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ASSESSMENT OF SMALL-HOLDER FARMERS' VULNERABILITY TO THE 2004/2005 DROUGHT IN MAKHADO MUNICIPALITY

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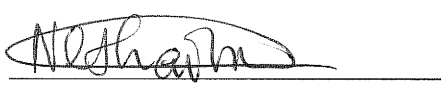
A research report for the partial fulfillment of Masters degree in the school of Geography and Environmental studies, Faculty of Science, University of the Witwatersrand, Johannesburg, 2007

DECLARATION

I declare that this research report is my own, unaided work, except where otherwise acknowledged. It is being submitted in partial fulfillment for the requirements of the degree of Master of Science in Environmental Science at the University of Witwatersrand. It has not been submitted before for any degree or examination in any other university.



Ntavhanyeni G. Nethavhani

9th Day of November 2007

ABSTRACT

In most African countries, small-holder farmers have been found to be vulnerable to a range of stress, including floods and droughts. Their agricultural production is often aggravated by climatic and hydrological regimes that are often marginal for agriculture. In certain regions several factors often continue to make farming a difficult enterprise. The location of farms in steep slopes, for example, can increase the chances of soil erosion and reduce the rate of infiltration. Low-income levels and lack of resources further reduce response options to drought. Lack of capital, for example, makes it difficult for small-holder farmers to afford fertilizers, and supplementation of water for irrigation when there is little or no rainfall. Small-holder farmers also usually lack access to markets where they can trade their products. Small-holder farmers also, in some cases, do not get government assistance from their respective national administrations.

Small-holder farmers in Makhado Municipality, Limpopo Province, who live in an area that is marginal for agriculture, are vulnerable to drought. Although they have water supply and irrigation structures in place, farm in areas of land that is not steep, have efficient early warning systems and do not lack human capital skills, their situation is being aggravated by a range of other complex stresses. This research seeks to assess these complex stresses, which 'make' these small-holder farmers vulnerable to drought. The research also seeks to come up with adaptation strategies that may reduce small-holder farmers' vulnerability to drought. Purposive sampling, where farmers were interviewed by the researcher from various villages in the municipality, was undertaken in this research. Data were collected through structured social surveys in the form of "open-ended" questionnaires. The area of study comprises villages, where subsistence farming is one of the most economic activities, with farms most located on the banks of the river (Nzhelele Rivers).

Climate variability, lack of financial capital and erosion of coping strategies were found to be some of the most limiting factors to Makhado Municipality's small holder farmers. An inefficiency and prompt provision of adequate water resources by relevant authorities,

inefficient utilization of water resources, in some cases, and limited scope to engage in alternative activities are shown to exacerbate small-holder farmers' vulnerability to drought in Limpopo Province.

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ABBREVIATIONS

AFRA- Association for Rural Advancement

DA- Department of Agriculture

DEAT- Department of Environmental Affairs and Tourism

DLA- Department of Land Affairs

DWAF- Department of Water Affairs and Forestry

FAO- Food and Agricultural Organization

GDP- Gross Domestic Product

IGBP- International Geosphere-Biosphere Programme

IPCC WG1- Intergovernmental Panel on Climate Change Working Group 1

IPCC WG2- Intergovernmental Panel on Climate Change Working Group 2

ISDR- International Strategy for Disaster Reduction

SADC- Southern Africa Development Community

UNCCD- United Nations Convention to Combat Desertification

UNDP- United Nations Development Programme

CHAPTER ONE

BACKGROUND OF THE STUDY

Introduction

This Chapter gives an account of what drought is, its effects and how climate variability in general has affected certain areas and a variety of enterprises and activities across the globe. Examples of previous droughts and vulnerability to drought in the African continent (particularly Southern Africa) is assessed. The vulnerability of small-holder farmers in Makhado Municipality (Limpopo Province), which is the study area or area of focus in this research, is also introduced.

Background of the study

Worldwide, around 800 million people are currently undernourished, and this number will probably grow as our climate changes (Devereux and Edwards, 2004). Food supplies have increased substantially in the world, but periods of drought can exacerbate a range of factors that together may prevent basic food needs from being fulfilled (Food and Agricultural Organization, 1996). Despite impacting on GDP and national food security (Benson and Clay, 2000), droughts also usually hinder small-scale farmers who are trying to ensure food supplies to their families.

The world's economic future depends on a stabilized climate and a worldwide effort to raise water productivity (Earth Policy Institute, 2004). Climate has always been dynamic and it varies across scales, both temporally and spatially (Ribot *et al.*, 1996). Current concern for climate has arisen because of the unprecedented pace and the extent to which expected changes in climate affect human and environmental systems (IGBP, 2002; Ribot *et al.*, 1996). Alley *et al* (2007) indicate that the global concentration of carbon dioxide has increased from a pre-industrial value of about 280 ppm^3 to 379 ppm^3 in 2005. The global atmospheric concentration of methane has increased from a pre-industrial value of

about 715 ppb to 1732 ppb in the early 1990s, and is 1774 ppb in 2005, while the global atmospheric nitrous oxide concentration increased from a pre-industrial value of about 270 ppb to 319 ppb in 2005 (Alley *et al*, 2007). The increase in concentration of these gases has effects on climate, which consequently impacts on human and the environmental systems. In this report, parts of southern Africa are also shown to be potentially at increased risk to changes in precipitation, including areas that are expected to experience reductions in precipitation.

Climate change or variability is expected to disapportionately impact developing countries, whose economies are closely tied to climate sensitive sectors like agriculture and which are already facing multiple stresses due to population growth, urbanization, industrialization, and globalization (McCarthy *et al*, 2001). In the tropics and sub-tropics, where some crops are near their maximum temperature tolerance and where rainfed agriculture dominates, yields are likely to decrease for even small changes in climate, which could lead to an increased risk in adequate food supply. Alley *et al* (2007) indicated that from 1900 to 2005, drying has been observed in Sahel, the Mediterranean, southern Africa and parts of southern Asia. Precipitation is highly variable spatially and temporally. More intense and longer droughts have been observed over wider areas since 1970s in the tropics and subtropics (Alley *et al*, 2007) and may increase in future (Alley *et al*, 2007) particularly for southern Africa.

Since the IPCC WG's first report in 1990, assessed projections have suggested global averaged temperature increases between 0.15 and 0.3 ^{o}C per decade for 1990 to 2005. The more recent report also concluded that:

- "Snow cover is projected to contract. Widespread increases in thaw depth are projected in the most permafrost regions;
- Sea ice is projected to shrink in both the Arctic and Antarctic seas;
- It is very likely that hot extremes, heat waves and heavy precipitation events will continue to become more frequent;

- Based on range of models, it is likely that future tropical cyclones will become more intense, with larger peak wind speeds and more heavy precipitation; and
- Extra-tropical storm tracks are projected to move poleward, with consequent changes in wind precipitation and temperature patterns, continuing the broad pattern of observed trends over the last half-century (Alley *et al* , 2007, 16)."

Climate variability affects all countries in different ways. For some countries the problems occur with variability in rainfall, others with temperature, snow pack and varying evaporation rates (Glantz, 1992). Climate variability is common throughout Africa (Lindesay, 1988). Extremes in rainfall are the most damaging aspects of climate variability occurring in the form of floods and droughts (Kates *et al*, 1985). This research focuses on vulnerability to drought, which is one of the consequences of climate variability in Makhado Municipality. Drought is considered to be the most complex but least understood of all consequences of climate variability, affecting more people than any other meteorological phenomenon in a sustained manner over time (Wilhite, 2000). It is a normal feature of climate and its recurrence is inevitable. However, there remains much confusion about its characteristics. Drought differs from other natural hazards or consequences of climate variability in several ways. Its effects often accumulate slowly over a considerable period of time and may linger for years after the termination of the drought event (Wilhite, 2000).

Drought usually results from a deficiency of precipitation from normal (long-term average rainfall amounts) that, when extended over a season or especially over a long period of time, is insufficient to meet the demands of human activities (Wilhite, 2000). All types of drought usually originate from a deficiency of precipitation that result in water shortages for some activity (such as crop production) or for some group (such as farmers). Droughts differ from one another in three essential characteristics: intensity, duration and spatial coverage (Wilhite, 2000). Other climatic factors such as high temperature, high wind, and low relative humidity are often associated with drought in many regions of the world and can significantly aggravate its severity (National Drought Mitigation Centre, 2006).

Periods of climate variation are a tragic interruption to the development process (World Bank, 2005). Lives are lost, social networks are disrupted, and capital investments are destroyed (World Bank, 2005). Disaster losses include not only the shocking direct impacts such as loss of life, housing, and infrastructure, but also indirect impacts such as the foregone production in utility services, transport, labor services, suppliers, or markets. Secondary losses impact on macroeconomic variables such as economic growth, balance of payments, public spending, and inflation (World Bank, 2005). Drought, for example, usually produces manifold impacts that usually extend across many sectors of the economy and go beyond the areas experiencing physical droughts (Vogel, 1994; Thompson, 1997).

The severity of drought and associated impacts also depends on the vulnerability of the particular area, including both the physical and socio-economic vulnerability to drought. This includes people's income status and factors such as the topography of the area (Asian Wildlife Unit, 2002). Often the poorest in rural areas occupy the most marginal lands, forcing them to rely on highly vulnerable livelihoods in areas prone to droughts, floodings and other hazards. Developing countries also lack the financial and technical resources to effectively defend against period of climate variation (McCarthy *et al*, 2001). Thus, regions and communities that are unable to cope with current climate hazards are also likely to be the most poorly equipped to cope with adverse impacts of climate change (Brooks and Adger, 2003).

Assessments of risks to drought and impacts of drought therefore require careful and rigorous analysis of a range of factors. Short-term, sudden 'disasters' can result in a very different spread of risks and consequences as those associated with a 'creeping', longer-term hazardous situation. The magnitude of drought costs is assumed to be less than that of other natural hazards because the losses associated with other natural hazards are more starkly evident and are generally incurred during short periods of time. In contrast, drought losses are generally distributed over longer time periods (Walker *et al.*, 1991). Losses from drought usually result from crop yields, pasture deterioration and livestock deaths, and poor production of most agricultural products. Additional direct financial

losses result from the transport of emergency food supplies for humans and animals, establishment of emergency water supplies either by additional boreholes for immediate use or surface-water storages for future use. Indirect losses are difficult to evaluate but would include losses from crops not planted and production from animals not conceived. Other losses include the abandonment of land, changes in land use following drought, and administrative costs resulting from the agro-economic and meteorological planning for alternative land use (World Meteorological Organization, 1975). The length of a drought also has a significant effect on the overall total costs; with long droughts usually being more costly than shorter droughts. A sustained drought can also have economic and social costs that are never quantified and remain 'hidden' (Walker *et al.*, 1991).

Although the primary drought losses directly affect agricultural and pastoral industries, the cost of drought is usually spread over the whole nation when the government makes relief grants to primary industries, assists with transport of fodder of livestock, constructs emergency water reservoirs. The general price of food stuffs usually rises due to shortage of food and imports from foreign countries. This can also result in negative ripple effects across an economy (World Meteorological Organization, 1975). The aggregated indirect costs are probably far greater than the direct costs, but because of their diffused nature they are difficult to identify and quantify and, thus, generally go unrecognized (Yevjevich *et al*, 1978).

Direct impacts of drought may be determined by comparing indicators before, during and after the event (Garcia, 1981; Hall, 1983). This can be done by comparing the concurrence of fluctuations and impacts against other variables that may have produced such coincidence. For example, farm production and income, although not linked in the broadest sense by climate may also be linked by factors such as market price (Vogel, 1994).

According to Heathcote (1967); and Berg (1975), for example, impacts are not always negative and some positive spin-offs from the consequences of an extreme event may include heightened ecological awareness, the stimulation of innovative behaviour, greater

awareness of development needs, broadened contacts with donor nations and institutions and sustained financial assistance. These positive benefits are often generated at the peak of the event but they unfortunately tend to wane as better weather conditions return (Vogel, 1994).

Farming in many parts of Africa is a risky business because an essential input, climate, is highly variable (Arndt, 2000). In spite of this, agriculture represents a large share of the total economy for most of the countries in Africa (Arndt, 2000). As indicated earlier, droughts are very frequent and severe in many parts of sub-Saharan Africa and usually have negative impacts on people and economies. Drought affects many more people than any other disaster hazard in Africa. The extreme vulnerability to rainfall in the arid and semi-arid areas of the continent and the poor capacity of most African soils to retain moisture result in almost 60 percent of sub-Saharan Africa being vulnerable to drought and 30 percent being extremely vulnerable (Benson and Clay, 2000).

The worst droughts in Africa were those of the early 1900s, which affected east and west Africa alike (Gommes and Petrassi, 1996). They were followed by increasing rainfall amounts, but negative trends were observed again from 1950 onwards culminating, in West Africa, in 1984. Since then, starting in 1988, the sub-Saharan Africa region has recorded a series of good years (frequently accompanied by floods) (Gommes and Petrassi, 1996). The years from 1960 to 1969, for example, were among the wettest of the period, while the seventies and eighties mostly recorded lower rainfall. The years 1973, 1984 and 1992 were however poor, while 1963, and to a lesser extent 1989, were remarkable good years in that almost the whole continent experienced above- average conditions (Gommes and Petrassi, 1996).

The economies of most of the African countries rely heavily on the exports of rain-dependent agricultural products which are often seriously affected during the years of severe droughts (Ogallo, 1995). Since very little land in Africa is irrigated, variable rainfall translates into variable production levels. Rural inhabitants are often very poor and depend upon agriculture for subsistence and they are often on the receiving end of

natural disasters such as drought (Arndt, 2000). According to a study by the United Nations Development Programme (UNDP), while drought occurs in all continents, seven out of the 10 most vulnerable countries are in Africa, and include Somalia, Sudan, Ethiopia, Uganda, Chad, Mauritania and Mozambique (Mwaura, 2006).

In the southern African region drought is no stranger to locals (Table 1). Since 1991, Zimbabwe has been affected by a series of droughts. Zimbabwe is usually one of the countries that are most affected by drought due to its heavily dependence on agriculture, hydroelectricity and large water-consuming industries (Gandure, 2005). Drought in Zimbabwe (Gandure, 2005) is also aggravated by poverty, land degradation, unemployment and other macroeconomic factors such as low level of preparedness, lack of contingency plans, low strategic grain reserves and insufficient financial resources for importing food (Made, 2002). Insufficient, short rains severely affected the harvest in 1998, resulting in a critical food shortage (Gildea and Geleta, 1999). The 1992 drought in Zimbabwe was recorded as the worst drought in living memory. It was experienced throughout southern Africa (Maphosa, 1993). Zimbabwe had come to be known as the 'bread basket of Southern Africa' as a result of surplus harvests in most years since 1980. The drought of 1990s, however, transformed Zimbabwe from a food surplus position to a net food importer. For most of the year (i.e. February-December 1992) the citizens of the country lived from hand to mouth, i.e. food was consumed as fast as it arrived into the country by rail or road (Maphosa, 1993). The 1991-1992, drought which ravaged most of southern Africa, killed more than one million cattle in Zimbabwe (State of the Environment in Southern Africa, SADC, 1994).

In 2002, drought affected about 587,000 people in Mozambique, with 84,000 hectares where crops have completely failed (Southern Africa Documentation and Cooperation Centre, 2002). A study over the period 1960-1988 carried out by the National Institute of Meteorology in Mozambique showed that drought is a persistent phenomenon: every year there are periods of drought in some parts of the country, mostly in the southern and central regions (Aragon *et al.*, 1996). The last two severe droughts in Mozambique occurred during the 1982/84 El Niño (the largest El Niño of the century, with temperature

increasing by 3-4 °C) and the 1991/92 El Niño, the latter initiating the most prolonged El Niño (1991-1995) since record keeping began in 1877. The drought of 1982 to 1984 affected one-third of the country's population and eight of 11 provinces. The most seriously affected provinces were Inhambane, Gaza, and Maputo, in the southern region of Mozambique. The drought in Inhambane persisted into 1984. Since then, the annual rainfall in the southern region of the country has been less than the normal average. The drought of 1991 to 1992, which strongly affected both Mozambique and the entire southern African region, further aggravated the precarious living conditions of Mozambicans, who also were affected at that time by civil war (Aragon *et al.*, 1994)

Like many African countries, Botswana has also been affected by climate variability. It is faced with recurring droughts, which are the most common consequences of current climate variability. Droughts in Botswana are known to be the major risk factor for sustaining livelihoods. Statistically, one in three years is a drought year (Kruger, 1999). A major part of the country's food and economic security is therefore at risk. The poor population is likely to be the most vulnerable to drought (Mooka and Mokone, 1993), largely as a result of reduced ability to cope with drought (Babugura, 2005). Although drought has been a recurrent phenomenon in the country, its impacts have been largely absorbed. This is because other than the agricultural sector, the country also largely depends on mineral exportation. Its currency is also still one of the best in the continent.

South Africa is a dry country that experiences drought from time to time, particularly in provinces such as Limpopo and the North West (South African Government Information, 2005). Severe droughts, for example, were experienced in 1926, 1933, 1945, 1949, 1952, 1970, 1983 and 1992 (Rouault and Richard, 2002). Recently in 2003, drought was experienced in several of the major crop-producing regions of north South Africa - e.g. Limpopo Province. Seven Limpopo districts were declared vulnerable to climate variation. The seven districts received emergency funding for subsistence stock farmers (Oltman, 2003).

The seven-month drought in South Africa in 2003 affected the entire northern side of the country (Oltman, 2003). Below-normal rainfall has led to soil moisture deficits in the maize-growing regions of South Africa. This was a huge setback since South Africa has been a significant source of maize for the other countries in southern Africa (Barlow *et al.*, 2003). Not only were the crop farmers affected, stock farmers were also affected as animals died in large numbers over the parched farmlands of Limpopo, Northern Cape, Eastern Cape and KwaZulu-Natal. Most of the aquifers supplying wells and farm dams which are the major sources of water for most of the farmers dried up. Lake St. Lucia's estuary silted up and the lake's level was the lowest ever known in recorded history (Oltman, 2003). Everywhere, except in the Western Cape, farmers were being forced to slaughter their livestock herds by the tens of thousands. The game reserves, some of the top income-producers from tourism, had to spend small fortunes buying fodder with which to feed their wildlife. Thousands of crop farmers have been unable to plant because of the drought (Oltman, 2003). In the Northern Cape and KwaZulu-Natal, tribal subsistence farmers were even cutting the grass from the heavily-polluted curbsides along highways in a desperate measure to keep their animals alive. This usually contains many plastic bags and other toxic pollutants rather than grass, and since ingested plastic bags also coat the stomachs of livestock, stopping their ability to ingest food, the end result was that the animal slowly starved to death (Oltman, 2003).

Table 1: Historical overview of drought and rainfall patterns in Southern Africa

Source: State of the environment in Southern Africa, SADC, 1994

1800-30	Southern African rivers, swamps and other water sources dried up. Some well-watered plains turned to semi-arid vegetation.
1820-30	This was a decade of severe drought throughout Africa.
1844-49	Southern Africa experienced five consecutive drought years.
1870-90	This period was humid in some areas and former Lake Ngami, in the northwest of Botswana, was full.
1921-30	Severe droughts in the region.
1930-50	Southern Africa experienced dry periods alternating with wet ones, and in some years the rains were very good. The 1946-47 season experienced a severe drought
1950s	There was abnormally high rainfall in some parts of the region.
1950s	East Africa experienced flooding, and Lake Victoria rose by several metres. Elsewhere, the equatorial region experienced below normal rainfall.
1967-73	This six-year period was dry across the southern African region.
	The equatorial region experienced above average rainfall.
1974-80	This period of six years was relatively moist over much of southern Africa. In 1974, the average annual rainfall was 100 percent above normal throughout the region.
1981-82	Most of southern Africa experienced drought.
1982	Most of sub-tropical Africa experienced drought.
1983	This was a particularly bad drought year for the entire African continent.
1985	Conditions improved.
1986-87	Drought conditions returned.

The Limpopo River Basin generally experiences short rainfall seasons, except for some few areas of the basin that have higher rainfall and longer seasons (Food and Agricultural Organization, 2004). The rainfall concentration is 60% and above, and this limits crop

production because most of the annual rainfall received within a very short space of time (Food and Agricultural Organization, 2004).

Before 1992, drought response in Limpopo focused primarily on mitigating the impact on the industrial and commercial agriculture sectors by the government of the time (AFRA, 1993). Not much was done to reduce the impacts on the economically impoverished communities of the rural areas. The response was however based on relief than mitigation strategies. South Africa has addressed many of these challenges by putting in place policies and institutions. Before 1994, the commercial farming districts came under the jurisdiction of national drought relief schemes. Farmers in the communal area (small-holder farmers) of old 'homeland' regions were assisted by special drought relief schemes implemented by respective governments (Food and Agricultural Organization, 2004).

During the 1991/92 drought, the Water Supply Task Force assisted in providing emergency water supply by means of tankers to 950 communities. The force also repaired existing water infrastructure, installed 800 emergency pipelines, drilled more than 5000 new boreholes, protected springs, and installed packaged water treatment plants. The Nutritional Task Force coordinated transport and distribution of food, while public works programmes facilitated job creation to stabilize household income. Various state structures were involved at local and regional level in drought relief (Food and Agricultural Organization, 2004). However, serious problems surfaced in the implementation of the drought relief activities. Some of the problems were; lack of funding, complicated geographical jurisdictions, poor coordination, lack personnel, lack of drought relief experience, poor community relations and rigid top-down approaches (Food and Agricultural Organization, 2004).

Recent investigations in 2004 indicate that Nzhelele River basin, which is one of the river basins in Makhado Municipality (others include Mutshedzi and Luvuvhu) is one of the most water-stressed catchments in the Limpopo Water Management Area (South African Government Information, 2005). Besides irrigation, Nzhelele Catchment also caters for

other uses such as recreation, environment, forestry, brick making and industries, which are also important livelihood sources. The water requirements in Nzhelele Catchment are as follows:

- Irrigation- 42 million cubic metres per annum
- Rural- 4 million cubic metres per annum
- Afforestation- 1 million cubic metres per annum
- Urban- 0.2 million cubic metres per annum (DWAF, 2004). The mean annual runoff (MAR) in Nzhelele River is 113 million cubic metres (Food and Agricultural Organization, 2004).
- At the downstream of the Nzhelele River is Nzhelele Dam which is mainly used for irrigation of commercial farms.

Small-holder farmers in Makhado Municipality have been trying to adapt to drought although with limited resources for a long time (Gwanya, 2004). Low levels of rainfall in some areas resulted in families having difficulties in ploughing maize and vegetables for the period 2001-2003. Many families in the municipality depend on planting their own foods, as they cannot afford to buy foods. Grazing of livestock has also become more of a problem (Gwanya, 2004). Limited resources, coupled with low levels of rainfall and high temperatures, result in small-holder farmers in Makhado Municipality being vulnerable to drought.

As will be shown in this study, a number of interacting factors are either enhancing or constraining local farmers in Limpopo to better 'live with' climate variability- including periods of droughts. Previous assessments, for example, have shown that the majority of small-holder farmers in Makhado Municipality often abandon their fields when there is not enough rain and water in the rivers to sustain their crops for the entire season (Gwanya, 2004). The crops often will wilt due to lack rain (Gwanya, 2004). Due to their income status they are not able to access ground water (Gwanya, 2004). Even if they could, the necessity of doing so is always questionable considering the smaller areas of farming that they have. Some are, however, more fortunate to be farming near rivers hence they can extract water through small generators and canals. It is, however, still

difficult for some farmers to raise the money for fuel, generators and pipes. Stock farmers are often left with no choice but to sell some of their cattle for a very low price in periods of drought when there is not enough pasture. In some instances, they are forced to kill their livestock herds (Oltman, 2003). They also do not have alternative land for pasture and they cannot afford to purchase supplementary feed in the form of lurcene and hay.

* * * * *

Climate variability affects all countries in different ways. It is common throughout Africa with extremes of rainfall in the form of floods and droughts being the major concern. Drought affects many more people than any other disaster hazard in Africa. This can be attributed to the continent's climate and hydrological regimes that are marginal for agriculture and the inability of most of African farmers to generally cope and adapt to the effects of climatic variability. Similar to farmers in most African countries, small-holder farmers in Makhado Municipality, have always been 'living' with *the consequences of climate variability such as drought, with certain severe droughts forcing them to abandon their fields and also sell their livestock. In the next Chapter, an overview on drought, the dimensions of drought and the range of interacting factors that enhance or reduce risks to drought are introduced.*

CHAPTER TWO

AN OVERVIEW ON DROUGHT

Introduction

In this Chapter the types, causes and impacts of drought are described. External and internal factors enhancing vulnerability to drought are also discussed. Factors either enhancing or reducing vulnerability to drought are described. Some drought mitigation and coping strategies are also identified and examined. This Chapter also outlines some of the typical drought response programmes that are being employed to fight drought in Africa.

Types of drought

As indicated in Chapter One, drought is usually described as a 'creeping' phenomenon. Droughts are however, seldom the result of one factor and are usually the product of a range of 'driving' mechanisms. There are four types of drought, namely: meteorolological, agricultural, hydrological and socioeconomic (Thinkquest, 2005). Meteorological drought refers to the amount of dryness and the duration of the dry period (Thinkquest, 2005). Atmospheric conditions that result in deficiencies of precipitation change from area to area. Agricultural drought mainly affects food production and farming. This type of drought cause soil moisture shortages and that badly affects the germination and growth of crops and pasture (Thinkquest, 2005). Hydrological drought is associated with effects of periods of precipitation shortages on water supply. Water in storage systems such as reservoirs and rivers are most of the times used for multiple purposes such as flood control, irrigation, recreation, hydropower and wildlife habitat. Competition for water in these storage systems increases during drought and conflicts between water users increase significantly (Thinkquest, 2005). Socioeconomic drought occurs when the demand for economic goods exceeds supply as a result of weather-related problems such as insufficient precipitation. The supply of many economic goods

such as water, forage, food grains, fish and hydropower, depends on weather. Due to variability of climate, water supply is sufficient in some years but not enough to meet human and environmental needs in other years (Thinkquest, 2005). When this happens, socioeconomic drought is considered to be taking its course.

Causes and impacts of drought

Climatic factors in the form of shortage of rainfall, as indicated in Chapter 1, over a long period of time is the major cause of drought. Poor land use practices, such as overgrazing, over-cultivation and poor irrigation are human factors that exacerbate the impacts of drought. Impacts of drought can be direct or indirect and can be listed as economic, environmental and social (International Union for Conservation of Nature and Natural Resources, 1998). Economic impacts of drought are experienced in agriculture and related sectors such as forestry and fisheries. The main reason is that these sectors usually rely heavily on surface and subsurface water supply. In addition to obvious losses in yields in both crop and livestock production, drought is also usually associated with increases in insect infestations, plant disease, extinction of both plant and animal species and wind erosion. Problems of insect infestations and plant diseases can also be experienced in forestry. The major social impacts of drought include human death or starvation, nutrition related diseases and migration to areas with favourable climatic conditions (International Union for Conservation of Nature and Natural Resources, 1998).

Vulnerability to drought

In addition to some of the more biophysical dimensions of drought, there are also a suite of factors that can further enhance the risk to droughts. In the literature these have been identified as 'vulnerabilities' to a phenomenon (Ziervogel *et al*, 2006). Most definitions of vulnerability include the idea of potential damage or adverse impacts in relation to a stress, a process or an event (O' Brien and Vogel, 2004). Vulnerability is a relative term, and within any society or community, some members tend to be more vulnerable than

others. While a community might face the same risks, all members will, however, not be equally vulnerable to such risks. The meaning and interpretation of vulnerability, moreover, tend to differ across societies and contexts, depending on particular values. For example, vulnerability to climate variability in a wealthy coastal resort will be different to a densely populated housing development vulnerable to a range of stresses in a flood zone. To the former, vulnerability will be expressed in terms of insurance payments and infrastructure losses. To the latter, it will be expressed in terms of lives lost and hunger. The identification differential elements of vulnerability is therefore important to improve the formulation of policies that will promote equitable and sustainable development (O' Brien and Vogel, 2004) and potentially reduce vulnerability to drought.

Drought vulnerability is defined as that property or characteristic of an area that increases the inherent or intrinsic probability of hydro-agricultural droughts, resulting in out-migration, crop failure, livestock distress, water shortage, etc (National Drought Policy Commission Report, 2000). Several factors go into the making of a drought, including ecology, production conditions, socioeconomic conditions, etc. The ability of the people and the land to withstand rainfall, hydrological and even agricultural deficits depends to a large extent on their status preceding the event or series of events of rain shortfalls. This status is, in turn, determined by a large number of factors (National Drought Policy Commission Report, 2000).

Both the societal and physical characteristics of vulnerability to drought reinforce or complement each other. Physical characteristics associated with vulnerability include hydrological and climatic regimes that are marginal for agriculture (crop and stock farming), highly seasonal hydrological regimes that are strongly dependent on seasonal rainfall, topography and land use patterns that promote soil erosion, sedimentation, etc (Asian Wildlife Unit, 2002). Societal characteristics associated with vulnerability include poverty and low income levels, conflicts, wars and pandemics, high dependence on rain-fed systems, lack of water control infrastructures which are important for water supply security and irrigation, etc (Asian Wildlife Unit, 2002).

Although there are clearly a range of complex, interacting factors, some are briefly described below to give a flavour of the causes and potential impacts and vulnerabilities of drought vulnerabilities.

External factors enhancing vulnerability

Climate

The degree to which a population or community will be impacted by drought depends on its response options and the degree of its vulnerability (Benson and Clay, 2000). The more directly dependent a population is on the natural resource base, the greater their vulnerability to a disruption in the productivity of that natural resource base. This scenario is particularly true of drylands, which are occupied by some of the most ecologically and politically marginalized populations on the globe. In the drylands, the most limiting natural resource is water, and therefore an extended disruption in rainfall can trigger a crisis, and sometimes even famine on a catastrophic scale (Patrick, 2003). Climate or rainfall has a greater influence on the lives of poor populations who depend on agriculture for livelihood and sustenance. Due to climate variability, those people lack secure access to water and food. The year to year variability of rainfall is a significant constraint to the sustainability of farming systems in poorer countries of the tropics (Dercon, 2004).

In the face of climatic uncertainty, risk-averse farmers usually employ conservative strategies, including avoidance of improved technology, underuse of fertilizers and shifting from productive to non-productive liquid assets. In sub-Sahara Africa, where soil nutrient depletion is now recognized as a root cause of declining per capita food production and a critical constraint to sustainable livelihoods (Stoorvogel and Smaling, 1990; Sanchez *et al.*, 1997), the apparent effect of climatic uncertainty on investment in soils (Bliss and Stern, 1982; Binswanger and Sillers, 1983) is a particular concern. These strategies that are designed to prevent climatic extremes, substantially reduce average income and marginal productivity of assets and negatively affect the poor (Rosenzweig

and Binswanger, 1993; Zimmerman and Carter, 2003).

Since rainfall or climate cannot be altered, using advance climate information through effective Early Warning Systems is arguably the most concrete step that the agricultural enterprise can take to build resilience to long-term changes in the global climate system (Hansen, 2005). With this information, a community can consider various response options in advance. Some of the response options are planting alternative crops such as soybeans, peas and sorghum which do not require a lot of water, alternative livestock such as ducks and chicken, culling of old cows that will not survive drought, engaging in home based enterprises such as sewing projects and crafts (Bell, 2002). A community with these response options will be less vulnerable to drought.

Topography and land use

To minimize the impact of drought, soil needs to capture the rainwater that falls on it, store as much of that water as possible for future plant use, and allow for plant roots to penetrate and proliferate (Food and Agricultural Organization, 2004). Soil loss due to water erosion reduces crop yields. Steep slopes and long, uninterrupted slopes are especially prone to water erosion. This increases vulnerability of the particular area to drought. The area does not retain a lot of moisture after rainfall or irrigation. Farm management decisions should consider the potential for erosion under different practices, especially on land that is marginal for annual crop production. Areas at high risk for erosion due to steep slopes or erodible soils may be better suited for forage production or grazing. Steeply sloped lands under cultivation can be converted to permanent cover to minimize erosion. Wooded areas with poor soils and steep slopes can be left in their natural state and managed profitably as woodlots. Alternative land uses can conserve the soil and have environmental benefits, while remaining profitable to the farm operation (Abday, 2001).

Sedimentation

Sedimentation is the deposition of eroded material in waterways (i.e. rivers, lakes and oceans) (Jensen and Beheim, 2005). It is one of the more insidious consequences of erosion. When sediments begin to accumulate in rivers or streams, the effective volume of materials flowing through the channel is increased. Once this has begun to happen flooding is likely to become a problem. High rates of sedimentation lead to reduction of surface water resource storage. Suspended sediments usually contain fertilizers, and when they are introduced into a waterway, the concentration of available nutrients in that system will increase, resulting in a condition known as eutrophication. High concentration of nitrogen or phosphorous leads to algal bloom, and this also reduces the storage capacity of a water body (Jensen and Beheim, 2005).

In Kaziba Village in the Kivu province of the Democratic Congo, formerly Zaire, agriculture and deforestation in steep hills have caused severe sedimentation in the river. The situation is out of control, the erosion process is about to devastate a large area of top quality agricultural land. The storage capacity of the river have been reduced in a manner that very few farmers can draw water from the river and this makes them vulnerable to natural disasters such as floods and droughts (Jensen and Beheim, 2005). Apart from farming in steep areas and deforestation, sedimentation is also influenced by natural disasters such floods and fire.

Internal factors enhancing vulnerability

Internal factors enhancing vulnerability are a host of factors that drive internal vulnerability. These factors are usually coupled to several societal factors.

Income levels

Vulnerability to drought, as described above, is complex, and yet essential to understand in order to design drought preparedness and mitigation strategies and relief policies and programmes. In general, the poorer the household or a society, the fewer the options it

can afford in terms of response (Benson and Clay, 2000). With different farming types such as large commercial, small-scale and subsistence type of farming, household vulnerability is usually differentially experienced, with each household too patronizing responding to drought in diverse ways (Benson and Clay, 2000). Different categories of farming and household types may thus share the same physical, climatological and institutional characteristics. They often share the same resources (water and land) and need to be developed and managed through integrated programmes (i.e. river catchment management), cooperative, institutional and community participation (i.e. disaster management centers) and intergovernmental monitoring and risk management programmes but they usually differ significantly when it comes to income levels, social coping mechanisms, etc (Benson and Clay, 2000).

Farmers in most developing countries (and some developed countries) usually do not have sufficient income to respond to drought and their regions are experiencing subsequent droughts. For example, Ethiopia's millions of small-scale farmers remain rooted in subsistence agriculture. They are almost entirely dependent on the weather, and the country is prone to drought three to four years out of every ten. The average annual income in Ethiopia is only about US$100 per person. Due to their income status, these people have very few response options to drought (International Food Policy Research Institute, 2003).

Income, however, is not the only limiting factor to effective response and hence a much more detailed and nuanced investigation of differential vulnerability is required. Other interacting factors also require investigation including water dependence, capital skills and access to resources.

High dependence on rain-fed systems and lack of water supply and irrigation structures

The majority of land users in sub-Saharan Africa and Southern Asia depend on rainfall for their livelihoods (i.e. green water), not on irrigation. This is because a large proportion of the arable land is located in water scarce areas subject to recurrent dry

spells. In most cases the land users in these areas do not have sufficient income to afford water supply infrastructure such as boreholes. Even the amount of ground water in such areas is often low because there is no constant recharge in the form of rain (Stockholm International Water Institute, 2001). In these areas it is essential to mobilize communities to work towards implementing soil and water conservation measures developed by scientists for the rainfed areas. For example:

- "Integrated watershed management should be adopted for conserving water and using it efficiently through rainwater harvesting. Diversion of rainwater into dugout ponds, mini-percolation tanks, dry wells, sunken gully silt traps, water tanks and checkdams should be taken up under watershed development programs.
- Soil organic matter also needs to be improved in the long term. Nitrogen-fixing shrubs like Gliricidia and Leucaena can be grown on bunds to improve the water-holding capacity of the soil.
- Vermicomposting farm residues and weeds can add valuable organic matter to the soil. Earthworms both improve fertility and increase water-holding capacity of the soil.
- Balanced and integrated use of nutrients and environment-friendly pest management options can increase the productivity of rainfed agriculture through efficient use of conserved soil and water resources.
- Increase green cover with suitable plants.
- Use improved varieties that resist pests and tolerate drought.
- Educate farmers on appropriate soil and water conservation technologies.
- Establish community-based systems for water resources auditing and use at village level to avoid over exploitation of groundwater.
- Desilting existing water harvesting structures to increase storage capacity. The silt can then be used as a valuable source of plant nutrition (The International Crops Research Institute for the Semi-Arid Tropics, 2002, http://www.icrisat.org/media/2002/media1.htm)."

Lack of human capital skills for agricultural sector

Lack of human capital skills in the agricultural sector is also one of the biggest problems in African countries frustrating not only overall development but also overall coping and adaptive capacities (United Nations University, 1997). It has been found that there is low extension officer to farmer ratio in the region (SADC), limited transport and housing facilities of extension officers and this is undoubtedly affecting local coping capacity of farmers because of poor support mechanisms. Lack of human capital skills also has a negative impact on agricultural interventions (Gandure, 2005). Without human capital skills, e.g. trained agricultural officers, farmers are unable to cope with drought due to lack of information. Although they apply local coping mechanisms, they also need appropriate strategies to reduce the effects of drought. A recent study in six countries of the Sahel (Burkina Faso, Mali, Mauritania, Niger, Senegal and Chad) (Lindley *et al.*, 1996), for example, shows that there are notable problems in the agricultural education systems of these countries. The following problems were found to be common to all:

- "Low internal efficiency rates (i.e., low output of graduates in relation to student capacity due to high drop-out and failure rates),
- Low quality of education, and,
- Lack of relevance to the national rural development needs; and in some fields (Lindley *et al.*, 1996, http://www.fao.org/sd/EXdirect/EXan0008.htm)."

In the agricultural sector, both formal and non-formal educations are essential for improving food security and rural employment and reducing poverty. Formal agricultural education is needed for the production of skilled manpower to serve the agricultural sector through extension, research, entrepreneurship and commerce. Non-formal agricultural education, often provided by both public and private extension services, is needed for training of farmers, farm families and workers and for capacity-building in a wide range of rural organizations and groups. To meet the challenges of agricultural production and food security facing Africa today, countries must be willing to invest in their human capital for development (Lindley *et al.*, 1996).

Inefficient early warning systems

While responsibility is placed on farmers to plan for and survive droughts with minimum intervention from the states, greater emphasis on locally relevant early warning systems is also required (Monnik, 2000). Early warning involves the projection or prediction of the state of a hazardous phenomenon into the future, and then develop risk reduction strategies before the hazard actually occurs (Sinange, 2000; Chang-Ko, 2003; Mutua, 2003; and Vordzorgbe, 2003). Most countries in Africa operate agricultural and meteorological early warning programmes. Conventional and remote sensing techniques are used to monitor environmental, weather and agricultural information. At the national level, agriculture ministries, national meteorological and hydrological services undertake monitoring of key early warning parameters for drought and flood hazards (Sinange, 2000; Chang-Ko, 2003; Mutua, 2003; Vordzorgbe, 2003).

The survey undertaken by the International Strategy for Disaster Reduction (ISDR) in 2005 found that considerable progress has been made in developing the knowledge and technical tools required to assess risks and to generate and communicate predictions and warnings, particularly as a result of growing scientific understanding and the use of modern information technologies. Early warning system technologies are now available for almost all types of hazards and are in operation in at least some parts of the world (Third International Conference on Early Warning, 2006).

However, the experiences of the Indian Ocean tsunami, the hurricanes in the Gulf Mexico, and many recent phenomena, such as heat waves, droughts, famine, wildfires, floods and mudflows, show that there is a major gap in existing early warning systems. Early warning systems, especially in developing countries but not limited to such cases, lack the basic capacities, skills and resources to ensure provision of reliable information. Integrated systems for hazards such as tsunamis and landslides are often absent where information flows are tied more closely to users. The ISDR survey concluded that there are many shortcomings and the world is far from having a global system for all hazards (Third International Conference on Early Warning, 2006).

The major constraints facing the early warning systems in Africa are:

- "Unreliable data services, especially from the national early warning units,
- Lack of trained personnel that can manage the early warning systems,
- Poor communication facilities,
- Low level of community awareness and education, and
- Poor timeliness of information (Vordzorgbe, 2003, 3)."

According to Vordzorgbe, (2003) the way forward for the early warning systems in Africa can be summarized as follows:

- "Improve national and institutional capacities to receive satellite data;
- Enhance the capacity for early warning systems decision support tools and networks;
- Improve institutional arrangements for sustainability of the early warning systems; and
- Empower disaster managers at all levels to be able to use modern information technologies to access early warning systems products and information (Vordzorgbe, 2003, 3)."

Economic factors

Having highlighted some factors heightening vulnerability to drought attention now turns to examine some of the wider, structural drivers of vulnerability such as the role macro-economy and its influence on drought. Low-income countries are likely to be the most severely affected by drought. There is thus a more complex relationship between the effects of drought and the structure of a country's economy (Benson and Clay, 2005). Although the economic implications of a drought depend on a complex set of environmental and economy-specific factors, the available evidence also suggests that certain features of the economic structure, in particular the level of economic complexity, legacies of past economic policies e.g. structural adjustment (Eakin, 2006), are the most

important driving forces in determining drought vulnerability. In order to understand the structural features of an economy that mediate the effects of drought as a climatic and hydrological event, a classification has been developed to distinguish four country situations in terms of impact of drought. They are simple, intermediate, complex and dualistic economies (Benson and Clay, 2005). The impacts of drought are thus usually great in simple economies and the recovery is usually very slow. In intermediate economies, the effects of drought are usually spread more widely through the economy, reflecting greater overall integration and stronger intersectoral linkages between the agricultural and manufacturing sectors. Impacts are usually more easily absorbed in complex economies, partly because agriculture contributes a smaller percentage of total Gross Domestic Product (GDP), exports, and employment while food expenditure forms a smaller percentage share of total household expenditure. Finally, in dualistic economies, with large extractive, mineral sectors, unless the extractive sector is water intensive or consuming, the economic impact of drought is also limited (Benson and Clay, 2005).

Drought vulnerability is thus closely correlated with socio-economic conditions. Impacts of drought do not differ only on different economies of different countries but also differ on individuals of the same country. According to Eakin (2006), livelihood strategies represent adaptations. The way the households organize their lives can reveal a lot about their adaptive capacity- the sets of assets, skills, and opportunities that reduce vulnerability to variety of stresses (Eakin, 2006). As a rule, the poor suffer more from drought than the rich, although poverty and vulnerability are not always correlated. In developing countries, drought constitutes threats to livelihoods and the ability to maintain productive systems and healthy economies. In developed countries, drought poses significant economic crisis and costs for individuals, public enterprise, commercial organizations and governments (Downing and Bakker, 2000).

Developed countries are usually able to afford to invest in systems to mitigate drought and have strong institutional frameworks that effectively provide collective insurance to cope with drought. The majority of the population in those economies have livelihoods

that do not depend directly upon the amount of rainfall or the short term state of the environment. In a developing country a large percentage of dryland populations depend directly on the often degraded natural resource base and lack alternatives to which to turn to in times of drought and have limited social safety nets to ensure food security (Patrick, 2003).

Most African countries have simple economies. They are predominantly rain-fed agricultural and livestock semi-subsistence economies, with limited infrastructure, low levels of per capita income and high levels of self-provisioning in the rural population. The overall impact of drought is particularly great because of the relative importance of the agricultural sector (Benson and Clay, 2005). Most African developing countries can also not afford to give farmers subsidies and loans due their economic status. The majority of farmers in those countries do not get grants which will help them to recover from natural disasters such as floods, drought, winds and fire.

Other societal characteristics associated with vulnerability include lack of water supply and irrigation systems' planning and management, lack of appropriate and empowered institutions, absence of appropriate land use planning and management, high population densities and other factors that inhibit population mobility and societal security, increasing demands for water, inexperience of communities to cope with droughts and unwillingness of communities to live with some drought risks as a trade-off against beneficial services or goods (Asian Wildlife Unit, 2002).

Improved scientific understanding of vulnerability is therefore important, particularly if appropriate ways are to be found in order to reduce heightened vulnerability, and also to improve the understanding of how enhanced vulnerabilities may act as triggers to complex environmental feedbacks in the ecosystem. Vulnerability is directly relevant and applicable to a number of policy issues concerning human security and development. It can be used to identify areas and people at risk from both natural and man-made threats. It can also be useful in assisting in development planning, food relief efforts, and climate adaptation strategies (Vogel and O' Brien, 2004).

Drought mitigation and coping strategies (adaptation)

The identification of drought vulnerability, as shown here, is an essential step in addressing the issue of drought vulnerability in the state and can lead to mitigation-oriented drought management (Wilhelmi and Wilhite, 2002). Drought plans need to be included in drought policy of the particular country (Vogel, 1994). Drought plans and policy will be defined by the most pressing needs of the moment. Drought planning involves actions that are taken by citizens, industry, government and others in advance of drought for the purpose of drought impact mitigation (Wilhite, 1987). This is a factor that has been missed in almost all the drought strategies of Southern Africa (Vogel, 1994).

Drought planning can therefore include monitoring or appropriate early warning systems and operational assessment programs which are crucial for determining drought impacts, an institutional structure for co-ordinating government actions, financial resources, educational and public awareness programs (Wilhite, 1989). While such options are clearly essential, a range of other complimentary strategies should also be considered. Local knowledge and coping mechanisms that have been used over time can and must also be taken into consideration as they are invaluable during the planning and distribution of drought relief and mitigation strategies (Vogel, 1994). Local people have a great deal of knowledge about their environment, with indigenous coping methods well adapted to their local conditions (United Nation Convention to Combat Desertification, 2004).

Local knowledge is generally described as the knowledge that local people have developed in a given area over time and which they continue to develop (Scoones and Thompson, 1994; Warren, 1991). Therefore, such knowledge is not static and not limited only to the original inhabitants of an area, rather it is locally developed knowledge that continues to be developed over time (Grenier, 1998; Langhill, 1999; Warren, 1992). It is usually:

- "Based on experience and can include the influences of externally derived

knowledge;

- Tried and tested over generations and even centuries of use (although this is not necessarily always so, as in the case of recent farmer innovations which might have been practiced over a shorter period but could include some older indigenous pratices);
- Adapted to local environmental conditions and forms part of the local culture; and
- Dynamic and changes continuously (Warren, 1992, 10)."

Most resource-poor farmers in marginalized areas have thus been practicing various coping and adaptive mechanisms such as low-external-input agriculture for generations due to their typical location in remote areas, and did this in spite of non-existent or minimal support from research and extension services (Hart and Vorster, 2006). In many cases, local knowledge can prove to be more sustainable than short-term solutions dealing solely with drought response (United Nation Convention to Combat Desertification, 2004).

It is widely assumed that poverty is an unavoidable consequence of climate change such as drought. For centuries, however, local knowledge has provided Africa's peoples with practical solutions to the problems of a fluctuating climate. As an example, the Maasai pastoralists of northern Tanzania and southern Kenya traditionally know where to find water and green shrubs that can be fed to young calves, even during long periods of drought (Burford *et al.*, 2003). Other livestock coping mechanisms to drought consist of herd diversification, herd splitting and migration and supplementing grazing with other sources of feed such as shrub or tree fodder and crop residues (Burford *et al.*, 2003).

In Ethiopia, the country often regarded as inevitably dependent on Western aid, the threat of famine is often overcome by the use local knowledge (Seabrook, 1993). There is a wild plant that grows on the Somali border, under the driest conditions, less than 200 mm of rain a year. People go to mountains and pick it and survive the recurrent droughts because it is rich in moisture (Burford *et al.*, 2003).

Shifting cultivation was a traditional practice in which land was never over used or repeatedly cultivated season after season and year after year. Land was left to rest and covered again with plants and leaves to enable it to accumulate vegetable manure. Mixed crop cultivation practice enables leguminous crops to restore nitrogen in the soil for other food plants. Knowledge of when to expect long or short rainy seasons enables the farmers to plan appropriately which crop is suited for a particular season. Traditional knowledge terminologies of types of soil and their reaction to water enables the people to use each type of soil appropriately by planting the correct crops (Kamara, 2004). Other useful indigenous agronomic practices include terracing to ensure that at least some of the fleeting rain showers would be caught, contour bunding, fallowing, organic fertilizer application and crop rotation. Indigenous soil and water conservation and antidesrtification practices are also useful in coping with droughts (Hart and Vorster, 2006). Rain water used to be stored, channeled and concentrated onto favourable cropping sites. A variety of methods for food storage and preservation (drying, salting, parching, fermenting, smoking, and curing) were combined when stress was high, with dietary changes, and wild edible plants (often known as famine foods) were tapped (Dietz *et al*, 2000; Fleuret, 1986).

In Zimbabwe, a variety of storage structures for household food security have been used. The use of natural pest control system and inter-cropping methods is also common (Food and Agricultural Organization, 2000). Indigenous knowledge, in Sudan, has developed through time by indigenous people who use their knowledge to adapt with their surrounding environments by adopting compatible coping systems (Elsiddig, 1998).

According to Burford and others (2003), the greatest threat to the economic stability of the African continent is not its changing climate. Rather, it is the gradual erosion of indigenous local and the accompanying destruction of natural wealth - plants, animals, insects, soils, clean air and water - and human cultural wealth. This robs people of their ability to respond to social and environmental change, both by removing the resource base, and by attacking the foundations of human identity.

Mixed farming systems are also drought coping strategies that are being used in most countries to reduce the severity of drought, including the mixture of fruit trees, vegetables

and crops. Mixed farming systems ensures the continuous availability of food. The rate of crop and vegetable evaporation and wilting is also greatly reduced due to the shade cast by fruit trees (Singh, 2000). Irrigating the crops in the late afternoon or early in the morning also reduces the rate of evaporation. Mulching also prevents moisture from evaporating directly from the soil surface, and it can greatly reduce competition from weeds (International Crop Research Institute for the Semi-Arid Tropics, 2003). Development of groundwater in times of drought will reduce the stress placed on surface water systems. Diversification of income sources is another way of coping with drought. For example, women may engage in sale of embroidery or handicraft to generate household income (Singh, 2000). Slaughtering or sale of livestock and livestock products also earn farmers money to meet the demands of life (International Crop Research Institute for the Semi-Arid Tropics, 2003). Changing of diets and diet habitats is also a critical component of dealing with drought (Singh, 2000). For example, changing from maize or mealie to sorghum.

Drought interventions

Finally, the role of interventions to reduce vulnerabilities to drought require more detailed investigation. Typical drought response programmes that are being employed to fight drought include drought relief schemes, drought rehabilitation schemes and drought mitigation schemes. Drought relief schemes include general food aid to most affected households, supplementary feeding programmes for children, pregnant mothers, elderly and disabled and emergency water supply for people and animals. Drought rehabilitation schemes include seed-pack and fertilizer distribution, livestock restocking programmes, nutritional garden projects and subsidies and loans. Drought mitigation schemes include dam construction, small irrigation schemes and food storage programmes (Scoones *et al.*, 2005). These, however, are also constrained by various factors (e.g. financial flows) and on their own can be damaging and indeed further undermine resilience to droughts hence emphasis should be put more on improving coping mechanisms.

* * * * *

Climatic variability and change is the major initial driver of drought while a range of human factors tend to exacerbate its impacts. The main impacts of drought include loss of livelihoods, enhanced food insecurity and stress on social and biophysical systems. Areas that are marginal to agriculture are often occupied by people with low levels of income and this further exacerbates their vulnerability to consequences of climatic variability such as drought. Identification of drought vulnerability, drought planning, appropriate early warning systems, use of local coping mechanisms and drought response systems are argued here as being key to improving drought mitigation and adaptation strategies. The next chapter presents the past and current drought experience for Makhado Municipality (Limpopo Province) small-holder farmers. The research aims, objectives and sampling methods are also outlined.

CHAPTER THREE

DROUGHT IN LIMPOPO (MAKHADO MUNICIPALITY)- PAST AND CURRENT EXPERIENCE

Introduction

The Chapter begins by outlining some climate background to the country and area of study and some of impacts of past droughts experienced in South Africa. Thereafter, the location of Makhado Municipality, Limpopo Province, its economic activities, past and current drought experiences, are discussed. The research aims, objectives and sampling methods that have been employed in this research are also presented.

Drought in Limpopo (Makhado municipality) - Past and current experience

Water is a vulnerable resource in South Africa (Veiligheid, 2003). A relative dry or semi-arid climate prevails over large parts of the country, with an annual average rainfall of 497 mm. Rainfall declines from more than 800 mm per annum in the east to less than 200 mm per annum in the west. Rainfall variability is experienced and this variability increases as annual rainfall decreases. Approximately 65 % of the surface area receives rain of less than 500 mm per annum (Weaver, 1990) (Fig. 1). Rainfed cropping is feasible in areas that receive enough rainfall (i.e. more than 500 mm per annum). In such areas, rainfed cropping is undertaken on approximately 15, 8 million hectors. Given the variability of rainfall and regular occurrence of drought periods, irrigation is an important farming practice used to compensate for the lack of rain. Nonetheless, extended drought periods have far reaching social and economic impacts in both rainfed and irrigated areas. Variability of rainfall is quantified by a reduction in the annual growth of gross domestic product by as much as 30 % during a severe drought period (Backeberg and Viljoen, 2003).

About 15 million hectares, or 12 % of the land area is under cultivation in South Africa, while 10 % of the land is under intensive irrigation. Agricultural production has suffered several drought periods since the seventeenth century, and probably even earlier. The worst droughts recorded in history were experienced in 1926, 1933, 1945, 1949, 1952, 1970, 1983 and 1992 (Rouault and Richard, 2002). All droughts resulted in crop yield reductions and livestock losses (Mondo *et al.*, 2004). Higher levels of rainfall (more than 700 mm per year) in South Africa are normally received in Western Cape and Kwazulu Natal. The rest of the country is relatively dry (Mason and Tyson, 2000).

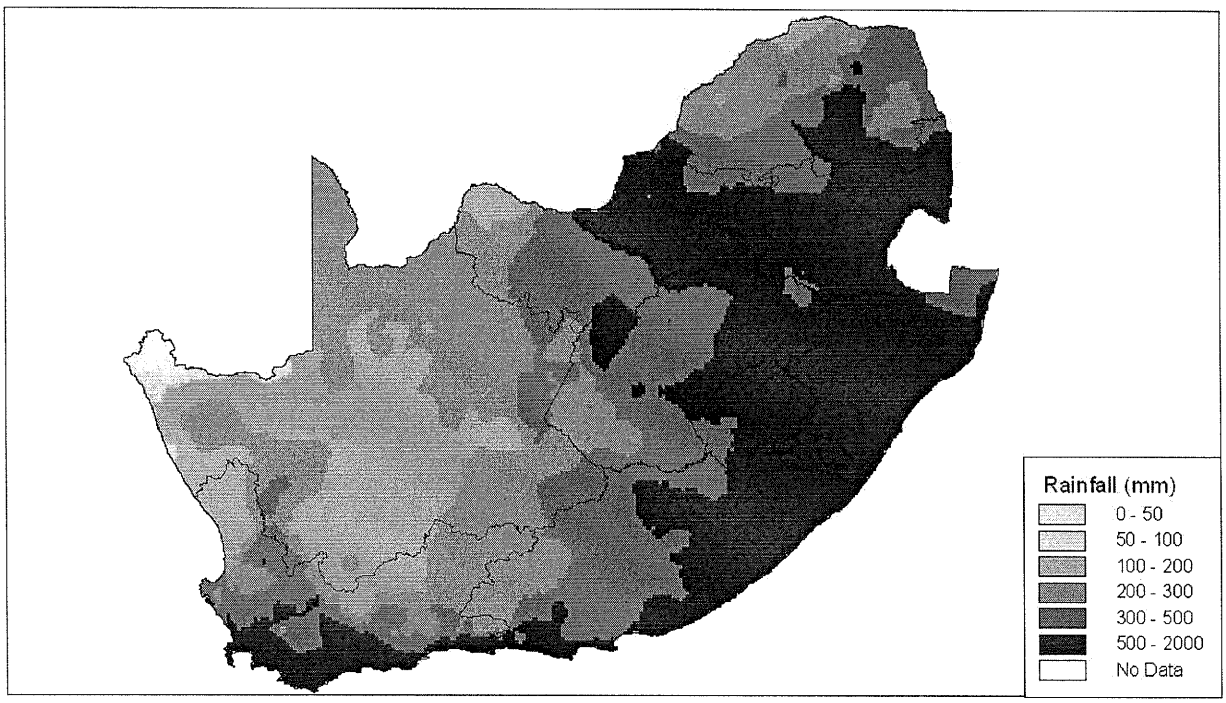

Figure 1: A map showing rainfall patterns for the season July 2004 to June 2005
Source: South African Weather Service, 2006,
http://www.weathersa.co.za/DroughtMonitor/DMDesk.jsp

In response to repeated drought, 'disaster states' are routinely declared. The President of the Republic of South Africa, for example, declared six Provinces as disaster zones in

2004, with as many as four million South Africans identified as at risk of food shortages due to a drought. The affected provinces were KwaZulu Natal, Eastern Cape, Mpumalanga, North West, Free State and Northern Cape. The most affected provinces were the maize growing regions of Free State, KwaZulu-Natal and Mpumalanga. In the Free State Province, the leading maize producer, only half of the usual crop had been planted by December. Limpopo Province was later declared a disaster area bringing the number of affected provinces to seven (Mondo *et al.*, 2004). Even at the time of completion of this report, parts of the country are reported to be experiencing drought (South African Weather Service, 2007).

With this as background, attention turns to the case study and the focus of this research. Located at approximately 100 km from Polokwane (formerly known as Pietersburg) (Figure 2), Makhado Municipality was first established on the 31st October 1934 as the Louis Trichardt Town Council. With the new municipal demarcations, a number of municipalities were established in 1997. In 1998, the municipalities were merged into a Northern Province 344 Makhado Municipality. It falls under the Vhembe District, which is one of six districts in Limpopo Province. Other districts are Eastern, Mopani, Capricorn, Waterberg and Sekhukhune. The Makhado Municipality includes the areas of Louis Trichardt, Nzhelele, Tshipise, Elim, Tshitale, Hlanganani, Levubu, Vuwani, Alldays, Buysdorp and Banderlierkop. Other municipalities in the Vhembe District are: Musina, Mutale and Thulamela (South African Government Information, 2005).

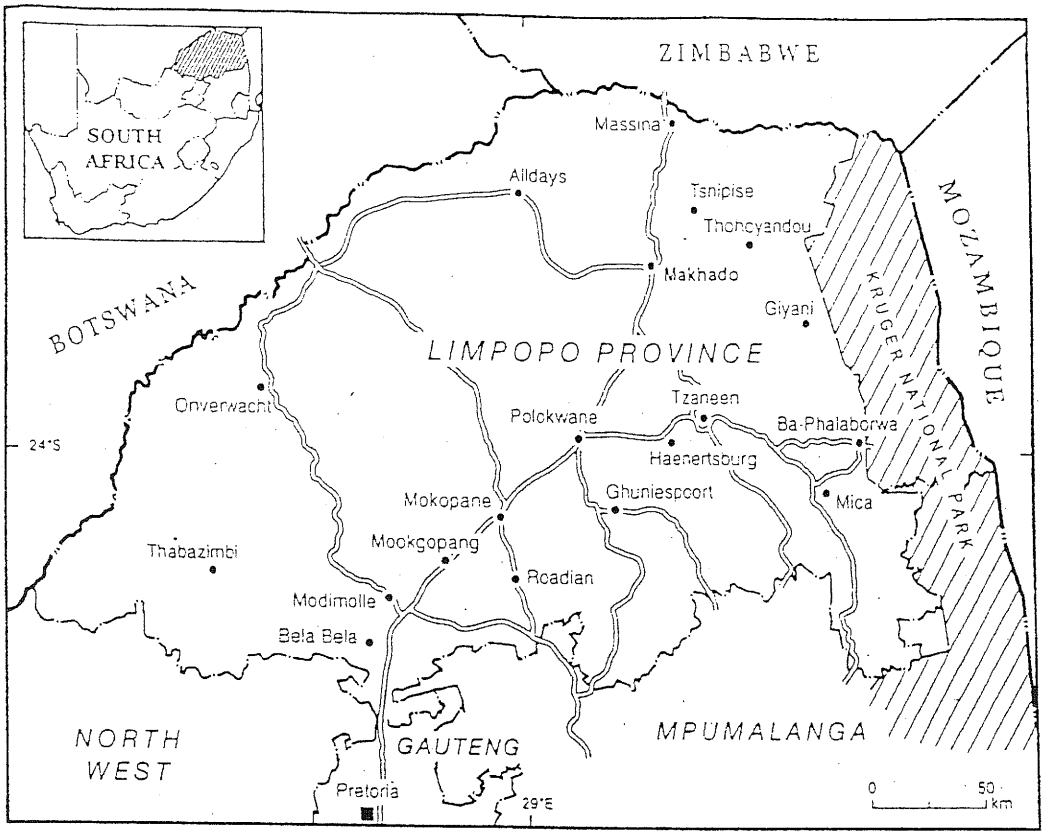

Figure 2: A map showing the location of Makhado Municipality and other areas in Limpopo Province

Source: Limpopo Province, 2005, www.sa-venues.com/north_province_tourist_info_htm

The economic center of the Makhado Municipality is the town of Makhado, formerly Louis Trichardt. The main industries and activities in the area are: agriculture, tourism, forestry, manufacturing, lumber mills, fruit and vegetable canning and juice extraction, edible oil extraction, food processing, service industries and warehousing, regional commercial center. In terms of agriculture, the region is well known for its agricultural diversity that ranges from tropical and sub-tropical fruit, nuts and maize to cattle and game farming (South African Government Information, 2005).

Maize is the crop most frequently planted by the majority of the small-holder farmers in Makhado Municipality, especially during the summer season (essentially October to April). Tomatoes, cabbage, nuts and vegetables are mostly planted during winter when there is scarcity of water. Most of farmers produce these crops (especially maize) for household consumption. The Nzhelele River, which is the main source water for most of the farmers, depends on rainfall for water supply. Canals and pumping machines are used

to draw water from the river. A reduced amount of rainfall is received in winter. The river is thus not reliable during this time. In addition to irrigation, small-holder farmers in Makhado Municipality also largely depend on rainfall.

Makhado Municipality, situated within the Limpopo Basin, is an area of summer rainfall. Rainfall is highly seasonal with 95% occurring between October and April, often with a mid-season dry spell during critical periods of crop growth (Food and Agricultural Organization, 2004). The mean annual precipitation of Makhado Municipality is between 560 and 700 mm per annum. Makhado Municipality has a relatively high humidity, usually aggravating high temperatures. Maximum and minimum temperatures reach an average of 29 ^{0}C and 18 ^{0}C in summer, and winter temperatures of 21^{0} and 8^{0} (The Limpopo Province, 2005). Evaporation within the area varies from 1600 mm per year to more than 2600 mm per year. The highest evaporation occurs in the hot Limpopo River Valley. High levels of evaporation results in soil drying up quickly and this reduces the amount of water available for plant uptake. Evaporation is also usually highest during rainfall season and this significantly reduces effective rainfall, runoff, soil infiltration and groundwater recharge (Food and Agricultural Organization, 2004).

Extreme drought in the Limpopo River Basin is a regular phenomenon and has been recorded for more than a century at intervals of 10-20 year periods (Food and Agricultural Organization, 2004). The Makhado Municipality was similarly affected by wider coarly droughts in, for example, 1926, 1933, 1945, 1949, 1952, 1970, 1983 and 1992 (Rouault and Richard, 2002). A study carried out in Khomele (which lies 80km north of Makhado, the major town in Makhado Municipality) by the University of Sheffield (2003) and Thomas *et al* (2005) revealed the following constraints to successful response to drought:

- "Lack of detailed weather forecast information that forces people to rely on using their own experience;
- Difficulty to break into the commercial sector;
- Difficulty in accessing information or advice from experts;

- Poverty makes initial start-up capital difficult to raise;
- No formal mechanisms for labour exchange;
- Lack of access to good quality grazing land within sections of the community;
- Small scale disputes over land access between different families;
- Loss of livestock to predatory wildlife; and
- Reliance on charismatic individuals to trigger successful initiatives (University of Sheffield, 2003, 3; Thomas *et al*, 2005)."

The study also found out the following as the most common responses in Khomele:

- "Reliance on family and friends to provide assistance;
- Selling of assets, such as goats and chickens;
- Local piece of work, petty trade of goods such as craftwork, clothes, vegetables, fruits and firewood;
- Applying for government financial support to sustain livestock business; and
- Eating of wild fruits (University of Sheffield, 2003, 5; Thomas *et al*, 2005).

Some of these initial findings will be tested in the present study.

Finally, drought coping, of various forms, is common in this Province. Dam levels were far below average in 2004/2005 season across the Province. This prompted the Department of Water Affairs and Forestry to allocate 51 million in the 2004/2005 financial year to Limpopo municipalities under the Drought Relief Programme. The funding was aimed at relieving the communities of the most severe effects of drought (Limpopo Province Water Summit, 2005). The small-holder farmers in the area were also, however, impacted by 2000 floods. Some of the farms were completely swept away while some were partially destroyed. Interventions therefore are not once-off activities and complex hazard occurrence will argually require a much more nuanced drought/flood response and risk-reduction approach.

Having briefly described the area in which this research is located attention now turns to outline the research in more detail. Firstly the research problem is described, followed by the objectives and methods of research undertaken.

Statement of the research problem

As indicated above, the areas of the Makhado Municipality are extremely vulnerable to periods of below-normal rainfall such as drought. A range of other factors also compound vulnerability to periods of stress, including poverty, reduced farming activities, etc. These factors, however, are usually poorly understood. To deepen our understanding of drought vulnerability in all its dimensions, some of the complex array of factors shaping vulnerability in the Makhado Municipality are probed in this study. Vulnerability of the small-holder farmers to the 2004/2005 drought is investigated here by collecting information from municipal documents and from a small sample of people affected by the drought. The intended outcomes of the research are hopefully information that enables a deeper examination of factors contributing to drought impacts and vulnerability to periods of climate stress. Moreover such information and analysis should improve and further inform strategies that can be employed to reduce the community vulnerability to drought in future.

Research objectives

The overall objective of this research is to examine small-holder farmer's vulnerability to drought in Makhado Municipality. Past and current adaptation strategies to reduce drought vulnerability are identified.

Specific objectives:

- To assess the vulnerability of small-holder farmers to the 2004/2005 drought, and,
- To identify some preliminary adaptation strategies that may reduce small-holder farmers' vulnerability to drought.

Research hypotheses

- Small-holder farmers in Makhado Municipality are vulnerable to drought. Their vulnerability to drought is enhanced by a range of factors, including, but not limited to, climate.
- There are a range of strategies that can be employed to reduce the vulnerability of small-holder farmers in Makhado Municipality to drought, in addition to strategies that are already in place.

Justification of the research

Small-holder farmers in Makhado Municipality have been employing various strategies to reduce vulnerability to drought. The strategies include the construction of erosion walls to prevent soil erosion and ensuring infiltration of rainwater, planting of drought–resistant crops such as sorghum and storage of maize in well-constructed, underground structures for use in times of drought both as seeds and food. A variety of social strategies including social sharing schemes are also used. Some of these strategies may, however, be eroding and being reduced overtime and there is therefore a need for the consideration of possible alternative strategies to reduce community vulnerability to drought. For example, people are no longer dependent on sorghum and are consuming maize.

Research design

Purposive Sampling

Nzhelele district, one of the 11 areas in Makhado Municipality, is the focus of the research. The area has been selected because it has the most number of small-holder farmers in Makhado Municipality. Most of the small-holder farmers in the area (Nzhelele) depend on farming for a living. Other areas such as Levubu, Alldays, Louis Trichardt, Banderlierkop and Tshipise, comprise commercial farmers while there is little

farming taking place in areas such as Elim, Hlanganai and Vuwani.

A misconception about sampling in qualitative research is that numbers are unimportant in ensuring the adequacy of a sampling strategy. Yet, small sizes may be too small to support claims of having achieved either informational redundancy or theoretical saturation, or are either too large to permit the deep, case-oriented analysis often required in qualitative research. Determining adequate sample size in qualitative research is ultimately a matter of judgment and experience in evaluating the quality of the information collected against the uses to which it will be put, the particular research method and purposeful sampling strategy employed, and the research product intended (Sandelowski, 1978). In this research, forty-five (45) people were selected and interviewed by the researcher. Clearly the sample size could have been larger, but the size used here was considered adequate for the scope of the research (e.g. a research report in partial fulfillment of an MSc degree). Various people were interviewed from Musekwa, Maangani, Rabali, Mandiwana, Dzanani and Siloam villages. The small-holder farmers who were interviewed were mostly (approximately 60%) older females (45 to 70 years).

The ethical issues of this research were also seriously considered before and during the interview (A copy of the protocol from Human Ethics University Committee is attached in Appendix 2). The researchers' positionality with respect to interviewees was considered. The selection of the most appropriate methods and approaches for interviewing to avoid an 'invasive' approach were also considered. Transparency, clarity of the reason for the research and the respondents situation were also considered (e.g. respondents were informed about the research as well as their right to withdraw from the study at any time). People were interviewed by the researcher using their own language (Tshivenda). The researcher is resident in the area, and has a good sense of the social dynamics in the area. Data were also collected from the Makhado Municipality Department of Agriculture and from the South African Weather Service.

Data Collection Methods

Primary data

Qualitative research is one of the two major approaches to research methodology in social sciences. Qualitative research involves an indepth understanding of human behaviour and the reasons that govern human behaviour. Unlike quantitative research, qualitative research relies on reasons behind various aspects of behaviour. Simply put, it investigates the why and how of decision making, as compared to what, where, and when of quantitative research (Adler, 1987), hence in this research data were collected through structured social surveys in the form of questionnaires (the questionnaires are attached in the Appendix). Questionnaires were designed in an "open-ended format" where questions were designed to not restrict the respondents and allow more of a dialogue amongst respondents.

An open-ended questionnaire requests the respondent to reply to the questions in their own words, and maybe even to suggest topics to which replies may be given. The ultimate open-ended questionnaire is a critical incident-type of questionnaire in which respondents explain several good or bad experiences, and the circumstances which led up to them, and what happened after, all in their own words (Kirakowski, 2000). Closed-ended questionnaires are good if the researcher is going to be processing massive quantities of data, or if the researcher's questionnaire is appropriately scaled to yield meaningful numeric data. Open ended questionnaires are good if the researcher is in an exploratory phase of the research or if the researcher is looking for some very specific comments or answers that can't be summarized in a numeric code (Kirakowski, 2000). Although they are time consuming and the researcher or interviewer may misinterpret a response, open-ended questionnaires give greater freedom of expression to the respondents. They also ensure that there is no biasness due to limited response ranges (Galloway, 1997).

Key themes that were included in the questionnaires included: rainfall received during 2004/2005 season, whether the farmers had early warning systems in 2004/2005 season, financial status of farmers and government assistance during 2004/2005 drought, and past and present coping mechanisms used to 'live with the drought'. Respondents were free to ask as much information as possible and a participatory approach was encouraged.

Secondary data

These data were collected from government documents, namely: sources from the Makhado Municipality Department of Agriculture in Makhado (formerly Louis Trichardt), Limpopo Province. Information about the rainfall received during 2004/2005 season in areas under investigation was obtained from government documents and the South African Weather Service. Such data were obtained to improve the understanding of source of the wider, contextual factors underpinning this study.

The findings were assessed qualitatively since the sample size was considered too small to employ any statistical analysis. Data were analyzed simply by obtaining a percentage of small-holder farmers who were affected or impacted by a particular theme (e.g. factor determining drought vulnerability) during 2004/2005 drought. These results were then presented graphically.

* * * * *

Agriculture is one of the main economic activities in Makhado Municipality, with maize, tropical and subtropical fruits, nuts and cattle farming being the main agricultural production activities. The study was conducted in Nzhelele, an area that is physically vulnerable to drought. The area also has the greatest number of small-scale farmers in the municipality. The area's physical and societal vulnerability to drought, during 2004/05, prompted the study. The research thus examined the small-holder farmer's vulnerability to the 2004/2005 drought, focusing particularly on past and current adaptation strategies to reduce drought vulnerability. The data were collected through structured surveys in the form of questionnaires with due considerations given to a range of ethical considerations. The next chapter presents findings and analyses emerging from the research.

CHAPTER FOUR

LIVING AND RESPONDING TO DROUGHT IN MAKHADO MUNICIPALITY, LIMPOPO PROVINCE

Introduction

The experiences of small-holder farmers in Makhado Municipality during the 2004/2005 drought are examined in this chapter. The responses of Makhado Municipality's small-holder farmers on rainfall received during the 2004/2005 season, water supply and irrigation structures, early warning systems, income levels, government assistance and coping and adaptation strategies, during the 2004/2005 are profiled. More importantly, drought coping strategies, which have been employed in the past and those are still being employed, are presented and assessed in the chapter. Such investigation and the emerging results will hopefully be of use in future drought risk-reduction in the province.

Living and responding to drought in Makhado municipality, Limpopo province

A number of factors can either enhance or reduce farmer's responses and adaptation options during periods of variable rainfall. In the discussion that follows, some of the current responses are outlined, beginning first with responses to some of the more clearly identifiable physical constraints. Thereafter some of the other social, and not least, compounding factors, influencing drought risk-reduction are discussed.

Water is a basic necessity for viable agriculture (Department of Water Affairs and Forestry, 2005). The agricultural industry accounts for about 52% of the water used in South Africa (Department of Water Affairs and Forestry, 2005). Without water sufficiency, it becomes almost impossible for the industry to operate. Small-scale farmers in Makhado Municipality have been vulnerable to drought in the past mainly because of a lack of water. Although most of them do not practice rainfed agriculture, the absence or low levels of rainfall always hinder their production. The river (Nzhelele River), which is

their main source of water, for example, depends on rain. Water supply is also impacted by demand. The catchment has already been declared stressed due to high demand of water resources (South African Government Information, 2005).

Climatic or rainfall variability in 2004/2005 season

As indicated in Chapter Two, the average rainfall in Limpopo Province is 550 per year (560mm and 700mm in Makhado Municipality) (The Limpopo Province, 2005). The average rainfall received in the Limpopo Province from July 2004 to June 2005 was 250 mm (South African Weather Service, 2006), almost half of the normal rainfall expected. With this amount of rainfall it is difficult to sustain the crops for the entire season. This was confirmed by 91% of the farmers interviewed in Makhado Municipality. The rain was so little that they were forced to abandon their fields in both the 2004 and 2005 summer seasons. Not only was the rain too little, but the onset of the rains was also delayed. Most of the crops had already wilted by the time the first rains were received.

Small-holder farmers, in this area and similar to other areas elsewhere, are forced to employ various farming strategies including application of fertilizers (Stoorvogel and Smaling, 1990; Sanchez *et al.*, 1997). Farmers in Nzhelele, farm along the Nzhelele River in a non-fertile sandy soil. Not only is the soil (sand) non-fertile, but it also has low water holding capacity. As a result of non-fertile soils and soils with low water holding capacity, small-holder farmers' production has generally been low, not only in 2004/2005, but over an extended period.

The situation is not dissimilar to what has been happening in most other southern African countries. Rainfall has been one of the most limiting factors to small-holder farmers in Mozambique (Southern Africa Documentation Centre, 2002), Botswana (Babugura, 2005), Zimbabwe (Gandure, 2005), Lesotho (Ziervogel, 2003) and other southern African countries.

Topography, erosion and sedimentation

Due to the heavy rainfall of the 2000 floods, Nzhelele River (together with other rivers affected by 2000 floods) was heavily sedimented and this greatly reduced its water storage capacity. As indicated in Chapter Three, some of the farms were completely swept away while others were partially destroyed. However, this was not due to the topography of the area, rather to the proximity of the farms to the river (Nzhelele River), as most of the farms are approximately 15 metres away from the river. As a result, farmers do not draw the amount of water that they used to. This is similar to what occurred in Kaziba, Kivu Province in the Democratic Republic of Congo (formerly Zaire), (Jensen and Beheim, 2005). Although the sediments are being eroded, it will take a considerable amount of time before the previous riverine conditions are restored.

Water supply and irrigation structures

Rainfed agriculture is dominant in most of sub-Saharan African countries. Farmers in such countries also lack water supply and irrigation structures, depending on rain-fed agriculture (Stockholm International Water Institute, 2001). On the contrary, small-holder farmers in Makhado Municipality do not practice rainfed agriculture as most have water supply and irrigation structures in place. However they also draw water for irrigation from the river that almost entirely depends on rainfall. The amounts drawn off, however, depend on farmers being able to access infrastructure such as pumps, generators and pipes. Most farmers surveyed do not, however, have generators and pipes to draw water from the river. Despite the lack of infrastructure to ensure regular sources of water, almost all of the respondents, that is 91% of the small-scale farmers interviewed, have canals from the river and furrows for irrigation. Almost half (47%) of the farmers interviewed also maintain these irrigation structures on a monthly basis. Mud and weeds are removed from canals and furrows while leaking pipes are sealed. The potential to ensure enhanced coping and adaptation to periods of variation rainfall could arguably be assured if additional and sustained infrastructure is improved. Farmers clearly see the value of maintaining this infrastructure, but such practice will require government

support.

This finding is not unique and has also been found amongst farmers in the North West Province (O'Brien and Vogel, 2003) and amongst other small-holder farmers in Southern Africa (Ziervogel, 2003) and also in other areas of the world e.g. Mexico (Eakin, 2005, 2006). According to Eakin (2005, 2006), the existence and development of local networks among farmers, service providers and information sources may be critical for facilitating adaptation, particularly in the context of economic liberalization and globalized agriculture.

Early warning systems

The vulnerability of small-holder farmers to drought is in some cases also associated with a lack of information (e.g. early warning systems) as to whether the particular area will receive enough rainfall for the particular season. Drought early warning systems are an essential component of drought preparedness. Farmers (particularly those in sensitive climate areas) need to constantly equip themselves with information from meteorological institutions (such as South African Weather Service) in order to reduce the risks associated with drought (International Strategy for Disaster Reduction, 2005). Early warning systems, as described earlier, in most African countries are usually inefficient to enable sustainable adaptation to drought risks. They do not have adequate financial support and trained personnel to assist in drought adaptation (Sinange 2000, Chang-Ko 2003, Mutua 2003 and Vordzorgbe 2003).

In South Africa, the South African Weather Service and other institutions have trained personnel and produce reliable data. As a result, most of the small-scale farmers in Makhado Municipality (81% of the farmers interviewed) had information concerning the rainfall for 2004/2005 season. It was found that they did receive the information that the rainfall will not be sufficient to sustain their crops (maize) for 2004/2005 season from the South African Weather Service through various sources including extension and the media (local radio station). Since most of the farmers do not have sufficient income to

buy food, however, many planted their crops regardless of the information they had. Some questioned the reliability of such information (early warning), citing reasons such as "only God has control over the rain". Thus it is the vulnerability context, into which information flows, that requires further examination.

Size of the area of farming

Generally, farmers with large areas of farming will always produce more thereby trying to compensate for drought seasons when there is less or no production. Farmers with reduced land of farming, with fewer options to enhance or intensify production, will produce less and thus may not have food in times of disasters such as drought, either for cash generation and or subsistence.

Hart and Vorster (2006) found that the size of land available to African farmers can be anything between 0.1 acres and 10 acres. Such is the case with small-holder farmers in Makhado Municipality. More than three-quarters of the sample interviewed, 87%, of the small-scale farmers interviewed either do not have enough land for farming or agricultural technological input to maximize production. On average the small-scale farmers have an area of farming of approximately 80 m^2. A farming area of 200 m^2 could increase their production and decrease their vulnerability to drought. Other options to support small-holder agriculturalists could also be considered e.g. enhanced agricultural extension, improved access to inputs, access to agricultural infrastructure, materials, etc.

Camps and size of grazing area for stock farmers

For stock farmers, camps are the most important factor. The grazing area may be large, but if there are no camps, the livestock tend to trample all over the area creating damage to the pasture. This leads to unavailability of enough pasture throughout the year. Due to their financial status, most of the farmers cannot afford supplementary feed for the livestock hence they are forced to sell them at a very low price. All the stock farmers interviewed in Makhado Municipality confirmed that although not of good grazing

quality, there is enough area for grazing. However there are no camps for practicing rotational grazing. According to them, camps were once in place but people destroyed these, by taking the available infrastructure that was used to demarcate grazing areas for use in their homes. This is one of the major concerns for Makhado Municipality's small-holder farmers as almost half of those interviewed own an average of 8 cattle. Again, the role of access to financial and physical capital clearly emerge as issues for further consideration as well as a call for more attention on the behavioral changes in farm and overall community responses to a range of factors producing changes in the area.

Government assistance during 2004/2005 drought

Effective grants from the government in times of natural disasters such as floods, drought, storms, fire, etc, can help farmers to recover after a particular period of heightened. It has been found that a large proportion of small-holder farmers in Makhado Municipality do not have abundant sources of income. The government has also changed drought support and grants for drought, particularly for crop farmers. According to farmers interviewed, grants were last given to crop farmers in 1997/98 season. Stock farmers have, however, been compensated by roughages (by-products resulting from maize meal production) during 2005/2006. For the drought experienced in 2004/2005 season grants were not readily available for crop farmers as they had been in the past. Farmers, when questioned did not necessarily want financial handouts but they did express a need for a more enabling environment. When asked how the government could assist them in times of drought and floods in the future, 80% of the farmers indicated that they want boreholes, pumping machines and dams to be put in place.

Human capital skills

Although the government does not give grants in times of natural disasters anymore, it gives support in terms of human capital skills for agricultural sector. Officials from the Department of Agriculture (DA) still go to the farms and advice farmers on which crops to plant, type of manure to use, irrigation methods, appropriate time of the season to

plant, controlling pests, etc. Countrywide, the Department of Agriculture, together with the Department of Land Affairs (DLA), are currently giving land back to the historical previous owners of land who were evicted from their land during the previous government system. Most of this land is being utilized for agricultural purposes by historically disadvantaged people but will require sustained and even more attention to effectively supporting and understanding how farmers live and cope with daily realities.

Makhado Municipality's small-holder farmers are more privileged in this regard when compared to other African small-holder farmers. As indicated earlier in Chapter Two, assessments in countries such as Burkina Faso, Mali, Mauritania, Niger, Senegal and Chad), for example, have shown that there are notable problems in agricultural education systems (Lindley *et al.*, 1996). Small-holder farmers are often the 'victims' of inadequate human capital skills in the agricultural sector.

Coping strategies

Drought is no stranger to communities in Makhado Municipality. Various coping strategies have been used and have evolved over time, some of which are described below. As indicated in Chapter Three, tomatoes, cabbage, nuts pumpkins and spinach are mostly planted during winter. Maize is mostly planted during summer when there is 'sufficient' water. A small proportion of farmers produce these crops for commercial purposes within their respective villages while majority of farmers are producing for household consumption. During good rains, farmers dry vegetables and fruits for use in winter when there is little or no rainfall. They also used to store mealies or maize in a well-constructed underground structures for use in times of drought. This involves digging a hole in the middle of the house or hut. A big drum would then be filled with maize and put in a hole. Although the maize on the top portion of the drum would have decayed after a considerable amount of time, the rest of the maize in the drum would still be ready for seeding and consumption purposes (Pers com, 2006). Cutting of meat into small and thin portions and drying it to make biltong is also a very common practice, since people did not have refrigerators. Nevertheless, very few farmers are still

employing these strategies. People can easily purchase maize meal whenever the production is low. They also now have refrigerators hence the erosion of some of the coping and adaptation strategies that used to be applied e.g. biltong making. Fishing, hunting of small antelopes, gathering of wild fruits and vegetables are, however, still common practices in the area. However fishing and hunting are not permitted without the appropriate license by the relevant authorities i.e. Department of Environmental Affairs and Tourism (DEAT).

Application of organic fertilizers, in the form of cowdung is also very common in the area. This results in production of more food because of the stimulation of crop productivity. Farmers also let their livestock graze in their farms when there is no enough pasture. This practice also ensures more organic fertilizer for farmers. Supplementation of pasture with grass harvested from riverbanks, canalbanks and other areas that are inaccessible by livestock is the practice that is still in operation. In addition to cattle farming, some farmers are also engaged in goat, pig and chicken farming which ensure extra food and cash. Most of the youth are ensuring diversification of income sources by seeking employment from cities such as Pretoria and Johannesburg. Illiteracy or low standard of education is, however, resulting in most of them getting underpaid jobs.

In other African countries such as Tanzania, Kenya, Ethiopia (Burford *et al*, 2003), Zimbabwe (Food and Agricultural Organization, 2000) and Sudan (Elsiddig, 1998), drought coping and adaptation strategies are still widely applied. A further study is required to reveal the cause for a sudden drop of some of these 'traditional' drought coping strategies and to assess the effectiveness of those coping strategies that are still being applied in this area of Limpopo.

Overall livelihood issues

Generally, farmers with enough capital and a better suite of livelihood options (jobs and businesses) to cover for extra costs, such as pumping water from the river and from the ground, are less vulnerable to drought. This is because they still manage to access enough

water to sustain their crops for the entire season even during drier periods. Though not entirely, the situation in Makhado Municipality is similar to that of Ethiopia and other developing countries where farmers have very few response options to drought due their level of income (International Food Policy Research Institute, 2003). Most of the farmers interviewed, 90 %, did not have crop insurance, strong social networks and a range of alternative income sources to cover for the extra costs incurred during the 2004/2005 drought. They were forced to watch their crops wilt helplessly. Sufficient water in the river is required for the canals to run or operate. As a result of the drought, the river did not have enough water and farmers could only draw water using generators and pipes, which most of them do not have.

Small-holder farmers are also not usually eligible for big loans from the banks that would help them to cover for those extra costs during drought as compared to their commercial farmers counterparts. Almost half of the small-scale farmers interviewed (48%) comprised elders who get monthly pension grants which are not enough to support or maintain the entire family. Some of the small-scale farmers interviewed, 43%, do also not generate other viable income sources. As a result of their financial situation, they cannot afford inputs such fertilizers, labour (apart from their family members) and machinery such as tractors. Small-scale farmers cannot engage in other strategies including social activities such as stockvels that help during the times of crisis. Most of the respondents indicate that they do not have sufficient money to engage in such social schemes. Another significant factor is that such schemes are seen as youth's (young women) activities, older women rarely participate. The consideration of livelihoods, diversification and dimensions of social capital (Adger *et al*, 2003) are key areas that clearly require much more investigation.

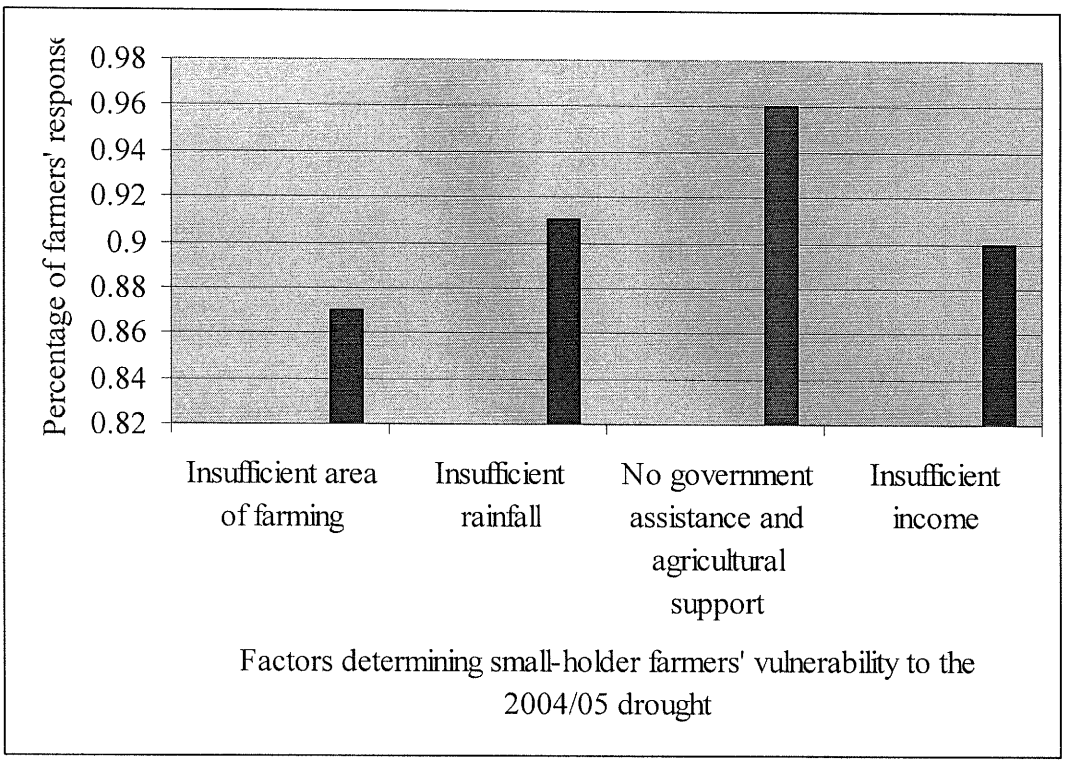

Figure 3: Small-holder farmers' vulnerability to 2004/2005 drought

Where: Insufficient rainfall= Rainfall less than 500 mm per year
Insufficient area of farming= Area less than 200 square metre
Insufficient income= Inability to cover extra costs that resulted in times of drought
Government assistance= Inability of government to assist farmers manage drought risks

The findings of this study correlates with those of the study carried out by the University of Sheffield (2003) and Thomas *et al* (2005) in Khomele in 2003. The constraints to successful response to drought such as difficulty to break into the commercial sector and initial start up capital are similar to the rest of the municipality. Similarly, drought responses such as selling of assets such as goats, eating of wild fruits and relying on government for cattle feed are common in the municipality.

Some of the expenses of farmers in Makhado Municipality, Limpopo Province, in the face of droughts have been identified here (Figure 3). Clearly the role of drought, as a persistent reality, needs to be further examined. Questions requiring further elaboration include the reasons for changes in coping strategies over time- this would usefully

include, to name but a few, the insightful inputs that could be gained from a closer anthropological assessment over time and a closer examination of government intervention in terms of drought including not only relief but also the range of institutional mechanisms and how these have or have not adapted over time. etc. This study has therefore only raised key issues and clearly more detailed investigation, that is beyond a masters report of this type,
is required.

* * * * *

It has been found that the climate in the area is extremely variable, making it difficult for the farmers to plan for the following season. The amount of rainfall varies from time to time, oscillating between periods of rainfall scarily followed by periods of rainfall abundance (floods on occasion). Small-holder farmers are particularly vulnerable to such swings in rainfall. They have precarious livelihoods, poor income and limited options for diversification. There is also a marked erosion of some 'traditional coping strategies' and the reasons for these need to be further investigated. Government support has also changed over time and the wider agricultural environment in which farmers operate seems to mitigate against their daily viability as farmers and more particularly constrains overall livelihoods. In the next chapter, the vulnerability of small-holder farmers in Makhado Municipality and Africa in general is summarized. Some suggestions on how small-holder farmers can better adapt, cope and 'live' with drought are outlined.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

Introduction

In this Chapter, the findings of the research are presented. Some suggested strategies that the small-holder farmers can employ to adapt and cope more with the recurrent droughts are provided. The roles that the relevant authorities could play to ensure that small-holder farmers are less vulnerable to the consequences of climate variability, such as droughts, are also sugested in this chapter.

Conclusion

Climate has always been dynamic varying across time and space (Ribot *et al.*, 1996). Africa is one of the continents that are extremely vulnerable to climate variability in the form of drought (Benson and Clay, 2000). This is due to a number of factors including climatic variability and the heavy reliance on the exports of rain-dependent agricultural products in several areas (Ogallo, 1995). Many rural inhabitants practice subsistence farming and are often the most affected people by the consequences of climate variability (Arndt, 2000). Drought, varies in severity and intensity, and is often found to be more severe in countries such as Somalia, Sudan, Ethiopia, Chad, Mauritania and Mozambique. Drought in such countries has resulted in several extreme, acute impacts, including starvation, deaths, nutrition-related diseases and economic losses of tens of millions of dollars (Mwaura, 2006). Droughts in parts of South Africa, although often not noted as causing human death, do, nonetheless, exhibit many of the chronic impacts associated with such events. South Africa has also experienced several dry years, with provinces such as Limpopo and North West being severely hit by drought, placing millions of South African at risk of food shortage (South African Government Information, 2005).

In the case study presented here, drought vulnerability of a particular community, was also shown, however, to be the result of a range of a variety of particular complex, multiple stresses. Drought was exacerbated by a range of societal and physical vulnerability to drought. Often the poorest in rural areas occupy the most marginal lands, forcing them to rely on highly vulnerable livelihoods in areas prone to droughts, floodings and other hazards (McCarthy *et al*; Alley *et al*, 2007). Identification of drought vulnerability (Wilhelmi and Wilhite, 2002), drought planning, appropriate early warning systems (Wilhite, 1987), combination of local and current mechanisms and drought response systems are some of the elements that require investigation to improve adaptation strategies (United Nation Convention to Combat Desertification, 2004). As indicated earlier in Chapter Two, the abandonment or erosion of local drought coping mechanisms is placing several rural African farmers in a heightened vulnerable state (Burford *et al*, 2003). Local knowledge can provide the currently constrained research and extension services with possible low-cost adaptation solutions (Torkelsson and Anandajayasekeram, 2000) and is an area that requires more extensive research.

The case study, for one period in time, has revealed a number of interesting results. Small-holder farmers in Makhado Municipality were found to be vulnerable to the 2004/05 drought (Figure 3), but were possibly less vulnerable than many other farmers because of their proximity to irrigation sources. Despite this apparent advantage, these sources were, however, being weakened over time. Several factors that were shown to be heightening drought risk in Makhado Municipality, included:

- Rainfall variability in the area;
- Inability to drain water from the river through canals because the river did not have sufficient water, and silting of the river;
- Lack of pumping machines and pipes to most of the farmers;
- Lack of grants, or state relief, for recurrent droughts;
- Inability to engage in a wide and flexible range of social activities that help in times of crisis particularly in rural areas; and
- Very few farmers have been found to be employing 'traditional' coping and

adaptation strategies such as supplementation of pasture with grass harvested from the riverbanks, application of organic fertilizers, drying of vegetables, etc. There is a noticeable erosion of 'traditional' and coping mechanisms over time.

There are a number of characteristics that distinguish African small-holder farmers from North American and European large-scale farmers and also from some large-scale farmers found in Africa, other parts of Asia and South America (Hart and Vorster, 2006), these included:

- "Generally restricted access to farmland;
- Production of crops for household consumption;
- Lack of subsidies;
- Insufficient mechanization;
- Low external-input agriculture; and
- Reliance on saved seed as primary source of plant material (Orton 2003 in Hart and Vorster, 2006, 6)."

These characteristics, coupled with the fact that most African small-holder farmers occupy drought-prone areas, as this study has attempted to show, can increase farmers' vulnerability to the climate variation, such as drought. The situation for most small-holder farmers in Makhado Municipality is summarized below:

- Land access- The average size of farm for Makhado Municipality's small-holder farmers was found to be less than 200 square meters. Restricted access to farmland, particularly small land holdings, can heighten vulnerability to drought, because there are limited options for diversification (Hart and Vorster, 2006).
- Government support- Sustained government support in terms of subsidies was apparently found to be lacking. However minimal support through agricultural extension was observed.
- Infrastructure- The majority of farmers do not have pumps and pipes in place. Most of them rely on canals for irrigation, which requires a lot of labour to ensure sustainability. They also cannot afford tractors, hence heavy reliance on donkey

ploughing.

- External input- Most of the farmers cannot afford external inputs such as fertilizers, chemicals and seeds. This tends to have a major effect on their production.
- Loss of coping strategies such as drying of meat and storing of mealies. As indicated in Chapter Four, there has been an erosion of 'traditional' coping strategies.

The findings emerging from the study undertaken by University of Sheffield (2003) and Thomas *et al* (2005) in Khomele resonate with some of the findings of this study, as indicated earlier in Chapter Four. Limited access to land has been found to be common in both studies. According to the study, not only is the access to land limited in Khomele, but there are also disputes over land resources in the area. Both sets of studies revealed a lack of financial resources for external inputs such as fertilizers for most of the farmers. Fenced camps for grazing rotations in the communal area were also dismantled in the early 1990s resulting in stock management problems for many farmers and seems to be a persistent problem.

These problems, it would seem, are not unique to the South Africa case. In villages of Torres, Plan de Ayala and Nazareno, east of Mexico City, where subsistence maize farming is common, it was noted that small-holder farmers are facing environmental and climatic challenges to production. Water resources for agricultural use are limited both in quantity and distribution. The cost and scarcity of groundwater resources has also been exacerbating the situation. As a result, in 2000, just over 11 percent of Mexico's agricultural area was irrigated (Eakin, 2006). Similar to Makhado Municipality's community, adaptation strategies in rural Mexico include changes in consumption patterns, livestock sales, off-farm employment and maize purchases (Eakin, 2006).

Recommendations

According to Wilhite (2000), drought is a normal feature of climate and its recurrence is inevitable. As a result, appropriate intervention, that is sustainable in the longer term, needs to be undertaken to improve the current situation. Small-holder farms in Makhado Municipality (Nzhelele) are closer to the Nzhelele Dam which is solely used for irrigation purposes. As indicated in Chapter One, Nzhelele Dam is located at the downstream of Nzhelele River, and it supplies water to the commercial farmers in Tshipise area. The relevant authorities (Department of Water Affairs and Forestry) should ensure equitable distribution of resources through provision of water resources to the small-holder farmers from the dam. The amount of water required for the small-holder farmers is far less when compared to the amount required by their commercial counterparts. The dam has enough water resources that with efficient management, can be sustainably supplied to the small-holder farmers who are farming in downstream areas such as Musekwa, Maangani, Tshituni, Rabali and Dzanani. The provision of infrastructure including, pumping machines and pipes by relevant authorities, could for example, also greatly reduce small-holder farmers' vulnerability to drought.

Small-holder farmers also have to strengthen some local drought coping methods that are still useful or applicable but that appear to be weakening over time, including, mixed crop cultivation (Kamara, 2004), organic fertilizer application (Hart and Vorster, 2006), food storage methods and preservation (i.e. drying, salting, parching, fermenting, smoking and curing) (Fleuret, 1986 and Subbiah, 2000), supplementing grazing with other sources of feed such as shrub or tree fodder and crop residues (Burford *et al.*, 2003). It was concluded in the United Nation Convention to Combat Desertification (2004), for example, that local knowledge can be more sustainable than only adopting or relying on technological response options. Irrigating the crops in the late afternoon or early in the morning and mulching are two ways of minimizing the rate of evaporation that could also be taken into consideration by farmers in times of drought (International Crop Research Institute for the Semi-Arid Tropics, 2003).

Soil and water conservation strategies such as terracing that ensure that at least some of the fleeting rain shower would be caught (Hart and Vorster, 2006), construction of checkdams in the direction of water flow on rivers for the purpose of water harvesting (Environnement et Développement du Tiers-Monde, 1999) and chanelling of rainwater to cropping sites (Dietz *et al*, 2000; Fleuret, 1986) would help small-holder farmers deal better with drought. Small-holder farmers could, given appropriate support, also plant alternative crops such as soybeans, peas and sorghum that do not require a lot of water in times of drought. Farmers could also engage themselves in other activities despite farming, to ensure diversification of income. Sewing projects and crafts are some of the activities that could earn farmers income in times of drought (Bell, 2002).

Although the small-holder farmers had information on rainfall for the 2004/2005 season, scientific networks for the enhancement of scientific and technical capabilities in meteorology and hydrology should be strengthened (International Strategy for Disaster Reduction, 2002). In their meetings with the officials from relevant authorities, farmers should be briefed about the rainfall for the coming season on an ongoing basis, and not only during periods of crisis as well as possible interventions discussed. With accurate information, small-holder farmers will then be able to take better decisions that could optimize outputs and enhance overall livelihood strategies.

The Department of Agriculture should also ensure that agricultural, (small-holder farmers) products, such as potatoes and peanuts, are made accessible to markets. In his third state of the Province address, on February 09 2006, Limpopo Premier indicated that in line with the agricultural development programme, from April, four dams would be built across the province in a bid to alleviate drought and poverty (Seale, 2006). He also announced that a fresh produce market, modelled along Johannesburg's City Deep Market, would be established for the processing of agricultural products. He also promised a consolidation of a comprehensive agricultural programme to support small-scale and subsistence farmers (Seale, 2006). Given these changes, and if they materialize they may improve small-holder farmers' livelihoods in Limpopo Province.

Drought and its associated impacts have been shown in this report to be highly complex. Farmers in Limpopo Province, much like many in similar contexts (e.g. Botswana, Lesotho, Zimbabwe, Mexico), are struggling against a range of locally *induced* factors that are driving change including the loss of coping mechanisms and other technical factors (e.g. lack of infrastructure and markets). More detailed examination is required of these complex dimensions, how they interact, support or frustrate local adaptation and coping in Limpopo Province. Such detailed investigations are arguably going to be required, particularly as climate change and variability unravel in this area.

* * * * *

Africa has for a long time been vulnerable to climate variability with the majority of rural inhabitants being at the receiving end of a number of negative consequences of climatic variability. South Africa is no exception, with small-holder farmers such as those in Makhado Municipality most vulnerable. Insufficient rainfall and lack of funds for responding to the effects of climate changes such as droughts greatly reduce their ability to provide for their families. Intervention by the government, improved understanding and the strengthening of local drought coping methods, more effective use of soil and water conservation strategies and serious considerations of a range of income and livelihood diversification strategies can provide options for small-holder farmers to reduce their vulnerability to drought.

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APPENDIX

Appendix 1

Questionnaires

Did you receive enough rainfall to meet your farming or water demands in 2004/2005 season? If so, how much rainfall is usually sufficient for your needs?

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Did you have information (e.g. early warning systems) as to whether you will receive enough rainfall during 2004/2005 season?

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Do you depend on rainfall for irrigation or do you have water supply and irrigation structures such as pumping machines, canals from the river, drips, sprays or furrows in place?

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How often do you maintain and fix these water supply systems and irrigation structures regularly?

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Was the river that you depend on for irrigation reliable in 2004/2005 season?

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.....

Is your area of farming on steep land, and do you experience severe soil erosion?

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.....

Do you have enough area of farming for implementing off-season tillage or shifting cultivation?

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.....

How many camps do you have for practicing rotational grazing?

.....

.....

Did you have financial backup that helped you to cover extra costs during 2004/2005 drought?

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Apart from farming, do you generate income from work or selling other things?

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.....

Did the government give you grants when you were affected by 2004/2005 drought?

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Did officials from The Department of Agriculture give you advice as to how you can overcome or reduce the impacts of 2004/2005 drought? If so, please describe this type of information.

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.....

How could the government assist you with droughts and floods in the future?

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Finally, do you have any local, social mechanisms to call to call on during times of crisis, for example, stockvel, local associations? How do these operate? Are they still a good source of help? If not, why not?

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Appendix 2

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Division of the Deputy Registrar (Research)

HUMAN RESEARCH ETHICS COMMITTEE (NON-MEDICAL)
R14/49 Nethavhani

CLEARANCE CERTIFICATE **PROTOCOL NUMBER 60301**

PROJECT
to the 2004/2005 Assessment of Small-Holder Farmer's Vulnerbiulity

INVESTIGATORS Mr NG Nethavhani

DEPARTMENT School of Geogaphy/Geography

DATE CONSIDERED 06.03.22

DECISION OF THE COMMITTEE* Approved unconditionally

This ethical clearance is valid for 2 years and may be renewed upon application

DATE 06.05.15 **CHAIRPERSON** Leah Gilbert
(Professor C Penn)

*Guidelines for written 'informed consent' attached where applicable

cc: Supervisor : Prof C Vogel
School of Geography

DECLARATION OF INVESTIGATOR(S)

To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10005, 10th Floor, Senate House, University.

I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee. **I agree to a completion of a yearly progress report.**

This ethical clearance will expire on 1 February 2007

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES