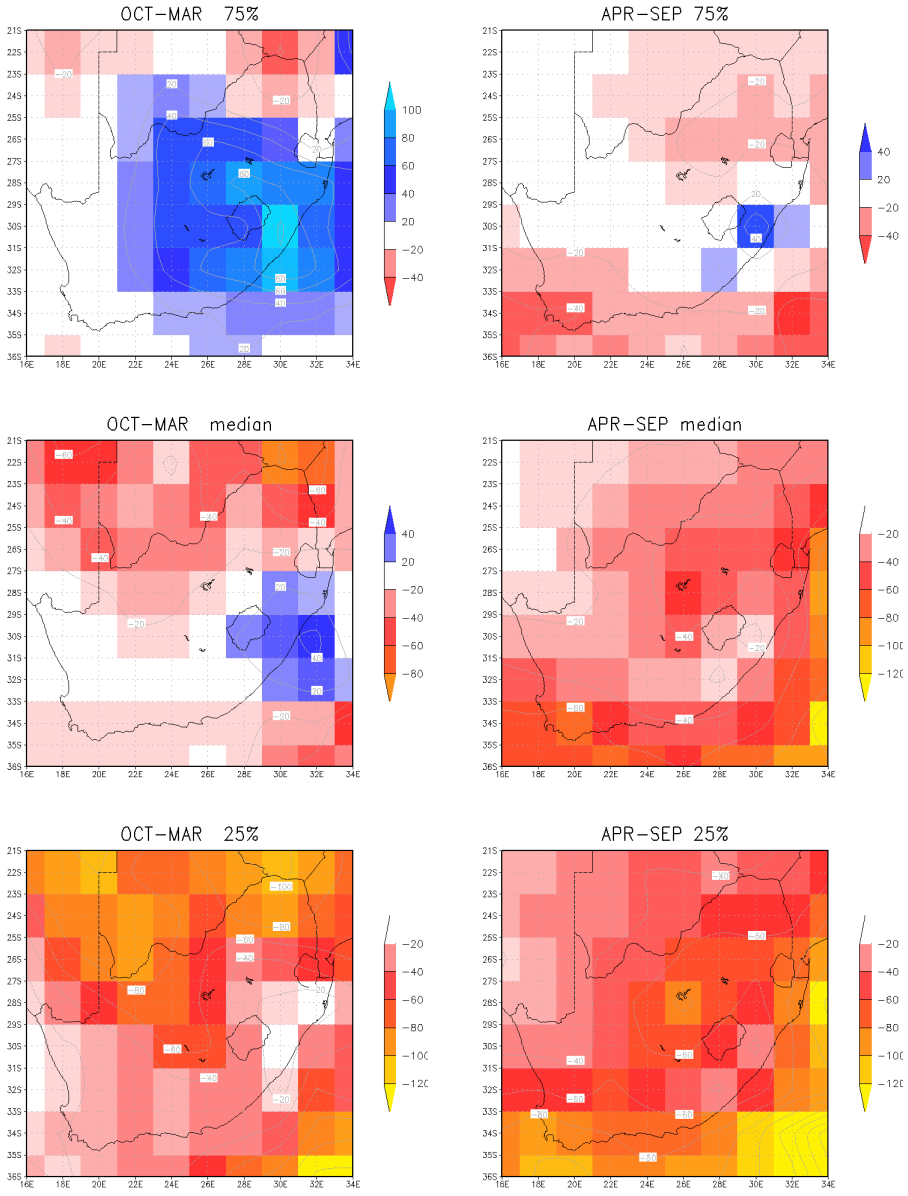


Fig. 15. Projected rainfall change (accumulated rainfall over 6 month, in mm) from 15 GCMs of the CMIP-3 archive, for 2080-2099 based on the SRES A2 scenario for the summer and winter seasons (average for each 6 month period). The upper row shows the 75th percentile of the 15 models, the middle row is the median, and the lower row the 25th percentile. Source: B. Hewitson, pers. conf.

Downscaled rainfall projections

The preliminary downscaled model projections (CSAG, UCT) indicate a trend towards wetting in spring/summer, and even to a small extent in autumn/winter, with potentially large increases over eastern Lesotho (Figs

16-17). More recent developments of the downscaling suggest these figures have a degree of wet bias, but the newer emerging results do not change the fundamental messages (B. Hewitson, pers. comm.).

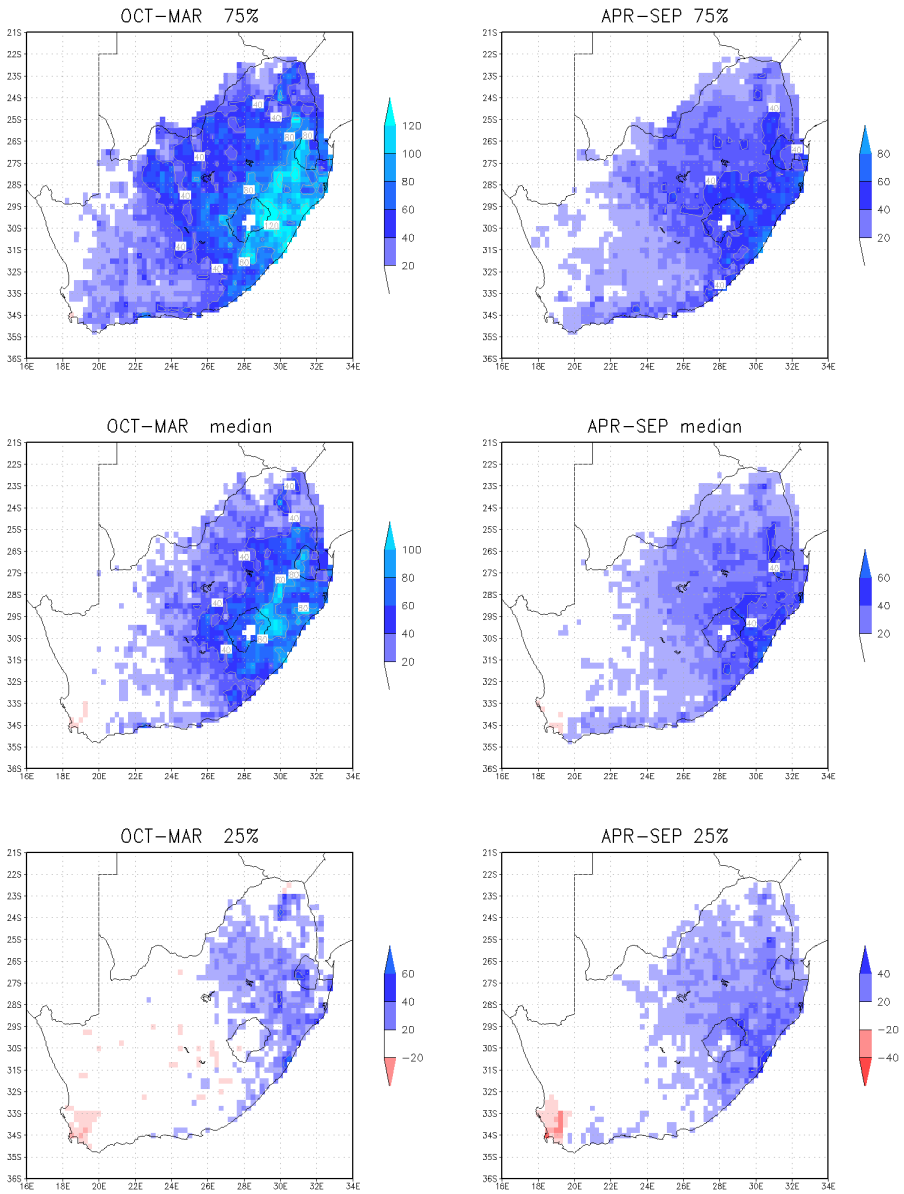


Fig. 16. Projected rainfall change (accumulated rainfall over 6 month, in mm) downscaled from 9 GCMs of the CMIP-3 archive, for 2046-2065 based on the SRES A2 scenario for the summer and winter seasons (average for each 6 month period). The upper row shows the 75th percentile of the 15 models, the middle row is the median, and the lower row the 25th percentile. Source: B. Hewitson, pers. conf.

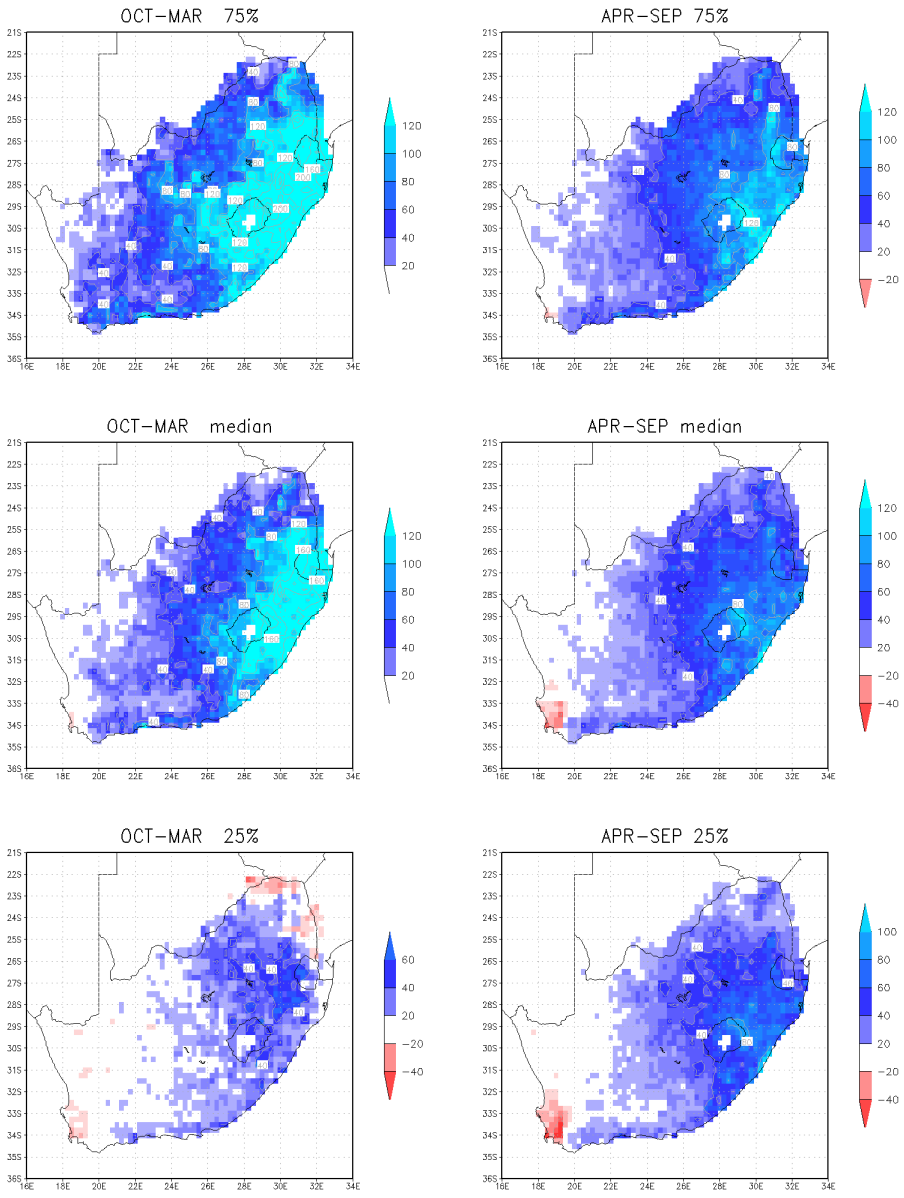


Fig. 17. Projected rainfall change (accumulated rainfall over 6 month, in mm) downscaled from 9 GCMs of the CMIP-3 archive, for 2080-2099 based on the SRES A2 scenario for the summer and winter seasons (average for each 6 month period). The upper row shows the 75th percentile of the 15 models, the middle row is the median, and the lower row the 25th percentile. Source: B. Hewitson, pers. conf.

Associated soil moisture projections

Using the hydrological model ACRU in combination with the GCM ECHAM5/MPI-OM, R. Schulze of the University of Kwazulu-Natal has modeled soil water stress for the three periods present, 2046-2065 and 2081-2100.

The results for the intermediate period are presented below (Fig. 18). In accordance with the projected rainfall patterns, the incidence (number of days per year) of soil moisture stress is expected to decrease over Lesotho, whereas the incidence of waterlogging could increase:

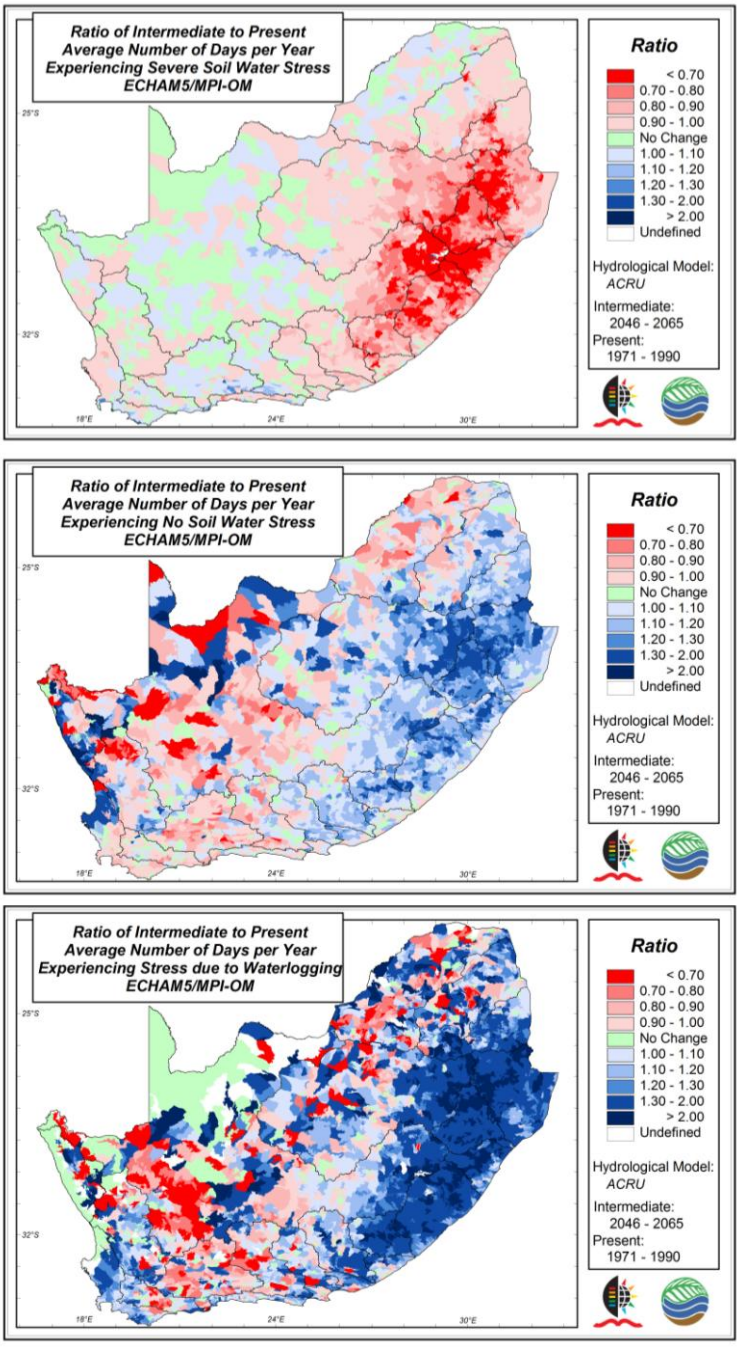


Fig. 18. Ratios of intermediate (2046-2065) to present changes in soil moisture stress (source: R. Schulze, UKZN).

6.4. Scenarios used for this report

The Risk and Vulnerability Assessment that follows will be based on both views of climate change:

- ***Changing climatic variability and frequency and intensity of extreme events:*** this can include droughts and heavy rainfall and thus captures magnitude of non-average climatic events over short time-scales rather than direction of change.
- ***Gradually changing means:*** this shows the general direction of change, usually with reasonable levels of confidence, but with higher levels of uncertainty for magnitude or rate of change. For temperature changes, we use an increase in annual mean temperature of approximately 2.0°C (2050) and 3.5°C (2080). For rainfall, we use a moderate drying in late autumn/winter, and moderate increases in spring/summer rainfall, with stronger spring/summer wetting towards the end of the century.

7.RISK AND VULNERABILITY ANALYSIS

We begin with a brief outline of the expected impacts of climate change on Lesotho's crops and livestock, followed by the R&V analysis.

7.1. Climatic sensitivities of Lesotho's crops and livestock

The primary staple crop maize, owing to its fairly shallow roots, is susceptible to droughts and erratic rainfall, for example a late start to the season, and lack of sufficient follow-up rains. It is also intolerant of nutrient-deficient soils, and prone to be uprooted by severe winds. In drought conditions, the growth rate is decreased, and formation and filling of the grain is considerably reduced resulting in yield reductions. It has been projected that, under climate change, maize yields in southern Africa could decrease by about 30% by 2030 (Lobell et al., 2008), and possibly up to 50% by the end of the century (IPCC, 2007). Wheat is also sensitive to climate change and could face yield reductions of about 15% across southern Africa by 2030 (Lobell et al., 2008). However, the projected mean climate for Lesotho (warmer, slightly wetter) could boost yields of both staple crops in "normal" years.

Lesotho's second most important staple crop, sorghum, has a higher water use efficiency than maize. Even though it grows best at temperatures of about 28°C, it can produce well under much higher temperatures which maize cannot tolerate. Sorghum is uniquely adapted to adverse growing conditions such as drought stress, high temperatures, poor fertility, waterlogging, high altitudes and salinity. It can thus be grown on a wider soil range than maize. In practice, it is usually grown on poorer soils, while good fertile areas are reserved for crops such as maize. Sorghum yields are not expected to be negatively impacted by climate change across southern Africa (Lobell et al., 2008). In Lesotho, future conditions could well become much more favourable for sorghum production in "normal" years.

Beans are an important crop in Lesotho, often grown as a cash crop and in rotation with cereals. The country generally grows beans in sufficient quantities to supply local demand. They generally thrive on moderate amounts of rainfall distributed throughout the rainy season. As members of the legume family, all the crops are able to fix atmospheric nitrogen due to the symbiosis with soil bacteria, and are usually able to meet their own nitrogen requirements. It is used as a soil-improving crop and on marginal soils, in rotation, or intercropped with other plants. Beans are expected to be sensitive to erratic rainfall and could show moderate yield decreases in years when rainfall is not well distributed.

Lesotho's climate is suited to temperate-zone pome fruit (apples and pears), which require considerable winter chilling, and stone fruit (especially peaches) which have a lower chill requirement. Fruit crops generally require regular inputs of water under irrigation, but can survive droughts albeit with reduced or no yields. Under gradual warming in Lesotho, these crops are expected to remain viable and even increase their yields and fruit quality, and many other types of fruit crops could become viable, provided that some form of irrigation can be supplied.

Livestock breeds used in Lesotho are generally hardy and well suited to the harsh climate. However, incidences of heat stress can impact negatively on animal growth, yield of animal products such as milk, and reproductive success. Livestock are also indirectly affected by climatic influences on rangeland productivity, and reduced nutritional content of grasses and browse under rising atmospheric CO_2 concentrations. Provided that rangeland condition improves, livestock are not expected to suffer under climate change.

If crop production becomes increasingly marginal, due to changing variability and incidence of extremes, livestock will provide an alternative. On the other hand, given the favourable gradual climatic changes projected for Lesotho, cropping may be favoured at the expense of livestock (Jones and Thornton, 2009).

7.2. Components of vulnerability

In order to ascertain the vulnerability to climate change of land-based livelihood systems in the Southern Lowlands and the Mountains, a Risk and Vulnerability Assessment was carried out on each zone. These assessments are summarized in the following pages. Each zone was assessed in terms of its exposure and sensitivity to climate change (according to the scenarios outlined in Chapter 6), as well as its adaptive capacity, any adverse implications foreseen, and, finally, its potential to benefit. A distinction was made where relevant between the poor ("very poor" and "poor") and the wealthier ("middle" and "better-off") groups of the population.

Definitions:

Exposure relates to the degree of climate stress and includes climate variability, frequency, magnitude and duration of extreme climate events (drought, flood, frost, hail, storm wind), and long-term climate changes (rising temperature, changing rainfall).

Sensitivity is the degree to which the system is modified or affected by a climate hazard, and thus reflects the responsiveness of a system to climatic influences. Sensitivity is shaped by both socio-economic and ecological conditions which can either worsen the hazard or trigger an impact. Indicators include the level of land degradation and soil erodibility, level of reliance on rainfed crop production, levels of crop diversification or mixed

farming, size of the average farming unit, the household dependency ratio, rural population density, and human health conditions.

Adaptive capacity is the capacity of the system to adjust to the new climatic conditions, including climate variability and extremes, and to moderate potential damages. The determinants include availabilities and uses of resources such as social capital (e.g. social and farmers' networks, diversity, gender equality), human capital (e.g. education and literacy rate, flexibility and entrepreneurship, HIV/AIDS prevalence, skills of public servants), financial capital (cash income, savings and assets, access to credit) and physical capital (road and communications infrastructure, markets, access to safe water). It is generally accepted that communities and people with the least resources have the least capacity to adapt and are thus the most vulnerable. This is not to be confused with coping mechanisms, which would include changing farming practices or household expenditure patterns, for example (see Appendix 2).

Adverse implications relate to serious negative impacts on ecological or socio-economic systems, such as permanent damage to soil and water resources or ecosystems, or irreversible declines in livelihood and employment opportunities.

Potential to benefit is the taking advantage of opportunities which arise from the change, such as new crops becoming suitable.

Exposure

Both the Southern Lowland and Mountain Livelihood zones are highly exposed to high inter-annual and intra-annual rainfall variability, which are expected to continue and possibly become exacerbated through climate change. Recurrent droughts have become a feature of the climate and are likely to remain problematic as the climate shifts to a new state. The Southern Lowlands, although arable over a large proportion of the area, experience some of the driest and hottest weather events in the country (although still comparatively mild when compared to other southern African regions), and heat stress in mid-summer can be expected to become a growing occurrence. In both zones, rising temperatures will lead to greater evapotranspiration rates, and more rapid soil drying between rainfall events. The period between rainfall events will thus become even more important than it currently is.

On the other hand, both zones could respond very positively to moderate increases in rainfall in a year with "normal" summer rainfall distribution, as projected by the majority of the downscaled climate models. Recent modeling results (Fig. 18) show a future reduction in the number of days per year experiencing soil water stress over Lesotho, using a GCM and the ACRU hydrological model (and assuming a "normal" rainfall pattern). It is, however, expected that at least some of the precipitation gains will come in the form of heavy rainfall events which cause rivers to swell and become impassable,

and result in waterlogging of fields (mainly in the Lowlands), as well as aggravated soil erosion and degradation. Increased moisture in the atmosphere, combined with periods of low atmospheric temperatures (particularly in autumn) could also lead to more frequent and heavy hailstorms. In contrast, the projected drier winters could result in less snowfall.

Since Lesotho has a cool climate owing to its high elevation, with mean annual temperatures well below those of the neighbouring region, the expected gradual warming could have positive impacts on crops, livestock and people. Cold stress will be reduced, the growing season will likely be extended, the diversity of crops suited to the climate will increase (especially in the Mountains) and the frequency and severity of frost may be reduced (although there is still poorer confidence in this outcome). All the crops grown in Lesotho would benefit from an increase in heat units which stimulate plant growth and development, particularly in spring when the greatest rise in temperature is expected. However, this will have to go hand in hand with sufficient soil moisture availability during the period of early rapid growth.

One of the most certain features of climate change (in fact one of the drivers of climate change) is the steadily rising concentration of carbon dioxide (CO_2) in the atmosphere. Based on current knowledge of plant and ecosystem responses to rising CO_2, it is very likely that vegetation (grasses, shrubs and trees) and crops in Lesotho will benefit significantly from CO_2 fertilization, which results in higher photosynthetic rates, growth rates and yields. Increases of 10-30% could be expected within a few decades. Shrubs and trees, in particular, can be highly responsive, especially where other factors such as warming are favourable for increased growth rates. Plant water use efficiency increases, thus conserving precious soil water and providing a buffer against warming-induced soil drying. However, increased standing biomass combined with warming and periods of drying, could increase the frequency and intensity of wildfires, with knock-on effects on grazing and soil degradation. It is also likely that the invasion of shrubs such as *Chrysocoma ciliata* at the expense of palatable grasses will intensify.

Sensitivity

Of all the factors determining sensitivity of the Lowland and Mountain zones to climate change, ***soil erosion and land degradation*** are probably the most important. Degraded lands have much higher sensitivity to climatic hazards than those which enjoy good vegetation cover and soil water infiltration abilities. The expectation that rainfall will continue to become more erratic, with longer dry spells punctuated by heavy rainfall events, could have disastrous consequences for further soil erosion. Denudation of the soil surface, brought about by the combination of recurrent droughts, constant grazing and trampling by livestock, and collection of fuel wood, multiplies the impacts of climate on soil losses. Heavy rainfall does not

infiltrate easily into such degraded soils, and runs off, taking with it vast amounts of loose topsoil. Recharge to groundwater is diminished and the excess surface water causes flooding. Declining groundwater levels in regions heavily reliant on it, such as the Lowlands, would reduce the availability of safe drinking water for people and livestock and exacerbate the effects of climate change by further reducing critical natural resources.

Land degradation has already reduced the productive capacity of Lesotho's agricultural lands. Continued and possibly escalating degradation would hamstring all efforts to improve production efficiencies and total production in the face of climate change impacts. National strategies and policies aimed at strengthening agricultural production have not been successful partly because of the dwindling area of arable land and reductions in soil fertility. Protection of the soil through careful land use planning and management will become increasingly critical in order to safeguard this non-renewable (in the short- to medium-term) resource for future generations living under a potentially harsher climate.

Both the Southern Lowlands and the Mountains (in fact almost all of the country) are heavily reliant on ***rainfed agriculture***. Rainfed agricultural systems have much higher sensitivity to climatic hazards and rainfall variability than those with some form of irrigation. Irrigated farms have a positive immediate response to warming, particularly those in cooler production regions (Kurukulasuriya and Mendelsohn, 2006). Maize is particularly sensitive to the timing and duration of dry spells, especially during the critical early developmental period until tasselling; the capacity to irrigate during this period can mean the difference between a normal yield and crop failure.

It is well-known amongst farmers that greater ***crop diversity and mixed farming*** (crops and livestock) offer considerable protection against farming risk, including climatic hazard risk. Farmers growing only one crop (quite commonly maize amongst subsistence farmers in Lesotho) are highly sensitive to climatic hazards. Larger farming enterprises with a range of different crop types, or even cultivars of the same crop, are much less likely to suffer complete crop losses. In the Lowlands and Mountains, it is these farmers that are already less vulnerable and are generally more food secure. The large proportion of subsistence and smallholder farmers with limited ability to diversify, increases sensitivity to climate change-related hazards.

By the same token, mixed farming enterprises are more resilient during a crisis, since they are able to sell livestock for cash to buy food when crops have failed. The "very poor" in rural Lesotho (about 20-25% of the population) who do not own livestock are more sensitive to climate shocks. Even a humble poultry business, together with homestead vegetable gardening, for example, can make these households less sensitive.

A region as a whole is also less sensitive to climatic variations if it can support a more diverse suite of crops. As in most of the sub-continent, Lesotho is arguably overly reliant on maize which, whilst it can be highly

productive during good rainfall years, is notoriously sensitive to erratic and below-normal rainfall. The availability of improved maize cultivars specifically suited to climatic variability, drier conditions, and a shorter season should the rains arrive late, together with a healthy mix of other more resilient crops such as sorghum and various hardy exotic and indigenous vegetables, would render an agricultural system within a region less sensitive. The Mountain zone is currently temperature-limited in what can be grown (maize and wheat) but a warming climate should create opportunities for greater crop diversity.

Regions with a high proportion of ***small farming units*** (subsistence and small-scale), such as the Lesotho Lowlands and Mountains, are more sensitive than those with larger commercial units. This is because larger units have better access to implements, technologies and credit facilities, and are better able to diversify. More favourable economies of scale result in higher profitability which provides a financial buffer against "bad years".

From a human perspective, ***household characteristics*** typical of each Livelihood zone play a large role in rendering the zone more or less sensitive to climate shocks. The high household dependency ratio (the ratio of children under-14yrs plus the elderly over-65yrs to the number of potentially economically active adults 15-65yrs) in both Livelihood zones creates a high sensitivity. The ratio is particularly high in the Mountains (0.90), but also very high in the Lowlands (0.72). The steep rise in the ratio over the last decade or two has been due to primarily to the HIV/AIDS pandemic which has robbed many households of their adult breadwinners. This worsens the impact of a crisis on the household.

The ***population density*** in the Southern Lowlands is high, so that any climatic hazard affects many people, thus adding to the region's sensitivity. In contrast, the population density in the Mountains is low.

Impact (exposure x sensitivity)

The overall impact of climate change on land-based livelihoods is a complex outcome of the scenario and exposure, together with the sensitivity. Both the Southern Lowlands and the Mountains are highly exposed to climate variability and increases in variability brought about by climate change. They are also highly sensitive, based on serious land degradation, high reliance on rainfed agriculture (often in monoculture), low economic and agricultural diversity, the burden placed on economically active adults in caring for children, the aged and the sick, and a high rural population density. Thus the impacts of climate change are expected to be severe. At a household level, higher levels of agricultural and economic diversity in the "middle" and "better-off" wealth groups would reduce the impact somewhat. Under the positive scenario of increasing, well distributed rainfall, together with warming, the negative impacts would be far less and would possibly be turned into positive impacts, particularly for the Mountains where warming could lead to higher agricultural diversity and productivities.

Adaptive capacity

Social capital has a strong positive influence on adaptive capacity. Social networks such as farmers' associations, women's associations, churches, and extended family groups often provide financial or food relief in times of crisis, as well as informal savings and credit mechanisms. They exchange experiences and information and assist with new technology uptake. Social capital is stronger where households and communities are more diverse, with a healthy mix of ages, women/men (especially where women enjoy higher levels of equality), educational background and skills. Married adults are more likely to own land and other productive assets, and although this category of marital status still dominates, it is declining. It is not clear what the status of social capital in rural Lesotho is at present since this is changing rapidly. Historically, communities and households enjoyed a strong fabric and mutual support; however, disruptions caused by migrant labour, and the devastating impacts of HIV/AIDS have placed great strain on these mechanisms. More formal groupings for purposes of natural resource management, such as grazing and water associations, where well managed and enjoying full participation of farmers, would also contribute strongly to adaptive capacity.

Similarly, strong ***human capital*** has a positive influence on the capacity to adapt to changing conditions. Higher levels of education and literacy increase people's abilities to access information and technology required for adaptation. In the Lowlands, levels of basic education and literacy are relatively high, in spite of 20.8% of the population not being able to read or write. However, in the Mountains, 47.0% of the population fall into this category. It is possible that strong social capital counteracts this impediment to accessing information.

The education level, skills and experience of public servants in a region, for example agricultural extension officers, would also contribute to human capital in those communities and their ability to be informed about and adapt to changing conditions. It is not possible from this desktop study to gauge this for the rural areas of the Lowlands and Mountains. However, based on farmers' perceptions (as captured in the Household Budget Survey 2002/03), it appears that government service levels are poorly rated. The reasons for this could be inadequate education/skills, lack of capacity and resources, and poor motivation levels.

Women are gradually becoming more empowered (Lesotho BOS 2008: Gender), and are more able to make decisions for themselves and their families. The percentage of female-headed households is increasing. Nevertheless, a higher percentage of women than men are reliant on subsistence agriculture, with 75% of females in Thaba Tseka (Mountains) earning a living from subsistence agriculture. Of great concern must be that the proportion of female-headed households which own land is only half that of male-headed households. Female farmers also own substantially fewer farming implements than male farmers. This would certainly put them at a

disadvantage in their ability to employ coping strategies and adapt their farming practices as the climate changes.

Regions with a high prevalence of HIV/AIDS have lower adaptive capacity, since sick and weak household members are unable to work the land or tend to livestock. The fact that this illness affects primarily adults and thus breadwinners, makes this a very serious impediment to household earning capacity and regional productivity. This reduces the ability to respond to climatic or other shocks. HIV/AIDS prevalence is very high in Lesotho (Demographic and Health Survey, 2005). The Survey does not give information on HIV/AIDS prevalence in the various districts or Livelihood zones. However, the proportion of children with a deceased mother, father, or both mother and father, is 25.8% in the Lowlands and 26.2% in the Mountains. Of these, 4.5% and 3.8%, respectively, are orphans. The figures are higher in the Southern Lowlands than in the Northern Lowlands.

Higher levels of ***financial capital*** provide greater adaptive capacity. Household monthly cash income in both the Livelihood zones is modest on average, and low for the poor. Approximately one quarter of the population has no or negligible cash income. A higher proportion of the "better-off" wealth group live in the Lowlands compared to the Mountains, probably due to more activity in the private sector and less in farming, as well as greater incomes from salaries and remittances. This would provide greater opportunities for adaptation. Regions with a high dependence on agriculture are less economically diversified and less able to respond to climatic shocks.

Household assets, in the form of ownership of farm and non-farm durable goods, provide a buffer against poverty and hunger in times of crisis, since they can be sold for cash or used to generate an income. Levels of ownership of such goods are much higher in the Lowlands than the Mountains. Lack of transport (other than horses/donkeys) in the Mountains limits the ability of people to find alternative or additional opportunities for income in neighbouring areas.

Access to credit by rural agriculture-based households remains low. Only 26% and 20% of household heads in the Lowlands and Mountains, respectively, have bank accounts. Credit is an important mechanism enabling changes in farming practices, or the development of new livelihood activities.

The density and condition of infrastructure, such as road and communications networks and markets, contribute to ***physical capital***, which is an important component of a region's adaptive capacity.

The road network in the Southern Lowlands is moderately good and in relatively good condition, with a reasonable proportion of paved road length to total road length. In the Mountains, on the other hand, there is a network of unpaved roads (in 2006 only 4km of road was paved in Thaba Tseka district) across mountainous, rugged terrain. Swollen rivers in the many steep valleys and gorges become impassable after heavy rains. Heavy snowfall in winter also cuts off communities for extended periods of time.

Isolation from towns and markets reduces the options available for income generation, through reduced sales of produce and assets, reduced access to labour opportunities and remittances, and the difficulty in developing non-farm enterprises (economic diversification). Transaction costs become very high and lack of choices (competition) raises the risk of exploitation and local price hikes by traders.

On the positive side, continuously improving access to cell phone communication systems can only benefit rural communities by empowering them with information (e.g. market opportunities, weather forecasts) which they can use to reduce and manage risk, and develop their enterprises. This fosters stronger adaptive capacity.

Adverse implications

There are many signs that Lesotho, and particularly its more vulnerable livelihood zones, could experience substantial adverse implications from a changing climate, if this manifests (as it is widely believed) in increasingly erratic rainfall and more frequent and intense extreme climate events. The primary danger is the possibility of escalating soil losses and the erosion (literally!) of the very basis of most of the population's agricultural livelihoods. Continuing declines in own food production and increasing reliance on food imports make the country extremely vulnerable to food price increases.

If land management is not substantially improved, then increases in flash floods are likely because surface run-off will dominate over infiltration rates, exacerbated by the increase in more heavy (short and sharp) rainfall under climate change conditions.

Potential to benefit

- Across southern Africa, Lesotho is probably the only country in the position where the ***agriculturally-based economy could benefit*** considerably from climate change, given the scenario that the growing season will become moderately wetter (but assuming that the additional rain will be beneficially distributed), the cool climate moderately warmer and the growing season longer, and the CO_2 concentration more favourable for plants. This scenario could well play itself out over a few years in every decade, creating "bumper" years. A wider range of crops could be grown, yields and total production would increase, and a competitive advantage would be gained for some crops in relation to current production in the region e.g. crops with a high chilling requirement such as apples, for which even the warmer climate would still offer optimal climatic conditions.
- These climatic conditions would also stimulate ***rangeland productivity***, but with a possible shift to more shrubland at the expense of grassland. If pressure on degraded land is removed, such

land would re-vegetate faster than is presently the case. ***Re-forestation and afforestation programmes*** would benefit from such a climatic shift since conditions would be more favourable for woody biomass accumulation.

- ***Less severe cold stress*** (particularly in the Mountains) could well make living conditions in winter more comfortable for people and animals, and allow for higher productivity levels. Also, the requirement for heating (and thus levels of firewood collection) would be reduced, with the added benefit of lower exposure to fumes from indoor heating, a common health hazard.
- Actions taken to ***"climate-proof" agriculture*** and land-based livelihoods would include renewed and integrated efforts to protect the soil, modernise agriculture, increase productivity, stimulate "climate-insensitive" production (such as poultry, pigs and vegetables raised in climate-controlled enclosures), and increase economic diversity. Out of this would develop business/industrial opportunities and jobs.
- Closer attention to ***crop and livestock pests and diseases***, especially under more humid and wet conditions, would have highly beneficial impacts on agricultural productivity, since this is already a necessity.
- Stronger interest in, and encouragement of the use of ***seasonal and medium-term climate forecasts***, and thus the required investment in improving these forecasts, would increase productivity in good years, and allow farmers to better manage risk in bad years.
- Since climate change will call for adaptation as well as mitigation actions, with investment opportunities opening up for the latter, the development of ***off-grid renewable energy sources*** would be hugely beneficial to rural communities and businesses and stimulate the development of new agri-businesses in remote regions.

7.3. Key vulnerabilities in the Southern Lowlands and Mountains

After all factors have been considered, it is clear that, as a whole, the Southern Lowland and Mountain Livelihood zones are highly vulnerable to climate change.

The most vulnerable households will be those with:

- weak social networks (e.g. family, church)
- female heads
- high dependency ratios including disability resulting from HIV/AIDS-related illnesses
- illiterate heads and adult members

- high levels of poverty ("very poor" and "poor") with little income and no assets
- exclusive dependencies on subsistence agriculture, especially maize mono-culture

On the positive side, the projections for gradual climatic changes are rather positive, and if farmers can capitalise on the benefits enjoyed during the "good" years, and steps are taken to stockpile food for the "bad years", vulnerabilities should be substantially lower than under only the "more frequent extremes" scenario.

7.4. Integration: first-to-fourth-order scenarios

In the following figures (Figs 19-20), up and down arrows (↑ and ↓) indicate 'increase/more' and 'decrease/less' respectively. The broad arrows show the links from one level of impact to another, and positive feedbacks are indicated by the upward, curved arrows. For example, in Fig. 19, ↑ *Sale of farm assets* (a fourth order impact) may result in reduced production the following year, which is a third order impact. The feedback arrows merely indicative, not explicitly showing specific feedbacks.

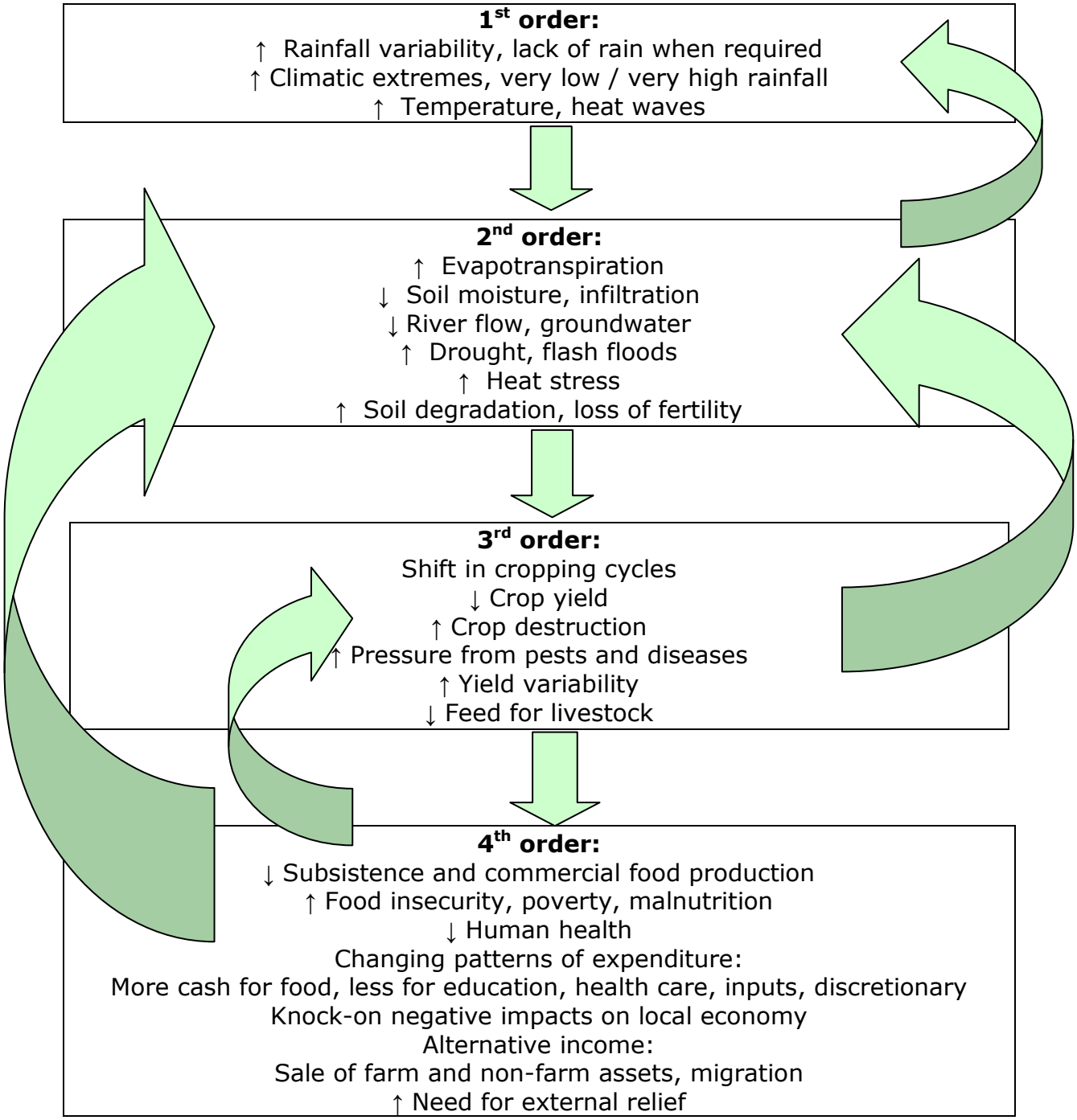


Fig. 19. Climate change impacts on crops under "variable and extreme climate" scenario

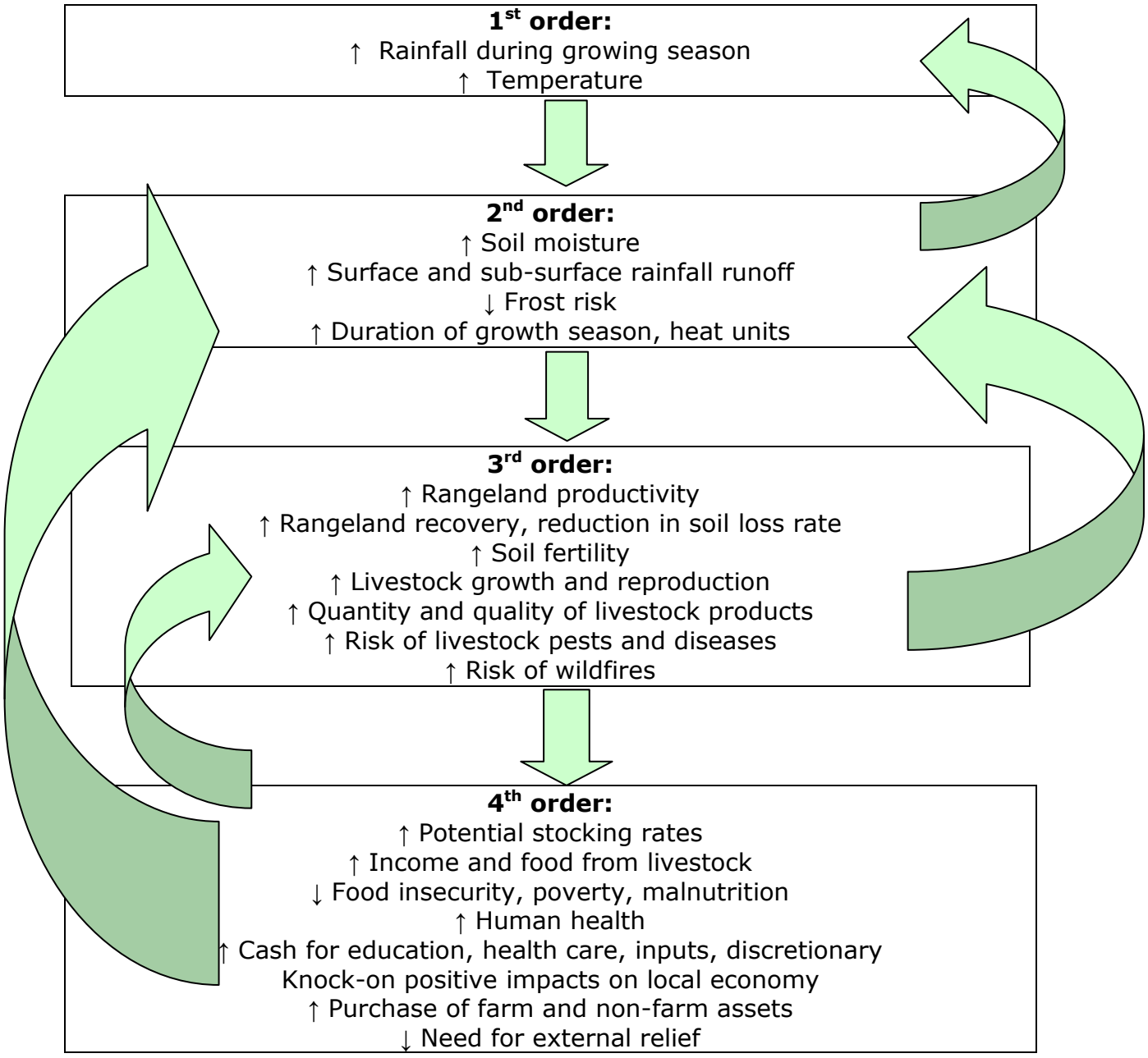


Fig. 20. Climate change impacts on livestock under "gradual warming and wetting" scenario

7.5. Climate impacts on progress towards the MDGs

The United Nations 2000 Millennium Declaration, adopted by 147 Heads of State incorporated a long-term development agenda and monitoring framework for low-income countries based on eight principle goals and 21 targets, referred to as the Millennium Development Goals (MDGs). This is being implemented over the period 2000-2015, with 1990 used as a baseline. Progress towards the achievement of the MDGs is assessed by each country on a regular basis using a set of 60 indicators, the last round being completed in 2008 in most cases.

How could climate change influence each of the MDGs?

Climate change could well undermine national efforts to attain the MDGs, could erode achievements that have already been attained over the last few decades, and place poverty reduction efforts in jeopardy (Boko et al., 2007).

Extreme poverty and hunger (MDG1): through reductions or losses of livelihood assets (health, access to water, homes and infrastructure), and negative impacts on food security (crop and livestock losses, failure to access lands during flooding, breakdown in distribution systems) and economic growth (longer term).

Education and gender equality (MDG2, MDG3): through losses of livelihoods assets and agricultural productivity, thus reducing education and income-generating opportunities for children and women, respectively; diversion of time to household tasks in times of stress; impaired access to schools and off-farm employment (floods); impacts of displacement and migration. Climate-related disasters impact more heavily on female-headed households, particularly those who are living in extreme poverty.

Health (MDG4, MDG5, MDG6): women and children are particularly vulnerable to climate-change-related impacts on water- and vector-borne diseases e.g. cholera, increased heat-related mortality; declining quantity and quality of drinking water; threatened food security and increased malnutrition; impaired access to essential health services (floods).

Environment (MDG7): through negative impacts on, and loss of natural resources (e.g. soil erosion) and ecosystem services; loss of biodiversity; environmental degradation; erosion of basic support systems for majority of livelihoods.

Global partnerships (MDG8): increased requirement for global co-operation to help developing countries deal with and adapt to impacts and climatic shocks.

Lesotho's progress towards achieving its MDG goals

Lesotho has adapted the MDGs to suit its own needs, see below (United Nations Development Programme: Development Goals in Lesotho, online).

1. Combat HIV & AIDS
2. Eradicate Extreme Poverty
3. Achieve Universal Primary education
4. Promote Gender Equality and empower women
5. Reduce Child Mortality
6. Improve Maternal Health
7. Ensure Environment Sustainability
8. Develop a Global Partnership for Development

We provide a brief summary of each (see also Fig. 21).

Combat HIV and AIDS

Lesotho apparently has the third highest prevalence rate of HIV/Aids in the world and little headway is being made in the rate of new infections. Opportunistic infections by associated disease conditions such as tuberculosis and other sexually transmitted diseases increase the morbidity and mortality rate. Young women and children are the prime affected groups. There is a prevalence rates of 26% for young women and 23.2% for young men. Appropriate and wide access to medical support remains a problem. It is unlikely Lesotho can decrease the infection rate soon.

Eradicate Extreme Poverty

Lesotho's economy is mostly bound up with that of South Africa's. An 8% layoff of migrant workers employed in South Africa's gold mines around 2004/05 and more so during the 2008/2009 global economic crisis has meant thousands of unemployed men returning to Lesotho and resulting in knock-on effects in households, with challenges to food purchases, education and medical treatment. There are few local employment options and there are strong income gradients between rural and urban dwellers and poverty in rural mountainous districts is high. Female-headed households are usually much poorer for socio-cultural reasons. The interactions between the ongoing poverty, land degradation, declining agricultural output, difficult climate and disease prevalence all contribute to ongoing and seemingly intractable poverty.

Achieve Universal Primary Education

A programme of free primary education has been relatively successful in increasing primary school enrolments, particularly amongst girls. Total enrolments reached about 85% in 2000-2007. There is a significant dropout rate for secondary school, in which enrolments for males drops to about 33% and 42% for females. Between 30-40% of school children are over-age for their officially recognized level. Provision of a highly skilled workforce therefore remains a problem, as will an over-reliance on labour exports to South Africa and the exposure to vulnerability that that incurs.

Promote Gender Equality and Empower Women

The Customary and Common Laws enshrined in the Constitution mean that women remain perpetual minors under the guardianship of spouses and male relatives. This hampers their potential for faster economic and health achievement. As women make up the majority of the SMMEs in Lesotho, they have a significant economic impact which could be improved by greater empowerment. The numbers of women in the highest levels of government are increasing slowly and on average about one third of Senate and National Assembly seats are now occupied by women.

Reduce Child Mortality

More than ten years ago, mortality amongst children was on the decline as a result of government initiatives such as the "Health for All" Primary Health Care Strategy of 1979. Recently, because of the HIV/Aids pandemic and economic problems in South Africa, leading to retrenchment of Lesotho-born labourers and subsequent increases in poverty, mortality is increasing. Economic, nutritional and disease-related challenges to children's health remains an ongoing problem.

Improve Maternal Health

Maternal health has declined significantly recently, between surveys in 2001 and 2004. The rate also reflects the rural/urban poverty divide and the limited access to health facilities, particularly related to the provision of pre-natal and post-natal health care. Infections, abortion- and labour-complications are the greatest contributors to maternal mortality. The government initiated an Emergency Obstetric Care project in 2005 but the challenge to maternal health remains dire.

Ensure Environmental Stability

The challenge to environmental stability is adequately addressed elsewhere in this report, suffice to say that soil erosion is one of Lesotho's ongoing and currently intractable environmental problems. Progress is being made in the supply of water and sanitation however at a rate of about 1% per year of the population gaining access. Access in rural areas has advanced most rapidly. The rapid migration to urban centres and uncontrolled establishment of dwellings especially in the late 1990s has contributed to the slow improvement in the urban areas. Population growth is withholding more rapid improvements.

Develop a Global Partnership for Development

While incomes from the South African Customs Union appear to be decreasing, Lesotho is looking to diversifying its economy as a way of improving income and resilience to economic challenges. While Lesotho is actively trying to improve exports to other SADC markets and the European Union, other developments include improving information and communication services, and developing the important tourism sector of the economy. This would make foreign direct investment increasingly

attractive. Favourable agreements with major economies are one important continuing source of income. For example, during 2001-2002, 89% of exports were AGOA-eligible (African Growth and Opportunity Act of the United States Government), which provides for duty-free access to the United States market. These types of arrangements need to continue.

LESOTHO MDG STATUS AT A GLANCE: Prospects for Achieving the MDG Targets.

GAOLS/TARGETS	WILL THE GOAL/TARGET BE MET?				STATE OF SUPPORTIVE ENVIROMENT			
HIV/AIDS								
Halt and reverse the spread of HIV/AIDS by 2008	Probably	**Potentially**	Unlikely	No data	Strong	**Fair**	Weak but improving	Weak
EXTREME POVERTY & HUNGER								
Cut by half the proportion of people living below the national poverty line by 2015.	Probably	**Potentially**	Unlikely	No data	Strong	**Fair**	Weak but improving	Weak
Halve the proportion of underweight among under five year olds by 2015	Probably	**Potentially**	Unlikely	No data	Strong	**Fair**	Weak but improving	Weak
UNIVERSAL PRIMARY EDUCATION								
Achieve universal primary education by 2007	**Probably**	Potentially	Unlikely	No data	**Strong**	Fair	Weak but improving	Weak
GENDEREQUALITY								
Achieve equal access for boys and girls to education and increase female participation in development issues by 2015	Probably	**Potentially**	Unlikely	No data	Strong	**Fair**	Weak but improving	Weak
CHILD MORTALITY								
Cut infant mortality by two -thirds by 2015	Probably	**Potentially**	Unlikely	No data	Strong	Fair	**Weak but improving**	Weak
MATERNAL HEALTH								
Reduce maternal ration by three - quarters by 2015	Probably	Potentially	Unlikely	**No data**	Strong	Fair	**Weak but improving**	Weak
ENVIROMENTAL SUSTAINABILITY								
Reverse the loss of environmental resources by 2015.	Probably	**Potentially**	Unlikely	No data	Strong	**Fair**	Weak but improving	Weak
Halve the proportion of people without access to safe drinking water and sanitation.	Probably	**Potentially**	Unlikely	No data	Strong	**Fair**	Weak but imp roving	Weak

Note: The determination of whether the goal/target will be met is based on a linear extrapolation of current trends. In determining the state of the supportive environment five basic areas were considered: (1) Does the Government have a policy in the area; (2) Is there a coordinating body; (3) Does it have capacity to implement; (4) Is funding available, and (5) Is the goal/target a Government of Lesotho priority.

Fig. 21. Lesotho MDG status (source: UNDP Common Country Assessment of Lesotho, 2005).

8. CONCLUSIONS AND RECOMMENDATIONS

Based on the Risk and Vulnerability Assessment, the following broad conclusions and recommendations can be made. We have not compiled a long list of potential adaptation options and projects (these can be found elsewhere and are site-specific) but emphasise overarching approaches:

- ***Cross-sectoral integration***, not only between the natural resource-based sectors (agriculture, forestry, water, soil conservation, biodiversity, energy) but in particular between these and the socio-economic sectors (health, education, planning, trade and industry, finance) is imperative for the success of adaptation actions. Institutional cooperation needs to become more streamlined, so that programmes and projects are not implemented at cross purposes. Climate change considerations need to be integrated into all planning processes and staff capacitated to understand the issues and connections. This could be achieved with the establishment of a Climate Change Cross-Sectoral Committee convened by one of the core Ministries e.g. the MAFS or the MFLR.
- The role of ***high quality data*** collection, management, analysis and information dissemination cannot be underestimated. This applies particularly to the Lesotho Meteorological Services, and the Lesotho Bureau of Statistics. Strategies, policies and projects must be underpinned by objective evidence. Information must reach those who require it in a reliable and timely manner for effective decision-making by farmers, administrators and policy-makers. We suggest that Lesotho make use of the Regional Climate Change Programme's (RCCP) Information Clearing House, both to disseminate information and to benefit from planned services such as cell phone/radio information dissemination for farmers.
- Although crop and livestock farming have been (correctly) identified as primary focus areas, cognisance should be taken of the strong ***links between climate, farming and poverty***. Poverty is the underlying stress which impedes people's ability to cope, adapt and change their livelihood strategies in response to changing conditions. Rural farming communities across the developing world include the "poorest of the poor". The agrarian structure of Lesotho does not stimulate investments required to gradually move out of subsistence mode into profitable mode and thus out of poverty. Climate change will exacerbate this poverty trap if necessary reforms in this sector are not undertaken.
- The potential ***opportunity for agricultural production to increase*** under climate change should be taken with both hands and made a reality. This will require a strong focus on predicting and managing climate variability and risk, using all the knowledge and technology currently available, and improved through research and technology transfer. If Lesotho can "climate-proof" its

agriculture, in the sense that variability does not time and again lead to food shortages but is incorporated into a modern and diverse food system, it could benefit tremendously and make substantial inroads into reducing food and human insecurity. This could, for example, include the development of postharvest processing and storage, so that food stocks and reserves can be accumulated during good years for the bad years (at household, district and national level). It would also include fast-tracking the efforts by the MAFS to diversify agricultural production.

- "Climate-proofing" crop production can also be achieved through the ***development of water for irrigation***. Water harvesting can be relatively easy and inexpensive, and the topography over most of the country is ideal for gravity-fed irrigation. Reservoirs (perhaps using the abundant stone) could be established on hills close to every village allowing water to be fed to fields by gravity. In addition, a range of formal small-scale irrigation schemes managed by local users would provide enough capacity for irrigated cropping to avert entire crop failure during drought years.

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10. APPENDICES

10.1. Appendix 1: selected data

Table 2. Agricultural productivity in the Lowlands and Mountains, and in selected districts within these Livelihood Zones (data from Lesotho Bureau of Statistics, BOS). The average production figures for 2006 and 2007 are shown for crops, for livestock the February 2006 figures are shown (Statistical Yearbook 2008). The household data comes from the 2002/03 Household Budget Survey (BOS).

Zone:	**Lowlands**			**Mountains**	
District:		**Mafeteng**	**Mohale's Hoek**		**Thaba Tseka**
Maize production (tonnes)	52,073	5,982	8,162	20,973	10,267
Maize yield (kg/ha)	501	242	471	428	749
Sorghum production (tonnes)	7,884	1,658	883	602	292
Sorghum yield (kg/ha)	297	221	136	86	104
Wheat production (tonnes)	2,967	813	456	1,492	538
Wheat yield (kg/ha)	227	148	219	145	256
Beans production (tonnes)	673	121	90	165	98
Beans yield (kg/ha)	44	37	25	32	24
Peas production (tonnes)	697	188	163	496	149
Peas yield (kg/ha)	244	161	219	284	380
Cattle	359,957	85,791	62,274	236,345	60,628
Sheep	234,286	96,528	70,244	656,664	122,784
Goats	179,778	65,050	141,527	394,578	92,065
Pigs	69,043	17,133	9,862	27,064	6,072
Horses	19,627	5,243	12,544	37,923	14,782
Donkeys	86,780	7,487	11,018	48,354	12,539

Wool production 2006/7					
Clean mass (kg)		42,393	94,501		183,559
Gross value (Maloti)		1,760,902	4,474,040		9,047,226
Mohair production 2006/7					
Clean mass (kg)		2,502	26,044		46,183
Gross value (Maloti)		279,986	1,466,119		2,966,982
Household ownership of productive assets (%)					
Land owned	33.8			22.1	
Livestock	29.9			22.4	
Poultry	29.1			27.8	
Tractor	34.5			13.9	
Plough	25.3			18.0	
Scotch cart	52.3			6.1	
Wheelbarrow	22.7			5.8	
Other major implements	27.7			20.2	
Household land ownership – male head	45.0			49.1	
Household land ownership – female head	22.6			22.1	
Household ownership of productive assets (%) by gender					
Tractor male	0.8			1.4	
Tractor female	0.5			1.2	
Plough male	11.2			33.8	
Plough female	7.3			13.0	
Scotch cart male	5.0			2.6	
Scotch cart female	1.3			0.3	
Wheelbarrow male	34.6			15.8	

Wheelbarrow female	10.9			4.3	
Other major implements male	20.4			19.6	
Other major implements female	7.9			8.0	
Household ownership of livestock (%)					
Cattle	31.9			24.3	
Donkeys	34.6			29.4	
Horses	23.2			42.4	
Sheep	25.8			33.2	
Goats	24.1			33.5	
Pigs	31.1			12.1	
Household perception of livestock keeping conditions (scale 1-10)					
Revenues from livestock		3.4	2.9		4.6
Health of livestock		4.6	5.0		6.2
Protection of livestock from wild animals		4.8	5.1		4.8
Compensation for lost animals		2.2	2.7		3.0
Access to grazing		4.2	6.4		6.4
Extension services		3.5	5.1		5.2
Fees for extension services		3.0	5.0		4.6
Average		3.6	4.4		4.9
Household perception of farming conditions (scale 1-10)					
Revenues from farming		2.8	3.0		4.5
Protection of crops from wild animals		3.3	4.5		4.1
Protection of crops from livestock		3.2	5.0		4.5
Compensation for lost harvest		2.7	3.4		2.7
Government services for farming		3.9	5.3		4.2

Fees for such services		3.6	5.4		4.1
Average		3.2	4.3		4.1

Table 3. Household profiles in the Lowlands and Mountains, and in selected districts within these Livelihood Zones. Data are taken from the 2002/03 Household Budget Survey (BOS) and the 2006 Census of Population and Housing (BOS).

Zone:	**Lowlands**			**Mountains**	
District:		**Mafeteng**	**Mohale's Hoek**		**Thaba Tseka**
Area (sq. km)	5,160	2,119	3,530	17,910	4,270
Population 2006	1,038,886 (55%)	193,682 (10.3%)	174,924 (9.3%)	364,388 (19%)	129,137 (6.9)
Population per sq. km 2006	201	91	50	20	30
Unemployment rate – male 15+ (%) 2006		22.0	18.9		21.0
Unemployment rate – female 15+ (%) 2006		27.2	25.9		21.9
Subsistence agriculture – male (15+) (%) 2006		43.5	41.6		62.9
Subsistence agriculture – female (15+) (%) 2006		50.7	48.7		75.4
Avg household size 2002/3	5.3			5.8	
Dependency ratio (ratio of children+aged to population aged 15-64) – female-headed household 2002/3	0.74			0.89	
Dependency ratio (ratio of children+aged to population aged 15-64) – male-headed household 2002/3	0.70			0.90	
Household head – male (%) 2002/3	67.1			69.6	
Household head – female (%) 2002/3	32.9			30.4	
Household head educational attainment 2002/3					
None: can't read/write	20.8			47.0	
None: can read/write	49.2			33.7	
Primary	24.4			16.7	
Secondary	3.6			1.6	
Vocational	0.1			0.2	
Teacher/technical	1.6			0.6	

University/higher	0.3			0.2	
Household members educational attainment 2002/3					
None: can't read/write	29.2			46.0	
None: can read/write	38.5			34.8	
Primary	26.5			17.0	
Secondary	4.7			1.8	
Tertiary	1.1			0.3	
Literate – male (%) 2002/3	78.4			51.6	
Literate –female (%) 2002/3	80.0			53.6	
Household head economic activity					
Employer	0.2			0.2	
Employed with salary	28.5			18.7	
Subsistence farming	33.8			47.4	
Other self-employed	4.4			3.2	
Housemaker/wife	19.5			20.0	
Unemployed	7.1			5.7	
Adult household members economic activity					
Employed with salary	16.9			13.1	
Subsistence farming	14.8			21.0	
Other self-employed	14.4			13.2	
Unpaid family worker	3.9			5.2	
Pupil/student	7.1			4.0	
Housemaker/wife	27.6			32.1	
Unemployed	11.7			8.0	
Household head has bank account	**26.3**			**19.9**	
Ownership of durable goods (non-farm) 2002/3 (% per category countrywide)					
Cooking equipment	28.3			2.9	
Energy equipment	36.9			3.7	
Transport and communication	25.7			1.2	
Photographic and audio equipment	35.2			7.6	
Sewing machine	32.9			10.4	
Refrigerators/freezers	26.5			2.3	
Other equipment	36.9			14.5	
Household monthly cash income 2002/3 (% per category countrywide)					
None	26.1			24.8	
1-999	23.6			14.6	
1000-2999	16.1			6.3	

3000+	11.5			6.0	
Household main source of income 2002/3					
From public sector	4.0			3.1	
From private sector	18.4			12.4	
Farming	44.2			60.4	
Other business	4.2			3.6	
Pensions	3.0			0.7	
Remittances	14.2			9.4	
Other	12.0			10.3	
Household annual consumption expenditure 2002/3					
Food and beverage	47.9			58.1	
Clothing and footwear	16.3			21.8	
Rent, fuel and power	5.2			5.2	
Furniture and household service	6.0			2.4	
Medical care and health	1.8			1.1	
Transport and communication	7.0			2.8	
Recreation, education and culture	5.1			3.5	
Misc. goods and services	10.7			5.2	
Household incidence, depth and severity of poverty					
Head count	62.37			56.88	
Depth	32.49			29.07	
Severity	21.16			18.96	
Gini coefficient for income inequality		0.48	0.53		0.50

Table 4. Infrastructure and access to amenities and services in the Lowlands and Mountains, and in selected districts within these Livelihood Zones. Data are taken from the 2002/03 Household Budget Survey (BOS) and the 2006 Census of Population and Housing (BOS).

Zone:	**Lowlands**			**Mountains**	
District:		**Mafeteng**	**Mohale's Hoek**		**Thaba Tseka**
Paved roads (km) 2006		176	77		4
Unpaved roads (km) 2006		53	71		273
Total roads (km) 2006		229	148		277
Time taken to reach					

public transport 2002/3					
0-14	43.1			25.0	
15-29	18.9			9.9	
30-44	14.0			8.7	
45-59	7.5			7.4	
60+	16.6			49.0	
Household access to electricity 2002/3	2.1			0.5	
Source of heating 2002/3					
Electricity	0.2			0.2	
Gas	3.4			0.4	
Paraffin	24.9			5.3	
Coal	5.7			0.9	
Cow dung	12.6			20.3	
Firewood	51.4			72.7	
Crop waste	1.2			0.2	
Time taken to reach the nearest drinking water source 2002/3					
0-14	60.2			65.2	
15-29	22.3			22.4	
30-44	10.7			7.7	
45-59	2.8			2.6	
60+	4.0			2.1	
Type of water supply 2002/3					
Piped water within premises	2.9			1.3	
Community water	47.1			41.7	
Public well	10.0			19.8	
Covered spring	6.2			12.9	
Uncovered spring	16.5			21.2	
River	0.9			0.4	
Borehole	14.0			0.4	
Type of toilet facility 2002/3					
No toilet	40.5			87.6	
Sewage system	0.1			0.2	
Own pit latrine	40.6			5.5	
Own VIP	17.4			6.2	

10.2. Appendix 2: agricultural and household coping mechanisms in times of climatic/food security stress

The following ***agricultural coping mechanisms*** are commonly used in Lesotho and other similar southern African countries during times of climatic stress (adapted from Ziervogel, 2004):

Below normal rainfall:

- Plant drought resistant crops; sow less maize and wheat
- Plant later
- Change to a short-season variety
- Reduce density of field crops
- Irrigate if the streams still have water, dig furrows next to fields to stop wilting
- Collect water and pour over plants
- Plough lucern and teff as animal feed since they survive harsh conditions
- Reduce the number of animals which cannot survive the harsh conditions (by selling)
- Take animals to the mofebong (rangelands) where there is better grazing and water

Above normal rainfall:

- Grow more vegetables as cash crops
- Plant earlier
- Increase crop densities
- Increase sharecropping as it results in greater yields (more labour and more land)
- Be aware of diseases and pests for crops and animals
- Plant different crops to neighbours so that there is a market
- Practice winter breeding since there will be water and feed for the sheep and goats
- Build animal shelters

The following ***household coping mechanisms*** are commonly used in Lesotho and other similar southern African countries during times of food insecurity stress (adapted from LVAC, 2006):

- The most common response in times of crisis is the re-allocation of expenditure to essential staple food purchases at the expense of non-essential or discretionary purchases e.g. clothing or beer. This

is an effective initial response. Households (especially poorer ones) also reduce the number of meals eaten daily, and the meal sizes.

- Those households with significant numbers of livestock (the "middle" and "better-off") increase the number of livestock sold in order to obtain cash for purchasing food.
- Wealthier households will often, even during "normal" times, donate food to poorer households as part of a broader community support mechanism. The latter will seek more assistance during a crisis, but this is only possible for as long as wealthier households can afford this.
- Poorer people, on the other hand, seek more opportunities for casual labour, although the availability of casual labour is limited in the region, and further limited during drought years when crops have failed. Household members will often travel further afield in search of jobs, especially younger members of households who are also able to move to South Africa where there are possibly more opportunities.
- If these responses are not sufficient to cover the missing food entitlements, then the household will draw on essential expenditure such as education and inputs. This will result in an expenditure deficit.
- If the missing food entitlement is likely not to be covered even after all essential expenditure is switched to buying food, then the household will experience both and expenditure and food deficit (LVAC, 2008). At this point, external relief is required.