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Strengthening Capacity for Climate Change Adaptation in Agriculture:

Experience and Lessons from Lesotho

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Strengthening Capacity for Climate Change Adaptation in Agriculture:

Experience and Lessons from Lesotho

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FOREWORD

Climate change is expected to exacerbate existing climate-related problems in Southern Africa where 68 percent of the population is rural and dependent on agriculture for basic livelihoods. FAO's State of Food Insecurity in the World (2010) estimates that nearly 34 million people (33 percent of the total population) are undernourished in the region. Climate change is already having an adverse impact on food security in Southern Africa notably in the Least Developed Countries (LDCs) like Lesotho that have a large rural population dependent on rainfed agriculture. Projected changes in future temperature and rainfall patterns for 2030 in Southern Africa indicate a significant decline in production of major staple crops such as maize, wheat and sorghum. Lesotho is a classic example of this scenario.

Climate change-induced effects in Lesotho are expected to have a far-reaching regional impact on regional fresh water resources as the country forms major source of fresh water and drainage areas extending into the Atlantic basin through South Africa, Namibia and Botswana. This publication highlights the urgency of adapting agriculture and natural resources management to the unfolding climate change scenarios and potential impacts. It also underscores the importance of creating awareness and action among policy makers.

The publication presents the main findings of climate change projections in the short-term (until 2030), identifies the key impacts on livelihoods and food security in major agro-ecological zones and outlines the experience and lessons learned on adaptation priorities with an overall aim of enhancing food security. The publication also provides a good example how the FAO Technical Cooperation Programme (TCP) has been instrumental in complementing and addressing some of the gaps in the National Adaptation Programme of Action (NAPA) on climate change of Lesotho. The emphasis is on identifying and testing locally-relevant and technologically appropriate adaptation practices (particularly for drought) and technical capacity building through need-based training programmes, focusing on crops, livestock and forest-based livelihood systems.

We trust that this publication "Strengthening Capacity for Climate Change Adaptation in Agriculture: Experiences and Lessons from Lesotho" will provide useful insight to all relevant policy-makers, development partners and field practitioners on the necessity of developing appropriate strategies for integrating climate change adaptation priorities into government policies and programmes at all levels. Furthermore, the publication will contribute to the on-going processes of developing a national development strategic plan in which the impacts of climate change on environment, agriculture and natural resources is among the main features of the plan.

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ABSTRACT

In many parts of southern Africa, agricultural production is stagnant or even in decline, particularly in subsistence and smallholder agriculture. The reasons are many and debatable, but include lack of suitable inputs for production, environmental constraints and degradation, inadequate agricultural infrastructure, external shocks including volatile markets, and social stresses such as the impacts of HIV/AIDS and growing poverty. As an additional stressor, increasing climate variability and climate change are impacting on agricultural livelihoods since resource-poor farmers are unable to cope with multiple stressors or adapt to climate-related risks. The Kingdom of Lesotho is a typical example of a country considered highly vulnerable to climate-related challenges: as one of the least developed countries (LDCs), it is over-reliant on rainfed agriculture for food production and has a large poor rural population engaged in subsistence farming, which is relatively undiversified. Vulnerability in Lesotho is characterized by high population pressure on the available arable land and natural resources, fragile and substantially degraded soils, high levels of food insecurity and poverty, and lack of infrastructure which curtails the ability of the population to deal with severe weather conditions. In line with the United Nations Framework Convention on Climate Change (UNFCC) guidelines Lesotho has prepared a National Adaptation of Programme of Action (NAPA) to respond to the immediate needs of addressing the country's vulnerability to climate change. Lesotho is seeking to understand its key vulnerabilities at national and local levels, and identify and prioritize locally relevant community-based adaptation strategies in key sectors which can be sustainably implemented in vulnerable subcatchments. This paper provides an overview of what climate change will mean to subsistence and smallholder farmers in Lesotho, and how the capacity for climate change adaptation in agriculture can be strengthened, focusing on selected areas of crops, livestock and forest-based livelihood systems, to stabilize and improve yields. We draw on experiences and lessons learned from a pilot FAO/Government of Lesotho project, and make recommendations as to how on-the-ground community-based responses could be scaled up to other parts of the country, and possibly to other vulnerable countries across southern Africa.

ACKNOWLEDGEMENTS

This publication is significantly influenced by experience gained from project formulation, launching and implementation of the TCP "Strengthening Capacity for Climate Change Adaptation in Agriculture in Lesotho" which is ongoing. This is among the first TCP focusing on Climate Change Adaptation with concerted effort to complement the Lesotho National Adaptation Programme of Action (NAPA). The project also cuts across the various disciplines and technical divisions at FAO (i.e. crop, livestock, forestry and land and water management). It went through a challenging review process before approval. It was also recommended to me as Lead Technical Officer for the TCP to make every effort to document and disseminate the findings from this experience widely, given the paucity of local level data on climate impact and experience in adaptation in the country and region. Hence, the idea and work for this publication has been in the process since launching of this TCP.

Many people have assisted and contributed in one way or another towards this publication and it would be difficult to name all of them. Still there are some whose encouragement, ideas and actions have contributed towards the realization of this publication. We are grateful for the support of key staff members from the various technical division of FAO that have reviewed the project document. This includes Simon Mack (Livestock Production); Susan Braatz (Forest Management), Theo Friedrich (Crop Management); Kwaku Agyemang (Livestock Management and Crop Livestock Integration); Selvaraju Ramasamy (Climate Impact) and Caterina Batello (Crop-Livestock Integration). Kwaku Agyemang and Susan Braatz have also made useful observations and recommendations during their backstopping mission duly referenced in the text.

The OneWorld Sustainable Investment, Cape Town, South Africa, has been our partner in undertaking the baseline survey as well as this publication. We would like to give special thanks to Arthur Chapman, Mandy Antzoylatos and Belynda Petrie at OneWorld Investment.

In Lesotho the support of Principal Secretary of the Ministry of Forestry and Land Reclamation, Mrs Nkareng 'Mota and her Deputy, Mr Nchemo Maile, the Principal Secretary of Ministry of Agriculture and Food Security, Mr Mohale Sekoto, has been instrumental throughout the process of project formulation, launching and implementation. At the Ministry of Forestry and Land Reclamation the support of the respective Directors of Forestry (Mr S.E. Sekaleli), Soil and

Water Conservation (Mr S.M. Mabaso), Mr B. Sekoli, Director of Lesotho Meteorological Services, and the Project Coordinator Mr Paepae Selahla has been most helpful. Special thanks also go to the National consultants Mr R.M. Lepheana (Crop specialist), Mr T. Maliehe (Agroforestry specialist) and Mr Ramoeketsi (Livestock specialist).

At the FAO Representation in Lesotho, the support of Nthimo Mokitinyane, Assistant FAO Representative, has been most helpful during all the stages of the project and facilitating for this publication. We also extend our appreciation to Mr Attaher Maiga, FAO Representative to Lesotho and the staff assisting our activities.

Many of the activities that have inspired this work are taking place at district and community level. The support of the District Administrators (DA) in Mafeteng, Mohale's Hoek and Thaba-Tseka respectively, Mr T. Lehloenya, and Mr R. 'Makong Mr S. Lenkoane; the respective District Agricultural Officers (DAO) : Mr M. Majara, Mrs M. Mahanetsa, Ms B. Khooa respectively, and the respective District Coordinators (DC) in the Ministry of Forestry and Land Reclamation: Mr L. Tjaoane, Mr N. Mothokho (and his predecessor Mr T. Rathipe), has been the foundation for any progress as the project requires close coordination of these sectors. This has encouraged interaction and communication among the technical officers in crops, livestock, forestry, rangeland management and extension at district level that will be central in achieving the overarching goal of strengthening local capacity for climate change adaptation.

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CONTENTS

INTRODUCTION

About one billion people worldwide are suffering from food insecurity, meaning that they do not at all times have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life (FAO, 2009a). Persistent food insecurity across southern Africa, over many decades, has recently been aggravated by a confluence of events and factors which threatens to plunge ever more marginalized people into severe hunger and malnutrition. The global financial and economic crises and the volatility of food prices have added extreme pressures, reducing the region's capacity to respond effectively. Already this is threatening to reverse progress made on achieving the Millennium Development Goals (United Nations, 2009). Other reasons for currently high levels of vulnerability to food insecurity include climatic hazards, such as recurrent droughts and floods and erratic rainfall, and growing pressure on land and water resources.

The underlying reasons for food insecurity are embedded across all spatial scales, from global, regional and national levels, to community, household and individual levels. In dealing with the problem of hunger, underlying structural causes of poverty and food insecurity must be addressed through development of the agricultural sector and the socio-economic improvement of poor rural communities (World Bank, 2007; IAASTD, 2009; CAADP, 2007).

Climate change is already, and will increasingly play a pivotal role in food security, through impacts on production, distribution and food prices (Easterling *et al.,* 2007; FAO, 2007b). How and where this will play itself out is still uncertain, but it can be expected that as an additional stressor, it will impact most strongly on those who are already food-insecure, subject to existing high levels of climate variability and stress, and unable to cope with or adapt to the added pressure. Southern Africa is considered highly vulnerable to climate-related challenges: many countries, notably the least developed countries (LDCs), are over-reliant on rainfed agriculture for food production, have a large poor rural population engaged in subsistence farming, and relatively undiversified economies and poorly developed infrastructure. A comprehensive analysis on impact of climate change (Lobell *et al.,* 2008) indicates that southern Africa is one of the two regions likely to suffer negative impacts of climate change on several crops (e.g. maize and sorghum) that are very important to large food-insecure populations. A GIS-based spatial analysis of climate change vulnerability for southern Africa (OneWorld Sustainable Investments, 2010a) showed that the most vulnerable countries and regions are characterized by high population pressure on the available arable land and natural resources, high levels of food insecurity and poverty, and lack of infrastructure which curtails the ability of the population to deal with severe weather conditions. The Kingdom of Lesotho is a model case and typical example of a least developed country fitting this scenario. As Lesotho falls within this regional hotspot of future food insecurity, sufficient adaptation measures need to be prioritized urgently and made available to the vulnerable communities. Climate change will also have detrimental impacts on the agriculture sector in the country already ravaged by recurrent droughts. Importantly, climate change induced effects in Lesotho will have a far reaching regional impact. Due to its situation at the highest part of the Drakensberg Escarpment, it is characterized by steep mountains which are extensively eroded. The headwaters of the Senqu (Orange), Mohokare (Caledon) and Makhaleng rivers cut deeply into the surface and form major drainage areas across much of the country extending into greater southern Africa as the Orange River Basin.

The objective of this paper is: (i) to provide an overview of what climate change will mean to subsistence and smallholder farmers in Lesotho and the broader region, and (ii) to draw strategies and mechanisms for strengthening institutional and technical capacities based on the analysis. The paper summarizes the experiences and lessons learned from a pilot FAO/Government of Lesotho project, and make recommendations as to how on-the-ground community-based responses could be scaled up to other parts of the country, as well as other vulnerable countries across southern Africa.

CHAPTER 1

CLIMATE CHANGE AND VARIABILITY IN SOUTHERN AFRICA AND LESOTHO

1.1 CLIMATE OF SOUTHERN AFRICA WITH EMPHASIS ON LESOTHO

Rainfall in Lesotho is driven by the regional expression of global atmospheric circulation systems over southern Africa and moderated by the topographic position of Lesotho (1 388 m to 3 482 m above mean sea level) on the southern African plateau. Mean circulation over southern Africa is anti-cyclonic throughout the year, meaning warm, dry descending air, and is responsible for the general aridity across the region. During the winter months (May to July), cool dry air is a feature of the interior southern African plateau, including Lesotho, and rainfall is very low. Occasionally deep cold fronts can deposit significant amounts of snow on the high ground, often at the beginning or end of winter. Snow falls annually on the mountains of Lesotho and generally once in three years over the low lying areas. Strong winds associated with frontal systems occur particularly during late winter.

This pattern weakens during the summer when a heat-driven low pressure trough associated with the Inter-Tropical Convergence Zone (ITCZ) can form over Botswana and surrounding areas, suppressing the anti-cyclonic circulation and enabling convection and thunderstorm activity. When these low pressure troughs intensify or deepen and extend southwards, heavy rains form east of the trough. This system particularly influences periods of heavy, extended rainfall in Lesotho and may preferentially form during the La Niña phase of El Niño Southern Oscillation (ENSO). Conversely, the El Niño phase of ENSO distorts the position of the Botswana trough, pushing it out to the east and causing dry conditions over Lesotho. During the rainy season over 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. Between 75 and 85 percent of rainfall over Lesotho occurs during the summer season months (November to January).

Precipitation in Lesotho is strongly controlled by topography and lack of marine influence. The highest mean annual rainfall (>1 200 mm yr^{-1}) occurs off the Lesotho escarpment in KwaZulu Natal (South Africa), a function of the orographic forcing of rainfall (Schulze *et al.,* 1997). The strong rainshadow formed by the eastern escarpment results in a much lower rainfall of about 400–600 mm yr^{-1} in the Senqu River valley, while the remainder of Lesotho receives about 600–800 mm yr^{-1} except in the northern lowlands and northeastern mountains (800–1 000 mm yr^{-1}). Precipitation occurs as rain, snow, hail and sleet. Potential evapotranspiration is higher than precipitation throughout the year with the exception of March. Variability of rainfall (inter-annual coefficient of variation) is high, ranging from 20 percent to more than 40 percent in the south. Rainfall during drier years is below that required for rainfed agriculture over much of the southwestern and western parts of the country.

The high altitude means that Lesotho experiences some of the lowest temperatures in southern Africa, especially along the mountain ridges and plateaus. A significant proportion of Lesotho experiences a mean annual temperature of <10 °C. Mean daily maximum and minimum temperatures mostly do not exceed 22.5–25 °C and 10-12.5 °C, respectively, except in the southwestern/western lowlands where temperatures can reach 27.5–32.5 °C and 15–17.5 °C, respectively. 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 high temperatures can occur up to 36–38 °C, mainly in the southwest.

Net primary productivity is low over most of Lesotho, linked to the climate and thin soils on steep slopes. Areas of higher potential are restricted to small areas in the lowlands and foothills. The main climatic constraints to agricultural production are the high levels of rainfall variability, soil characteristics which combine with rainfall and evaporation to determine effective soil water regimes and availability for crop production, and the duration of the growing season as determined by the temperature regime, rainfall seasonality and the frost risk.

1.2 CLIMATE VARIABILITY AND VULNERABILITY PATTERNS IN THE REGION AND LESOTHO

Southern Africa has often been affected by climate vulnerability and extreme climate events in the past. Even before records were kept, droughts and floods have had significant impacts on southern African societies (Ballard, 1986; Vogel, 1989). Around AD 1200 to 1500, drought led 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).

A long and intensive drought during the early 1800s, which resulted in substantial loss of grazing and water resources, led to widespread famine and starvation. It appears that this was precipitated by a sequence of volcanic eruptions during this period which resulted in atmospheric cooling (Robbock, 2002). Around 1815 began the Lifaqane, a 25-year period characterized by a famine and war between nations within the southern African regional (Ballard, 1986).

Vogel (1989) and Lindesay and Vogel (1990) indicate that large areas of southern Africa experienced eight periods of drought during the nineteenth century, alternating with six wetter phases which brought widespread flooding. The region's weather is heavily influenced by ENSO, and research has shown clear links between this phenomenon and twentieth century climatic patterns across southern Africa. For example, a serious regional drought linked to ENSO was experienced during 1991/92, and was unusual in that it continued for much longer than usual, from 1991 to the middle of 1995. During 1992, 20 million people in the region (about 15 percent of the population of SADC) were in need of food relief due to the drought. Food deficits were partially a result of the severity of the drought, but the impact was aggravated by socio-economic and political factors.

The southern African droughts of the early 1990s highlight two important points:

- Firstly, that short-term climate variability can be responsible for serious and immediate impacts on human and animal well-being and crop production, and
- Secondly, that the magnitude of the impact of climate variability is determined by the social, economic and political vulnerability of different communities and nations, as well as local agricultural management practices.

Climate-related stresses have also been prevalent in Lesotho for a long time. The people of Lesotho have 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 apparent increasing frequency, magnitude and duration of climatic shocks, leaving little or no time to recover from the last event. In addition, the country has experienced 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. A picture emerges of increasing inability to deal with additional climatic shocks (OneWorld Sustainable Investments, 2009). This emerges starkly in the national agricultural production statistics (Government of Lesotho, 2007a, 2008).

Despite the impacts of climate variability, it should be noted that crop yields in the Free State Province (FSP) of South Africa, just across the border from Lesotho's drier Mafeteng and Mohale's Hoek districts, surpass the crop yields in Lesotho by 2.5 to 9 times. The distinct contrast could be attributable to widely differing crop, livestock and natural resources management, and efficient use of agricultural inputs, and underlines the scope which exists for adaptation. The FSP and Lesotho sides of the border mostly share the same climatic and soil conditions, indicating that Lesotho's agriculture can be improved.

1.3 CLIMATE CHANGE PROJECTIONS FOR THE REGION AND LESOTHO

Climate variability and climate change

Trenberth *et al.*, (2003) describe how warming associated with climate change will lead to increasing intensities of rainfall, decreasing frequencies of low intensity (soft soaking) rainfall, and longer dry periods between rainfall events. These scenarios will likely manifest already in the short- to medium-term, before any major shifts in background climate are experienced. There is already an apparent increase in intensity of rainfall experienced worldwide (Easterling *et al.*, 2000; Groisman *et al.*, 2005) and in parts of southern Africa (Usman and Reason, 2004; Kruger, 2006; New *et al.*, 2006). As much of the rainfall in Lesotho comes from convection, these storms can be very intense, leading to local flash flooding, which impacts on human security and leads to increasing severity of erosion. Recently, very severe thunderstorms, some centred in the interior Eastern Cape of South Africa close to Lesotho, have caused loss of life and significant damage to lands and infrastructure (Pyle, 2006). Increased moisture in the atmosphere, combined with periods of low atmospheric temperatures (particularly in autumn) could lead to more frequent and heavy hailstorms. In contrast, the projected drier and warmer winters could result in less snowfall.

The above trends and projections are not well captured by climate models, and where they are addressed, they are characterized by high levels of uncertainty. Therefore, we also need to employ 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. Global Circulation Models (GCMs) are used at larger spatial scale and lower resolution, and are often supplemented with “downscaled” models for regional climate change projections.

For the purposes of this study, we assessed a range of modelling 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 (Christensen *et al.,* 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.

1.4 GCM SIMULATIONS OF FUTURE CLIMATE: REGIONAL

Regional climate change projections based on GCMs were published in the IPCC Fourth Assessment Report (Christensen *et al.,* 2007), for 2080-2099 relative to 1980-1999. Warming over southern African landmasses will very likely be greater than the global annual mean in all seasons. For summer, warming will be in the range 1.8-4.7 °C, depending on the emissions scenario (SRES) used, with a median projection of 3.1 °C. For winter, warming will be 1.9-4.8 °C, with a median of 3.4 °C. Cold days and nights will be warmer and less frequent, and hot days and nights will be warmer and more frequent. Regionally downscaled model projections show broad convergence with the GCMs (Hewitson and Crane, 2006), but also identify local scale variation in the projected changes.

Varying changes in rainfall over the region are predicted (Christensen *et al.,* 2007). The projections show reduced rainfall for much of the region in winter (May to July), but this winter drying is less significant for the summer rainfall regions (including Lesotho) than for the western winter rainfall region. Drying trends are also indicated in the winter rainfall region in summer (November to April), with little to no annual total changes in the central parts, but wetting in the eastern and northern parts in mid- to late-summer (December to March). However, there is still considerable uncertainty over annual rainfall changes in the summer rainfall regions.

Regional research on changes and increases in extremes is limited but shows that there may be an increase in the intensity of high-rainfall events, particularly in summer, and shifts in the onset of the rainfall season (Tadross *et al.,* 2005, 2009; Christensen *et al.,* 2007). In regions of mean drying, there is generally a proportionally larger decrease in the number of rain days, indicating compensation between intensity and frequency of rain. During the transitional medium-term period, changes are expected to be experienced as individual anomalous events interspersed with "normal" years, rather than sudden permanent changes. Thus, an "increase in variability" means that the range of weather conditions experienced on an inter-annual basis would be larger, thus exposing regions to a less predictable and more variable rainfall season.

Atmospheric CO_2 concentrations are rising and will continue to rise gradually, constituting a primary climatic change which has profound implications for plant growth and crop production. Through increased rates of photosynthesis, CO_2 acts as a kind of fertilizer, giving rise to increases in crop growth and yield. The response is, however, dependent on interaction with other environmental conditions, and genetic factors.

1.5 GCM SIMULATIONS OF FUTURE CLIMATE: LESOTHO

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 GCMs. Since then, updated climate change simulations performed by the Lesotho Meteorological Services (2009, pers. comm.) show temperatures increasing by about 1 °C by

FIGURE 1

Annual temperature scenarios for Lesotho (source: Lesotho Meteorological Service).

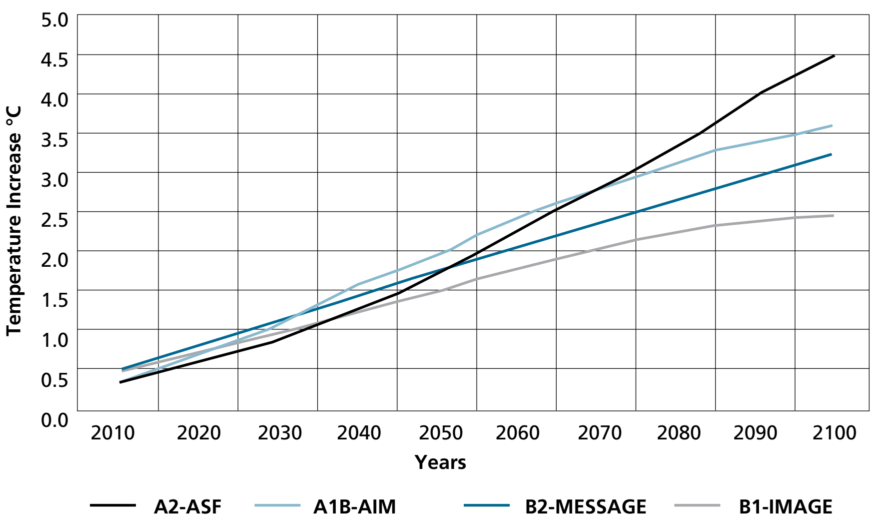
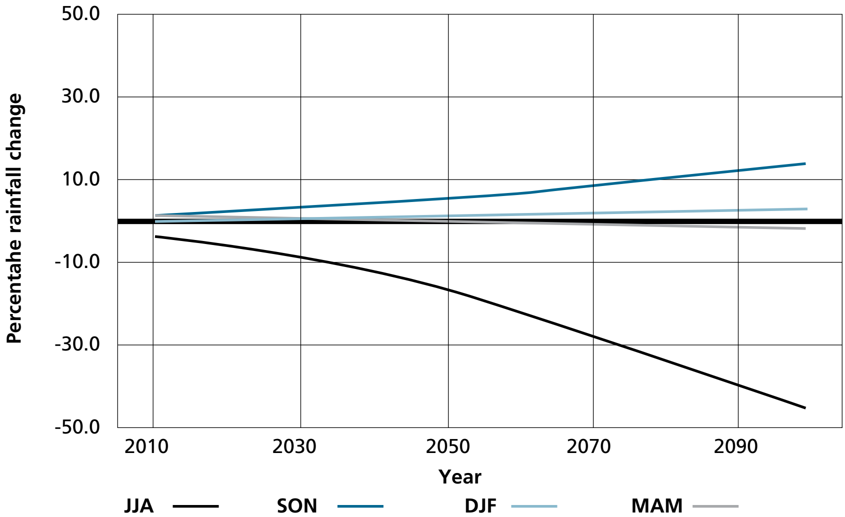


FIGURE 2

Seasonal rainfall projections for Lesotho (source: Lesotho Meteorological Service)



2030, 1.5-2.0 °C by 2050, and by about 2.5-3.5 °C by the 2080s (Fig. 1). Winter rainfall shows strong decreases, with no change in summer and autumn rainfall, and gradually increasing spring rainfall (Fig. 2). These projections are in line with the simulation modelling performed as part of the IPCC Fourth Assessment Report (Christensen *et al.*, 2007, 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 to a 25 km grid resolution for the periods 2046-2065 and 2080-2099 using the A2 SRES scenario. This dataset formed the basis for the Fourth Assessment Report of the IPCC (2007). The preliminary results 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 October-March season, with a median result of slight drying (2046-2065). The April-September season is shown to experience varying degrees of drying. For 2080-2099, these trends remain similar although intensifying, but the median result for October-March is a wetting.

1 We acknowledge the modelling 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.

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. 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.).

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 2046-2065. 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 (Schulze, 2010).

In summary, the following climate change projections appear likely for Lesotho for the periods ca. 2030, 2050 and 2080:

- ***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 mea:*** 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, an increase in annual mean temperature of approximately 1.0 °C (2030), 2.0 °C (2050) and 3.5 °C (2080) is likely. For rainfall, a moderate drying in late autumn/winter is expected and moderate increases in spring/summer rainfall, with stronger spring/summer wetting towards the end of the century.

Smallholders in Lesotho are vulnerable to the slightest change in climate and it is crucial to create more awareness and action amongst policy-makers about the implication of changes in temperature and rainfall to the country's food security and well-being in the coming decades. As over 15 percent of Lesotho's 2.0 million people are undernourished (2005–2007) and the figure has not declined over the past two decades (FAO, 2010), the immediate priority should be to address the need to enhance food production whilst ensuring sustainable management of natural resources. In addition to the projected increase in high temperature stress on major crops such as maize, wheat, beans and peas, the moderate drying during winter may cause water stress situations during the wheat-growing season. On the other hand, a moderate increase in spring/summer rainfall may not always lead to adequate moisture for maize, the most important crop in the region in the context of food security. As droughts are already common in the mountains, foothills and lowlands, increasing temperature and uneven distribution of rainfall can further aggravate the situation and warrants immediate and urgent attention to adaptation. This report addresses the key issue of taking forward the climate change projections for the next two decades (2030) and identifies the key impacts (chapter 2) and adaptation priorities (chapter 3) which are considered feasible within the local biophysical and socio-economic context with an overall aim of enhancing food security.[2]

2 During the FAO TCP project formulation mission and subsequent project launching mission, the FAO team (Alemneh Dejene and Selvaraju Ramasamy), placed great emphasis on projection scenarios and impact up to 2030. There was also consensus with the Government and local counterpart for this TCP to focus the adaptation priorities and options that would improve/stabilize smallholder productivity and arresting degradation resources that are being exacerbated by climate change and variability.

CHAPTER 2

CLIMATE IMPACT ON AGRICULTURE AND NATURAL RESOURCES AT NATIONAL AND COMMUNITY LEVELS

The two important determinants of the impact of climate change in a given region are the degree of exposure to climate stressors, and the underlying sensitivity of the natural and social systems. Exposure includes climate variability both within and between years, the frequency, magnitude and duration of extreme climate events (droughts, floods, frost, hail, storm winds, heat waves, cold snaps), and long-term climate changes (rising temperature, changing rainfall regimes). Impacts on land-based economic activities and associated livelihoods are usually very significant, through direct effects on critical natural resources such as soil and water, and on the growth and economic value of crops and livestock.

During 2009/2010 a technical study was conducted to assess climate change impacts, risks and vulnerabilities on food security and livelihoods in the southern lowlands and mountains of Lesotho, previously identified in the Lesotho NAPA (Government of Lesotho, 2007b) as the most vulnerable livelihood zones. Subsequently, under the Technical Cooperation Programme (TCP) between the FAO and the Government of Lesotho (FAO, 2009b), baseline survey was undertaken of climate related risks, local vulnerabilities and perception and coping strategies in three pilot subcatchments within the vulnerable zones, representing the southern lowlands, the transition from lowlands to foothills, and the mountains. A livelihoods-based vulnerability assessment approach was adopted, together with core aspects of the Household Economy Analysis (Boudreau *et al.*, 2009; for details refer to OneWorld Sustainable Investments, 2010b).

The following discussion is a summary of the baseline survey on impacts of climate variability and climate change at both the national level (represented by the two livelihood zones) and at the level of farming communities within the three pilot subcatchments. We focus on livelihoods and food security, as well as impacts on the critical natural resources, with emphasis on soil and water.

Both the southern lowlands and the mountains experience suboptimal spatial and erratic distribution of rainfall and 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 rangeland, and thin and highly erodible soils of varying fertility, make the country particularly sensitive to climatic events. Longer dry spells punctuated by heavy rainfall events could have disastrous consequences for the escalation of soil erosion.

Degraded lands have much higher sensitivity to climatic hazards than those which enjoy good vegetation cover and soil water infiltration abilities. Denudation of the soil surface, brought about by the combination of constant grazing and trampling by livestock (severe overstocking), collection of fuelwood, and conventional agricultural practices (e.g. ploughing) on croplands, multiplies the impacts of climate events such as drought and heavy rainfall on soil losses. Heavy rainfall does not infiltrate easily into such degraded soils, and runs off taking with it vast amounts of nutrient and organic matter rich 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 water for people, home gardens and livestock.

Land degradation has already seriously reduced the productive capacity of Lesotho's croplands and rangelands. Continued and likely escalating degradation would hamstring efforts to improve production efficiencies and total production in the face of climate change impacts (FAO, 2009c). 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 brought about by unsuitable and detrimental land use practices. Protection and rehabilitation of the land through careful land use planning and management will become increasingly critical in order to safeguard this resource for future generations living under a potentially harsher climate.

From the household survey it appears that a higher proportion of farmers in the mountains rate their soils as being highly erodible and currently highly eroded, compared to those in the lowlands. This is paradoxical to reality, since the lowlands are in a worse situation than the mountains, and suggests that lowland farmers are not fully aware of the crisis. This can be attributed to the nature of soil erosion in the lowlands compared to the mountains. In the lowlands the soils are deeper to bed rock and loss of the fertile topsoil is not often perceived by farmers. In contrast, the same loss of soil in the mountains leads to strip erosion leaving the bedrock exposed. Only half of those in the mountains are using soil erosion control methods (primarily diversion furrows, with some terracing). In the lowlands this figure is generally higher (furrows, terracing, contour ploughing and barriers). In both zones, one-third of the farmers indicated that erosion control structures were not being maintained. There is great potential for increased uptake of locally proven erosion control methods to improve resilience against the impacts of climate change. However, these conventional approaches are ineffective without substantial changes in land management, since they are merely “band aids” for underlying poor catchment management. Thus, greater potential lies in adopting production practices such as conservation agriculture, based on reduced tillage, maintenance of soil cover and crop rotation. The participating communities displayed little understanding of such holistic approaches.

Land degradation and loss of topsoil also diminishes fertility and increases the need to ameliorate fertility levels. This will be compounded by the expected negative impacts of climate change on soil fertility. Soils in the mountains are perceived to be more fertile than those in the lowlands and a very low proportion of farming households (14 percent) add nutrients (manure) to their croplands. By contrast, over 65 percent of farmers in the lowlands use manure or inorganic fertilizer. This misinformed perception is borne of the fact that initially the mountain soils are formed from parent material with higher base saturation and generally higher organic matter levels deriving from the original rangelands ecosystems. Unfortunately, over time, this myth has perpetuated the exploitation and mining of the nutrients and organic matter resulting in soil degradation, declining fertility and reduced yields. Furthermore, the mountain agriculture is increasingly encroaching onto steep slopes dominated by shallow entisols and/or inceptisols. However, a higher proportion of households in the mountains practice intercropping, usually with beans (which are nitrogen-fixing), in contrast with the lowlands where little mention was made of this practice. Intercropping with N-fixing legumes is an effective natural fertilizer and should be further encouraged in both mountains and lowlands. It is unclear whether the benefits of nitrogen-fixing species are known to the farmers.

In the lowlands, 10-15 percent of farming households use purchased inorganic fertilizer, sometimes mixed with manure. The use of fertilizers goes hand-in-hand with greater access to tractors for ploughing and planting (10-20 percent) than in the mountains (6 percent). Additional soil ameliorants or other methods aimed at soil improvement (e.g. ash) are not widely used in the mountains. In the lowlands, a number of farming households use effective micro-organisms (though there is no valid scientific proof of effectiveness) and ash or ash/manure mixtures, and some farmers perform winter ploughing, incorporating crop residues and adding manure/ash in order to increase soil fertility and water holding capacity. Under warming conditions associated with climate change, soil fertility loss rates could rise, and practical and affordable methods of raising nutrient levels, carbon levels and thus also water holding capacity will become an important adaptation response. Both conservation agriculture and various forms of agroforestry, particularly incorporating nitrogen-fixing and fodder species, would answer to this need.

Across southern Africa, climate change impacts and responses will often be very closely associated with water resources and access to water for agricultural production. In contrast to most countries in the surrounding region, Lesotho is essentially one large catchment and endowed with extensive water resources. However, the Lesotho Highlands Water Scheme is already providing considerable water to the industrial heartland of South Africa, and is expected to be extended further with the construction of further reservoirs and inter-basin transfer capacity. While it is still uncertain whether rainfall will increase or decrease under climate change and what this means for water resources (De Wit and Stankiewicz, 2006), what is certain is that South Africa will make increasing demands on this resource. Only 1 percent of crop production in Lesotho is under irrigation and almost all subsistence and smallholder farming is rainfed. The development of medium to larger irrigation schemes is expensive and may not be suitable due to the demanding topography and geology, and lack of local scheme management skills and experience is a serious limitation. The fragile soils also demand very careful irrigation management. Thus, while water is available it is being allocated for other purposes and farmers have yet to productively exploit their country's water resources. Small-scale water harvesting schemes are seriously lacking and yet these remain viable adaption options for smallholders in the face of expected climate change impacts on water resources.

The survey indicated that by far the majority of households have relatively easy access to a village water supply for household purposes. In parts of the lowlands some households also use water from groundwater sources. Surface water sources (mainly rivers) are used for livestock watering. Accessibility of water sources is generally good (livestock can reach water within 30 minutes). However, sufficiency of water supplies is more problematic in the mountains than in the lowlands. During spring droughts, livestock have to be driven down to larger rivers when rivers near to the settlements dry up. A lack of grazing on these routes leads to considerable mortality especially of lambs. Increasing variability of river flows would increase the frequency of such events.

The third most important natural resource in Lesotho is wood. Almost all households use firewood for cooking or heating, or both. Dependency on firewood is particularly high in the mountains; in the lowlands cow dung, gas and paraffin are used to supplement wood-based energy. In the mountains, natural lack of forest and exploitation combine to force people to walk long distances in search of woody shrubs: 92 percent of households take more than one hour. In the lowlands this figure is ca. 30 percent. The primary source of wood is that growing naturally, particularly in parts of the lowlands where there are no mature government woodlots and limited access to private woodlots. In the mountains, a high proportion of wood from shrubs is sourced from own land. Roughly 40 percent of households are struggling to access firewood for household purposes. There are, however, some efforts at tree planting on both communal and private land holdings. The future trend in natural wood availability is uncertain since tree establishment will depend on the complex interaction of rainfall trend and distribution, warming, rising CO_2 concentration, incidence of wildfire, incidence of pests and diseases, and land condition.

Rising CO_2 concentration is one factor of climate change which could have a positive impact in some areas. However, this is not likely to significantly ameliorate the negative impact climate change will have on Lesotho's water and natural resources and on food security and smallholder productivity. Based on current knowledge of plant and ecosystem responses to rising CO_2, it is likely that some vegetation (grasses, shrubs and trees) and crops in Lesotho will benefit from CO_2 fertilization. On the downside, research conducted in other parts of southern Africa indicates the potential for increasing frequency and intensity of wildfires, with knock-on effects on grazing and soil degradation (Bond *et al.*, 2003). It is also possible that the invasion of shrubs such as *Chrysocoma ciliata* and /or *C. tenufolia* at the expense of palatable grasses could intensify. Lesotho requires further local research on these potential impacts.

CHAPTER 3

CLIMATE IMPACT ON LIVELIHOODS AND FOOD SECURITY AT NATIONAL AND COMMUNITY LEVELS

In both the southern lowland and mountain livelihood zones, the majority of the population engage with rainfed agriculture and are dependent to some degree on own production for household food supply and/or cash income. Climatic variability and thus variability of yields have direct impacts on the household cash and food situation.

Regular droughts have become a feature of the climate and are likely to remain problematic as the climate shifts to a new state. The arable southern lowlands experience some of the driest and hottest weather in the country, and heat stress in mid-summer can be expected to become an increasingly regular occurrence (Battisti and Naylor, 2009). In both zones, rising temperatures will lead to greater evapotranspiration rates, and more rapid soil drying between rainfall events, particularly where soils are exposed. The preservation of soil moisture between rainfall events will thus become increasingly critical. Drought impacts on crop yields in various ways, depending to a large degree on the developmental stage of the crop. Dry spells at the beginning of the cropping season delays planting and can lead to fallowing of fields; during the flowering period (all crops) or tasselling (maize) lack of soil moisture causes poor fruit and seed set; drought during critical growth phases stunts growth and seed development.

Rangelands persistently affected by drought cannot easily produce pastures with adequate feed intake and enough nutrient content to sustain acceptable livestock production standards. Draught animals suffering from malnourishment are not strong enough for ploughing, resulting in reduced food production. This is exacerbated when drought conditions render the soil profile harder to penetrate, forcing the animals to expend more energy per work load and consequently more feed requirement. A lack of stock management during droughts exacerbates this situation and impedes rangeland recovery.

An increased frequency or intensity of hailstorms, floods and frost can destroy crops and kill livestock. The physical land degradation that comes with high intensity rains is potentially devastating, particularly under conventional agriculture where soils are disturbed (ploughed) and left exposed. The rate of leaching of nutrients through these structurally poor soils is high and manifests in stunted or nutrient deficient crops. Lack of water infiltration could lead to increased waterlogging of fields after heavy rainfall, disrupting farm operations.

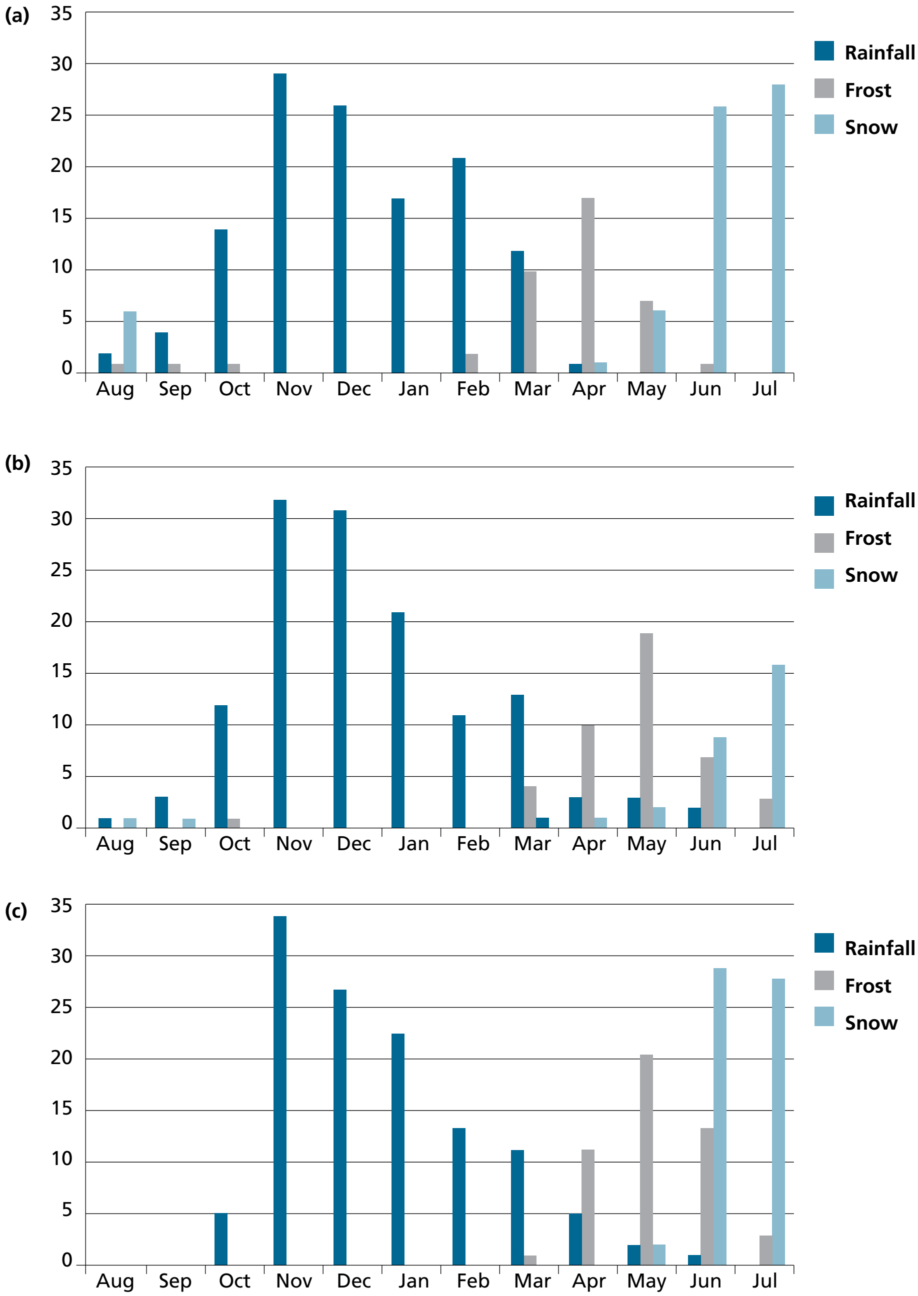
Lack of rain is frequently accompanied by increased infestations of pests and diseases, although too much moisture can have a similar effect. Crop wilting due to either high midday temperatures or fungal diseases has become an increasing problem in recent times, especially for vegetable producers, at high economic cost. Cattle are prone to tick-borne diseases and anthrax, whereas the main disease in sheep is scab. Many areas of Lesotho are normally characterized by cool growing season weather conditions and very cold winters which inhibit pests and diseases. Increasing temperatures are conducive to increased pest and disease pressure, in both crops and livestock. Most of the farmers in the three subcatchments have inadequate access to pest and disease control in crops and livestock, with veterinary services severely under-resourced.

Following this account of potential negative impacts of extreme events and warming on agricultural production, we note that both agro-ecological zones could respond very positively to moderate increases in rainfall in a year with reasonably well distributed summer rainfall. Recent hydrological modelling results (Schulze, 2010) show a future reduction in the number of days per year experiencing soil water stress over Lesotho. Also, since Lesotho has a cool climate, the expected gradual warming could also have positive impacts on crops, livestock and people during winter. However, the expected gradual warming may lead to negative impact on summer crops (e.g maize) especially in the foothills and lowlands. Cold stress will be reduced, the growing season will likely be extended especially during winter, and the diversity of crops suited to the climate will increase (especially in the mountains) (see Fig. 3 for current seasonal patterns of rainfall, frost and snow). Some crops (e.g. legumes and root crops) grown in Lesotho could 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, and efficient monitoring and control of pests and diseases. Of great concern is the scenario of decreased snowfall, since snow melt currently supplies much of the required moisture in spring during the crop planting and early growth season. Thus, on balance, increasing temperatures and heat waves will continue to have negative impacts on agriculture and food security for smallholders.

Inhabitants of both zones, but particularly of the lowlands, pay close attention to the weather and rate their exposure to weather hazards as high or very high. In the mountains, human discomfort and health issues related to cold winters

FIGURE 3

Seasonal rainfall, frost and snow for the reference year (2008/09) expressed as number of respondents identifying each month for each event. (a) Rantsimane (mountains), (b) Mabalane (southwestern lowlands) and (c) Thaba Tsoeu (western lowlands/foothills). **Source: OneWorld Sustainable Investments (2010b)**



are currently still problematic but could be reduced under climate change. Approximately 95 percent of households in the lowlands believe that weather patterns have changed over the last 10-20 years, compared to 82 percent in the mountains. Rising temperatures and decreasing or more unpredictable rainfall have been perceived by farmers across southern Africa, especially the older, more experienced generation (Maddison, 2006). Most Basotho attribute climatic extremes and disasters to natural variability, but a significant number attribute these events to religious or cultural beliefs. Drought is regarded as the primary climatic hazard, followed by strong winds and storms. This is followed by hail and heavy rainfall in the lowlands, and heavy rainfall, frost and heavy snow in the mountains.

A consistent account of changing weather patterns in the recent past emerged from both zones: the start of the rainy season is delayed, with the first rains arriving one to two months later than expected. Lands ploughed in winter or early spring then have to be re-ploughed before planting can take place. This conventional practice of multiple tillage operations in a growing season further degrades soil quality and exacerbates the energy costs of production. Sometimes, crops which were planted in early spring have to be re-planted. Rangeland grass re-growth is delayed leading to lack of grazing and livestock starvation especially of lambs. This spring drought is followed by heavy rainstorms in early summer which cause flooding. Strong winds wreak havoc to the bare soils devoid of ground cover in the early spring. Unseasonal cold snaps have occurred in early summer, just after the shearing season, killing small stock. Dry spells in January/February cause yield reductions, sometimes also linked to pest outbreaks. Late planting often due to early season drought and late incidence of rains result in crops not reaching maturity, especially in the mountains where the season is much shorter due to early frost incidences which destroy crops before they can reach maturity. Based on this anecdotal (but consistent) oral evidence, it is evident that climatic hazards have been experienced regularly over the last 5-10 years, singly but also often in combination and in close succession, leading to heavy impacts on farming households from which they are finding it difficult to recover.

Rainfed agricultural systems have much higher sensitivity to climatic hazards and rainfall variability than those with some form of irrigation. A study of African crop farming under various climate change scenarios showed a positive response of irrigated crops to warming, particularly in cooler production regions (Kurukulasuriya and Mendelsohn, 2008). Maize is particularly sensitive to the timing and duration of dry spells; the capacity to irrigate during sensitive developmental periods can mean the difference between a normal yield and crop failure. Lesotho's agricultural sector would be considerably less vulnerable if irrigation could be developed.

It is well known amongst farmers that greater crop diversity and mixed farming (crops and livestock) offer considerable protection against farming risk, including climatic-related risk. Larger farming enterprises with a range of different crop types, or even cultivars of the same crop with differing drought or pest resistance traits, are much less likely to suffer complete crop losses. Warming trends in Lesotho could open up opportunities for new crops. A co-benefit is increased nutritional diversity, which is very low in Lesotho. Larger 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. Those who do not own livestock or own only very few animals are more sensitive to climate shocks. Even a humble poultry business, together with homestead vegetable gardening, for example, can make these households less sensitive. The keyhole garden system introduced to Lesotho by the NGO CARE and prevalent across the southern lowlands appears to be working well and is popular, with communities calling for continued support in constructing and managing these homestead gardens. This is a good example of a low-cost adaptation practice which is also supported by local government and can be up-scaled to the national level.

As over most of the subcontinent, 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. A recent modelling study (Lobell *et al.,* 2008) found that in southern Africa, maize and wheat are particularly sensitive and show consistently negative impacts of climate change. The model impacts for sorghum range widely from negative to positive, due to large uncertainties in future precipitation. The authors conclude that maize is the crop in greatest need of adaptation in southern Africa. It is likely that maize could become a "boom or bust" crop in future, with high potential yields in good rainfall years, but increasing risk of crop failure in bad years. The downside of widespread monoculture is clearly visible in the lowlands. Very few households grow beans, sorghum or peas in addition to maize. Sorghum has been mostly abandoned in the southern lowlands presumably due to the destruction caused by flocks of birds. This trend, however, is indicative of the lack of penetration of drought and bird tolerant sorghum varieties released by the National University of Lesotho researchers in the last ten years. The pea crop is an important winter legume in the lowlands although harvest fails during droughts. In contrast, mountain farmers have a healthier mix of crops, with maize, wheat, beans and peas planted in more equal proportions. On the other hand, farmers in the lowlands are more likely to practise mixed livestock and crop farming, albeit with few animals. Nevertheless, a high proportion of households in both zones (on average 15 percent) have only crops (Fig. 4). These farmers, together with those who have no cropland, are at highest risk.

Regions with a high proportion of small farming units (subsistence and small-scale) 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 in years with poor production. Land holdings are significantly smaller in the mountains than in the lowlands. In the former, 22 percent of interviewed households were landless, compared to only 2 percent in the lowlands (Fig. 5). Average land holdings per household were 0.72 ha in the mountains and 1.43 ha in the lowlands. This describes the severe lack of arable land in the mountains and may be one of the reasons explaining the low levels of fallow lands in the mountains (8 percent) compared to the lowlands (32 percent), despite drought being experienced in both zones during the reference year.

From a human perspective, household characteristics typical of each livelihood zone play a large role in determining sensitivity to climate shocks. The household dependency ratio (the ratio of children under the age of 14 plus the elderly over the age of 65 to the number of potentially economically active adults 15-65 years) in both livelihood zones is high, indicating the high demands made on economically active adults. The population density in the southern lowlands is high (Government of Lesotho, 2007c), so that any climatic hazard affects many people, thus adding to the region's sensitivity and vulnerability. Food is primarily obtained from own production, followed by purchases, in all three sites. Collection of wild foods (vegetables) is an important supplement everywhere, particularly during the "hunger season" between November and March (Fig. 6). Dietary diversity is generally low, with meals based on maize and vegetables in the majority of households. Beans are also consumed by a number of households, but consumption of milk, meat and fruit is low everywhere.

Ownership of agricultural implements is skewed towards the lowlands. The plough is the major implement of primary tillage and is owned by only 40 percent of households in the mountains, compared to over 55 percent of lowland households. Lowland crop farmers are also more likely to own cultivators, planters and harrows, or a means of transport (scotch cart, wheelbarrow). Even smaller hand implements used for vegetable gardening and weeding are in short supply in the mountains.

FIGURE 4

Households engaged in crop and/or livestock farming (percent of households interviewed) for (a) Rantsimane (mountains), (b) Mabalane (southwestern lowlands) and (c) Thaba Tsoeu (western lowlands/foothills).
Source: OneWorld Sustainable Investments (2010b)

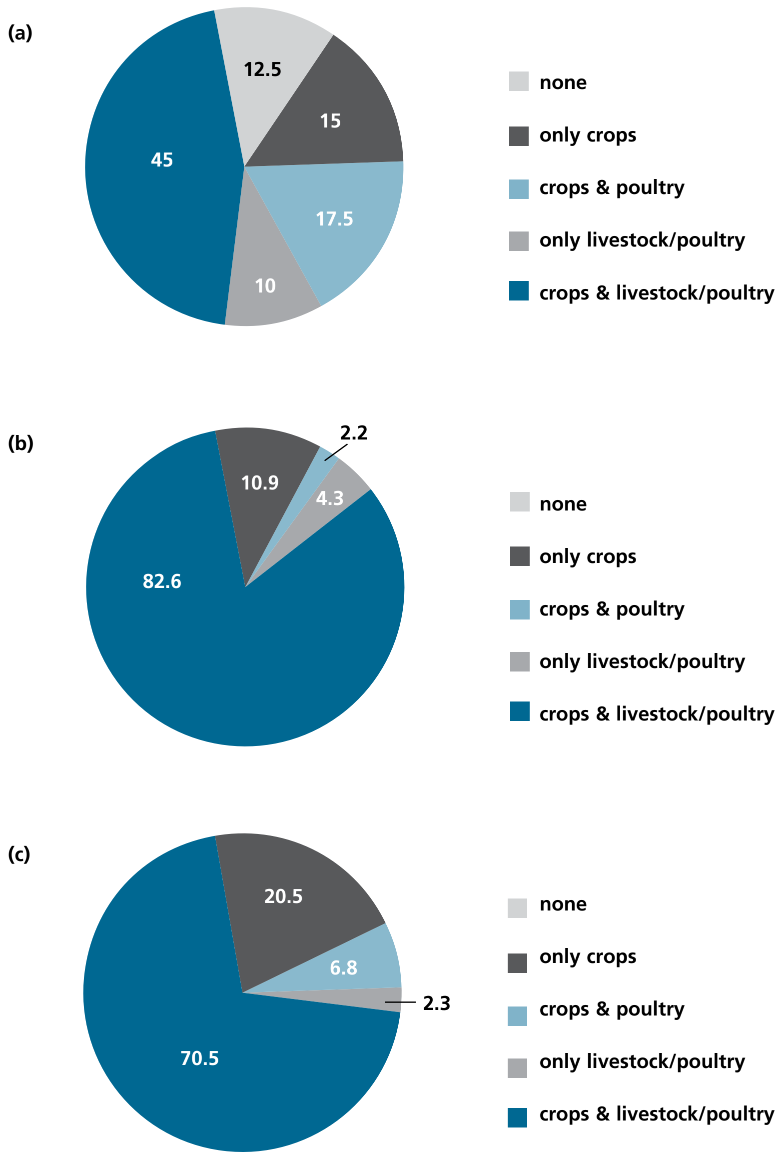


FIGURE 5

Land holdings (percent of households interviewed) for (a) Rantsimane (mountains), (b) Mabalane (southwestern lowlands) and (c) Thaba Tsoeu (western lowlands/foothills). Source: OneWorld Sustainable Investments (2010b)

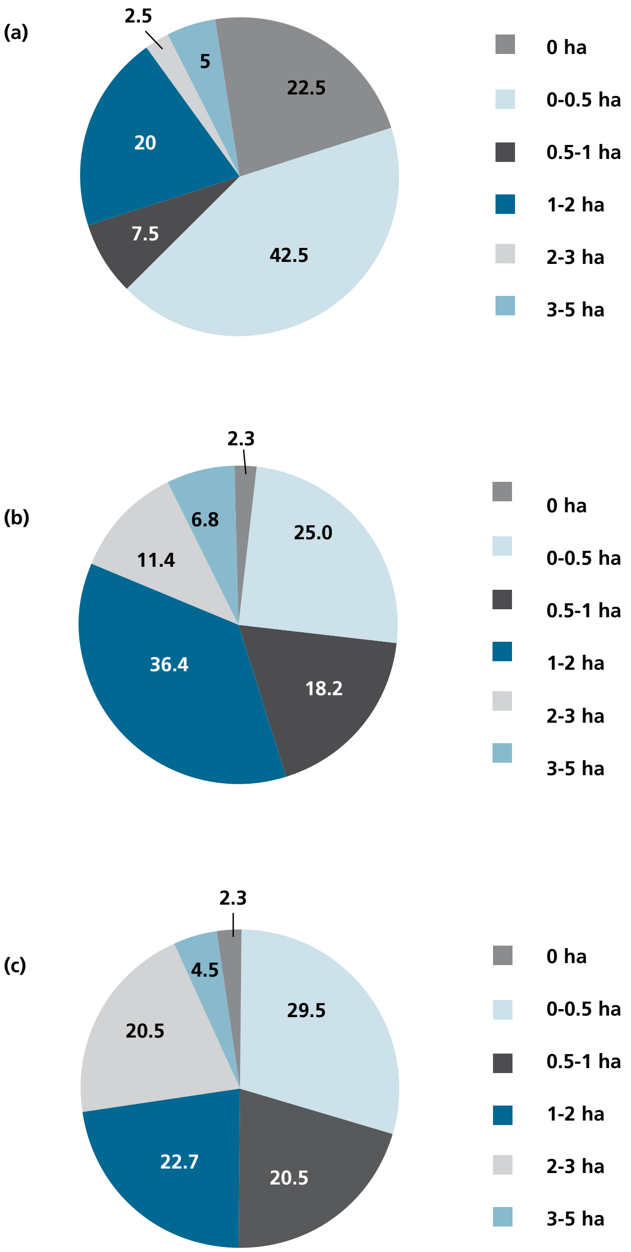
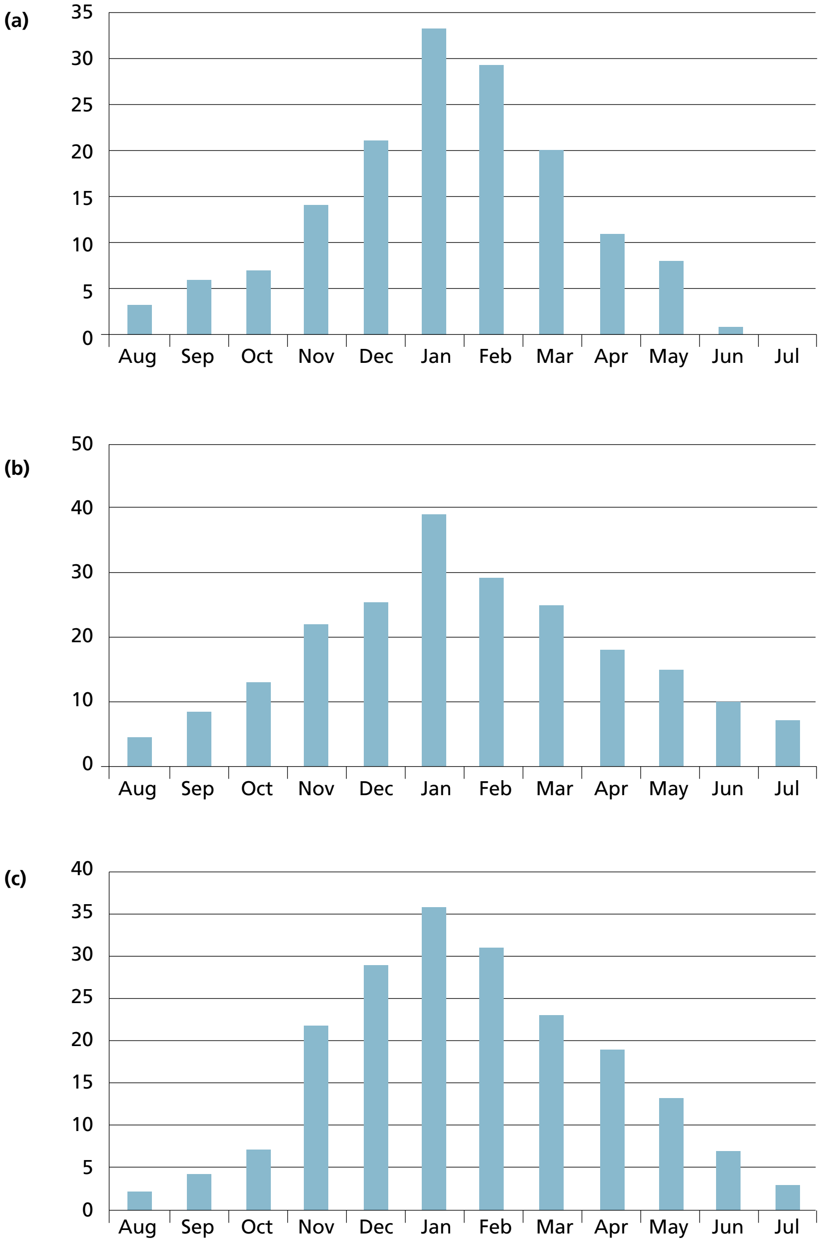


FIGURE 6

Seasonal calendar for the hunger season for the reference year (number of respondents identifying each month for hunger). (a) Rantsimane (mountains), (b) Mabalane (southwestern lowlands) and (c) Thaba Tsoeu (western lowlands/ foothills). **Source: OneWorld Sustainable Investments (2010b)**



The overall impact of climate change on land-based livelihoods is a complex outcome of multiple stress and vulnerability. 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 in the lowlands. Thus, the impacts of climate change are expected to be severe.

CHAPTER 4

THE CASE FOR CLIMATE CHANGE ADAPTATION: INITIATIVES AT THE COUNTRY LEVEL

Given the high current and expected future impact of climate-related hazards and climate change on agrarian communities across southern Africa, planning and implementation of effective adaptation responses is urgently required. It is generally accepted that farmers with the least resources have the lowest capacity to adapt and are thus the most vulnerable and in need of assistance. However, the specific nature of such vulnerabilities and associated coping and adaptation options is highly contextualized at national, district, subcatchment and village levels. Local micro-climatic characteristics, combined with spatially heterogeneous soils, vegetation cover, water resources, and pests and diseases, as well as social, economic and infrastructure differentials, call for interventions that are strongly rooted within this context and are not completely foreign to those who will be expected to implement them.

Reducing food security will require that social, economic and environmental determinants of vulnerability be integrated in policies. Effective long-term agricultural policies must certainly be developed, but it must also be integrated within a wider sustainable development framework, according to local and national situations, and be grounded in the local context (Ziervogel *et al.*, 2006).

Thus, following an overall risk and vulnerability assessment at national and district levels detailed local information must be sought on past and current coping strategies (or lack of) in the face of climatic variability and extreme events.

4.1 COMMUNITY LEVEL COPING STRATEGIES

The people of Lesotho have evolved within a specific climatic context and a range of coping mechanisms have served them well in the past. However, rapid socio-economic changes and environmental degradation have disturbed their ability to deal with shocks. Some coping mechanisms may no longer be effective or even desirable, and new ones are arising or becoming necessary but unachievable without programmatic assistance.

The baseline surveys revealed that farmers in the mountains and lowlands are currently doing very little, and claim to have few options for adapting to climatic-related stresses or recovering from their impacts. Drought was consistently reported by all communities to be the main stressor. It is seen as the reason for low yields or total crop failure, forced late plantings, increased fallow land and degraded rangelands, hence inadequate animal nutrition leading to less productive livestock. When farmers were asked what they would like to do to protect themselves better and adapt to a changing climate, a number of options emerged, including agroforestry, household water harvesting, the use of drought-tolerant crop varieties, increased production of poultry and pigs, and the building of shelters for livestock, amongst others. Farmers were clear on what they perceived to be their technology needs, including the provision of improved seed (tolerant to drought and pests and of short cycle), and in the southern lowlands a request for access to implements for better ploughing and planting, manure/fertilizer for improved yields, and irrigation technology. Unfortunately, in the lowlands, no understanding was shown of the probable acceleration of land degradation which implementation of these conventional practices would bring about. In the mountains, access to tractors was not rated highly; the reason being given that it would accelerate erosion. By far the main perceived hindrance to achieving their aspirations and accessing these technologies (albeit misguided in some cases) is the high prevalence of unemployment and poverty, and lack of financial capital. Thus, people place a high priority on higher levels of education, which they believe will increase their chances of employment, salaried jobs, ability to diversify agriculture, and generally broaden their chances of livelihood improvement.

Thus far, autonomous actions have usually been reactive rather than pro-active. Pro-active actions, although few, include implementation of erosion control through tree planting, irrigation of household vegetable gardens through various water harvesting technologies from small community dams to household roof water harvesting, the application of pesticides to prevent pest outbreaks, gradual shifts to demand led extension services, the use of inputs to strengthen crop growth and survival, and the shifting of the date of planting by some farmers to coincide with changing rainfall patterns (only viable in the lowlands where the season is longer).

The communities recognize the importance of crop irrigation as a response mechanism to droughts, but little has been done to attempt some form of implementation. Although potential access to low input and low cost systems, such as gravity fed irrigation and treadle pumps exists, the only irrigation practised is on a very small scale in homestead vegetable gardens. Some households are not aware of assistance, from the Ministry of Forestry and Land Reclamation, for the construction of roof water harvesting tanks. The Ministry provides cement and knowledge, while the farmers have to contribute labour and stones. If implemented, this facility would take care of irrigation needs around the homesteads. It should be noted that awareness of water conservation and demand management approaches was lacking; this needs to be addressed before supplemental approaches are considered.

No clear responses with respect to livestock are evident, other than vaccinations during disease epidemics. Livestock farmers claim that they have few options for coping with the impacts of erratic weather and recurring droughts. The average number of cattle owned per household is four or less, four being the minimum draught requirement. Thus, incidental sales of cattle (off take) for meat, cash or cultural purposes are not readily achieved. Similarly, small average flock sizes of sheep and goats do not easily allow for incidental sales or slaughter of small stock. However, in one lowland subcatchment (Mabalane), small-scale production of dual purpose chickens takes place based on reasonable market demand.

The indigenous cattle breeds of Lesotho have endured the test of time and are highly adapted to drought and spells of extreme low temperature and snowfalls. They are multifunctional, being used for draught power, milk and meat production, and ritual functions. Livestock farmers have seen no need to change to exotic breeds – in fact, national experts believe that the indigenous cattle breeds only require optimization of herd management to express their full adaptive and production potential. However, farmers are not culling undesirable animals, so that improvement is difficult and the grazing pressure on the rangeland persists, which is compounded by climate change. Similarly, sheep and goats supply both wool/mohair and meat, and are well adapted to Lesotho's harsh climate. There is, however, a moderate systematic breeding programme for small stock and an annual ram replacement programme using hardy breeds from South Africa. Unfortunately, the studied communities do not appear to be benefiting from this programme.

Communal rangelands are badly mismanaged, the range vegetation cover is extremely low and being replaced by unpalatable species and severe erosion contributes to loss of productive land. Nowhere is this more starkly visible than in the fence-line comparison between the Lesotho side of the Mabalane subcatchment and the South African farmlands across the border. Range management practices are not strategically planned to respond to recurring drought, resulting into low livestock conception and birth rates. In the mountain subcatchment, severe overstocking on limited rangeland subjects animals to highly stressful conditions resulting in very high mortality rates especially of young animals. There are a high proportion of unproductive animals which should be culled, but owners are unwilling to do this. In the lowlands, animal numbers are not currently high but still exceed the very low carrying capacities of the available rangelands, making range rehabilitation and regeneration all but impossible. The old practice of transhumance, whereby grazing animals are moved to the cattle posts during the summer months and brought back to the local rangelands during autumn and winter months, contributes to the severe degradation and has been all but impossible to discourage. This is possibly a good example of adaptive practices which have evolved historically becoming "mal-adaptive" under the new conditions. No effort is made to produce and preserve fodder in adequate quantities to sustain animals during cold winters and dry spring months. Fodder production is seen only as a supplement for livestock nutrition, and not for the reduction of pressure on the rangeland.

A reasonably high level of awareness (but not technical knowledge) exists around the benefits of agroforestry, but existing tree planting activities could be stepped up considerably. Some of the agroforestry systems or technologies adopted by farmers in southern Africa have been used for many decades, and not necessarily because of climate variability, but because they are traditional systems that have been used for subsistence for a long time (Maliehe, 2010). However, it appears that some of these traditional agroforestry systems have managed to withstand climate variability quite appreciably over the years, thus they could become effective responses in the face of climate change.

4.2 MOVING TOWARDS INTEGRATED ACTION FOR ADAPTATION

This understanding of the impediments to autonomous adaptation leads naturally to the question "What needs to be done?" for each set of farming communities. Strategies for strengthening adaptation capacity must acknowledge the communities' stated needs and aspirations and align these with targeted innovations to create resilience and sustainability. A holistic approach is required, taking into account factors critical for the development of rural livelihoods. Essentially, the main barrier of poverty must be addressed, and farmers should be guided to gradually re-orientate their farming approaches to be resilient to the eminent impact of climate change in fragile and highly vulnerable production system. It is highly debatable whether commercialization (which could involve moving into large-scale production) would be economically and environmentally sustainable given that the average land holding size is 1–2 ha per household and a considerable area of the country is mountainous and highly degraded. Sustainable crop intensification on some crops (i.e. maize) in the lowlands, with clear principles of environmental conservation and livelihood diversification, would be a more viable strategy in this country that largely depends on its water resources.

Hassan and Nhemachena (2008) recommend that policy-makers support adaptation by promoting farmer education and improving their access to climate forecasting, by investing into research that target the development of farm-level climate adaptation technologies, and also by opening access to credit and developing markets. Furthermore, these recommendations should be considered even more attentively in areas where rainfed farming currently predominates.

Technical responses (husbandry) require support by transitional government assistance through infrastructure development, subsidies, and credit and marketing facilitation. Infrastructure needs include maintenance of roads, networks to ease service and goods delivery, irrigation infrastructure such as the provision of immovable equipment, dam construction, installation of wind and solar energy systems for the exploitation of groundwater resources, and agricultural business centre establishment in villages. These centres should provide improved access to inputs and marketing outlets where farmers can sell as well as process their produce. Implements and spare parts could be available in various ways from the depots. Implements could be stored here for sale or kept for community use based on agreed arrangements. Not only crop produce should be handled here, but also that of livestock.

All programmes aimed at strengthening agriculture and developing resilience must include some form of organized credit provision. Donations and grants are fundamentally handouts that should not be viewed as viable options in support of climate change responses. The credit facilities that already exist amongst these communities are weak and should be strengthened and modified where necessary. The modification will serve to facilitate co-existence of the informal mechanisms with more formal mechanisms such as revolving funds. Development of intensive pig and poultry enterprises is impossible without sustainable credit facilities. *Stokvels* are important gatherings to raise funds that can be used to develop agricultural businesses. Experience has shown that for crop production, cooperatives are the best option for smallholders to support their transition to commercial agriculture. Cooperatives should be encouraged from the beginning, to facilitate a smooth transition from project to autonomous community managed programmes. Community-based organizations also play a role in defining common problems and taking advantage of new technologies.

From the discussions with these farmers, the need for training emerges very strongly. Training should be broad and holistic to cater for a wide range of coping mechanisms. Training must not be confined to new coping mechanisms, but should also focus on basic sustainable crop and livestock husbandry practices which are lacking. Training of district technical staff is essential since they will in turn train the farmers. A lack of staff capacity in terms of numbers and knowledge/skills was observed. However, direct training of farmers by professionals is not recommended since it may interfere with the agricultural extension service delivery. Clearly, the extension service requires considerable strengthening.

Agroforestry is still poorly and variously understood (Maliehe, 2010), and is made up of a number of disciplines. Training must cover a wide range of technical issues or topics, and be targeted across all stakeholder groups, from farmers to extension staff to senior government officials in the relevant ministries. Some ministerial staff members also need to know more about the technical aspects of agroforestry.

In addition to technological responses to climate variability and change, provision of need based localized weather and climate information to the farmers can benefit pro-active risk and opportunity management. The need-based information can enhance the potential opportunities during good seasons and reduce the risks of yield loss and crop failures during bad seasons. The availability of forecasts to vulnerable farmers could contribute to improved management of climate variability in the short term and increase adaptive capacity in the long term. Significant opportunities exists within the current institutional mechanisms if the currently available forecast products from the Lesotho Meteorological Services (LMS) are properly interpreted and made available to the farmers for decision-making. Currently, Lesotho Meteorological Services provides daily forecasts for selected locations within the country, weekly synopsis, four-day forecasts and seasonal climate outlooks produced through the regional seasonal outlook forums. Integrating the recent improvements in prediction in different time scales can advance farm level adaptation to climate change (Ziervogel and Calder, 2003; Ramasamy, 2010).

Following a baseline assessment, and expert analysis and consultation with technical ministerial staff, researchers and local communities, specific locally suitable technical interventions have been identified. An adaptation options matrix for the three pilot communities is shown in Table 1. In the following section, the most suitable options are discussed based on a more detailed assessment by local experts. These are clustered around three themes: crop management, livestock management and agroforestry.

4.3 CROP MANAGEMENT

For crop farmers, packages based primarily on conservation agriculture (CA) and irrigated crop production have been proposed (Lepheana, 2010). But this has to be approached cautiously given the diverse landscapes across the country, where the mountains and foothills cover a significant portion of the area and are not suitable for commercial agriculture based on large- or medium-scale irrigation. These ecosystems are fragile and constitute a water tower for the country and region, thus requiring careful management; a diversification scheme outside agriculture may be required.

Lesotho is rapidly losing productive capacity and improved production systems need to be urgently introduced which will help to: (i) reduce and reverse soil loss; (ii) improve soil chemical, physical and biological properties; (iii) increase water infiltration and reduce evaporation from the soil, and (iv) protect the vast and degraded watershed particularly in the mountain areas. In Lesotho, CA is an important option in addressing the challenges smallholders face in some parts of the country (notably the lowland where maize is extensively cultivated). CA addresses the key problems responsible for low soil productive capacity – it holds real sustainable benefits for food security and an effective response to climate change, and thus represents a win-win approach. For a country like Lesotho, the focus is primarily on adaptation to address immediate needs. In the long term conservation agriculture can also bring synergistic agricultural adaptation and mitigation benefits (FAO, 2009d).

The three principles of CA are: (i) minimal soil disturbance, (ii) permanent soil cover, and (iii) crop rotations and associations. But this may need to be broadened as appropriate (depending on local conditions) in order to respond to the immediate and eminent threat smallholders face from climate change and variability. For example, capturing the synergies of crop-livestock interaction and introducing agroforestry systems are viable means to enhancing the resilience of the smallholder sector in many LDCs that depend on rainfed agriculture and are most vulnerable to climate shocks.

In Lesotho, good results have been attained in some parts of the country with manual CA using *likoti* (planting basins) (Silici *et al.*, 2007). This involves digging holes/basins using a hoe and placing and covering fertilizer, seeds and other inputs into the holes. The crop stands during drought have been very good due to the moisture conservation achieved by not disturbing the soil, and yields have been double the average for the regions. Water-mediated soil erosion in these fields was minimal or absent compared to fields managed under conventional agriculture. Soil degradation in Lesotho is largely human-induced as a result of overgrazing in the uplands above the fields. In CA fields, the crop residue or grass mulch placed on the soil surface facilitated water infiltration even during heavy storms which are very common in Lesotho. CA improves soil fertility through soil organic matter improvement, thus enhancing sustainable agricultural production and reducing fertilizer costs. A recent FAO mission recommended the establishment of some successful pilot demonstration cases of CA in the FAO project sites and on selecting suitable farmers and working in the field with these farmers to initiate upscaling of CA along with trees and livestock integration (Friedrich, 2010).

In a country like Lesotho where smallholder is the dominant mode in agricultural production, CA has to broaden its scope to incorporate crop-livestock integration and agroforestry. Fodder production is a major constraint in Lesotho and suitable fodder and tree species can be introduced as cover crops if planting is well planned.

Crop management is also closely linked to water management and control. Weak water and watershed management will continue to be a major constraint in agricultural production and food security and needs to be addressed as an important adaptation option to reduce smallholder vulnerability. However, the Lesotho NAPA does not mention small-scale irrigation and water harvesting and management as a priority adaptation option. Of the available approaches, smallholders will need to make the correct choices based on affordability, suitability for the terrain, and skills requirements. Gravity fed irrigation is the most inexpensive - the costs of purchase, installation, operations and maintenance are minimal. It has particular potential in the mountains and foothills due to the feasibility of rain water harvesting through establishment of small to medium scale surface water harvesting structures. However, the experience of irrigation in Lesotho shows that success stories are far outnumbered by costly failures. Nevertheless, as an adaptive technology in climate change scenarios, the arguments for small-scale, low-cost irrigation technologies like gravity fed sprinkler and/or drip systems are compelling. More research in appropriate technology development and/or adaptation and re-skilling of farmers will be pre-requisite to meaningful irrigation development in Lesotho.

4.4 LIVESTOCK MANAGEMENT

In the livestock subsector, the reduction of climate-related risks and adaptation to climate change will not be easy and will require long-term approaches (Ramoeketsi, 2010). This is because the fundamental systems and processes that must be changed or adapted are communal in nature, unless a radical shift from current cultural norms of livestock management is experienced. Firstly, rangeland overgrazing and degradation must be halted and reversed to allow for recovery to full production potential. The cornerstone of all range management systems in Lesotho is the "Maboeela" system which is a traditional management strategy of the rangeland common property resources. This is complemented by the transhumance system. Any innovations in range management systems must improve on these traditional strategies for management of rangelands under common property resources, with transhumance practices giving way to more innovative systems of range management acceptable to the people.

The failure and stress on the rangelands in Lesotho is not merely a matter of the failure in the management of rangeland, but reflects the deterioration of traditional authority of the chiefs and teething problems in the transition to authority and competence of the emerging local governance structures. Planned and controlled range management programmes must be implemented, with grazing areas realistically divided into manageable blocks that allow for rotational grazing with managed rest periods. However, the most dramatic innovations in rangeland management by way of range management areas and grazing associations in the 1980s were seriously set back by cultural norms, policies and legislation. Simultaneously, only productive animals should be retained - undesirable and unproductive animals must be culled. Such a system must be based on established rangeland carrying capacities countrywide. Re-seeding with palatable grass species will be required in some places with due consideration for likely competition with the native grass species and suitability for erosion control. The challenge, however, is the fact that promulgation of such controls is politically controversial and experience shows that strong political will is required. In the 1990s, the government of Lesotho backed away from implementing tax regimes on grazing systems.

Over the short term, interventions which reduce pressure on the rangelands will be required, such as fodder production and preservation, and the use of other supplementary feeds. A fodder production scheme would provide a key alternative and/or supplementary approach to scarce rangeland resources. Fodder species could include inter-row legumes (perennial), erosion controlling kikuyu grass (perennial), annual teff grass, and rye, oats and barley for grazing in winter and early spring. Furthermore, in some of the FAO project sites, it is recommended that fodder production be introduced and encouraged on the crop farm lands to boost livestock feed supplies and to relieve pressure on the local rangelands. In this respect, it is also recommended that dual purpose (food-feed) fodder species and varieties (e.g. dual purpose legumes, sorghum) be given consideration as this will be more attractive to farmers than only planting fodder for animals (Agyemang, 2010).

Whilst indigenous cattle breeds are well suited to the current and future climate, livestock owners require basic training in herd management to optimize the breeds' genetic potential, such as introducing seasonal mating systems, providing for suitable weaning times, culling unproductive animals, and maintaining a manageable animal health programme year-round. Veterinary services are available in all three pilot sites, but qualified veterinary officers serve vast areas, sometimes one person for an entire district. Livestock farmers thus generally have inadequate access to veterinary services resulting in high mortality rates. Districts should be divided into Animal Health prototype areas, manned by paravets (individuals within communities trained to undertake animal health services). The district veterinary office should serve as resource centre for training and supply of drugs and suitable appliances. The paravets must eventually be serviced by the community.

Cash income from the sale of livestock products would strengthen livelihoods across the rural areas of Lesotho, but linkages to markets are very weak. All three pilot sites are characterized by very small local markets for meat, milk and eggs, owing to a lack of disposable income. However, small urban centres are close by and provide viable opportunities for livestock product marketing. Currently, the communities suffer from lack of marketing infrastructure. Coordinated investments and support by outside partners (public or private sector) will be required at district level as and where supply and demand of suitable products begin to develop. Development of abattoir facilities in towns would also be in support of any planned culling programme. In the lowlands, a market for live animals is feasible, where weaners are sold and fattened/finished before delivery to abattoirs.

Alternative intensive pig and poultry production schemes in the rural areas are seen as a desirable climate risk adaptation option, since no rangeland is required (except if feed is grown), and the animals are housed and thus protected from the elements. However, this approach should be viewed with a great deal of caution in the pilot sites (Ramoeketsi, 2010). Currently, there is very little activity in relation to these production lines and inadequate home-grown grain to support it. Thus, they would rely heavily on essential feed inputs and animal health services and drugs that have to be readily available and affordable, and consistent year-round provision of other extension services. Abattoirs are also required. These communities have limited resources to acquire inputs and they have insignificant access to animal health services and other technical support. Intensive dairy production and fish ponds at this juncture must be strongly discouraged, for reasons of high initial capital outlay, high input demands, and lack of developed markets.

Crop-Livestock integration (C-LI) can be an economically viable and environmentally sustainable option for climate change adaptation if introduced properly. In the FAO TCP intervention sites, effort is being made to consider C-LI as a vital part of the crop diversification strategy pursed by the project Agronomist. For example, it is recommended that instead of introducing Irish potatoes (plant tops and vines do not have much feeding value for livestock), sweet potatoes should be encouraged (vines and leaves are used for feeding livestock). Similarly, legume introduction should not be limited to Pinto beans, but should also include dual purpose (food-feed) cowpea varieties to serve both household food security and livestock fodder needs. Any proposed drought resistant crop/tree species should try to consider dual purpose (food-feed) varieties (Agyemang, 2010).

The focus of the Lesotho Department of Livestock Services' climate change adaptation response has been on fodder production to improve the productivity of livestock, and on the reduction of livestock numbers through support and promotion of culling and off take. In the past a programme of exchanging one improved animal from the Government for two unproductive animals from farmers was used. There is currently no policy framework or programme for breeding and developing animals that are better adapted to climate changes such as heat, drought and high humidity. In fact, the current Livestock Policy of 1994 contains no specific guidelines on breeding. This situation has led to indiscriminate cross-breeding which may lead to the production of crossbreds less adapted to the local environment and climate change effects. This problem needs to be addressed at a national level (Agyemang, 2010).

4.5 AGROFORESTRY

In Lesotho, agroforestry programmes have existed for decades, driven by the Government or NGOs such as CARE Lesotho and the Rural Self-help Development Association (RSDA). While some short-term successes were achieved, most of these programmes eventually failed. Reasons are numerous and include lack of sustained technical support (e.g. extension), lack of simultaneous market development (e.g. for fruit), and project termination and withdrawal of support and subsidies (Maliehe, 2010). The use of trees for soil conservation and donga (gully) reclamation has achieved good results in some sites, as has the establishment of woodlots, and protective hedges and live fences around homesteads and home gardens. Both food and non-food, including fodder tree species and trees for fuelwood and construction material, have been used.

Thus there is a substantial body of work that has been undertaken on agroforestry development and promotion in Lesotho in the past (Rok, 1994). This could be a good starting point for the further advancement of agroforestry in the country, not only in terms of climate amelioration, but also as a means for communities to improve their livelihoods and food security through the multitude of products and services it can provide.

Lessons learned from the past should inform a more sustainable approach. A number of agroforestry systems have been identified which hold much potential for the improvement of livelihoods. These systems have been shown to be effective in meeting the various basic needs of communities elsewhere in southern Africa and further afield, as well as in a few cases in Lesotho. The selection of appropriate agroforestry systems is usually based on existing practices, climate, soil conditions, the level of soil erosion, livestock population, availability of pastures, household food supply and nutrition, and fuelwood requirements.

Agroforestry makes specific demands when applied to the mountains or lowlands, and will require locally adapted systems. Features of the mountains to bear in mind include the increasing land degradation and decreasing carrying capacity of the rangelands, and the severely cold winters, often accompanied by strong winds, snow and frost. Since most fast growing tree and shrub species do not tolerate these conditions, there are very few or no trees to shelter or protect livestock from the cold, and there is very little in the form of fuelwood for the local communities to warm themselves. The southern lowlands are the driest and warmest areas in the country, and overgrazing has led to significant land degradation and soil erosion. The population density is high, placing great pressure on natural resources (notably trees of all ages), and there is an acute shortage of fuelwood. In the recent past many houses in the lowlands have been damaged, with roofs blown away by strong winds, giving rise to urgent calls for windbreaks. The agroforestry systems recommended are as follows, and are supported by identified species suitable for each zone (Maliehe, 2010; Braatz, 2010):

i. **Homestead gardens and orchards:** this system has the advantage of being practised within the homestead where young trees can be monitored and protected relatively easily from damage by livestock.

It involves the establishment of small orchards or the scattered planting of individual fruit trees in the home garden, interplanted with various vegetables. In the mountains, fruit species that can tolerate the climatic conditions can be used e.g. stone and pome fruit, and nut species. The same species, and in addition figs, pomegranates, grape vines, mulberries, Citrus species, and appropriate olive cultivars are suitable for the lowlands.

ii. **Windbreaks:** establishing windbreaks in the mountains may be more difficult than elsewhere due to the very cold winters and the short growing season, and requires a long-term perspective. It may also be preferable to establish windbreaks around homesteads and homestead gardens rather than around fields, for protection of homes and gardens against cold, strong winds. Windbreaks may also protect the soil against wind erosion.

iii. **Hedges and live fences:** problems of trespassing are much higher in the lowlands than the mountains, but in both regions it is advisable to establish protective hedges and live fences around the homesteads, especially against livestock kept within the village but also trespassing humans. A number of species are suitable for live fencing, including *Agave americana*, which can also be used for fencing in livestock near the homestead. *Agave* has the added benefit in that it is used in the production of medicinal products, and its large inflorescence is eaten by livestock.

iv. **Fodder banks/trees on contour strips in cultivated fields:** this system is more applicable to the southern lowlands where grazing resources are poor. In arid and semi-arid areas of Africa, leaves and edible twigs of trees and shrubs can constitute well over 50 percent of the biomass production of rangeland. At high altitudes, tree foliage may provide over 50 percent of the feed available to ruminants in the dry season, branches being harvested and carried to the animals (Bennison and Paterso, 1993). Even in regions of higher rainfall where grass supplies the major proportion of the dry matter eaten by ruminants, tree leaves and fruits can form an important constituent of the diet, particularly for small ruminants. These trees could be planted in rows intercropped with herbaceous annual or perennial fodder crops.

v. **Donga (gully) rehabilitation:** the extent of soil erosion in the southern lowlands is critical. Some erosion control and donga reclamation work has taken place in parts of these areas but much more work is required. A combination of tree, shrub, grass and herbaceous plant species may be used. Willows and poplars, amongst other species, can be planted on the donga floor where there is likely to be sufficient moisture to support tree establishment.

iv. **Beekeeping:** there are already a number of beekeepers in the lowlands, although the practice needs to be more organized. Indications are that many more lowlands farmers are willing to embark on beekeeping as a business. At the pilot site Thaba-Tšoeu Ha Mafa there are probably enough flowering plants to justify the starting up of beekeeping on a pilot basis. Suitable species include the fruit trees recommended for home gardens and several *Eucalyptus* species. They should ideally be drought tolerant.

Table 1 matches livelihoods and environmental needs in the project areas with the five agroforestry systems deemed most appropriate to the project areas (Braatz, 2010).

Seedling production is a key element in most agroforestry projects. The question of how best it should be organized has been a subject of considerable debate, which ranges from the use of centralized and highly controlled nurseries to decentralized farmer-run nurseries, the latter being more aligned with current government policies. However, what is very clear is that farmers in rural areas often face difficulties regarding the availability of seedlings of various species for specific purposes. This requires dedicated attention.

TABLE 1

Main roles of agroforestry systems in meeting livelihood and environmental needs in the project areas

	AGROFORESTRY SYSTEMS					
Key needs in the project sites	**Fruit trees in homegardens and orchards**	**Trees on bunds / contour strips in cultivated fields**	**Donga rehabilitation**	**Windbreaks**	**Hedges / live fences**	**Beekeeping**
Diversifying crop production/increasing food security	x	x				x
Supplementing livestock fodder/feed	x		x		x	
Increasing fuelwood availability	x	x	x	x	x	
Reducing the risk of soil erosion		x	x	x	x	
Generating income						x

CHAPTER 5

PAST AND ONGOING INITIATIVES RELEVANT TO MANAGING CLIMATE VARIABILITY AND CHANGE

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, declining 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 to climate risk and climate change are becoming increasingly obvious.

The Government of Lesotho's development priorities and associated policies and strategies have in all cases emphasized the attainment of food security, employment generation, combating environmental and natural resources degradation as well as the HIV/AIDS pandemic in order to meet the WFS objectives and the target of reducing the number of hungry people by half by 2015 (MDG-1) and attaining environmental sustainability (MDG-7). Lesotho also aligns itself with the New Partnership for Africa's Development's (NEPAD) Comprehensive Africa Agriculture Development Programme (CAADP) investment pillars on land and water management (Pillar 1) and increasing food supply and reducing hunger (Pillar 3). In this context, 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 of poverty and food insecurity better, so that they can be addressed effectively.

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 relevant Ministries, international partners and local NGO's, on the appropriate responses. It has became increasingly clear that responses to food crises need to go beyond short–term food aid needs to longer term livelihoods interventions. 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 FAO, CARE Lesotho, World Vision Lesotho, Lesotho Red Cross, Rural Self Help Development Association, and 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.

Food security demands a clear legal framework, especially with regard to land acquisition, marketing, import and export of agriculture produce, quality standards, natural resources management, local governance as well as national food reserves management. The Government has enacted a number of laws, but although legislation is in place, enforcement mechanisms are weak and increased efforts are needed to strengthen institutional capacity particularly at the district and constituency levels.

In this context, the Government of Lesotho has completed the Lesotho National Report on Climate Change (Government of Lesotho, 2000) (First National Communication to the Conference of the Parties to the UNFCCC), and the National Adaptation Programme of Action (NAPA) on climate change under the UNFCCC (Government of Lesotho, 2007b). The outcomes of the NAPA are identification of regions and communities vulnerable to climate change and prioritization of responsive adaptation activities for implementation in the vulnerable regions. The NAPA identified 11 adaptation options most of which address crop and livestock production, listed in order of priorities for immediate implementation with support of the international community (Table 2).

The NAPA team has evaluated that Options 1-3 directly address the vulnerable groups and have the highest potential for sustainability, employment creation and poverty reduction. However, outside support for the implementation of the NAPA prioritized actions has not been forthcoming. The NAPA options

TABLE 2

NAPA list of prioritized adaptation options/projects for implementation in the vulnerable zones of Lesotho (Government of Lesotho, 2007c)

OPTIONS NO	OPTION TITLE
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 in 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 ecotourism-based rural livelihoods
Option 10	Promote wind, solar and biogas energy use as a supplement to hydropower energy
Option 11	Stabilizing community livelihoods which are adversely affected by climate change through improvement of small-scale industries

have been perceived to be highly sectoral and require a more integrated and community-based approach that is flexible and responsive to farmers' needs to manage their production risks associated with changing climatic conditions.

Several technical gaps and barriers to NAPA implementation were identified by the FAO project formulating team and national expert representing the Government of Lesotho (Dejene, Marake, Ramasamy, 2009):

i. There is no systematic body of knowledge on location specific adaptation practices available for most vulnerable livelihood zones. The NAPA proposed adaptation measures are general and prioritized to broad livelihood zones. They are also not prioritized for more location-specific livelihood zones vulnerable to the most important hazards, notably drought. Currently, there are no programmes to address drought risk management in the agriculture sector.

ii, The NAPA process has recognized that inadequate institutional and technical capacity at the national, district and community levels are the main barriers to implementing NAPA priorities.

iii. The NAPA options do not include forest/agroforestry practices in reducing vulnerability to climate risk in the major livelihood zone in any significant way. Yet, Lesotho is a virtually denuded country, attributable to the high demand by humans and livestock outstripping supply. Furthermore, Lesotho relies on its water resources (from the mountain regions) as a significant source of revenue from the sale of water to South Africa and hydropower generation.

iv. Integration of climate change issues into the sectoral policies and development plans is identified as one of the priority areas of the NAPA (Table 3, Option 3). Such integration would not be possible without awareness creation and strengthening the information and knowledge base within key institutions on the impact of climate change on agricultural based livelihoods.

CHAPTER 6

FAO'S ADAPTATION INTERVENTION

In an effort to address these technical shortcomings in the NAPA and make progress on implementing priority adaptation needs, FAO and the Government of Lesotho are piloting a Technical Cooperation Programme (TCP) which began in 2009.[3] The overall development goal of the project is to reduce the risks associated with climate change and variability on food security among smallholder and subsistence farmers in Lesotho. The TCP promotes an integrated and community-based approach in addressing climate change risks through strengthening of technical and institutional capacity at national, district and local levels. The emphasis is on identifying, evaluating, prioritizing and testing locally relevant adaptation practices (particularly for drought), focusing on selected areas of crops, livestock and forest-based livelihood systems, to stabilize and improve yields (Dejene, Marake and Ramasamy, 2009). Technical capacity building takes place through need-based training programmes focusing on location specific adaptation practices identified above.

The TCP will also build an information and knowledge base on climate change impacts and community-based adaptation, and will harness the existing opportunity provided by the NAPA for integration of climate change issues into national and district development plan and sectoral policies. The pilot project has potential for upscaling and replicating across the country and beyond.

The TCP was devised as a pilot project for implementation in the three districts of Thaba Tseka, Mafeteng and Mohale's Hoek, identified in the NAPA as the most vulnerable to climate change. Rantsimane, a subcatchment of the Senqu River in Thaba Tseka, represents the vulnerable areas of the mountain ecological and livelihood zones. Thaba-Tšoeu Ha Mafa, a subcatchment of the Tsoaing River in Mafeteng, is on the transition zone, between the foothills and the mountains. Mabalane, a subcatchment of the Kolo-La-Pere River in Mohale's Hoek, is in one of the drought prone parts of the southern lowlands of Lesotho. The two lowland subcatchments also represent the densely populated rural areas of the country. Taken together, these three catchments represent a

3 The project formulation team consisted Alemneh Dejene and Selvaraju Ramasamy from FAO and Prof. M. Marake from the National University of Lesotho. This resulted in the FAO TCP document endorsed by FAO and the Government of Lesotho entitled: Lesotho: Strengthening capacity for climate change adaptation in the agriculture sector; TCP/LES/3203 (D), 2009, FAO, Rome.

major transect of vulnerability ranging from the southwestern lowlands to the mountain zones of Lesotho, via a transitional site between the southern lowlands and the foothills.

The Programme was structured in three well-defined phases, with planned transitions from one phase to the next. The project was launched in June 2009 (Dejene and Marake, 2009). The first phase involved the assessment of climate change related impacts and vulnerabilities on crop, livestock and forest-based livelihood systems in the two vulnerable livelihood zones. This was documented in a Technical Report. Furthermore, baseline studies on local climate-related vulnerabilities and coping and adaptation strategies were conducted, analysed, validated at national and local levels, and documented. This phase was completed in March 2010.

During the second phase, an inventory of potential suitable adaptation practices (i.e. crops, livestock, crop-livestock interaction and agroforestry) relevant to southern lowland and mountain ecosystems was undertaken, drawing from various sources, with particular focus on the pilot subcatchments in view of their specific vulnerabilities. These adaptation practices were screened using key criteria, notably: (i) comparison with the list of potential adaptation measures options suggested in the NAPA document; (ii) enhancement of both productivity and ecosystem services, and (iii) capacity to address drought risk management. Finally, field demonstrations were conducted on key potential adaptation practices identified above, for farm level application and upscaling.

During the baseline study validation workshops held in each subcatchment, the final activity of the first phase conducted by the external consultant, the national consultants ("experts") who were engaged for phases two and three also participated. This ensured a seamless transition into phase two. Shortly after the validation workshops, the experts re-visited the pilot sites to discuss in detail the issues raised during the baseline study and during the validation workshops and any other issues considered relevant to the assignment. Subsequently, farmers (40 at each site with interests in crops, livestock or agroforestry) were selected who would participate in the pilot studies, and individual interviews were held with each farmer to provide further detailed baseline data.

Key results emanating from phases one and two have been summarized elsewhere in this paper.

The project is now in the third phase, and implementation of targeted practical activities has begun. These include demonstration/pilot areas for conservation (no-till) agriculture, fruit tree seedling planting around homesteads, establishment of windbreaks, and planting of tree seedlings for donga (gully) rehabilitation.

During this phase, targeted training programmes will also be conducted to strengthen technical capacity to address climate-related vulnerabilities and risks at national, district and community levels. This will align with the suitable adaptation strategies and practices identified above. Beneficiaries of the training will include national technical staff members, national policy-makers, district technical staff and administrators, and farming community participants. Efforts are now underway to extend the project until December 2011 and cover the experience of the planting season in 2011.

Some of the key findings and observation based from these experience and consultation are summarized below (Table 3).

TABLE 3

A comprehensive adaptation options matrix for the pilot districts

TYPOLOGY OF OPTIONS	SPECIFIC ACTIONS TO BE ELABORATED LATER AFTER DETAILED INVESTIGATION	REMARKS
Crop Improvement and cropping systems	Use improved seed (drought resistant or short cycle)	Identify suitable high yielding varieties tolerant to various abiotic and biotic stress; biotic stresses include pest and diseases and birds.
Diversified crops and cropping systems and changing crop types	Improved cropping patters with inclusion of dominant crops in highlands, foothills and lowlands (maize, wheat, sorghum, beans, peas and potatoes)	Community preference and detailed analysis of existing risks is needed to identify most reliable growing season for all major crops.
Input management and enhancing input use efficiency	Improve agricultural technologies focusing on timing and quantity of inputs (seeds, fertilizers, pesticides etc.) and farm operations to reduce the impacts of climate	Prepare a basic cropping calendar and associated risks for each season for three districts.
Soil and water conservation; recycling and management	Implement water runoff control to prevent soil erosion; Plant trees/hedges for protection of soil and conservation of moisture Implement in situ soil and moisture conservation techniques; Assist houses in installing rain water collection tanks Use of animal manure in restoring soil fertility	Actual location for establishing erosion control structures in the pilot districts should be identified; most suitable models of in situ soil moisture conservation techniques should be prioritized. Farmers do not pay much attention to using animal manure in soil fertility which is an important adaptation practice with synergy to mitigation.

(CONT.) TABLE 3

A comprehensive adaptation options matrix for the pilot districts

TYPOLOGY OF OPTIONS	SPECIFIC ACTIONS TO BE ELABORATED LATER AFTER DETAILED INVESTIGATION	REMARKS
Livestock	Build shelters for livestock Improve livestock breeding and health strategies Increase poultry/pig production Promote expanded use of animal draught power	A standard for shelters to protect from heat in the lowlands and wind and cold in mountains is needed. Diversification with poultry and pig are some of the preferred options by the farmers but suitable breeds should be identified and provided to them. Baseline survey shows that farmers have strong desire to use tractors even in land not suitable for it. Draft power is viable and less costly and climate neutral options to promote among smallholders.
Grazing land management	Improve grazing management; better legislation for community grazing lands Further study on local rangeland classification (A &B) to design strategy for optimal use of rangelands	Farmers in mountains articulated need for informal groups and by laws for better managing rangelands and common grazing lands. The options should consider conservation of soil and promotion of palatable grasses. There are indigenous vegetation not preferred by the animals suppress palatable grass species.
Small-scale water harvesting and management	Smaller –scale irrigation, water harvesting and watershed management	Small-scale water harvesting and storage facilities need to be promoted to reduce the crop yield variability and management of dry spells. As the rainfall season has two components (less dependent on each other), early season wet spells (Nov–Dec) can compensate the late season water deficit (Jan–Mar).
Strengthening community-based institutions	Establish village farmer communities to enable spread of information	Community hubs are required to disseminate recent technologies and new adaptation options; this can be built through existing institutional systems and should be facilitated by district level extension office.

(CONT.) TABLE 3

A comprehensive adaptation options matrix for the pilot districts

TYPOLOGY OF OPTIONS	SPECIFIC ACTIONS TO BE ELABORATED LATER AFTER DETAILED INVESTIGATION	REMARKS
Strengthening extension systems	Improve extension services Localized weather and climate information to the farmers Upscaling keyhole gardens in most vulnerable communities, women-headed household	Training on latest technologies and transfer needs improvement as it came up during the district level validation workshops. Year-round vegetable garden close to homestead.
Improved early warning systems	Improve climate hazard forecasting and dissemination Implement an early warning system	It was generally accepted that the weather and climate information from Lesotho Meteorological Service is useful for decision making. But, it is unclear how farmers used this information at farm level. The training expert may address some of the issues related to interpretation of weather and climate information met services.
Crop-Livestock Integration	Dual purpose (food-feed) fodder species and varieties on crop farm land	Responds to both household food security needs and livestock needs making smallholders resilient to climate related risks.
Conservation agriculture	Promoting conservation agriculture that consists of Crop-Livestock Integration and agroforestry in smallholder sector	The basic principles of conservation agriculture may need to be broadened according to the local situation in a county dominated by smallholders and with diverse and fragile ecosystems. Stabilizing yields and ecosystem service and livelihood diversification important in large part of mountain ecosystem and foot hills. Lesotho National University is involved in this efforts and Dr Marake will contribute to development of suitable model.

TABLE 3

A comprehensive adaptation options matrix for the pilot districts

TYPOLOGY OF OPTIONS	SPECIFIC ACTIONS TO BE ELABORATED LATER AFTER DETAILED INVESTIGATION	REMARKS
Diversification of enterprises	Diversify from farming to non-farming/find off-farming employment	Income diversification activities and generation of off-farm employment opportunities should consider gender sensitivity. As many households are women headed, their involvement in farming is necessary to manage food needs of the household. Some men in pilot districts offer remittances to the household from off-farm employment in South Africa. Small scale enterprises for women may provide additional benefits to the household in the context of securing food.
Develop market facilities and business skills with farmers	Develop markets and trade flows Develop entrepreneurial and business skills	An entrepreneurial skill for farm women and youth is required as they are involved in small-scale farming and livestock rearing and grazing.
Agroforestry	Develop agroforestry models for mountains and lowlands – need to consider the criteria such as natural resources management (soil and water), enhancing livelihood opportunities by providing fodder and fruits and controlling soil erosion.	Suitable agroforestry systems are required for donga rehabilitation. Previous experiences from other development partners and Ministry of Forestry and Land Reclamation need to be reviewed to come up with suitable agroforestry model. The national expert (agroforesry) is working on developing suitable models.

CHAPTER 7

LESSONS LEARNED

A project of this nature requires not only careful planning and implementation but also critical reflection and documentation of lessons learned to facilitate institutionalization of success stories scalable to other communities and districts nationwide, and possibly to other countries in the region.

Pilot projects which can be deemed successful and suitable for scaling-up should meet the following key criteria:

Sufficient time for planning, inception, implementation and phasing out stages:

The project planning and inception phases were allocated sufficient time. However, the timelines for implementation and phasing out activities appear to be insufficient. The implementing bodies and affected communities are lagging behind in view of the implementing procedures. Also, responses to seriously mismanaged rangelands and herd development require implementation timeframes far exceeding the project lifetime. The project will have to support the Ministries of Forestry and Land Reclamation and Agriculture and Food Security to strengthen existing or planned programmes in this regard. Project timelines should be reviewed at this stage to ensure successful implementation and a transition to sustainability. While the project activities were planned in such a way that they are institutionalized into the respective district departmental portfolios, the lessons to be drawn out of the screening and demonstration studies would be most useful if they took place well inside the project timeframes.

Financial sustainability beyond the project and funding lifetime:

This is a recurring development hurdle. In this project, the first and second phases are mainly focused on assessment and analysis, whilst the third phase will address policy integration and issues of sustainability. At this stage, donor agencies and associated government ministries will need to link the project with long term budgetary commitments. Nevertheless, for a project of this nature it is essential that the Government is involved from day one, there is full government buy-in and support at all political and administrative levels (up to this point the project has been successful in achieving this), and that this leads to long-term budget allocations (this remains to be achieved).

Sustainable implementation at community level:

It is critical that there is full involvement and buy-in of the community which is intended to be the beneficiary, from day one. This project has had strong engagement with the communities during the first phases, but momentum towards full participation in implementation needs to be accelerated. Communities must be allowed sufficient time to engage with the programme, understand its objectives and feel empowered to start implementing, with measurable and sustainable results evident before programme end. In the current situation, the community implementation of the project activities has lagged behind and is happening too close to project end. It would have been better if this stage of the project was reached with at least one year to go on the project timelines to facilitate more engagement of the communities.

A systems-based approach which transcends sectoral interests:

It is particularly important that all relevant and affected government ministries participate, are adequately briefed, and show commitment to achieving the project purpose based on collaboration. Climate change resilience building will be most effective when approached in an integrated systems-based manner. Within the context of agricultural and rural development, urban- and rural-focused authorities must find improved ways of collaborating to develop the necessary value chain for agricultural inputs and outputs and create a market economy at district and ultimately national level. This project was conceptualized along these lines; the real test will be the actual building and strengthening of supportive infrastructure and financial mechanisms, to link the rural economy into a modern urban-driven market economy.

A high degree of reality in devising feasible activities and outcomes rooted in the local context:

This is one of the core strengths of the project. The focus on community-based adaptation strategies should ensure that science-based responses are embedded in local knowledge, practices and circumstances (both biophysical and socio-economic), are understood, wanted, and implemented by the farmers participating in the project and lead to improved livelihoods.

Avoidance of "hand-outs" (grants) in favour of credit mechanisms:

Many development projects based on grants have failed, and have fostered the development of a "hand-out mentality" not just in Lesotho but many other developing countries in the region. The granting of credit which requires re-payment, on the other hand, tests the commitment and practical orientation of a farmer. It links closely with long-term sustainability. The project favours this approach, which is supported by the farmer participants in all three pilot sites, as found during the baseline interviews. However, implementation of the pilot adaptation demonstration requires some support to farmers in order to reduce the risk factors on them. In addition, if the choice of farmers participating in the project would adopt a criteria of those who can afford to test the recommended technologies, it would run the risk of being perceived as a project for those who have the means.

Objective monitoring and evaluation:

Success needs to be measured and documented if it is to be scaled up to other communities; conversely, upscaling of mistakes and absence of benefit should be avoided at all cost. Monitoring and evaluation procedures have to be undertaken concurrently with project implementation processes. The first phase of this project included baseline studies which were also validated – these provide the basis for future M&E and evidence of positive change. This is a key component which should not be compromised by financial or time constraints.

CHAPTER 8

SCALING-UP AND FUTURE DIRECTIONS

The challenge going forward is to scale up the programme so that successes can be replicated over much wider areas of Lesotho and eventually over other countries in the region. The various elements which are required for scaling-up include:

- Calculations of return-on-investment for the pilot projects in the three agro-ecological regions and for each of crop management, livestock management and agroforestry. This should take a medium- and long-term view, incorporating the potential damages costs of no action in the face of climate change, and/or the lost opportunity costs of no action.
- Widespread communication of the benefits to farming communities across Lesotho. This should be holistic and include yield increases, financial benefits, food security benefits, conservation benefits, income diversification, and human/social benefits (e.g. education and training). Information sharing between pilot communities of varying maturities would be useful. Awareness raising in the media (e.g. radio) should be fostered. This prepares the ground for wider implementation.
- Communication of benefits to key policy-makers and decision-makers, ministerial senior staff, cabinet members (particularly the Minister of Finance), senior academics and advisors. The focus should be on reductions in poverty and food insecurity, and cost-benefit messages.
- The setting of clear and realistic time-bound and budgeted targets for phased upscaling across Lesotho and the region. Phased upscaling should be based on continued objective prioritisation of vulnerability, and endorsed by stakeholder consultation.
- Engaging with the new target communities and local government structures from day one; assessing and addressing barriers to adoption at community level; assessing and addressing capacity constraints of officials and extension services in each new region; alignment with the local work of various Ministries wherever possible.
- Transferring learning from the pilots in the three agro-ecological zones to new zones with similar circumstances, whilst identifying uniquely

different circumstances in each new community. This should be based on indicators developed for each agro-ecological zone.

- Encouraging the local manufacture of required machinery and technologies on a bigger scale, and development of local technical support services, for improved sustainability.
- Monitoring of the impact and benefits of the pilot projects, as measured against the baseline data, over various timeframes.
- Data and knowledge management using data collation, entry into databases, analysis and trend identification, and occasional publications for various target audiences. Feedback from farmers to be included on a regular basis.
- Mainstreaming the prioritized adaptation practices, capacity building and awareness raising strategies into government programmes and projects will ensure sustainability of interventions.
- There are opportunities to strengthen need-based research at the research station level based on the feedback from the farmers and local communities. This can revitalize future research programmes by orienting them towards ground realities.

It should be borne in mind that other countries have identified, via their own national climate change assessments and processes, different sets of priorities. As was done for Lesotho, an adaptation programme needs to build on these experiences and align with national policy development and existing programmes, whilst incorporating the local context. Unfortunately, whilst all the NAPAs developed by southern African least developed countries include agricultural strengthening as one of the top three adaptation priorities (OneWorld Sustainable Investments, 2010c), they are all lacking in specific practical actions to be taken as determined by the local context and most suffer from the same deficiencies identified in the Lesotho NAPA. This TCP could chart a possible way forward for turning high-level ideals into fundable and implementable local actions across the region.

From a regional point of view, scalability would be enhanced by the inclusion of other key themes relating to the impacts of climate change on natural resources-based livelihoods and food security, and potential adaptations. These could include climate-resilient development of freshwater and marine fisheries, climate-resilient wildlife management and associated tourism, and high value diverse fruit and vegetable production under small-scale irrigation, and agriculture-health-labour linkages. Agricultural and livelihood diversification is the key element of climate-related risk reduction and adaptation, and has the additional benefit of nutritional diversification with associated health benefits, and elimination of the dreaded “hunger season” so prevalent across the region.

CHAPTER 9

CONCLUSIONS

Many factors have contributed to the precarious situation of many of southern Africa's subsistence and smallholder farmers, for which Lesotho is a good example. Destructive management practices and overuse of natural resources have rendered once productive crop- and rangeland unable to support those making a living from it. This weakened system, particularly in the major livelihood zones of Lesotho (lowland and mountain areas) is no longer able to absorb the climatic shocks, and the prospect of an ever increasing frequency and intensity of extreme events due to climate change is truly alarming.

This paper shows the need for a more systematic adaptation response with close coordination at the national, district and community levels. Some low input and affordable adaptation responses are already available for implementation in vulnerable farming communities, but they require upgrading and coordinated support. Experience has shown that documenting and field testing location specific adaptation practices (i.e. crops, livestock, and crop-livestock integration), combined with an integrated approach and targeted training, has the best chance of success and sustainability. The TCP between the FAO and Government of Lesotho has provided a good example and a case study of how such an approach can be structured and implemented at local and community level. Whilst the project is not yet completed, useful information has been documented and valuable lessons have already been learned on the challenges and potential for climate change adaptation at local level. This will help to contribute to the knowledge base on climate change impact and process at national and local levels, and the possibility of upscaling in Lesotho, thus serving as a benchmark for the region.

REFERENCES

Agyemang, Kaku, 2010; Report of the Livestock Production and Manangment Back Stopping Mission, TCP/LES/3203 (D). FAO, Rome.

Ballard, C., 1986. Drought and economic distress: South Africa in the 1800s. *Journal of Interdisciplinary History* 17: 359-378.

Battisti, D.S. and Naylor, R.L., 2009. Historical warnings of future food insecurity with unprecedented seasonal heat. *Science* 323: 240-244.

Boko, M., I. Niang, A. Nyong, C. Vogel, A. Githeko, M. Medany, B. Osman-Elasha, R. Tabo and P. Yanda, 2007: Africa. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds.]. Cambridge University Press, Cambridge, UK, 433-467.

Bond, W.J., Midgley, G.F. and Woodward, F.I., 2003. The importance of low atmospheric CO_2 and fire in promoting the spread of grasslands and savannas. *Global Change Biology* 9: 973-982.

Boudreau, T. (ed.) *et al.* (2009). The Practitioner's Guide to the Household Economy Approach. Regional Hunger and Vulnerability Programme (RHVP), Save the Children UK (SC UK) and the Food Economy Group.

Braatz, S., 2010. Report of the agroforestry backstopping mission, TCP/LES/3203 (D). FAO, Rome.

CAADP, 2007. Comprehensive African Agriculture Development Programme. Pillar III Draft Framework for African Food Security. NEPAD, AU.

Christensen, J.H., B. Hewitson, A. Busuioc, A. Chen, X. Gao, I. Held, R. Jones, R.K. Kolli, W.-T. Kwon, R. Laprise, V. Magaña Rueda, L. Mearns, C.G. Menéndez, J. Räisänen, A. Rinke, A. Sarr and P. Whetton, 2007: Regional Climate Projections. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Dejene, A., *et.al.* Back to Office Report on Project formulation mission, 2009. TCP/LES/3203 (D), FAO, Rome.

Dejene, A and Marake, M., 2009 Report of the TCP Launching Mission, TCP/LES/3203 (D). FAO, Rome.

De Wit, M. and Stankiewicz, J., 2006. Changes in surface water supply across Africa with predicted climate change. *Science* 311: 1917-1921.

Dunwiddie, P. and LaMarche, V., 1980. A climatologically-responsive tree-ring record from Widdringtonia cedarbergensis, Cape Province, South Africa. *Nature* 286: 796–797.

Easterling, D. Evans, J. Groisman, P. Karl, T. Kunkel, K. and Ambenje, P., 2000. Observed variability and trends in extreme climate events: a brief review. *Bulletin of the American Meteorological Society* 81: 417-425.

Easterling, W.E., P.K. Aggarwal, P. Batima, K.M. Brander, L. Erda, S.M. Howden, A. Kirilenko, J. Morton, J.-F. Soussana, J. Schmidhuber and F.N. Tubiello, 2007: Food, fibre and forest products. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 273-313.

FAO, 2007. Adaptation to climate change in agriculture, forestry and fisheries: Perspective, framework and priorities. FAO, Rome.

FAO, 2009a. Declaration of the World Summit on Food Security. World Summit on Food Security, 16-18 November 2009, Rome.

FAO, 2009b. Lesotho: Strengthening capacity for climate change adaptation in the agriculture sector; TCP/LES/3203 (D), FAO, Rome.

FAO, 2009c. Review of evidence on drylands pastoral systems and climate change: Implications and opportunities for mitigation and adaptation. FAO, Rome.

FAO, 2009d. Food security and agricultural mitigation in developing countries: options for capturing synergies. FAO, Rome.

FAO, 2010. The State of food insecurity in the world: addressing food insecurity in protracted crisis. FAO, Rome.

Friedrich, T. 2010, Report of the crop management and conservation agriculture backstopping mission, TCP/LES/3203 (D). FAO, Rome.

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

Government of Lesotho, 2007a. Bureau of Statistics. Lesotho Agricultural Situation Report (1981/82 – 2004/05), Planning and Policy Analysis Department, Ministry of Agriculture and Food Security and Ministry of Finance and Development Planning. Maseru, Lesotho.

Government of Lesotho, 2007b. Lesotho National Adaptation Programme of Action (NAPA) on climate change under the UNFCCC. Maseru, Lesotho.

Government of Lesotho, 2007c. Lesotho Census of Population and Housing 2006. Preliminary Report. Bureau of Statistics. Ministry of Finance and Development Planning. Maseru, Lesotho.

Government of Lesotho, 2008. Bureau of Statistics. Statistical Yearbook 2008. Maseru, Lesotho.

Groisman, P. Knight, R. Easterling, D. Karl, T. Hegerl, G. and Razuvaev, V., 2005. Trends in intense precipitation in the climate record. *Journal of Climate* 18: 1326-1350.

Hall, M., 1976. Dendroclimatology, rainfall and human adaptation in the Late Iron Age of Natal and Zululand. *Annals of the Natal Museum* XXII: 693-704.

Hassan, R.M. and Nhemachena, C., 2008. Determinants of African farmers' strategies for adapting to climate change: Multinomial choice analysis. *African Journal for Agricultural and Resource Economics* 2(1): 83-104.

Hewitson, B.C. and Crane, R.G., 2006. Consensus between GCM climate change projections with empirical downscaling: precipitation downscaling over South Africa. *International Journal of Climatolology* 26: 1315–1337.

Holmgren, K. Karlén, W. Lauritzen, S. E. Lee-Thorp, J. A. Partridge, T. C. Piketh, S. Repinski, P. Stevenson, C. O., S. and Tyson, P. D., 1999. A 3000-year high-resolution stalagmite based record of palaeoclimate for northeastern South Africa. *The Holocene* 9: 295–309.

IAASTD, 2009. Agriculture at a crossroads. International Assessment of Agricultural Knowledge, Science and Technology for Development Vol. V. Sub-Saharan Africa. McIntyre, B.D., Herren, H.R., Wakhungu, J. and Watson, R.T. (eds). Island Press, Washington DC.

Kruger, A.C., 2006. Observed trends in daily precipitation indices in South Africa: 1910-2004. *International Journal of Climatology* 26: 2275-2285.

Kurukulasuriya, P. and Mendelsohn, R., 2008. A Ricardian analysis of the impact of climate change on African cropland. *African Journal for Agricultural and Resource Economics* 2(1): 1-23.

Lepheana, R.M., 2010. Crop management and conservation agriculture. Strengthening capacity for climate change adaptation in the agricultural sector. Report to the Food and Agriculture Organization of the United Nations and the Ministry of Forestry and Land Reclamation, Government of Lesotho. Maseru, Lesotho.

Lindesay, J.A. and Vogel, C.H., 1990. Historical Evidence for Southern Oscillation-Southern African Relationships. *International Journal of Climatology* 10: 679-689.

Lobell, D.B., Burke, M.B., Tebaldi, C., Mastrandrea, M.D., Falcon, W.P. and Naylor, R.L., 2008. Prioritizing climate change adaptation needs for food security in 2030. *Science* 319: 607-610.

Maddison, D. 2006. The perception of and adaptation to climate change in Africa. CEEPA. Discussion Paper No.10. Special Series on Climate Change and Agriculture in Africa. ISBN 1-920160-01-09.

Maliehe, T.M., 2010. Agroforestry. Strengthening capacity for climate change adaptation in the agricultural sector. Report to the Food and Agriculture Organization of the United Nations and the Ministry of Forestry and Land Reclamation, Government of Lesotho. Maseru, Lesotho.

New, M., Hewitson, B., Stephenson, D.B., Tsiga, A., Kruger, A., Manhique, A., Gomez, B., Coelho, C.A.S., Masisi, D.N., Kululanga, E., Mbambalala, E., Adesina, F., Saleh, H., Kanyanga, J., Adosi, J., Bulane, L., Fortunata, L., Mdoka, M.L. and Lajoie, R. 2006. Evidence of trends in daily climate extremes over southern and west Africa. *Journal of Geophysical Research* 111: D14102, doi:10.1029/2005JD006289.

OneWorld Sustainable Investments, 2009. Technical report on climate change impacts, risks and vulnerabilities on food security and livelihoods in the lowlands and mountains. Food and Agriculture Organization of the United Nations (FAO) in partnership with the Government of Lesotho. Project number TCP/LES/3203 (D).

OneWorld Sustainable Investments, 2010a. Climate Risk and Vulnerability Mapping for Southern Africa: Status Quo (2008) and Future (2050). Regional Climate Change Programme. For the Department for International Development, UK.

OneWorld Sustainable Investments, 2010b. Baseline Report on climate related risks, local vulnerabilities and perception and coping strategies in three subcatchments of Lesotho. Food and Agriculture Organization of the United Nations (FAO) in partnership with the Government of Lesotho. Project number TCP/LES/3203 (D).

OneWorld Sustainable Investments, 2010c. Climate change and food security policy analysis for Southern Africa. Regional Climate Change Programme. For the Department for International Development, UK.

Pyle, D.M. 2006. Severe convective storm risk in the Eastern Cape Province of South Africa. PhD thesis, Rhodes University, Grahamstown, South Africa.

Ramasamy, S. 2010, Report of the climate change impact and relevance to local adaptation strategy. FAO, TCP/LES/3203 (D), FAO, Rome.

Ramoeketsi, 2010. Livestock. Strengthening capacity for climate change adaptation in the agricultural sector. Report to the Food and Agriculture Organization of the United Nations and the Ministry of Forestry and Land Reclamation, Government of Lesotho. Maseru, Lesotho.

Robbock, A., 2002. Volcanic Eruption, Tambora. In: Encyclopaedia of Global Environmental Change. John Wiley and Sons, Ltd, Chichester, pp. 737-738.

Rok, F., 1994. Agroforestry in Lesotho: experience, possibilities, constraints – a concept paper. Matelile Rural Development Project, Maseru, Lesotho.

Schulze, R.E. (ed.) *et al.,* 1997. South African Atlas of Climatology and Agrohydrology Technical report, Water Research Commission, Pp 276. Pretoria, South Africa.

Schulze, R.E., 2010. Atlas of Climate Change and the South African Agricultural Sector: *A 2010 Perspective*. Department of Agriculture, Forestry and Fisheries, WRC Report 1843/1/10. Pp 387. Pretoria, South Africa.

Silici, L., Pedersen, S.H. and Mapeshoane, B., 2007. The impact of conservation agriculture and small and subsistence farmers. The case of Likoti in Lesotho. Roma, Lesotho.

Tadross, M.A., Hewitson, B. and Usman, M.T., 2005. The interannual variability of the onset of the maize growing season over South Africa and Zimbabwe. *Journal of Climatology* 18: 3356-3372.

Tadross, M., Suarez, P., Lotsch, A., Hachigonta, S., Mdoka, M., Unganai, L., Lucio, F., Kamdonyo, D., Muchinda, M. 2009. Growing-season rainfall and scenarios of future change in southeast Africa: implications for cultivating maize. *Climate Research* 40: 147–161.

Trenberth, K. Dai, A. Rasmussen, R. and Parsons, D., 2003. The changing character of precipitation. *American Meteorological Society* 84: 1205-1217.

United Nations, 2009. The Millennium Development Goals Report. UN, New York.

Usman, M.T. and Reason, C.J.C., 2004. Dry spell frequencies and their variability over southern Africa. *Climate Research* 26: 199–211.

Vogel, C. H., 1989. A documentary-derived climatic chronology for South Africa, 1820-1900. *Climatic Change* 14: 291-307.

World Bank, 2007. World development report 2008: Agriculture for development. The World Bank, Washington DC.

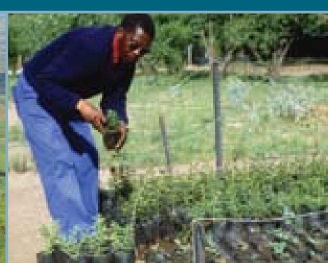
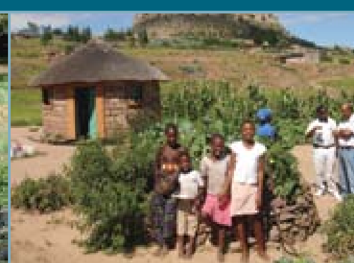
Ziervogel, G. and Calder, R., 2003. Climate variability and rural livelihoods: assessing the impact of seasonal climate forecasts in Lesotho. *Area* 35(4): 403–417.

Ziervogel, G., Bharwani, S. and Downing, T.E., 2006. Adapting to climate variability: pumpkins, people and policy. *Natural Resources Forum* 30: 294-305.

Climate change and variability are already having considerable impact on agricultural-based livelihood in Southern Africa and Lesotho, particularly among smallholders who depend on rainfed agriculture. Lesotho is a classic example of the least developed countries (LDCs) with a large smallholder and rural population that are vulnerable to the slightest change in climate.

This publication aims to create awareness and prompt action amongst policy-makers and practitioners to address the impact of climate change (notably changes in temperature and rainfall) to the country's food security. It serves as a good example of how the ongoing FAO and Government of Lesotho project activities are complementing identified by the National Adaptation Programme of Action (NAPA) on climate change. It also draws on lessons learnt on strengthening capacity for climate change adaptation in agriculture at national, district and community level, focusing on selected areas of crops, livestock and forest-based livelihood systems.

The publication would be a useful resource to policy-makers, development partners and field practitioners on documenting and identifying viable community-based response and practices in climate change adaptation, and in pointing out opportunities for scaling-up in other parts of the country and region with similar agro-ecological and social context.

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