CHAPTER 1
AN INTRODUCTION

1.1 Introduction and Conceptual Framework

The past few decades have witnessed a period of unprecedented change in the environment of the planet. The earth has gone through many natural environmental changes over several thousands of years during which extreme cooling and intense warming took place as well as the emergence and mass extinction of a number of animal and plant species (McNeill, 2005). These changes have been driven, to varying degrees, by both natural and human forces (Bernal, 1991; Archer *et al*., 1996). Such changes, moreover, are both interacting and interdependent and occur in a complex and ever-shifting system. Human beings and their activities have been particularly instrumental in affecting the earth's environment since the beginning of their existence (McNeill, 2005). This has put stress on the environment and its resource base (Archer *et al.*, 1996).

One of the most visible and cross-cutting global environmental changes is that of climate change. The Working Group 1 of the Inter-governmental Panel on Climate Change (IPCC) recently released the Fourth Assessment Report on Climate Change (IPCC, 2007). Concerns have, however, now been raised that the warming of the earth's atmosphere is taking place at a rapid pace (Neftel *et al.,* 1988).

Climate change is projected to bring with it a number of impacts including changes in rainfall, temperature regime changes as well as possible increases in the number of droughts, floods and other extreme events. These changes may, in turn, add additional stress to water resources, health, food security and infrastructure (van Jaarsveld *et al*., 2001). These changes may also constrain development. Changes in rainfall when coupled with intensified land use, for example, may lead to an increase in desertification. A decrease in surface runoff and precipitation may affect already highly sensitive river systems, which in turn may likely affect agriculture and other livelihood activities (IPCC, 2007).

A significant amount of research and other work on climate change and climate risk has so far focused very strongly on mitigation initiatives and the possible impacts of future climate

scenarios. Current and past emissions have committed the earth to some degree of change in the climate (IPCC, 2007). Even if dramatic and effective mitigation measures are undertaken to reduce greenhouse gas emissions, the climate will continue to warm (IPCC, 2007). It is thus important to begin identifying communities and sectors most vulnerable to the effects of climate change and to investigate factors 'driving' risks and the impacts of risks, as well as looking at other stresses. Adaptive capacity must be strengthened and adaptation strategies to deal with the expected impacts of climate change need to be enhanced and/or enforced.

Before one can adapt to change, the sensitivity to risks and the vulnerability of the system need to be understood. Vulnerability is seen in the literature to be an indication of people's exposure to external risks, shocks and stresses and their ability to cope with, adapt to and recover from, the resulting impacts placed on their wellbeing and livelihoods (Chambers, 1989). Vulnerability is also a dynamic entity in a continual state of change. The biophysical and the social processes that shape local contexts and the ability of people to cope with change (O'Brien *et a*l., 2004) are also critical to understand when considering adaptation options and strategies.

Adaptive capacity is the ability of a system to cope with and/or adjust to either actual or expected stresses (more details of these and other related themes are provided in chapters 2 and 3). Adaptation itself can take place on a number of levels. It can be both reactive and/or anticipatory (IPCC, 1995). Adaptation can also be localised or widespread, and can serve numerous functions and take on various forms. It can be undertaken by individuals, communities, or specific groups (IPCC, 2001) and is a dynamic and social process (Adger, 2003). Adaptation usually also varies over time, location and sector. Given this brief background, attention now turns to examine the aim, hypothesis and research questions used to guide this study.

1.2 Aim of this Study, Hypothesis and Research Questions

The aim of this research is to examine the contextual environment in which farmers operate so as to improve our understanding of the factors shaping vulnerability to climate risk. A key focus is on the livelihoods of sugarcane farmers, using a case study of small-, medium-scale (emerging) and large-scale sugarcane farmers in the KwaZulu-Natal Midlands area of Eston

and its surrounds. This detailed examination uses as its point of departure a social vulnerability assessment using the Sustainable Livelihoods Framework in order to understand better how these livelihoods are configured and some of the stresses and the dynamics acting upon such livelihoods. The hypothesis of this work is that farmers' ability to cope with and adapt to changes, such as those associated with climate change, is either constrained or enhanced by the context in which they find themselves and in which they undertake farming activities (i.e. vulnerability determines overall adaptive capacity). The influence of climate as a risk was thus considered together with a careful investigation of the influence and role of other stresses on farmer's livelihoods.

The following research questions were posed:

1. What are some of the main external threats (hazards and risks) that commercial farmers face?
2. What coping and response strategies have commercial farmers adopted in response to climate variability (short term changes), climate change (a change in rainfall, temperature etc. over the long term) and their risks?
3. What factors enhance or restrict these strategies? (Both on-farm and off-farm).

This study therefore involved an investigation into the multiple stresses (both external and internal, on-farm and off-farm, climatic and non-climatic) acting on the system in order to determine the role and influence that climate risk, as one risk, plays in shaping the vulnerability of the livelihoods of farmers. Examples of adaptive efforts and potential adaptive capacity were also explored so as to better understand the ability of farmers to undertake coping and adaptive strategies in response to threats and stress acting on and within the system (including climate risk and variability).

Adaptive capacity was investigated by exploring the livelihoods assets available to the farmers (social, financial, natural/environmental, physical, human, knowledge assets and capital under the Sustainable Livelihoods Framework). Access and entitlement issues around these assets were investigated in order to determine the level of adaptive capacity present. Institutions and policies that configure access to assets and entitlements were also investigated. The coping and adaptive strategies adopted in response to threats and stresses

(including climate change and variability) were explored and factors enhancing or restricting these strategies analysed. The outcomes of these strategies were then also explored.

1.3 Outline of the Dissertation

This section gives a short overview of the content of this dissertation. Chapter 2 begins with an overview of global environmental change and the past few decades of work on this topic. A discussion on the impacts (current and prospective) of climate change, both globally and locally (e.g. Africa and South Africa) is given. Definitions and basic concepts related to vulnerability, adaptive capacity, resilience, coping and adaptation are then explored.

Chapter 3 presents the framework, approaches and methods used in this study. An evolution of vulnerability studies from 'impact' focused to 'interactional' assessments and the integration of human dimensions into research paradigms is discussed to set the scene and to further articulate the approach adopted here. A particular focus is placed on vulnerability assessments and sustainable livelihoods approaches as this links directly with the methodology used in the study presented in this work. The second part of the chapter examines the actual study undertaken. It outlines in more detail, the frameworks and methodologies adapted and used in this work. It also gives the research and theoretical framework informing the study. A step-by-step explanation of the various stages of research is provided.

Chapter 4 and 5 present the findings of this study and discussion on the main points. Chapter 4 begins by examining the context of the research area, agriculture and the sugarcane sector. In the chapter the results of the study are also presented. The main livelihood assets available to these sugarcane farmers under the Sustainable Livelihoods Framework (these include natural, financial, physical, human, knowledge and social assets) are investigated. The main threats and stresses to livelihoods and livelihood assets are also identified (in order of importance to the farmers: Climate change risk and climate variability; the low domestic and world sugarcane price; the fluctuating Rand; high input and operational costs; a lack of access to start up and production capital and high levels of debt and land issues). These also include: access to skills; planning tools; networks; support and knowledge systems; crime and violence; conflicting and restrictive government legislation and policy decisions; labor issues.

Chapter 5 explores the main coping and response strategies employed by these farmers to reduce their risk and vulnerability to climate risk. These include: Diversification (in type of farming and in the activities undertaken besides farming in order to generate an income), changing land use and farm practices, the use of social networks and support systems, combined farming practices and the use of crop modelling and climate forecasts. It also investigates issues of access to livelihood assets which are critical to the adaptive capacity of the farmers. Access to livelihood assets is examined and the role of institutions considered. Institutional structures in this case appear to constrain some livelihood assets such as finances (sugar prices and Rand value) and natural assets (land reform and management processes) but enable others, such as social and human assets. Constrained access to livelihood assets reduces the adaptive capacity of the farmers and the adaptation options available to them, thereby increasing their vulnerability to the multiple and interacting threats and stresses

In Chapter 6 a summary of the dissertation is presented. Relevant elements of global environmental change and climate change literature are briefly revisited followed by reference to the conceptual framework including vulnerability, adaptive capacity and adaptation. An overview of the methodology used is given showing the basic elements of the primary and secondary research. The main findings and conclusions from the study are then presented followed by a S.W.O.T analysis investigating the key strengths and opportunities, weaknesses and threats of the work. Recommendations drawn from the study are then given along with a section on areas for further research. The chapter then closes with a glimpse into the future of this sector and the main conclusions of the study.

CHAPTER 2
LAYING THE GROUNDWORK:
CLIMATE CHANGE, VULNERABILITY AND ADAPTATION

2.1 Introduction

This chapter sets the scene for this dissertation by examining some important concepts related to this study. Global environmental change is a field of study that has evolved over a number of decades and includes both natural and human induced changes. One of the human induced changes under global environmental change is climate change. An overview of climate change and possible expected changes at various scales (regional and local) is provided as background to the research on vulnerability and adaptation that follows.

As introduced in Chapter 1, over the past few years, the concept of vulnerability has emerged as a cross-cutting topic in research on the human aspect of global environmental change and climate change. The distinctions and linkages between vulnerability, adaptive capacity and adaptation, as they inform this research, are introduced.

2.2 Global Environmental Change

The intensity and scope of human impact increased with the beginnings of agriculture and later the discovery and use of fossil fuels in the 18th century (McNeill, 2005). The past three or four human generations have greatly increased the scale and scope of human practices such as forest clearing, the use of fire and fuel, fishing, agriculture and manufacturing (McNeill, 2005). This has been accompanied by an increase in population size. All of these factors have brought about a change in land cover and landscapes, a change in atmospheric gas composition and changes in species diversity. These have, in turn, placed additional stress on the environment and its resource base via complex feedbacks in the system (Archer *et al.*, 1996). Some of the human activities and factors that underpin some of the environmental change can be clustered into three broad categories (Table 2.1).

Table 2.1: A Typology of Human Driving Forces (after Archer *et al.*, 1996).

Population change	Population at the global scale (and at the regional scale in certain areas) is growing at an increasing rate and is accumulating in settlements that stress the landscape (urbanization).
Technological change	Acts of technological innovation have become increasingly divorced from their environmental impacts. Thus, in addition to societal benefits, technology often contributes to environmental change or deterioration.
Socio-cultural and socio-economic organization	Economic institutions and markets, political economy, political ecology, and political institutions, all affect the relationships between humans and their environment.

It must be explicitly noted that the way humans organise their space and activities is inextricably linked to alterations to the natural environment. Economic, political (institutions, policies, legislation, rules and regulations) and social factors (ideologies, beliefs, cultures and traditions) all directly or indirectly affect the way human beings relate to, use and interact with the natural environment and use its resources (Kasperson *et al.,* 1995, Archer *et al*., 1996).

We have seen that a variety of factors, particularly those related to human activities, have interacted to produce a number of global environmental changes. These factors vary spatially, at different scales and at different times in human history. One of the most publicized, and talked about, as well as some of the most emerging changes currently impacting the Earth system, is climate change (IPCC, 2007).

2.2.1 Climate Change: The Global Context

Climate change is not a new concept or phenomenon. As briefly illustrated in Chapter 1, the earth has undergone a number of significant changes during the past five billion years or so and will continue to change again naturally in the future (Bernal, 1991; Archer *et al.*, 1996). The concern at present, however, is that warming of the earth's atmosphere is happening more rapidly than during other periods of climate change (Neftel *et al*., 1988).

What one does and does not know with certainty will affect responses to global environmental changes. For a number of years, both scientists and politicians have debated the real possibility of climate change. Recently the debates have shifted to discussions, not on whether or not global warming will occur but on how much the climate will change in response to such influences.

2.2.2 Actual Observed Changes in Climate

A key outcome of the recent IPCC assessment is that the warming of the earth's climate system is incontestable (see Figure 2.3, IPCC, 2007, 2008). Within the instrumental records of global surface temperature (since 1850) eleven of the last twelve years (1995 –2006) rank among the 12 warmest. "The updated 100-year linear trend (1906-2005) of 0.74 [0.56 to 0.92] °C is therefore larger than the corresponding trend for 1901 – 2000 given in the TAR of 0.6 [0.4 to 0.8] °C. The linear warming trend over the last 50 years (0.13 [0.10 to 0.16] °C per decade is nearly twice that for the last 100 years" (IPCC, 2007, 5).

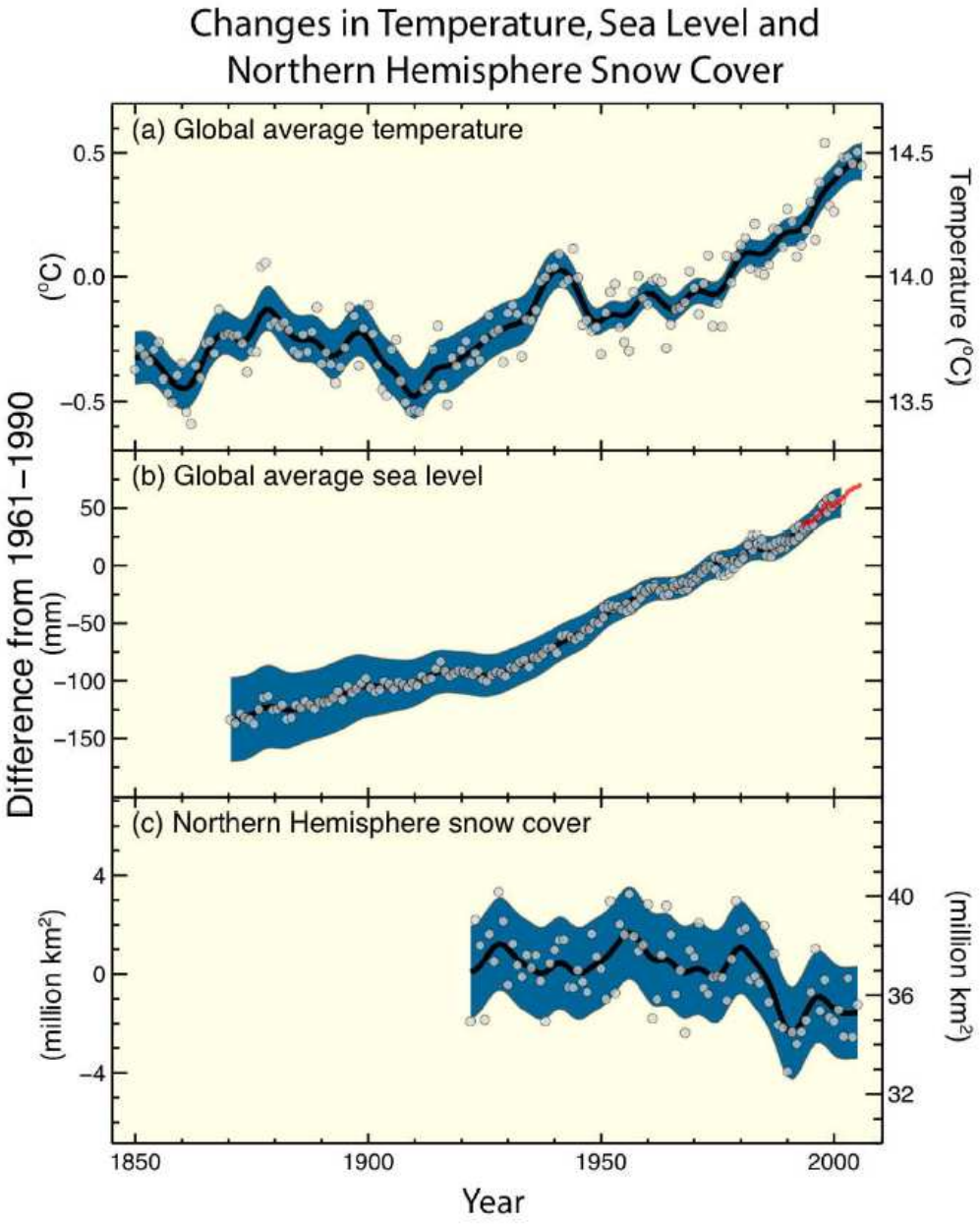

Figure 2.1: "Observed changes in (a) global average surface temperature; (b) global average sea level rise from tide gauge (blue) and satellite (red) data and (c) Northern Hemisphere snow cover for March-April. All changes are relative to corresponding averages for the period 1961-1990. Smoothed curves represent decadal averaged values while circles show yearly values. The shaded areas are the uncertainty intervals estimated from a comprehensive analysis of known uncertainties (a and b) and from the time series (c)" (IPCC, 2007, 6).

Some of the noted changes that have already been observed include that eastern parts of North and South America, northern Europe and northern and central Asia have shown significantly increased precipitation and drying has been detected in the Sahel, the Mediterranean,

Southern Africa and parts of southern Asia. Data are limited, however, in some regions. Since the 1970s, (especially in the tropics and subtropics) more intense, longer droughts have been experienced over wide areas. An increase in drying linked to higher temperatures and a decrease in precipitation have contributed to these changes in drought (IPCC, 2007).

2.2.3 Future Climate Changes

A large number of simulations are now available from a broad range of models (since the IPCC 2001 report). These provide a basis for estimating likelihoods for many aspects of future climate change (IPCC, 2007).

"Since IPCC's first report in 1990, assessed projections have suggested global average temperature increases between about 0.15°C and 0.3°C per decade for 1990 to 2005. This can now be compared with observed values of about 0.2°C per decade, strengthening confidence in near-term projections. Model experiments show that even if all radiative forcing agents were held constant at year 2000 levels, a further warming trend would occur in the next two decades at a rate of about 0.1°C per decade, due mainly to the slow response of the oceans. About twice as much warming (0.2°C per decade) would be expected if emissions are within the range of the SRES scenarios' (IPCC, 2007, 12). The continued emission of greenhouse gas whether at or above current rates, would cause further warming and changes in the earth's climate system that are likely to be larger than those seen during the 20th century (IPCC, 2007) (Figure 2.4)

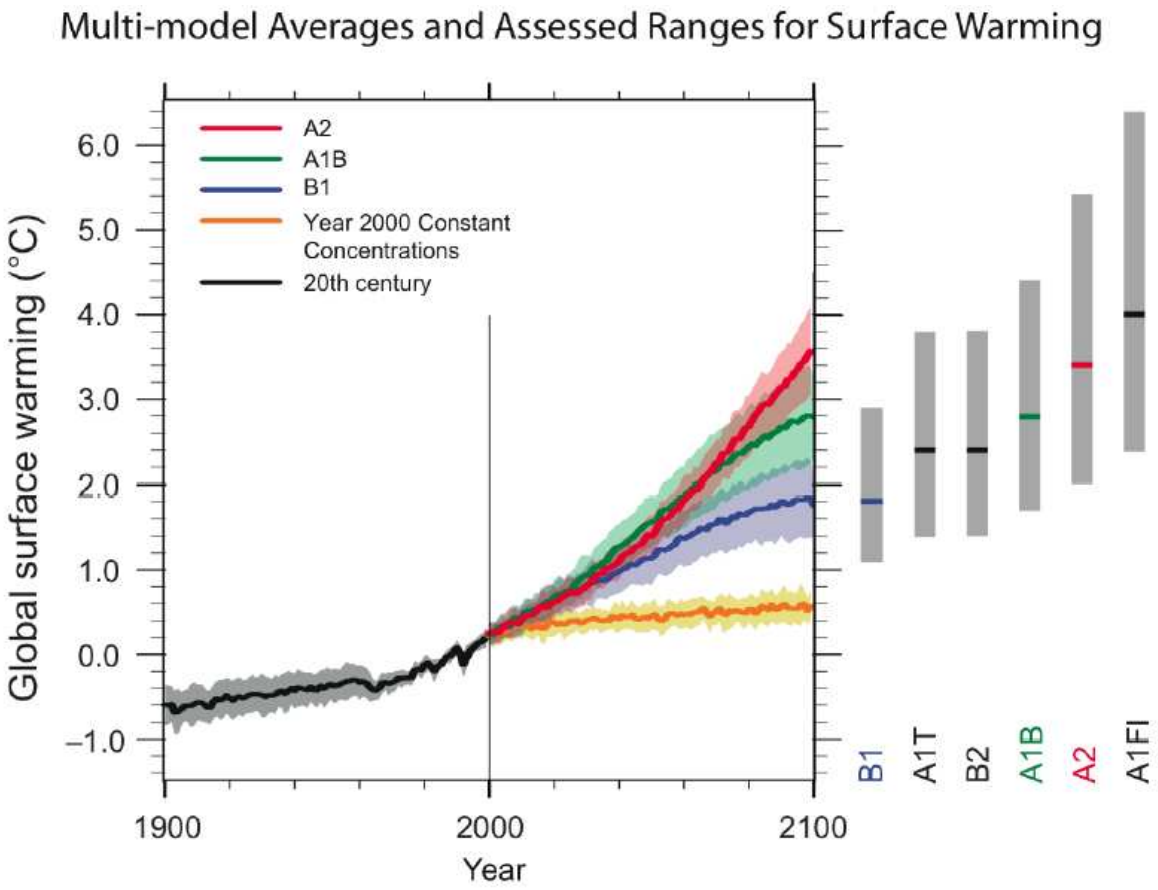

Figure 2.2: "Solid lines are multi-model global averages of surface warming (relative to 1980-99) for the scenarios A2, A1B and B1, shown as continuations of the 20th century simulations. Shading denotes the plus/minus one standard deviation range of individual model annual averages. The orange line is for the experiment where concentrations were held constant at year 2000 values. The gray bars on the right indicate the best estimate (solid line within each bar) and the *likely* range assessed for the six SRES marker scenarios. The assessment of the best estimate and *likely* ranges in the gray bars includes the AOGCMs in the left part of the figure, as well as results from a hierarchy of independent models and observational constraints" (IPCC, 2007, 14).

It is seen as *very likely* that hot extremes and heat waves as well as heavy precipitation events will become more frequent and it is *likely* that future tropical cyclones (typhoons and hurricanes) will become more intense (IPCC, 2007). There is higher confidence in projected patterns of warming (Figure 2.5) as well as changes in wind patterns, precipitation and some aspects of extremes (IPCC, 2008).

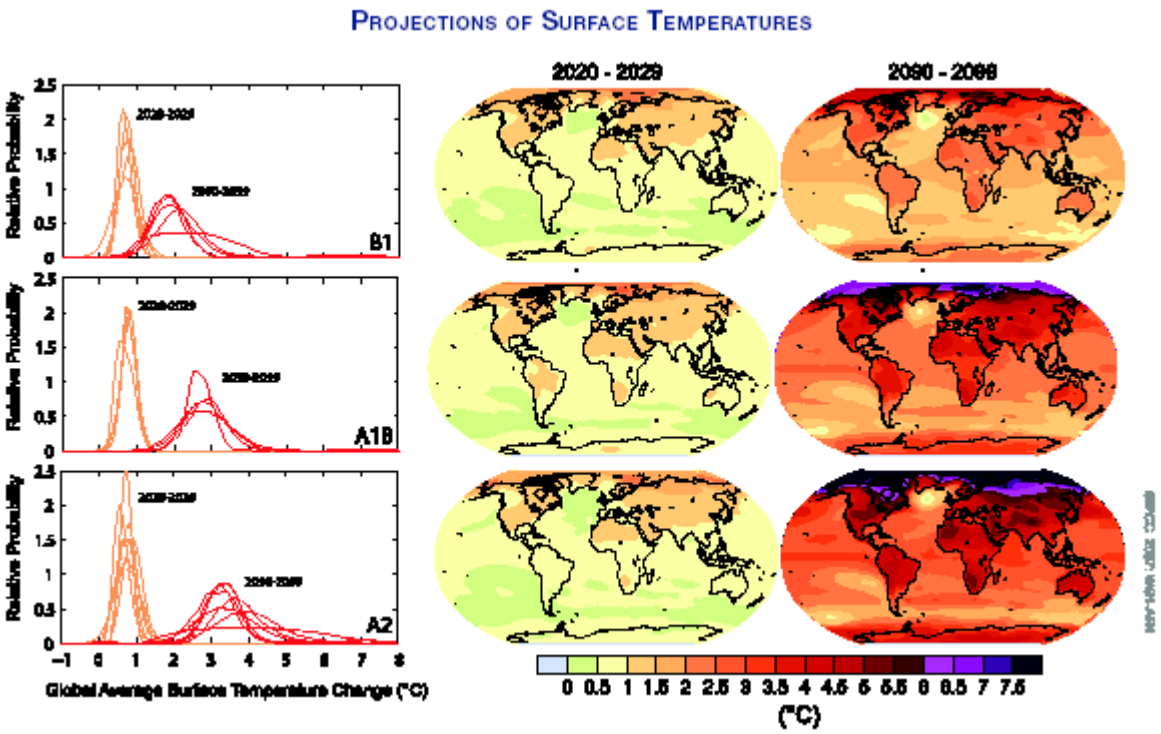

Figure 2.3: Projected surface temperature changes for the early and late 21st century relative to the period 1980–1999. The central and right panels show the AOGCM multi-model average projections for the B1 (top), A1B (middle) and A2 (bottom) SRES scenarios averaged over the decades 2020–2029 (centre) and 2090–2099 (right). The left panels show corresponding uncertainties as the relative probabilities of estimated global average warming from several different AOGCM and Earth System Model of Intermediate Complexity studies for the same periods. Some studies present results only for a subset of the SRES scenarios, or for various model versions. Therefore the difference in the number of curves shown in the left-hand panels is due only to differences in the availability of results (IPCC, 2007, 15).

There is also now an improved understanding of projected patterns of precipitation. An increase in the amount of precipitation is *very likely* in high latitudes. Decreases are *likely* in most subtropical land regions (IPCC, 2007) (Figure 2.6).

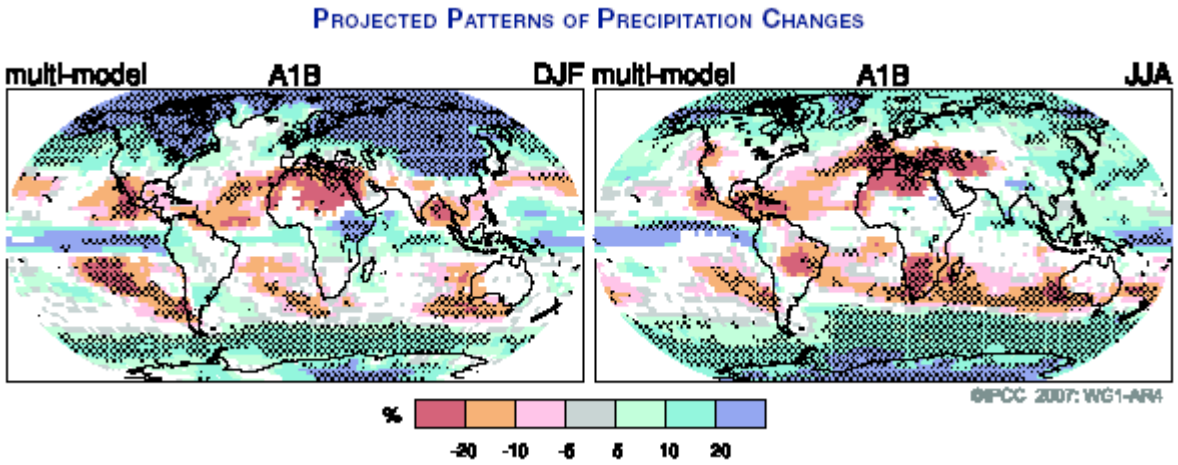

Figure 2.4: Relative changes in precipitation (in percent) for the period 2090–2099, relative to 1980–1999. Values are multi-model averages based on the SRES A1B scenario for December to February (left) and June to August (right). White areas are where less than 66% of the models agree in the sign of the change and stippled areas are where more than 90% of the models agree in the sign of the Change (IPCC, 2007, 16).

2.2.4 The African and South African Context

It is against this background that attention now turns to briefly examine some of the continental and more local projections associated with climate change. The African climate ranges from humid equatorial regimes and seasonally arid tropical regimes, to sub-tropical Mediterranean-type climates. These climates vary in that they exhibit differing degrees of temporal variability (particularly concerning rainfall) (Hulme *et al*., 2000). "The continent of Africa is warmer than it was 100 years ago. Warming through the twentieth century has taken place at the rate of about 0.5% century, with slightly larger warming in the June – August and September – November seasons than in December – February and March – May" (Hulme *et al*., 2000, 8). This rate of warming is not unlike that observed globally. Periods of most rapid warming (the 1910s to 1930s and the post- 1970's) occur concurrently in Africa and the world (Hulme *et al.*, 2000). It is very likely that all of Africa will warm during this century. This warming is very likely to be larger than the global, annual mean warming with drier subtropical regions warming more than tropical areas (IPCC, 2007) (Figure 2.6). Annual rainfall is likely to decrease in many Mediterranean Africa areas and the northern Sahara. In southern Africa rainfall is likely to decrease in a number of winter rainfall regions and on western margins (IPCC, 2007). In East Africa there is likely to be an increase in annual mean rainfall (IPCC, 2007) (Figure 2.5).

The IPCC (2007) reports that "Warming is very likely to be larger than the global annual mean warming throughout the continent and in all seasons, with drier subtropical regions warming more that the moister tropics. Annual rainfall is likely to decrease in much of Mediteranean Africa and the northern Sahara". "Rainfall in southern Africa is likely to decrease in much of the winter rainfall region and western margins" (IPCC, 2007, 850).

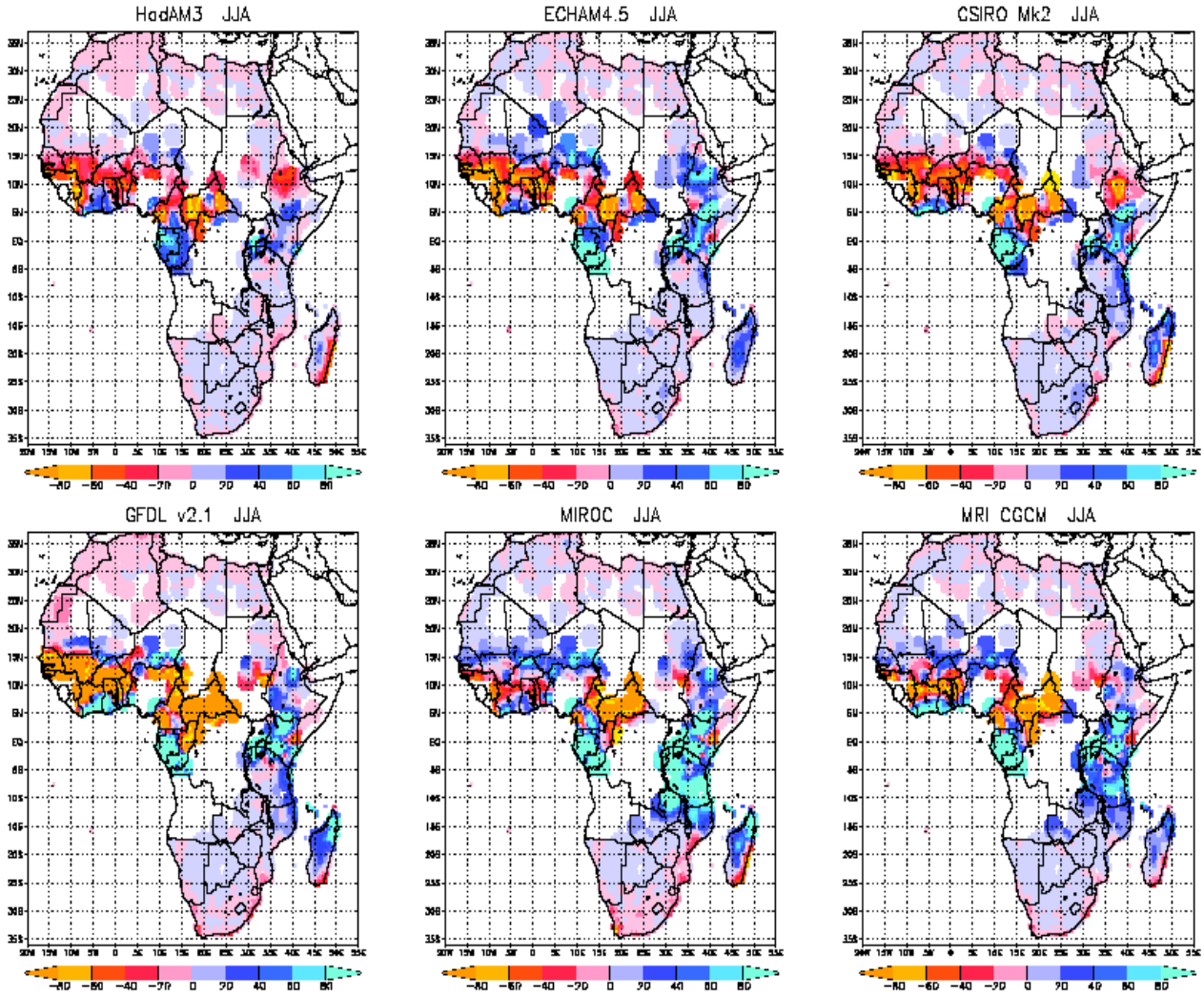

Figure 2.5: Anomaly of mean monthly precipitation (mm) using daily data empirically downscaled from six GCMs (ECHAM4.5, Hadley Centre Atmospheric Model (HadAM3), CSIRO Mk2, GFDL 2.1, MRI, MIROC) to 858 station locations. The GCMs were forced by the SRES A2 scenario. Anomalies are for the future period (2070 to 2099 for the first three models, and 2080 to 2099 for the latter three models) minus a control 30-year period (from Hewitson and Crane, 2006 in IPCC, 2007).

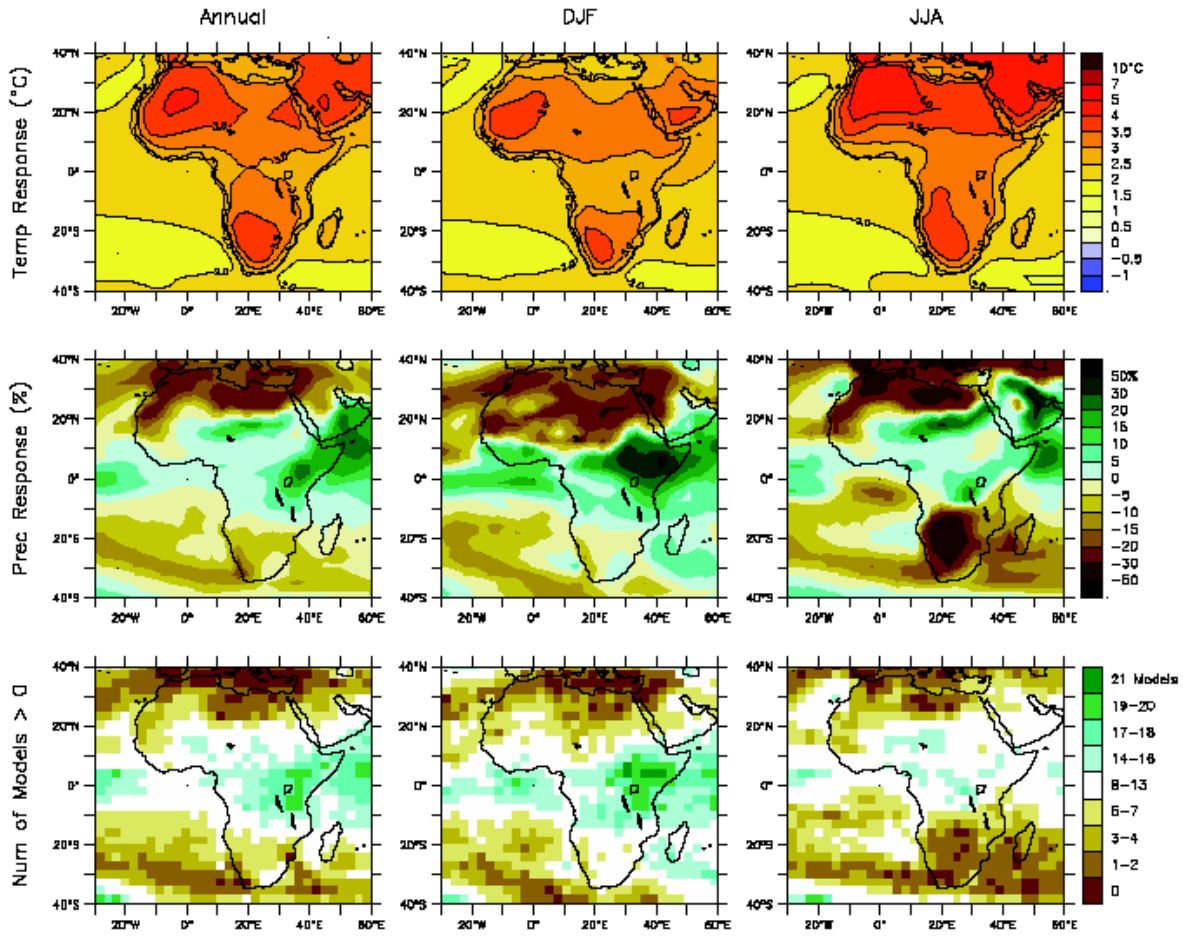

Figure 2.6: Temperature and precipitation changes over Africa from the MMD-A1B simulations. Top row: Annual mean, DJF and JJA temperature change between 1980 to 1999 and 2080 to 2099, averaged over 21 models. Middle row: same as top, but for fractional change in precipitation. Bottom row: number of models out of 21 that project increases in precipitation (IPCC, 2007).

More research is, however, required to understand the various modeled precipitation responses both in the Sahel and elsewhere in the tropics (IPCC, 2007). Progress is being made in the development of new methodologies for this purpose (e.g., Chou and Neelin, 2004; Lintner and Chiang, 2005; Chou *et al*., 2007 in IPCC, 2007).

In the South African context, much research effort is focussed on trying to develop projections for future climate, including patterns of rainfall and temperature. Global Circulation Models (GCM), for example, are used to obtain indications of projected climate. Both historically, and from the projected change, the expected temperature changes are

cohesive and clear in that most areas warm (Hewitson, *et al*., 2005). Indications are that surface air temperatures warm and inland regions warm more than coastal regions. Land surface feedbacks can be very important, however, exacerbating or mitigating changes being projected (Hewitson, *et al*., 2005). Some examples of model projections are provided in Figures 2.7 and 2.8).

In terms of precipitation, some of the more general statements on climate change include:

- On the eastern half of the country (particularly on the escarpment and eastward), increased moisture availability supports a projected increase in precipitation as well as an increase in rain days and an increase in rainfall intensity (Hewitson *et al*., 2005) (Figure 2.9 and Figure 2.10).
- More ambiguous changes are shown in the interior regions to the west of the eastern escarpment. A slight increase is shown for much of the region. The intensity of precipitation may be anticipated to increase, although this is not clear from the projections (Hewitson *et al*., 2005).
- Over the Western Cape winter rainfall shows indications of drying (Hewitson *et al*., 2005). Once seasonally averaged, the message is less consistent. In terms of monthly anomalies, however, most months indicate drying.
- "Extremely cold days and nights have decreased, and hot days and nights have increased. Moreover, hot extremes generally have trends of greater magnitude than their cold counterparts suggesting that the warm tails of the daily temperature distributions are changing faster than the cold tails; this implies that the shape of the distribution of daily temperature is changing along with the mean" (New *et.al*., 2006, 10).

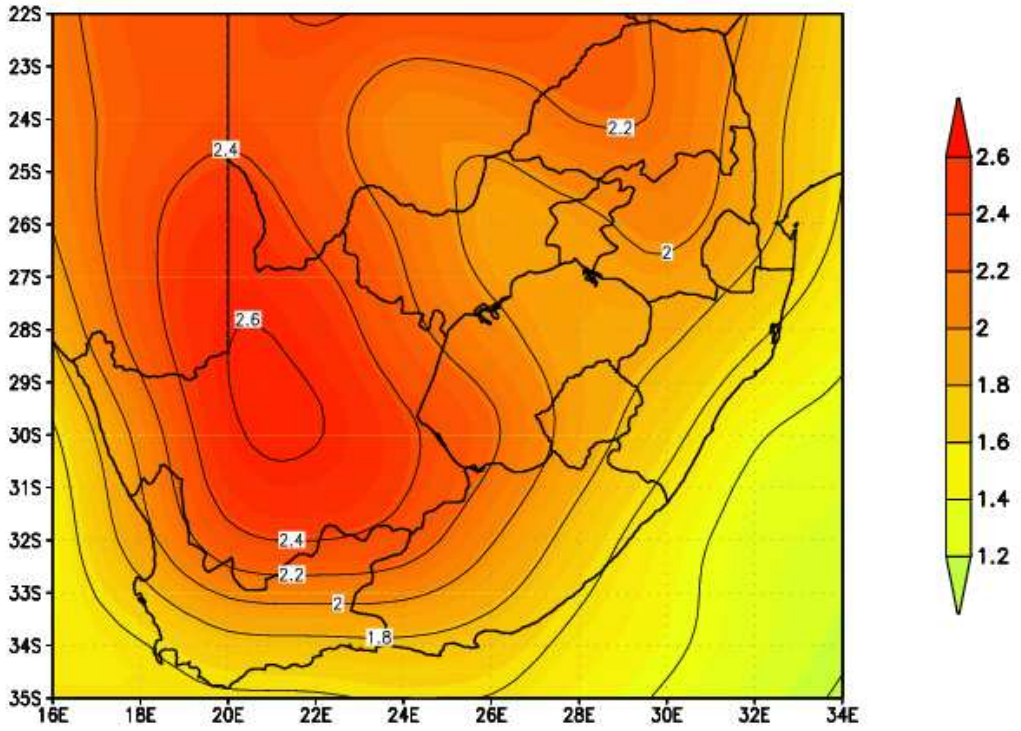

Figure 2.7: Examples of projections for temperature change (degrees Celsius) December, January and February year 2030-2040 (CSAG, 2007).

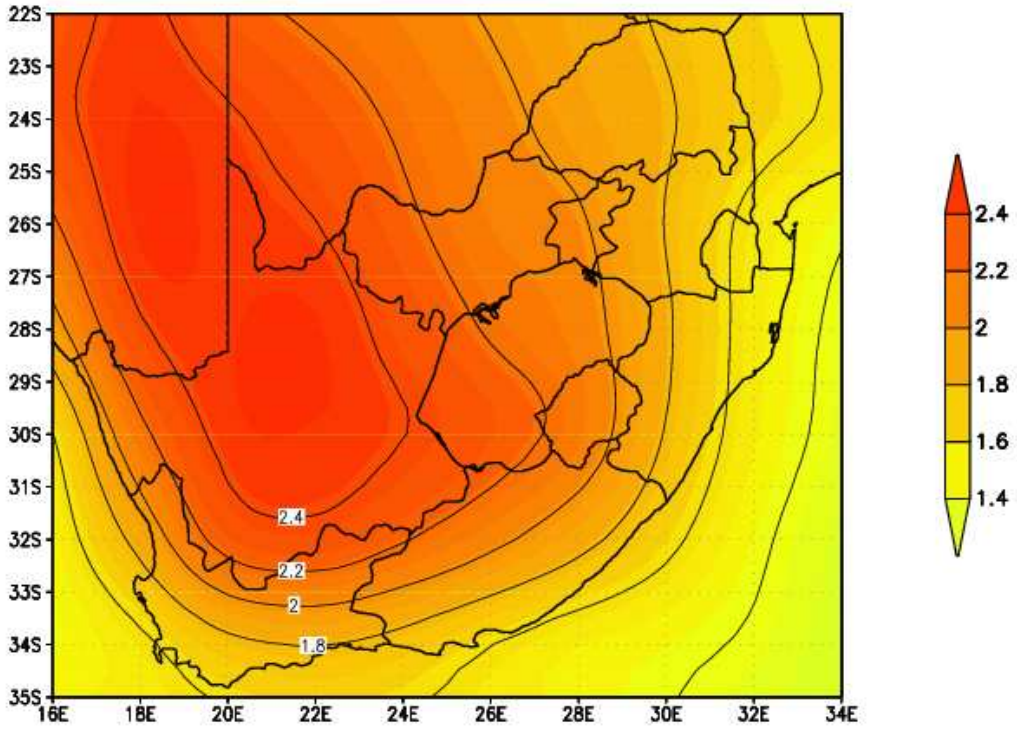

Figure 2.8: Examples of projections for temperature change (degrees Celsius) June, July and August year 2030-2040 (CSAG, 2007).

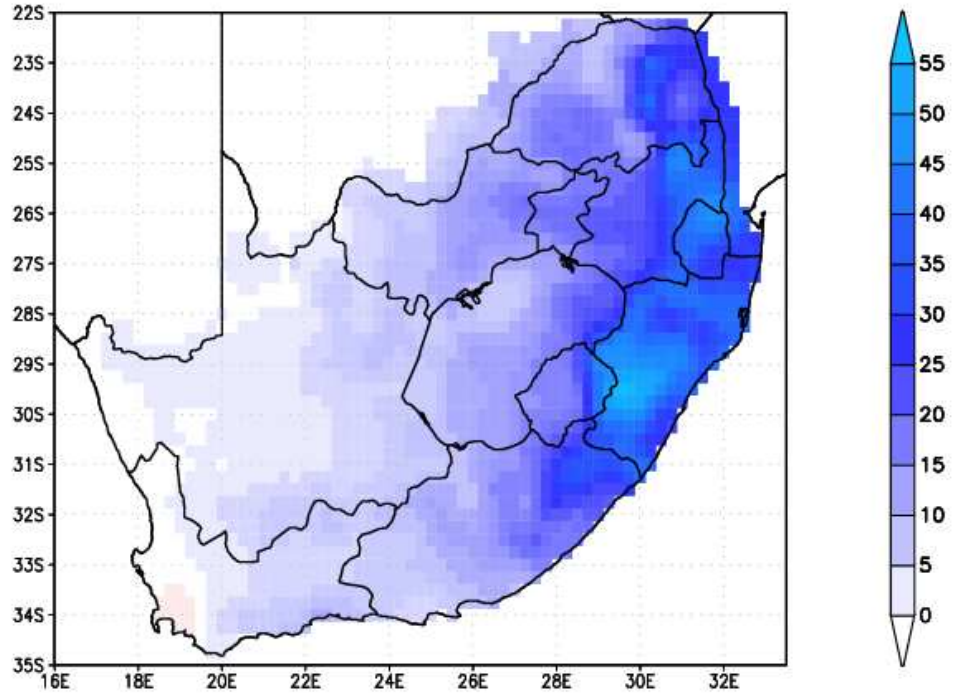

Figure 2.9: Examples of projections for rainfall change December, January, February year 2030 -2040 (CSAG 2007).

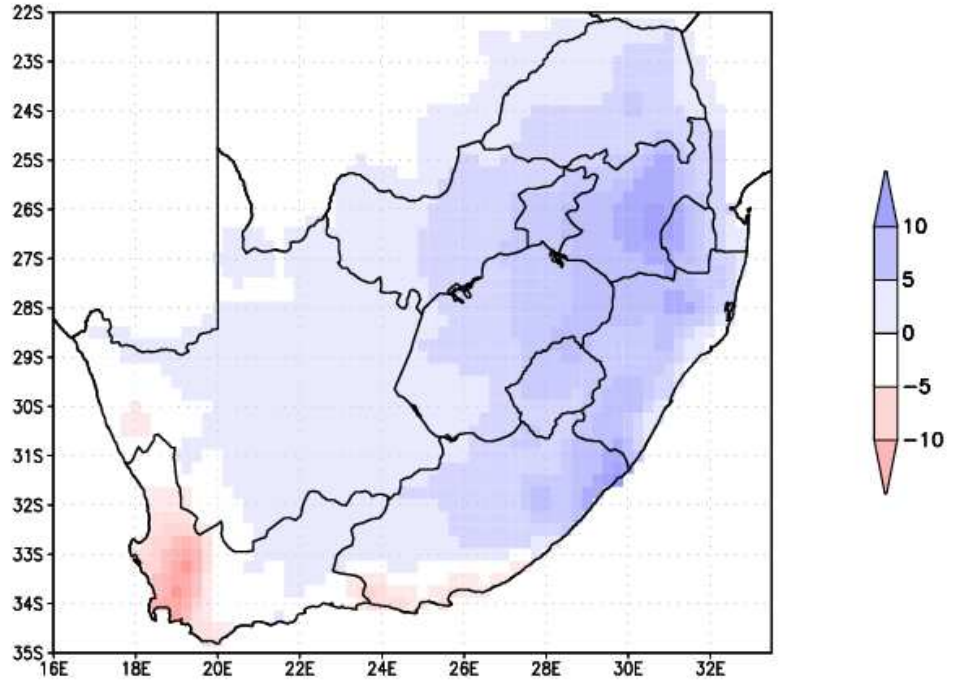

Figure 2.10: Examples of projections for rainfall change June, July, August year 2030 -2040 (CSAG 2007).

"Most of the work so far has been careful not to draw comparisons between observed change and future projections. There are several reasons for this: 1. It is hard to distinguish robust signals across models besides increases in rainfall intensity during seasons and an increase in rainfall intensity/total at the end of the rainfall season - there are indications in most GCMs and some empirically downscaled models of decreases in early summer rainfall; 2. Trends are often calculated for periods that do not coincide with the periods when we expect to see those robust changes in projections; 3. It is arguable that some of the physical processes leading to the climate change projections may not happen for another 10 -30 years" (Tadross, 2008).

Further, the degree of model simulation skill for seasonal forecast is challenging for KwaZulu-Natal. The skill of the information available is poor (as shown in Figure 2.1). This is particularly evident for summer seasons when the rainfall of this area is at its highest and farming needs climate information the most. "Uncertainty about future climate conditions is an important retarding factor for decision-making in agriculture, food security and many other water sensitive sectors of the economy. It is the highly variable nature of rainfall over much of Southern Africa which enhances the potential use and value of reliable and dependable seasonal forecast in the decision-making processes of different sectors" (Klopper, 1999, 311). "Constraints on the optimal use of climate forecast information includes factors such as the information provided is too general, non-specific to an area or particular application, received too late for use and is often too difficult for the user to interpret and apply" (Klopper, 1999, 311).

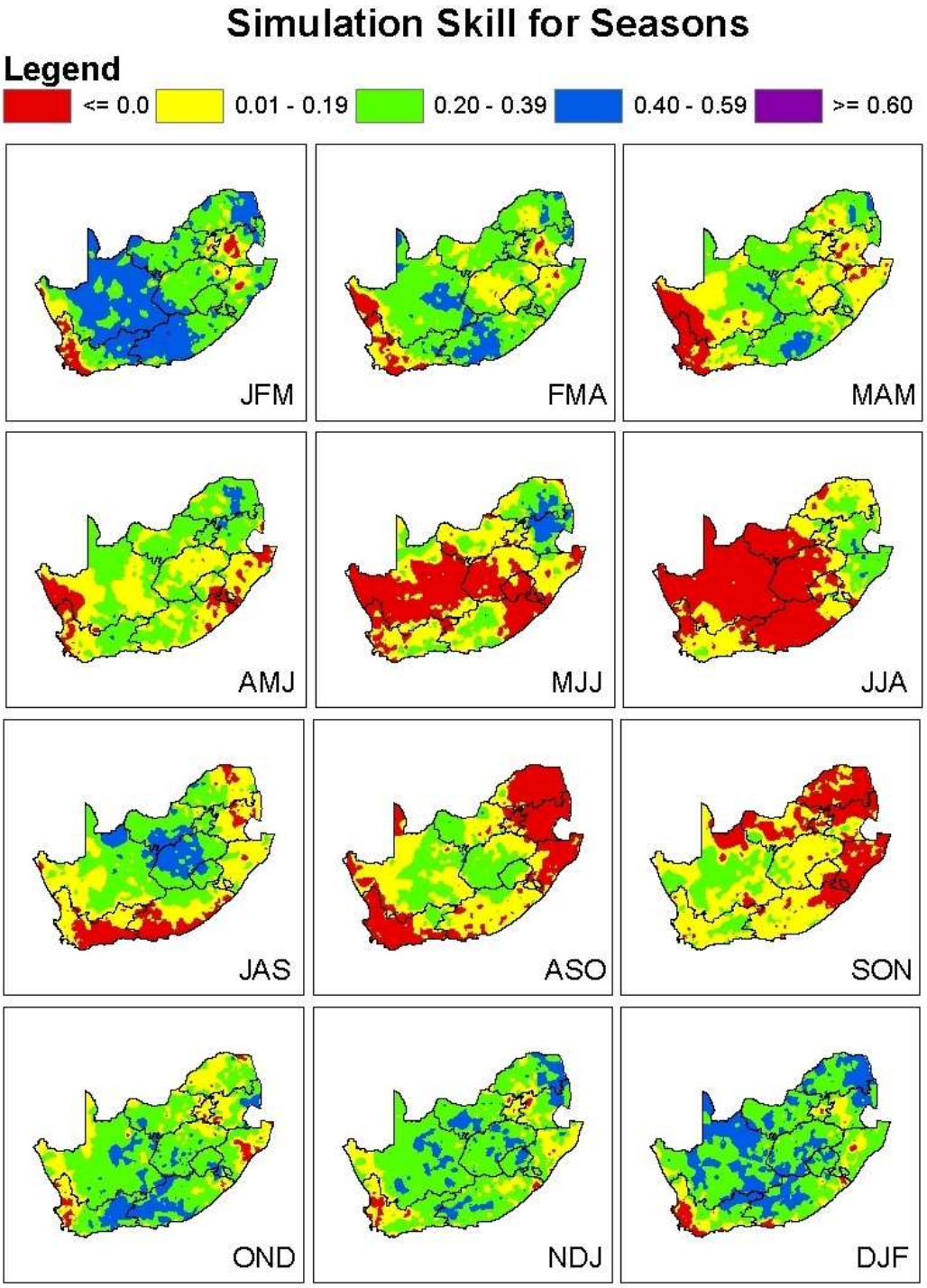

Figure 2.11: Correlation values between observed and forecast seasonal rainfall totals estimated over a 40+ year period. These skill maps are only applicable to forecasts made at lead times of a month or two (Landman, 2008).

In this work, downscaled projections and model outputs (even seasonal outlooks) were not tested with farmers, rather their perceptions of change and constraints to broader understandings of change (e.g. wetter than; drier than) were dialogued with farmers.

2.3 Climate Change and Farming in Africa

2.3.1 The Physical and Human Dimensions

Having outlined the potential climate changes, attention turns to an assessment of possible impacts that may accompany such changes. A number of African countries are heavily reliant on natural resources to sustain their economies. The agricultural sector is particularly dependent on these resources. Analysis of potential impacts, using models and scenarios assessments, dynamic simulations and various geographic databases, has been demonstrated for South Africa and the southern Africa region (see Hulme, 1996). The results reaffirm the dependence of production and crop yield on intra-seasonal and inter-annual variation of rainfall. Changes in temperature and precipitation will alter the distribution of agro-ecological zones. Changes in soil moisture and content, and the timing and length of growing seasons will be affected in a number of ways (Kurukulasuriya *et al.*, 2003). An increase in extreme events such as droughts and flooding as well as a change in the availability of water brought on by changes in the climate, will also affect agricultural practices negatively.

Carbon dioxide effects are, however, expected to have a positive impact on some crops due to, for example, greater water use efficiency and higher rates of photosynthesis. The direct effects are largest on crops with C_3 photosynthetic pathways (wheat, rice, and soybean) compared with C_4 crops (maize, sorghum, millet, and sugarcane). The growing seasons may lengthen and crops may have an increase in yields. Plant growth and health may benefit due to fewer frost days. However, any change may bring with it a forced alteration in farming practices and livelihoods (IPCC, 2007).

Climate change is a global issue, even more so for traded commodities such as agricultural products. Some regions, for example, may be less competitive in national and global agricultural markets. African climates are diverse, rainfall variability is large and observational data are inadequate to make an accurate assessment of local scale changes (IPCC, 2007). Yet, even if changes are not as drastic as predicted, impacts that occur with

other ‘drivers’ of change (e.g. land use policy, development needs, poverty and HIV/AIDS) within many sectors such as health, water and agriculture, may be significant (IPCC, 2001). The institutional arrangements and governance implications that may be required to better manage and design processes to reduce risks to climate variability and change, may thus be substantial. These outcomes may be heightened when superimposed on existing chronic vulnerabilities and stresses on various environments.

The degree of vulnerability of the agricultural sector to climate change is thus dependent on a number of wide-ranging local environmental and management factors. These include local biological conditions such as soil content, type of crop grown, and extent of knowledge and awareness of expected change in climate. Also included are the type and objectives of the management regimes prevalent in agriculture, the extent of support from government and other external, private agencies, and the ability of key stakeholders (at national, local and household level) to undertake the necessary remedial steps to address climate concerns (Kurukulasuriya *et al.*, 2003).

2.3.2 Climate Change and Sugarcane

Limited data are available on the climate change impacts on sugar cane farming and also on the response of the sugarcane crop to future climatic change, however, we do know that climate change is expected to affect sugarcane farming in a number of ways. The sugarcane crop’s phenology is expected to change, which will bring with it varying effects on productivity. More dry matter is expected to be portioned into trash and the sugarcane may accumulate more fibre at the expense of sucrose yields. Abundant flowering of the sugarcane stalk and an eventual yield reduction as well as (in some cases) a reduction in flowering will affect breeding programmes, sucrose yields and the industry in the long run (Nayamuth *et al*., 2002).

Insects, pests and diseases are expected to thrive as the ecological balance is disrupted with the change in climate (Nayamuth *et al*., 2002). Insects may colonise new areas and new species could move into sugarcane growing areas. Disease boundaries could shift and diseases develop as the climate becomes more favourable towards these threats. A number of weed species will benefit from carbon dioxide fertilisation, completing their cycle more rapidly.

The distribution and weed mix could change, affecting chemical control on crops (Nayamuth *et al*., 2002). Land suitability may change resulting in the shift of sugarcane areas thus competing with other crops for appropriate arable land and growing areas. Land use changes will have to be analysed in relation to mills and infrastructure as well as the surrounding communities. A deterioration of sugarcane quality will potentially reduce milling efficiencies and the cost of production and evolution in the world market sugar prices could play on the variability of the industry (Nayamuth *et al*., 2002). A decrease in sucrose yield will need to be countered by mass irrigation, the growing of drought resistant varieties and a change in crop cycles. Some negative effects of climate change may be countered by a rise in atmospheric carbon dioxide, which is essential for plant growth.

It must again be emphasised that the focus of this dissertation is on vulnerability and adaptation and so the next section examines elements of these concepts. The section that follows therefore devotes some time to investigating the links between vulnerability and adaptation to climate change and variability and the role that these concepts play in the core thrust of this work.

2.4 Climate Change and Human Vulnerability

Although there is uncertainty about the magnitude and the extent of climate change impacts, it is important to now begin assessing vulnerability and planning for adaptation to impacts. This is particularly necessary in Africa where there is still much uncertainty around the nature and processes of human adaptation especially to long-range climate change (IPCC, 2007). Progress has been made but significant gaps remain in knowledge systems regarding vulnerability, resilience, coping and adaptation of social, physical and ecological systems to the impacts of climate change (IPCC, 2007). "Advances in these areas are priorities for advancing understanding of potential consequences of climate change for human society as well as to support analysis of possible responses" (IPCC, 2001, 72-73).

Most of the work involving climate risk research has focused only on the possible impacts of future climate scenarios and on mitigation initiatives rather than on identifying and understanding the complex interaction of factors 'driving' risks and other multiple stresses.

These include institutional concerns, globalization, entitlements and access to livelihoods assets.

2.5 The Concept of Vulnerability

Over the past few years, the concept of vulnerability has emerged as a cross-cutting topic in research on the human aspects of global environmental change (encompassing global climate change) (Kasperson and Kasperson, 2001; Polsky *et al*., 2003). Vulnerability is a much contested term. It has its origins in the literature on natural hazards and food security. It is, however, increasingly being applied in assessments of climate variability and climate change impacts (Vincent, 2004). A variety of definitions of vulnerability have been proposed (for a review of these see Cutter, 1996).

It is essential that the definition of vulnerability used in this study is outlined because the definition or use of the word vulnerability in this context determined the methodology of this study both in the fieldwork stages and in the analysis of the results. Providing a definition of vulnerability also assisted in developing a conceptual framework for this work.

2.5.1 Viewing Vulnerability as a Starting Point

Vulnerability is sometimes viewed as an end point, a residual of a climate variability and change impact minus the adaptation. It is shown as the net impact of climate change or a climate change related event. Vulnerability can then be viewed as a characteristic, or state, generated by many different environmental and social processes (exacerbated by climate change) (Kelly and Adger, 2000). Instead of being defined by climate change scenarios and the anticipated adaptations, vulnerability also represents the present inability to cope with the external pressures. Vulnerability is seen as a characteristic of social and ecological systems generated by various factors and processes in a particular context. Addressing present day vulnerability thus will assist in reducing future vulnerabilities under future climate change conditions and stresses (O'Brien *et al*., 2004). Much of the research effort in this work is devoted to this dimension of vulnerability.

The starting-point and interpretation used in this thesis has its origins in the assessment of social vulnerability, which has the primary purpose of identifying the character, distribution,

and causes of vulnerability. It is critical that vulnerability is seen to be a dynamic entity in a continual state of change, as the biophysical and the social processes that shape local contexts and as the ability of people to cope with change (O'Brien *et al.*, 2004). Viewing vulnerability in this way also assumes that vulnerability determines adaptive capacity and thus adaptation. This has important implications for how both the problem and possible interventions are seen and approached (O'Brien *et. al.*, 2004).

In short, vulnerability as defined here, refers specifically to individuals and social groups. It is an indication of people's exposure to external risks, shocks and stresses and their ability to cope with, adapt to and recover from, the resulting impacts placed on their wellbeing and livelihoods. Vulnerability can differ seasonally and across groups or individuals due to their livelihood activities. This type of research approach is often applied to rural and smaller-scale assessments (e.g. Eakin *et al*., (2003).

2.5.2 The Nature of Vulnerability

Human vulnerability to climate risk is a mixture of physical impact (drought, floods), the responses of biological components to these impacts and the likelihood of adaptation of people. Vulnerability is multi-layered and multidimensional, as suggested above, and is produced by continual processes and is not simply a single, once-off outcome of sudden shocks and hazards. It is further characterized as a function of three components. They are adaptive capacity (discussed in greater detail later in this section), sensitivity, and exposure.

- Adaptive capacity: The potential or capability of a system to adapt to (that is to say, alter or better suit) climatic stimuli or their effects and/or impacts (IPCC, 2007).
- Sensitivity: This is the degree to which a system will respond to a change in the climatic conditions of the area (IPCC, 2007).
- Exposure: Exposure is the degree of the climate change stress on a particular unit of analysis. This may be represented as either a long-term change in the climatic condition, or by the changes in climate variability. This will be largely socially determined and will depend on where groups of people choose to live (or are

forced to live), and on how they construct both their communities and livelihoods (Adger *et al.*, 2004).

When examining vulnerability to climate change risk it is essential to examine both the 'internal' and 'external' dimensions of vulnerability as well as examine wider socio-economic and historical contexts in which agents may find themselves located (e.g. Chambers, 1989 and Bohle, 2001). The internal dimension examines the capacity of the system to anticipate, cope with, resist and then recover from the shock and in the long term adapt (coping and action to overcome or at least mitigate the negative effects of certain changes). The external dimension examines the exposure of the system to an external influence such as climate, flooding, drought etc. (Figure 2.2). The external dimension of vulnerability exposure has been discussed in much detail in other studies. The internal dimension has largely been neglected (Bohle, 2001).

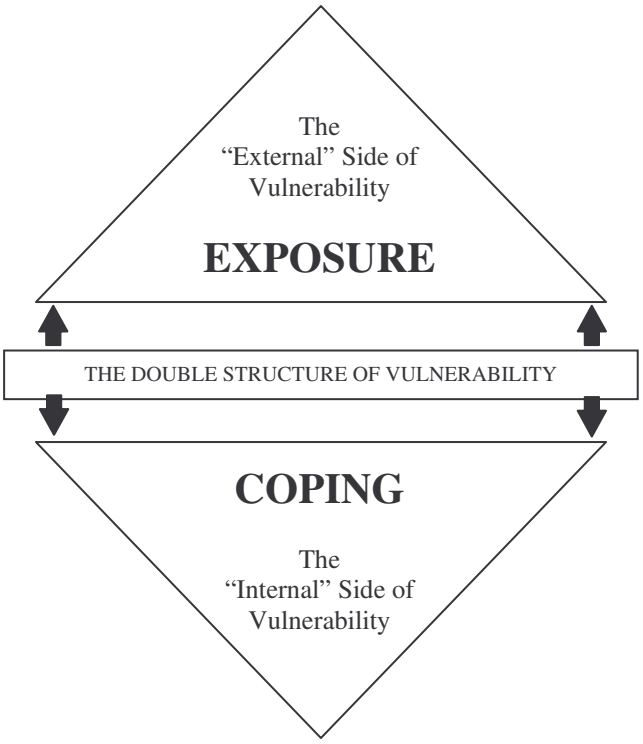

Figure 2.12: A Conceptual model for Vulnerability (after Bohle, 2001)

A group's capacity to anticipate, cope with, resist and recover from stresses (particularly climate stress) is a key factor (Kasperson *et al*., 2001). Vulnerability can be viewed as a function of adaptive capacity and the ability of a system to cope (UNEP, 1998).

2.5.3 Resilience and Adaptive Capacity

2.7.3.1 Adaptive Capacity

Adaptive capacity represents potential rather than actual adaptation. It refers to the ability of a system to adjust to either actual or expected stresses (climate), or to cope with the consequences it brings. It is considered a function of a number of elements including material wealth, education and information, skills and technology as well as infrastructure, access to resources (O'Brien *et al*., 2004) and the role of both formal and informal institutions.

"The vulnerability of populations is both event-based and a product of political and economic structural factors" (Adger *et al*., 2003, 190). Social vulnerability, and subsequently adaptive capacity, is visible in, and influenced by, various factors. These include assets (social, financial, natural/environmental, physical, human, knowledge systems), availability of and access to these assets, access to technology options and services, as well as access to infrastructure, agricultural support and inputs. These also include levels and sources of income, aspects of social capital, security of entitlements and the quality of various institutions both formal and informal. The structure of relevant institutions and decision-making groups, as well as the structure's access to risk spreading processes and the ability of decision-makers to manage information, are also critical (Yohe and Tol, 2002).

One must note that the adaptive capacity of societies is also dependent on the ability of the system to act together in the face of climate change threats. Adaptive capacity can be further examined by looking at the institutions in place for resource management and both their effectiveness and legitimacy (Adger *et al.*, 2004). "The nature of adaptive capacity is such that it has culture and place-specific characteristics that can be identified only through culture and place-specific research" (Adger, 2003, 400). Caution, however, needs to be taken here as adaptive capacity is difficult to measure since it is connected to levels of human and social capital as well as economic and political stability and current climate conditions (UNFCCC, 2002).

2.5.3.2 Resilience

Allied to these concepts of adaptive capacity and vulnerability is the notion of resilience. Girot (2002) identifies three defining features of resilience in an integrated human-ecological system. The first is the amount of disturbance that a system can handle or absorb and still remain within a stable state. The second is the degree to which the system is capable of self-organization or organization by external factors and, lastly, the degree to which the system can build and increase the capacity for learning and adaptation.

Resilience can be either risk specific (drought, flood, etc) or general (the ability to withstand impacts of shocks and tendencies that upset lives and livelihoods). Examples of general resilience include overall health or the economic status of the household, the innovation and diversity of livelihood resources and sources, access to savings or credit, or inclusion into strong supportive social networks (Girot, 2002). This is particularly important where communities or households are facing various multiple vulnerabilities that are not connected with climate or natural resources. Here, improving overall resilience or adaptive strategies would be more effective than trying to examine and reduce specific vulnerabilities (The Task Force on Climate Change, Vulnerable Communities and Adaptation, 2003).

2.6 Coping and Adaptation

Having outlined some general similarities and differences in conceptualization attention now turns to further examine what is meant by coping and adaptation. Coping and adaptation differ in both scale and scope. Coping usually refers to short-term responses to stresses while adaptation refers to longer-term strategies put in place to reduce both sensitivity and vulnerability to a hazard. Adaptation refers to: “changes in processes, practices, or structures to moderate or offset potential damages or to take advantage of opportunities associated with changes in processes, practices, or structures to moderate or offset potential damages or to take advantages of opportunities associated with changes in climate. It involves adjustments to reduce the vulnerability of communities, regions, or activities to climate change and variability. Adaptation is important with regards to climate change issues in two ways. The first relates to the assessment of impacts and vulnerabilities, the other to the development and evaluation of response options” (IPCC, 2001, 881).

Adaptation can take place at all levels, including changes to global systems at regional or national level and adaptation made by local communities and individuals. Adaptation can be reactive (after the impact has taken place) or anticipatory (in preparation for the expected impact) (IPCC, 1995). Adaptation can be localized or widespread, and can serve numerous functions and take on numerous forms. Adaptation can be undertaken by individuals, communities, or specific groups (IPCC, 2001) and is a dynamic and social process. The ability of a group to adapt is partly determined by the ability of the group to act collectively (Adger, 2003). Adaptation usually takes place in dynamic, social, economic, technological, biophysical, and political contexts that vary over time, location and sector.

These adaptive actions will be directly dependent on access to assets and on the individual or community's capabilities. Their actions, though, will also be the most appropriate given the specific threats and impacts and potential they have to respond to them. We must therefore ask: What is already happening within households? or what is likely to happen? among the people who are vulnerable (The Task Force on Climate Change, Vulnerable Communities and Adaptation, 2003). The next step is to ask: What adaptation measures have been adopted? Why have groups adapted? To what they have adapted and what is likely to happen in the future?

Every stakeholder has specific interests, risks, information and resources used to manage risks and therefore would consider and use distinct types of adaptive responses. This needs to be rooted in an understanding of how vulnerable groups sustain their own livelihoods and enhance their own resilience. One must also focus on how sensitive and sustainable these adaptations are to existing and potential changes within the climate (The Task Force on Climate Change, Vulnerable Communities and Adaptation, 2003). This sustainability applies both to the effectiveness and long-term use of strategies, but also the effect that these strategies have on the local natural environment.

2.7 Summary

Climate change is expected to bring with it a number of changes that influence social, biophysical and economic systems both globally and locally. Even if we undertake immediate and drastic mitigation activities the earth is still committed to some degree of climate change

(IPCC, 2007). It is therefore important to assess ways of adapting to expected changes and assessing vulnerability to these changes. With this in mind the methodology for this study included the use of a vulnerability assessment in an effort to investigate the vulnerability of farmers, to threats and stresses, including both climatic and non-climatic factors as well as the adaptation capacity and adaptation strategies undertaken by farmers in response to possible climate change.

Vulnerability is viewed as a starting point in this study. It is seen as a function of three components: Adaptive capacity, sensitivity and exposure. There is both an external and an internal side to vulnerability. The internal dimensions of vulnerability examines the capacity of a system to anticipate, resist, cope with and recover from a shock and in the longer term adapt. The external dimensions include the examination of the exposure of a system to an external threat such as climate change impacts. Adaptive capacity refers to the ability of a system to adapt to either actual or expected stresses and cope with the consequences it brings. Coping is viewed as a short-term response to stresses while adaptation involves a longer-term strategy put in place to reduce sensitivity and vulnerability to a hazard. Adaptation thus involves changes in process, practices, or structures to mitigate or offset potential damage or take advantage of changes.

The next chapter will examine the methodologies, approaches and applications related to the study. The chapter will investigate the development of vulnerability studies from a research paradigm focused primarily on the 'impacts' of climate and variability, to a recognition that vulnerability is both a biophysical and a social characteristic. It will also explore the various methodologies, approaches, and applications shown in the literature used to capture vulnerability data. The chapter, finally, shows the step-by-step approach of the primary data gathering process undertaken in this study.

CHAPTER 3
VULNERABILITY STUDIES AND ASSESSMENTS: METHODOLOGIES, APPLICATIONS, AND APPROACHES

3.1 Introduction

The previous chapter examined the relevant topics of global environmental change, climate change (global and local), vulnerability, adaptive capacity and adaptation. In this chapter, the methodologies, approaches and applications related to the study of these concepts and their relation to the study presented in this work are examined. The evolution of vulnerability studies from a research paradigm focused primarily on the 'impacts' of climate and variability, to a one that includes a recognition that vulnerability is a biophysical as well as a social characteristic, is examined. A suite of methodologies, approaches, and application shown in the literature to capture vulnerability through vulnerability assessments is then presented. The final part of the chapter shows the step-by-step approach of the primary data gathering process and secondary data collection underpinning the particular study.

3.2 Vulnerability Studies: A Progression through Time

During the 1970s, initial developments in the field of impact assessment were sparked by the first concerns over the depletion of atmospheric ozone (Parry, 1990). Most of these studies were concerned either with the impact that human beings had on the environment or with the effect of climate variability on agriculture. This 'impact' approach was based on the assumption that there was a direct cause and effect relationship between a climate event and the response of the system studied. This approach may, however, be misleading. It tends to treat climate variability, the exposure unit (area under study) and the impacts as isolated elements separated from the various other factors that may intervene and combine to influence the 'vulnerability' of the system to a risk such as climate change.

Since 1980, there has been an increased emphasis on attempting to better understand the interactions between climate change and the potential response to this, by assuming that the climate event is simply one of a number of processes (including biophysical and socio-economic) affecting the exposure unit (Parry and Carter, 1998). This 'interaction' approach, as opposed to an 'impact' approach, considers the interactions that occur between different

elements within the particular exposure unit (Parry and Carter, 1988; Parry 1990). This approach examined the capacity of societies to cope with and absorb impact and recognized that this was not a simple and one-dimensional linear function but a complex interactive relationship between social and natural systems. This approach called for the identification of vulnerable groups, regions and activities and introduced the new approach of vulnerability which directed attention to relative capabilities to cope with climate variability and change.

There has thus been a growth in theoretical and conceptual studies that aim to highlight the nature of vulnerability to climate change. Social vulnerability is now viewed more as a potential state of a community in contrast to being seen as an outcome and is therefore seen to affect the way natural hazards are experienced (Adger, 1999; Adger *et al*., 1999; Blaikie *et al*., 1994). Such an approach has, on may argue, turned impact assessment on its head. Now the multiple stresses and factors shaping vulnerability when combined with climate events generate critical outcomes are also examined (Ribot, 1995) (Figure 3.1 and Figure 3.2).

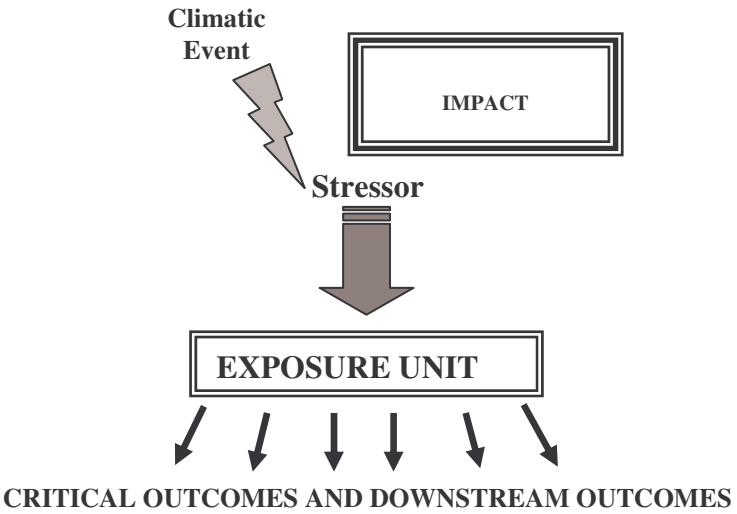

Figure 3.1: Impact assessment (after Vogel *et al*., 2004).

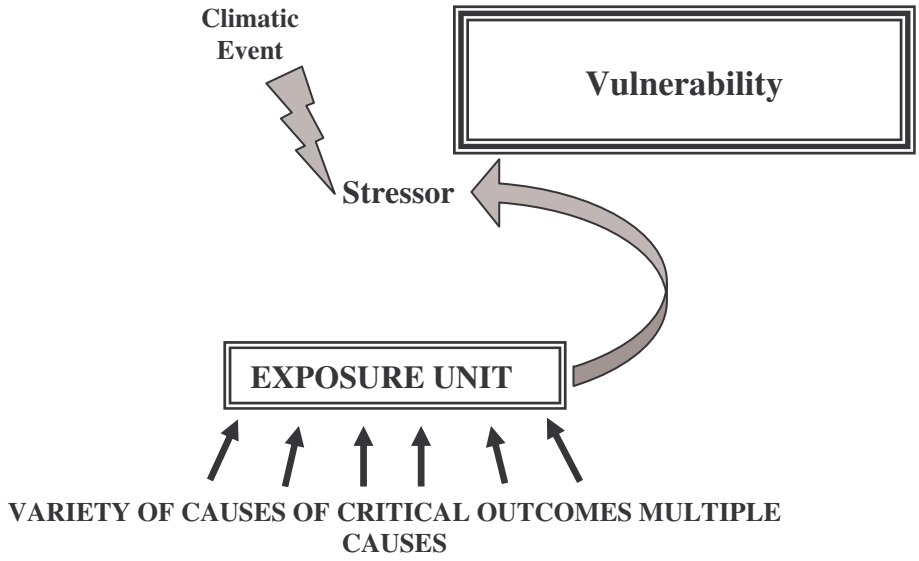

Figure 3.2: Vulnerability assessment (after Vogel *et al*., 2004).

3.3 Integrating Human Dimensions

The late 20th century and the early 21st century saw an increase in research focused on the link between human dimensions and global change and has received significant attention in new assessment and policy initiatives (such as the Millennium Ecosystem Assessment and reports of the IPCC). Local level vulnerabilities, resilience, differentiation and human responses have been covered extensively in these initiatives (Adger *et al*., 2005).

These global and regional concerns to enhance the human dimensions of climate change and climate variability research have resulted in a number of initiatives aimed at trying to capture vulnerability. Within this context vulnerability is not viewed as a result of an extreme event (as implied in impact studies) but rather as a societal characteristic which is intrinsic and inherent in a social system before the onset of the event. It is because of this view that a number of working groups operating within the field of rural livelihoods have seen close linkages between vulnerability and livelihoods and have conducted a number of studies in this area. These groups have explored the relationship between vulnerability and the assets base that a household has, their entitlements and access to these resources and the extent to which people with these assets at their disposal can adapt. These groups do not focus on climate

model output, but rather try and better understand the context in which a climate stressor may operate. It is this approach that is shown here.

3.4 Vulnerability Assessments: An Overview of Methodologies, Approaches, and Applications

The previous section examined the evolution of an input/output informed 'impact' approach, to a more holistic and realistic interactions approach that examines the role and interaction of different elements and actors, shocks and stresses within a system. Vulnerability assessments have developed as a methodology informed by this 'interactive' approach.

In the next section, the applications and approaches to vulnerability assessments in certain sectors are presented. This section, however, is not dedicated to assessing the success or failure of previous studies because it is difficult to measure 'success' across a variety of assessments that emerged from a variety of different contexts. These applications and approaches, nonetheless, illustrate the range of frameworks that may be used in assessing vulnerability both at an international and at a local scale. In 2005, the UNFCCC Secretariat released a compendium of methods and tools to evaluate impacts of, and vulnerability to, climate change. This gave a comprehensive listing and brief explanation of current methodologies and applications. The methodologies and approaches discussed in this section of the dissertation are the approaches that are most closely linked to this work and which were the most useful in informing the methodology and achieving the aims of the study presented in this work.

3.4.1 Approaches to Vulnerability Assessments and Global Environmental Change

Various global change research studies have included vulnerability assessments; for example the AIACC (Assessment of Impacts and Adaptation to Climate Change in multiple regions and sectors) projects and the UNEP/TWAS/START/GEF project on climate change adaptation. Some of the projects specific to the farming sector are:

- "Adaptive Capacity of Farmers to Climate Variability and Change: Mexico" (Gay *et al*., 2003). This project focused on adaptive capacity and social vulnerability of farming communities.

- Sustainable Livelihoods in Sudan (Osman *et al*, 2004). This used DFID's Sustainable Livelihoods Framework and assets studies to assess vulnerability and resilience to climate change (http://sedac.ciesin.columbia.edu/aiacc/methods.html, 2007).

A variety of methods were used for vulnerability assessments in each project. These methods included the use of: Sustainable Livelihoods Indicators, Decision Support system methodologies, Cost-benefit analysis and Multi-Criteria Analysis (which involves the development of indicators to guide the study).

There are a number of other studies and literature on vulnerability (particularly social vulnerability) to climate change, which often include an investigation into the role and nature of entitlements (linked to SLF and Political ecology) (Adger *et al.*, 2004). More specifically in Africa, Downing *et al*. (2006) have studied in depth the topics of vulnerability and adaptation while undertaking case studies of impacts on agriculture and water. Other research on this topic includes Adger (2003) and Leichenko *et al*. (2004).

3.4.2 Famine Early Warning Systems and Food Security Vulnerability Assessments

Agriculture and food systems dynamics can also influence vulnerability to change particularly climate change. Livelihoods and household level assessments that are used in this study can assist in identifying particular vulnerabilities to stress. The food security research paradigm, for example, has evolved over the years to include issues of entitlement, vulnerability, risk and access (Maxwell *et al*., 2003), as well as an emphasis on sustainable livelihoods and household specific studies (central to vulnerability assessments).

A number of vulnerability assessments have been carried out in Africa, particularly in Southern Africa (SADC FANR Vulnerability Assessments). Detailed vulnerability analyses have been conducted in countries such as Tanzania (Jere, 2005), Zimbabwe (using Risk Map and indicator based approaches) and in Mozambique (Diriba, 1997). More recently vulnerability assessments have been undertaken in six Southern African countries using Vulnerability Assessments Committees. The SADC Vulnerability Assessment Committee collaborated with a number of partners gathering varied and critical information on food security in the region in order to respond to food shortages experienced during the 2001/2003

drought season. These were rapid iterative studies, which were intended to meet the food relief objectives of policy makers and donor groups. Several snapshots were obtained of vulnerability in the area.

Given the emergence of a multiple stressor focus it is key to find appropriate ways to identify the interacting causes of change.

3.4.3 Political Ecology and Actor Network Theory: Entitlements and Access in Vulnerability Assessments

"Vulnerability is fundamentally a political ecological concept" (Oliver-Smith, 2004, 10). Political ecology frameworks are an important starting point of vulnerability assessment design that assists in identifying the complex web of social 'driven' change. They blend the relationship between people and their environment with the political economic forces of society. They combine elements of politics, environment, culture, and society. This is particularly important as vulnerability, as outlined above, takes different forms including natural, physical, economic, social, political, technical, ecological and institutional vulnerability. Political ecology offers a way to make sense of 'non-place-based' forces (such as policies and institutions) over 'place-based' activities such as agricultural production.

The advantage of using this analysis is that it follows a chain of explanations through various scales and different levels of analysis. It is also concerned with analyzing a number of complex human-environmental interactions. It is interdisciplinary (integrating human and biophysical factors which is key in vulnerability assessments and features strongly in the SLF) and attempts to connect social structure, human agencies, and the biophysical environment as well as demonstrate and layout the differential vulnerability of human groups (Stonich, 1993). According to a political economy approach, vulnerability should be understood in terms of powerlessness rather than simply material need. A political economy approach should incorporate a wide historical and geographical perspective" (Clover, 2004, 45). This has a great deal in common with the Sustainable Livelihoods Framework of analysis which also investigates the impact of access and entitlements, institutions and policies as a central part of its analysis.

Political ecology also has a historical mode of analysis, which is able to single out narratives and identify the power relations within these narratives. It moves from a structuralist approach to aspects of vulnerability, to a careful consideration of the whole schema of vulnerability and adopts a cross-scale analysis. Because of the nature of vulnerability and political ecology, we are able to understand causal chains that are formed. One is able to explore the allocation and distribution of resources within society (Oliver-Smith, 2004).

The key to this approach is the necessary analysis of the interactions between actors and processes that occur at different scales and in different networks or chains. A political economy framework has, for example, been put forward using the entitlements approach developed by Sen (1981) (in Devereux *et al*., 2001) in the analysis of vulnerability. This approach brings in a household perspective on vulnerability. It focuses on the vulnerability of individuals and social groups. Vulnerability is viewed and understood here as determined by access to resources. This specifically looks at individual entitlement to call on resources. Some of the links between vulnerability assessments and sustainable livelihoods approaches are outlined below.

3.4.4 Vulnerability Assessments and Sustainable Livelihoods Approaches

"A livelihood comprises the capabilities, assets (stores, resources, claims and access) and activities required for a means of living: a livelihood is sustainable when it can cope with and recover from shocks and stresses, maintain and enhance its capabilities and assets and provide sustainable livelihood opportunities for the next generation and which contributes net benefits to other livelihoods at local and global levels in the long and short term" (Chambers and Conway, 1992 in de Satge, 2004, 29).

The Sustainable Livelihoods Framework (SLF) links together a stressor (for example climate change) to a range of other factors. This is useful in the examination of vulnerability. The SLF approach is people-centered and aims to examine how people operate within the vulnerability context. The livelihoods approach draws on, among other things, aspects of: Integrated rural development planning (during the 1970s), participatory research methods including Rapid Rural Appraisal (RRA) and Participatory Resource Appraisal (PRA), farming systems research, entitlements and capability theory, vulnerability theories and appreciative enquiry

(de Satge, 2004). This approach also allows for a broad range of influences to be brought into a single frame of analysis. It links, in a systematic way, macro- and micro- level factors and shows how they interact. It also enables us to see the combinations of livelihood (and adaptation) strategies used and gives an active and historical context to these combinations and strategies.

The SLF also requires that relationships between different activities be investigated. It helps one to understand the highly varied activities and strategies adopted, to highlight their dynamic and complex nature and to reveal hidden vulnerability. The approach places current events in their dynamic context, avoiding focusing on snapshots of situations at a singular moment in time (Carney, 1999). The inter-connections and interplay of these factors are usually tracked with reference to their impact on various capitals or livelihood assets.

The concept of livelihood assets is central to the SLF and is the building block of adaptive capacity and resilience. Livelihood assets are the means of production that are available to communities and that can be used in their livelihood activities. These assets are the basic building blocks on which livelihoods strategies are built and, in general, the greater and more varied the assets and assets base, the higher or more durable the level of security and sustainability of the livelihood strategies are.

There are traditionally five forms of assets that can be identified. The first of these is **Natural/environmental capital:** this is the natural resources stock where farmers obtain resources useful to their agricultural strategies. The actual resources available reflect the characteristics of the local resource base and the extent to which the farmer can gain access to these resources. The access and availability of technology that makes the use of the resources possible is also important.

Social capital includes a range of networks, contact networks, membership of groups and organizations as well as relationships of reliance and trust and access to wider institutions that are needed in the operation of agricultural strategies and activities. These can be determined in terms of access to markets, credit, government services and other production situations.

The third is **human capital,** which includes skills, labour, knowledge (to a limited extent), good health and the ability to do work. This includes both the quantity and the quality of human resources within the farm. It includes knowledge and skills from both formal education and experience within non-formal learning (e.g. life experience).

Physical capital includes basic infrastructure such as transport, buildings, water management, energy and communications as well as productive capital (tools, machinery etc.). This includes what farmers own and what they have access to, for example roads, irrigation and telephone networks. These may be provided by government or by the private sector.

Financial capital is the financial resources available to farmers. These may be savings, credit supplies, monetary aid and grants as well as insurance or other government grants assistance. These provide farmers with different livelihood options. This includes finances for investment in new productive assets for responding to the effects of shocks including recovering and reconstructing farms and agricultural strategies.

Altogether these livelihood assets illustrate much about how livelihood strategies work. Various assets are more significant or important to some than to others at different times and in different contexts or situations. They can be put to use or traded off against each other and substituted or they can also be capitalized to generate future resources. Assets are also affected by both political and economic policies as well as institutions and processes (Poverty and Climate Change: Reducing the Vulnerability of the Poor, 2002). Central to the concept of livelihood assets are issues of access and entitlements. Limited access will restrict the use of these assets and subsequently limit the adaptive capacity of communities.

The SLF echoes some of the elements of vulnerability studies and approaches and supports the integration of human dimensions into climate change and vulnerability studies. The progression of the research paradigm from ‘impact’ assessment to an ‘integration’ approach is also supported through the use of this framework. The SLF is a useful operating framework in vulnerability assessments approaches, which would involve relating livelihoods to their exposure to risk (Chambers and Conway, 1992).

Examples of the application of and studies using the sustainable livelihoods framework methodologies include the work of Livelihoods Connect (IDS and FAO) (www.lalr.org.za/summary/communication-plan-and-user-engagement/, 2007). These include studies such as the University of Cape Town's Disaster Mitigation for Sustainable Livelihoods Programme's (www.egs.uct.ac.za/dimp/, 2007) work on "The Role of Local Level Institutions in Reducing Vulnerability to Natural Disasters and in Sustainable Livelihood Development - Case Study of South Africa" and similar work by Matsimbe in Central Mozambique (www.fao.org/sd/dim_pe4/pe4_041201_en.htm, 2007). The Overseas Development Institute has also worked on developing methodologies for Livelihood Impact Assessment particularly in East Africa (Ashley and Hussein, 2000). The Task Force on Climate Change, Vulnerable Communities and Adaptation (IUCN, SEI, ISD and Inter cooperation) has also looked extensively at livelihoods and climate change (www.iisd.org/pdf/2003/natres_livelihoods_cc.pdf, 2007). Having given some background to SLF and various vulnerability approaches attention now turns to the role of such assessments in the agricultural sector.

3.4.5 Vulnerability Assessments, Agriculture and Sugarcane

A number of impact studies have been conducted in South Africa analysing the impact of climate change on the production of maize (Du Toit *et al.*, 2001), analysing the farming sector of the Western Cape (Erasmus *et al.,* 2000) and sugarcane farming (Thomson, 2004, Deressa *et al.*, 2005). Vulnerability studies are also currently being undertaken under the Southern Africa Vulnerability Initiative (SAVI). Studies have also been conducted in other parts of Africa such as Kenya and Swaziland (Nangendo, 1998, Swaziland Sugar Association Research). There have also been a number of publications (Downing, 1992) focusing specifically on climate change and the vulnerability of agricultural production and individual farmers in African countries (Kurukulasuriya *et al.*, 2003). Studies have been undertaken by Kaiser *et al.* (1993) examining farm-level alternatives and efficient adaptation under various climatic scenarios (Kurukulasuriya *et al*., 2003). A number of impact studies have been undertaken investigating the effect of climate change on agriculture in developing countries (Dinar *et al.*, 1998; Kumar *et al*, 1998, Kurukukulasuriya *et al*., 2003). Little research has, however, been done on the effect that climate change and other multiple stresses have on the

social vulnerability and livelihoods of sugarcane farmers in South Africa, particularly in the Eston and Kwa-Zulu Natal Midlands sugarcane growing regions.

3. 5 Vulnerability Assessment Methodology as Used in This Study

3.5.1 A Brief Introduction

Having described some of the methodological approaches and theoretical frameworks linked to vulnerability assessments and climate change, attention now turns to examining the methodology adopted in this research. The aim of this study was to examine the context in which vulnerability to climate stresses is shaped e.g. the overall livelihoods of commercial sugarcane farmers. A case study of small-, medium-scale (emerging) and large-scale sugarcane farmers in the KwaZulu-Natal Midlands area of Eston and its surrounds was undertaken including a detailed social vulnerability assessment in order to obtain a better understanding of the various perspectives on the stresses acting on and the dynamics acting within the system. This was also done to test the hypothesis of this work - that farmers' ability to cope and adapt to changes, such as those associated with climate change, is either constrained or enhanced by the context in which they find themselves and in which they undertake farming activities (i.e. vulnerability determines overall adaptive capacity). The influence of climate as a risk was thus considered together with a careful investigation of the influence and role of other stresses on farmer's livelihoods.

The following research questions were posed:

1. What are some of the main external threats (hazards and risks) that commercial farmers face?
2. What coping and response strategies have commercial farmers adopted in response to climate variability (short term changes), climate change (a change in rainfall, temperature etc. over the long term) and their risks?
3. What factors enhance or restrict these strategies? (Both on-farm and off-farm).

This study thus involved an investigation into the multiple stresses (both external and internal, on-farm and off-farm, climatic and non climatic factors) acting on the system in order to determine the role that climate risk plays in shaping vulnerability of farmers in the research area. The adaptive capacity of the farmers was also explored in order to determine and

identify what coping and adaptive strategies may already be operational and what may need to be designed or supported in response to the future climate change.

Adaptive capacity, for example, was investigated by exploring the livelihoods assets available to the farmers (social, financial, natural/environmental, physical, human, knowledge assets and capital) in keeping with the Sustainable Livelihoods Framework (SLF). Institutions and policies linked to access and entitlements are also investigated as they can have a significant part to play in determining access and entitlement issues. The coping and adaptive strategies adopted in response to climate change risk (a change in temperature, rainfall etc. over the long term) and variability and subsequent outcomes were explored and factors enhancing or restricting these strategies analysed. This study is in line with the interaction approach, which evolved out of the 'impact' approach mentioned earlier.

3.5.2 The Research Framework

A suite of methodologies, many adopted from others in the field, was used in this study to avoid pitfalls and strengthen the methodology within the study context, reduce error and increase reliability of the research. A multi-method approach, in this case, also increased the validity and reliability of the data set obtained. It also ensured objectivity and accuracy of the results and ensured that the weaknesses of one technique were offset by the strengths of the others.

All vulnerability assessments, as shown earlier, are different. They include different variables, cases, contexts and foci. They are undertaken in different fields, have different levels of analysis, and are conducted at different scales. This is because of the dynamic nature of vulnerability and climate change and because vulnerability varies across communities, sectors and regions. For this vulnerability assessment, the focus is a social one examining the local, farm level vulnerability of farmers' livelihoods, including a focus on the context in which farmers operate, with a focus on climate change (a change in temperature, rainfall etc. over the long term) and variability.

Vulnerability assessments should, however, satisfy specific criteria (several of which have been identified in dealing with livelihoods):

- The knowledge base used for analysis should be varied and flexible. This means that all relevant academic disciplines can be used, that a coupled human-environment system should be incorporated and that indigenous and local knowledge should inform much of the work (PRA and RRA) (Polsky *et al*., 2003).
- The vulnerability research and assessment should be "place-based" (Polsky *et al*., 2003).
- Stresses that are examined must be recognized as multiple and interacting instead of unique and independent. This pulls in the elements of "double exposure" (Polsky *et al*., 2003).
- Information should be prospective and historical (Polsky *et al*., 2003).
- Predictions of possible future vulnerabilities and adaptation strategies need to be investigated (Polsky *et al.*, 2003). The degree of future risk is dependent on the likelihood and effectiveness of adaptation within the system.
- The study of the how, when and why of adaptation processes and strategies is also important to make informed decisions and judgments on the vulnerabilities of communities and households (de Satge *et al*., 2002).
- Vulnerability assessments should also allow for differential assessment of adaptive capacity (Polsky *et al*., 2003). As people in various areas rarely have the same abilities and capacity to adapt, many of the vulnerability assessments and studies draw on entitlements and political ecology approaches to examine access to resources and capital (social) in pursuing coping and adaptation mechanisms (Kelly *et al*., 2000; O'Brien *et al.*, 2004).

The Sustainable Livelihoods Framework (SLF) was identified as the conceptual and theoretical framework best suited to guide this vulnerability assessment. Adapted slightly, through the inclusion of knowledge/ information as an asset on its own, it was used to guide and inform the methodology and the research framework shown below. The SLF was also chosen as the best methodology to inform this work because:

- Agriculture has a complex and dynamic web of vulnerability, which is best explored under an interactive, dynamic and inclusive framework such as SLF which has a people centered approach and looks at multiple macro and micro, internal and external dynamics.

- The study aimed to explore interacting and multiple stresses both external and internal, spatially and temporally acting on and within the system. The SLF provides a guiding framework for this.
- SLF offers a holistic approach, which enables the identification and examination of coping and adaptation strategies and their outcomes.
- The SLF is the most effective framework under which adaptive capacity can be examined using the backdrop of livelihood assets and the access and entitlements to these assets (institutions and policies).

The research framework (Figure 3.3) was adapted from the Sustainable Rural Livelihoods Approach (Carney, 1998). Its basic structure has been kept in place to keep the conceptual framework of the approach but has been adjusted slightly for use in this vulnerability assessment. Knowledge (information) was added to the framework as an extra asset. This asset was identified in the early stages of this work as crucial in this context and has been included and investigated as an asset in itself. This knowledge can come either from external sources (for example, early warning information from agricultural departments) or can be internal (for example, local knowledge about the climate of the area or about which agricultural strategies work best in which situations).

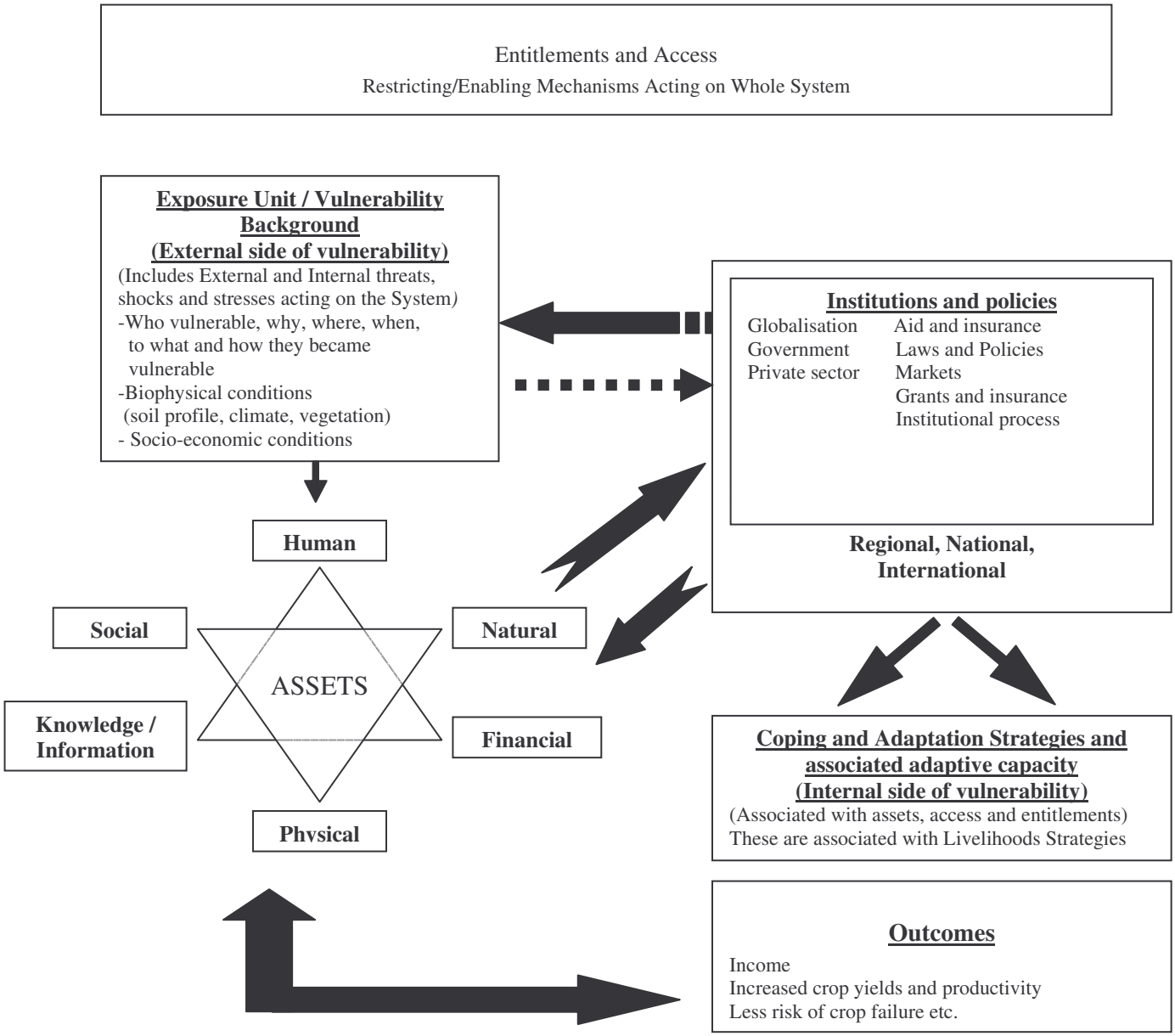

Figure 3.3: The Research Framework for assessing the social vulnerability of farming groups in the study area adapted form the Sustainable Rural Livelihoods Approach (adapted from Carney, 1998).

3.6 A Step-by-Step guide through the Research Process

This section examines in detail how the primary and secondary research was undertaken informed by the theoretical and conceptual frameworks of vulnerability assessment and the SLF. Figure 3.4 shows the 5 stages of the research, the activities undertaken at each stage and the analytical and conceptual approaches informing each stage. This framework is flexible

and dynamic (as shown by the arrows above and between the 'Stage' boxes) and is in line with the research framework. It is designed in order to capture the information and data to adequately investigate the vulnerability, adaptive capacity, and adaptation in the research context.

3.6.1 The Primary Research

Stage 1: Research Design

General information gathering and identification of the geographical area (context of the research) was undertaken during the first stage of the research. Information from secondary data was gathered and assisted in determining the location for undertaking the case study. The hypothesis of this work was identified from the initial information about the geographical context and its commodity chain (sugarcane). This gave focus to the research. A literature review was done on issues of global environmental change, climate change, vulnerability, adaptation, climate change, the sugarcane industry, and agriculture in South Africa. Information was also sought on research that had been done on this topic in this area.

Research questions were developed from the general information gathered following the literature review and the identification of the hypothesis and geographical area. The methodological techniques and activities to be used in answering the research questions and testing the hypothesis were also identified in this process. The theoretical frameworks that would underpin the methodology and analysis were mapped out.

A pilot questionnaire was developed from the research questions and information gathered in the literature review. Three types of survey data were used. These included data which classified people, their circumstances and their environment; data which related to the behaviour of people and data that relates to the opinions and attitudes of people (this data does have the limitations of bias and patterned responses to certain issues as well as possible insincerity). Both open and closed questions were included in the questionnaire. There were also opportunities given for the interviewee to give any other comments or make any other contributions on issues that may not have been included in the questionnaire.

Guiding questions were also developed for use in the semi-structured interviews. These questions were designed to get better insight in to the underlying vulnerabilities, and the adaptation strategies adopted in the study context. As indicated before, downscaled model projections of climate scenarios for the area were not used. Rather farmers were prompted to contextualise their responses and reflect on adaptation practices through broader references to possible climate change in the area (e.g. wetter than usual/normal conditions, more rain days in a season). Climate change impacts were reflected on particularly. Farmers were asked about the impact that climate change would have on their livelihoods and subsequent livelihood practices (for example if temperatures were to rise or rainfall was to increase or decrease). Climate change was initially introduced as the main thrust of the research and so questions were answered in this light.

To ensure that an ethical procedure was followed, an Ethics Certificate was obtained from the University of the Witwatersrand's Ethics Committee. A copy of the set of questions to be asked during interviews as well as a clear description of interview procedures and processes was submitted.

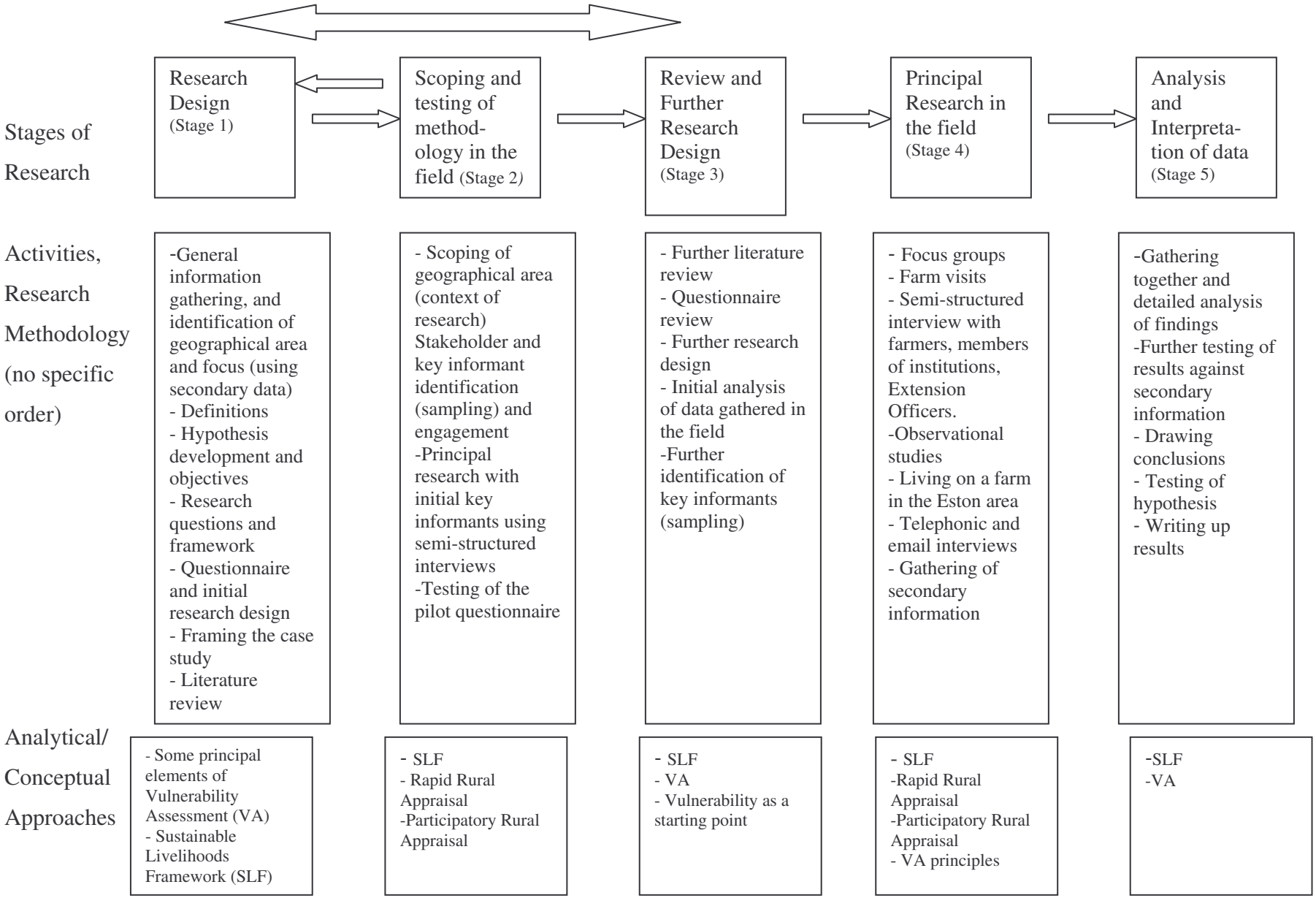
Stages of Research
Research Design (Stage 1)
Scoping and testing of method-ology in the field (Stage 2)
Review and Further Research Design (Stage 3)
Principal Research in the field (Stage 4)
Analysis and Interpreta-tion of data (Stage 5)
Activities, Research Methodology (no specific order)
-General information gathering, and identification of geographical area and focus (using secondary data)
- Definitions
- Hypothesis development and objectives
- Research questions and framework
- Questionnaire and initial research design
- Framing the case study
- Literature review
- Scoping of geographical area (context of research)
Stakeholder and key informant identification (sampling) and engagement
-Principal research with initial key informants using semi-structured interviews
-Testing of the pilot questionnaire
- Further literature review
- Questionnaire review
- Further research design
- Initial analysis of data gathered in the field
-Further identification of key informants (sampling)
- Focus groups
- Farm visits
- Semi-structured interview with farmers, members of institutions, Extension Officers.
-Observational studies
- Living on a farm in the Eston area
- Telephonic and email interviews
- Gathering of secondary information
-Gathering together and detailed analysis of findings
-Further testing of results against secondary information
- Drawing conclusions
- Testing of hypothesis
- Writing up results
Analytical/ Conceptual Approaches
- Some principal elements of Vulnerability Assessment (VA)
- Sustainable Livelihoods Framework (SLF)
- SLF
- Rapid Rural Appraisal
-Participatory Rural Appraisal
- SLF
- VA
- Vulnerability as a starting point
- SLF
-Rapid Rural Appraisal
-Participatory Rural Appraisal
- VA principles
-SLF
-VA

Figure 3.4: Stages of the Research, Activities, and Analytical/Conceptual Approaches underpinning it.

Stage 2: Scoping Phase and Testing of the Questionnaire and Methodology

This stage involved field work in the geographical areas identified. Scoping of the area (context of the research) helped to begin the process of developing a historical understanding of the area, the different forces that have helped to mould it, helped to understand power issues and how they are reflected in the local institutional arrangements. It also helped to understand how people understand the range of activities, assets or capital and capabilities that are used in creating different livelihoods. The process also assisted in assessing key aspects of the vulnerability context such as risks, hazards and trends and identify local level issues that are influenced by the broader environment.

Stakeholders and key informants (to answer the questionnaires and participate in semi-structured interviews etc.) were identified through engagement with the community and institutions in the geographical area and sugarcane sector and through non-probability sampling techniques.

There are two types of techniques for selecting a sample. The first is probability sampling which refers to techniques such as simple random, systematic, stratified and cluster sampling. This ensures that every member of the community has a known probability of being selected as part of the sample set (Ward *et al*., 2000). The second technique is a non-probability sampling method (accidental/convenience, quota, judgmental/purposive, and snowball sampling). These techniques are convenient and cost effective but there is little to no guarantee that every member of the community has a chance of being selected. There is also no way of computing the probability that any individual will be chosen (Ward *et al*., 2000). In the case of this study, resource constraint dictated the use of non-probability (convenience, judgmental/purposive, and snowball) sampling. Respondents were approached (randomly) and asked if they were willing to participate in the study.

Principal research with initial key informants and testing of the pilot questionnaire was undertaken at this stage. Reliability and validity is an important feature of this research. The

purpose of the pilot questionnaire was to ascertain whether the time it would take to fill out the questionnaire and the length of the process was appropriate and whether or not the right data would be gathered. The pilot survey tested the methodology and checked that the questionnaire tool was working correctly. It was pre-tested at this stage to ensure that it was understandable, that it was as far as possible free from bias and that it was able to elicit all the information to answer the research questions and effectively test the hypothesis. Questions were asked of the people and the answers recorded on a dictaphone or written down. This saved time and facilitated the process especially with those informants who were unable to read or write. Informants were also asked for their views on the questionnaire process (Was the questionnaire easy to read and understand? Was the length appropriate and was the purpose of the study clear?).

Some semi-structured interviews were also undertaken with some key informants at this stage in order to fine-tune the methodology and research design. These interviews were mainly undertaken with institutions and extension officers who knew the area and sugarcane sector, as well as also being familiar with climate change assessments, and who worked with the sugarcane farmers in the area on a daily basis. This process also assisted in identifying other key stakeholders and helped in picking up on climate change, vulnerability and adaptation elements that were not identified during the literature review process in Stage 1.

Stage 3: Review and Further Research Design

With the information gathered from the 1st and 2nd stages, the research methodology and research design were reviewed. Some elements of the research design needed to be adjusted, particularly some of the questions in the questionnaire and the semi-structured interviews. A number of questions needed to be rephrased as they were misunderstood in different contexts. A further literature review was also done to pick up on some of the vulnerability, adaptation and climate elements raised by the key informants in the semi-structured interviews and, to some extent, the questionnaires. An initial analysis was done of the primary data gathered in the field during stage 2. Additional key informants were identified through the analysis of the information gathered in stage 2 and the redesign of the research framework.

Additional questions were added to the pilot questionnaire in order to gather more detailed information on assets and the farmers' access to these assets as well as to identify the institutions and government processes that they interact with. This is directly in line with the elements of the Sustainable Livelihoods Framework (SLF) and vulnerability assessments as well as to answer the research questions.

Stage 4: Principal Research in the Field

This is the main body of the field research and was undertaken with farmers (small-, medium- and large-scale), key informants, institutions and government workers, extension officers and others involved in the sugarcane industry. It took the form of questionnaires, semi-structured interviews, focus groups, farm visits and transect walks, a period of residency on a farm in the Eston area and observational studies. Secondary data was also gathered at this stage.

This research was undertaken using participatory research techniques drawing on indigenous and local knowledge. Participatory research is essential in the context of the research because of the nature of the area, of vulnerability and adaptation and in line with SLF and vulnerability assessments. Chambers (as cited in de Satge *et al*., 2002). These techniques are adaptive and flexible, empowering people to frame the guiding questions. This assisted in reducing error and increase reliability.

There are many methods of participatory research. These can be used together and in different contexts. Two of these methods are Rapid Rural Appraisal (RRA) and Participatory Rural Appraisal (PRA). They are most appropriate for this research context and are complementary to the Sustainable Livelihoods Framework and the enquiry into the vulnerability and adaptation strategies of commercial farmers in the research area through a vulnerability assessment.

RRA emerged in the 1970s as an efficient and a cost-effective way of research by outsiders, particularly about different agricultural systems. RRA highlights the significance and the relevance of knowledge (particularly situational knowledge) as well as the importance of ensuring that one gets the big things largely right as opposed to gathering sometimes deceptive statistical accuracy. Its main techniques are reviewing of secondary data, direct

observations, transect walks, participation in activities, interviews with key informants, group interviews and workshops as well as mapping, documenting biographies, local histories and case studies (Finan *et al*., 1998).

While the methodology is informal and constrained by time, it is nevertheless rigorous in its design (Finan *et al*., 1998). This process can however be extractive and externally driven. PRA builds on RRA, taking it a step further. It describes "a growing family of approaches and methods to enable local people to share, enhance and analyse their knowledge of life and conditions, to plan and to act" (Chambers, 1991, 953). It enables and empowers communities with knowledge that comes from the process and the results of the research. This comes to be owned by the community involved through the participatory process. This is particularly effective where time and resources are constrained. PRA is useful in solving problems requiring some spatial or temporal ordering of livelihoods and communities. Techniques such as these are designed to reduce measurement errors through enabling an environment in which people can reflect on areas within their lives not often analysed. It also assists in enhancing rapport and limiting the interview role of the fieldworker (Finan *et al*., 1998).

One must be careful of two important pitfalls when using RRA techniques. The first is statistical in terms of non-representivity. The second is one that stems from a situation where information is either intentionally, or unintentionally, distorted or incorrect. The cause of this involves factors such as the inability to establish a good rapport with the local community, the socio-economic and cultural or language differences that may occur between the interviewer and interviewee, the fact that local people may provide 'appropriate' answers. Other issues include errors in recording information and the fear of revealing information that the interviewee might feel will affect their reputation in the community.

As far as was possible these pitfalls were avoided in this research through the use of various methods such as personal involvement in the community, carefully structured questions during semi-structured interviews and focus groups, confidentiality guarantees and the use of both written and recording techniques to ensure that a fair representation of what people said during interviews was given. Information was cross-checked and information from interviews was backed up by information gathered during observational studies, transect walks and

through secondary information gathered (Finan *et al*., 1998). The secondary information was also verified through the primary research.

a) Questionnaires, Semi-Structured Interviews and Focus Groups

Each farmer was asked to fill out a basic questionnaire and then semi-structured interviews followed. These led to informal discussions where farmers spoke about whatever issues they felt needed to be raised which were not brought out in the more formal part of the visit. The questionnaire format and semi-structured interview guiding questions are shown in the appendices.

Semi-structured interviews and focus groups were conducted with thirty commercial large scale and fourteen medium scale (emerging) growers. To prevent bias and inconvenience for the interviewees they were interviewed on their farms and or places of work. With the permission of the interviewees the discussions were recorded to get an accurate record of what was discussed. This proved to be an effective means of recording data. Focus groups were also conducted with thirty small-scale growers. Focus groups were held specifically with emerging medium scale growers, the Eston Mill Group Board and the Umbumbulu small-scale growers who intended starting a combined farming project. Guiding questions were used to keep the focus group discussions somewhat structured. All major South African race groupings were included as well as both genders in the sample of the key informants and stakeholders who took part.

Different generations of farmers were interviewed (fathers and their sons or daughters) who both cultivate sugarcane crops and in some cases work together on the same farm or have taken over the management and running of the farm activities from their seniors. This proved very useful in enhancing knowledge on a key component of this research, namely understanding how the context in which farmers operate influence how they are able to respond to change, e.g. climate change/risks/stresses. This provided a picture of past, present and future threats and adaptive strategies (again in line with vulnerability assessment criteria). Grower representatives for the area were also interviewed. Farmers were interviewed both inside and outside the milling and harvesting seasons. Different times of the year bring about

different vulnerabilities and livelihood strategies that needed to be captured in order to get a true picture of the threats and stresses faced throughout the year.

Some members and staff of the South African Cane Growers Association were interviewed as well as staff of the South African Sugarcane Research Institute (SASRI) at Mount Edgecombe. The chairperson of the SA Cane Growers Association was interviewed as well as the SASRI extension officers for the small and large-scale growers both at management level and at regional levels. Some of these extension officers from SASRI work closely with the Department of Agriculture and Environment. Technicians from the Department were also interviewed. (Note: the words grower and farmer are used interchangeably in this sector). Interviews were also held with farmers who were unable to be interviewed personally but were willing to answer questions via e-mail messaging and telephonic discussion. These interviews used the same questionnaire and guiding questions.

b) Farm Visits and Transect Walks

Interviews with farmers were done at their farms. This presented an opportunity to see what the main agricultural and farm activities were and how the farm operated. It was also a particularly participatory process. Transect walks around the farm after the formal interviews gave the farmers an opportunity to speak more freely about some of the past and present difficulties experienced and how they have managed to mitigate the damage and adapt to the impacts. This also helped to trigger conversations around elements that were not raised by the use of formal questions. They were also able to physically show the changes in land use and the various agricultural activities and techniques adopted. Farmers were better able to explain the dynamics of their farm and the processes that take place both daily and seasonally while walking through their fields. Site visits were also undertaken to combine observation of farming projects (Gququma), with small, medium and large scale growers' farms, mills and to demonstrate seed cane crops.

Transect walks were also undertaken with SASRI extension officers who work with the farmers and their land on a daily basis. These walks were informed by a set of guiding questions on issues of natural recourse management, recent disasters, and areas of vulnerability, livelihood strategies, access and control of resources.

c) Residence on a Farm and Observational Studies

A number of vulnerabilities and farm dynamics are not always reflected through the answering of questionnaires and during interview processes. Two weeks were spent living on a farm with a farmer and his family. It was possible to be part of a number of informal discussions around the operations of the farm and the daily challenges faced. Understanding the inner dynamics that take place at farm level provided very valuable data. Observational studies also took place during this time. These studies helped to check the information from the interviews with what was observed on a daily basis during routine farm operations.

Stage 5: Analysis and Interpretation of Data

The 5th stage of the research was to organise all the data that was gathered during the previous stages and begin with an analysis of this data under the theoretical frameworks of the Sustainable Livelihoods Framework and concepts of vulnerability and adaptation that underpin this work. Principles of political ecology and entitlements approaches were also used to assess adaptive capacity. Further testing of results against secondary information was done and conclusions and recommendations drawn. The survey data was analysed only for trends and not to define absolute values.

3.6.2 The Gathering and Use of Secondary Data

Secondary data plays an important role in guiding the geography of the topic and shows the current understanding of various issues. It shows what the area of study was like in the past in relation to the present and can show actual or potential relationship between variables. It provides the context into which the primary data will fit and provides an overlap in types of contexts (economic, social, historical and geographical) (Clark, 1997). Using the secondary data in a comparative context is useful in understanding the spatial, historical and social differences and tends.

Secondary information was gathered from government departments and local councils, academic research, international and local non-governmental organizations (NGOs), government gazettes and web sites, historical information from archives and information from key informants. Information was also sourced from the South African Sugarcane Research Institute and its Sugarcane Library as well as Extension Officers. Data was gathered that gave

information on the local asset base (people, land, water, climate, natural resources, infrastructure and services), institutions that govern access (to resources), central trends that mould the vulnerability context such as seasonality, variability, shocks and stresses, and finally the local economic activities in the area.

The strength of this form of research is that it is often more easily found and more quickly gathered than primary data, it provides contextual material; it is more often than not of proven quality and is reliable (Clark, 1997). However the data can be inflexible and often cannot be customized to the study. The quality is sometimes unverifiable as it is not always replicable.

The secondary data is used in conjunction with the primary data gathered to assist in validating and analysing the research results.

3.7 Summary

A number of early 'impact' approach studies were based on the assumption that there was a direct cause and effect relationship between the climate event and the response of the system studied. Since then vulnerability studies have evolved from a research paradigm focused primarily on the 'impacts' of climate and variability to a point where the research methodology has recognised that vulnerability is a biophysical as well as a social characteristic and these elements cannot be studied in isolation from each other. Vulnerability approaches, moreover, highlight the role that various factors play in configuring an environment that is either robust or more brittle in the face of a stress (e.g. climate stress).

A number of vulnerability methodologies and approaches were discussed in the chapter, focusing on those most closely linked to this work and those most useful in informing the methodology and achieving the aims of the study presented in this work. A suite of methodologies, many adopted from others in the field, were used in the study to avoid pitfalls and strengthen the methodology within the study context. This multi-method approach also increased the validity and reliability of the data set obtained. The Sustainable Livelihoods Framework (SLF) was identified as the conceptual and theoretical framework best suited to guide this vulnerability assessment.

The chapter also examined how the primary and secondary research was undertaken and informed by the theoretical and conceptual frameworks of vulnerability assessments and the SLF. The 5 stages of the primary research methodology undertaken were shown in this chapter. These included the following: Research Design (Stage 1), Scoping and Testing of Methodology in the field (Stage 2), Review and Further Research Design (Stage 3), Principal Research in the field (Stage 4) and Analysis and Interpretation of data (Stage 5). The activities undertaken at each stage and the analytical and conceptual approaches informing each stage were also shown. The framework is flexible and dynamic and in line with the research framework. It was designed in order to capture the information and data and to adequately investigate the vulnerability, adaptive capacity, and adaptation in the research context.

The next two chapters will examine the data gathered from the primary and secondary research undertaken in the study area. Chapter 4 will primarily investigate the livelihoods assets available to and used by the farmers, the enabling mechanisms, the main threats and stresses to coping, and adaptation acting upon this system. An in-depth discussion on the findings follows.

CHAPTER 4
"DOUBLE TROUBLE": VULNERABILITY IN THE STUDY AREA

4.1 Introduction

The previous chapter of this dissertation investigated the methodologies used in the assessment of vulnerability as well as the evolution of these methodologies over the years from purely impact-based studies to a more "interactive" vulnerability framework. The research framework for this study has also been explained and a step-by-step guide through the primary and secondary data gathering processes and analysis given, showing at every point the analytical and conceptual approaches used to inform the work. This chapter examines the data gathered from the primary and secondary research undertaken in the study area. It also examines the livelihoods assets available to, and used, by the farmers, the enabling mechanisms and the main threats and stresses to coping and adaptation which act upon this system.

4.2 Context of this Study

This thesis is based on research conducted during 2004, 2005 and 2006 and the beginning of 2007 as indicated in Chapter 1. The focus of the work was particularly limited to small-, medium- and large-scale sugarcane farmers in the Richmond, Eston, Talla Valley, Cato Ridge and Camperdown regions - all part of the Eston Mill Area, Midlands South in KwaZulu-Natal (Figure 4.1). Sugarcane was chosen as the focus area for this research as it is the main agricultural commodity grown in the area. Data gathering and analysis would have become cumbersome if all agricultural activities were explored. Each agricultural commodity has a varying process and supply chain, markets, market access, stresses and sensitivities which need to be investigated independently.

Variations in agricultural practice in the area also complicate issues and introduce a suite of factors that help to configure vulnerability to change in the area. It should be noted that a two-year sugarcane crop is, for example, grown in the Midlands rather than a one-year crop on the KwaZulu-Natal coastline. This is due to the prevalence of the Eldana borer worm, which prefers the younger and sweeter sugarcane. This timeframe of planting and harvesting brings with it its own vulnerabilities. Planting takes place during spring and autumn with harvesting

taking place from March to April. The area is a major supplier and exporter of sugarcane for South Africa, and the farmers in the area generally supply sugarcane to the nearby market, the Eston Mill (formally the Illovo Mill). Sugarcane is a cash crop and the price received for the crop is set by the Sugar Industry bodies.

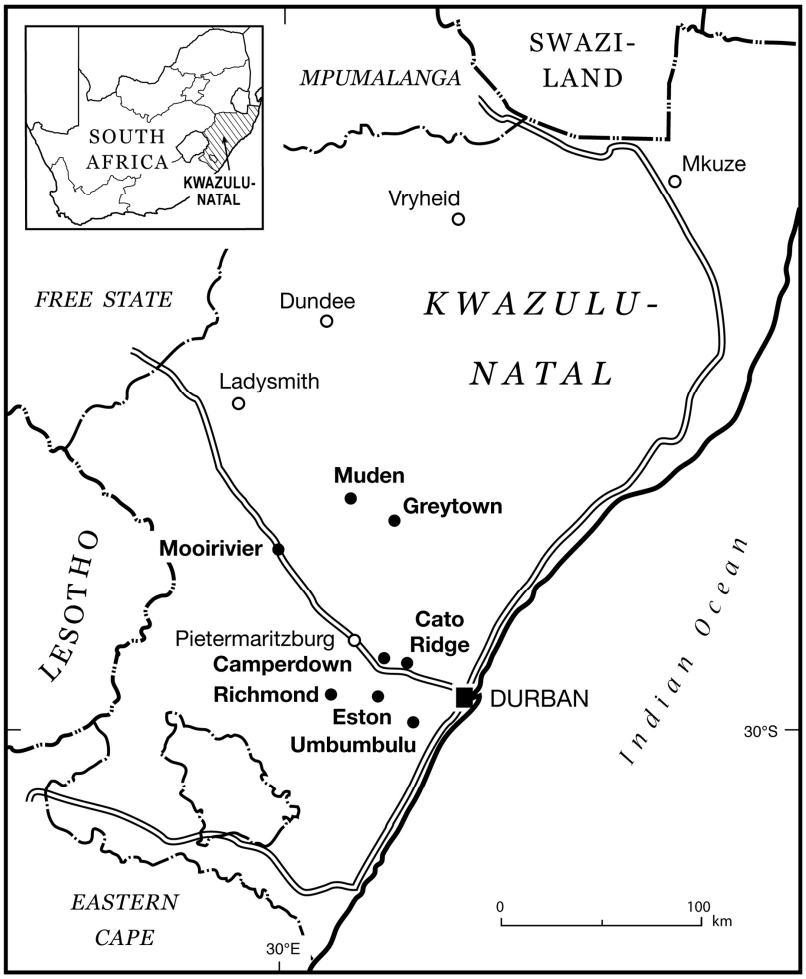

Figure 4.1: Map of the area research area between Pietermaritzburg and Durban (Reid *et al*., 2005).

Average rainfall in summer (December, January and February) ranges from between 100 and 200 millimeters and between 10 and 50 millimeters in winter (June, July and August). The mean annual precipitation for the study area is approximately 600 millimeters to 1000 millimeters. Mean daily maximum and minimum temperatures are 23.2°C and 13.2°C respectively. Soils found in the area originate mostly from Table Mountain Sandstone and Beyka tilite, and, to a lesser extent, from Table Mountain Sandstone, dolerite and lower Ecca

Shale parent materials. The region is classified as Humid Sub-Tropical, receiving rainfall throughout the year with warm humid summers and mild winters. (http://www.weathersa.co.za/climate/Climstats/Pietermaritzburg_Stats.html, 2007).

Other agricultural activities in the area include rearing of livestock (primarily cattle), dairy farming and timber plantations. The combination of intensive commercial farming and distinct climatic and non-climatic conditions makes this area an important site for this type of research. This area was chosen because it is characterized by extreme climatic periods, varying socio-economic patterns and policy conditions. It reflects a complex environmental system with significant biodiversity (Dialogue on Water and Climate, 2002).

4.2.1 The Broad Agricultural Context

Agriculture makes up a significant percentage of African countries' economies. For most of these countries an average of 21 % of gross domestic product (GDP) is made up of agriculture. Some are as low as 10 % of the GDP and others as much as 70% of the GDP (Vogel, 2005). "Agriculture is also an important sector in both the formal economy and in sustaining local livelihoods. Agriculture is, however, currently constrained by biophysical and socio-economic problems including land degradation, poor infrastructure and market access, lack of access to information and resources, and insecurities around water often occasioned by poor infrastructure and very often highlighted by periods of climate stress" (Vogel, 2005, 30).

Constrained competitiveness, skewed participation, low investor confidence in agriculture, inadequate, ineffective and inefficient support and delivery systems, as well as poor and unsustainable management of natural resources, are also seen as some of the challenges faced (The Strategic Plan for South African Agriculture, 2001). Reasons for these challenges include, amongst other things, policies implemented in the past (such as apartheid) and those being implemented at present, including the difficulties arising from uncoordinated policies.

Other constraints include input prices, natural resource productivity, labour issues, administration costs and the quality of infrastructure, as well as the availability of capital and technology (The Strategic Plan for South African Agriculture, 2001). A particular macro challenge has been one of globalisation and deregulation that cascades down the agricultural

system. At the end of the 1990s the impact of the start of globalisation and deregulation in the world agro-food economy and agricultural system became evident. A number of groups drive globalisation processes; these include transnational corporations, multi-lateral institutions and governments of well-developed industrialised states. Major technological advances, specifically with regard to information and communication, have been the backbone of the movement and have made capital, financial and commodity flow much faster (The Strategic Plan for South African Agriculture, 2001).

At a local level there are approximately 13 200 commercial farmers in South Africa (Stuijt, 2007). Commercial farmers employ nearly one million workers (nearly 11 % of the total formal employment in South Africa) providing livelihoods and housing for about six million family members. The National Department of Agriculture has authority over the use of natural agricultural resources in South Africa. Strict legislation governs best practice for the conservation of natural agricultural resources through the maintenance of the land's production potential; controlling erosion, protecting vegetation and managing weeds and invader species. Specific laws and guidelines apply to all land users with regards to the undertaking of certain activities (for example the cultivation of virgin land and the burning of natural vegetation which are all subject to prior approval) (http://www.southafrica.co.za/agriculture_29.html, 2007).

Agriculture in South Africa has undergone a number of drastic changes in recent years. A number of processes have reversed the impact of discriminatory legislation; other initiatives have deregulated and liberalised the sector. A number of policy shifts have also taken place including liberalising agricultural trade and the deregulation of the marketing of agricultural products. The implementation of land reform policies and programmes, as well as the removal of certain tax concessions and direct subsidization, have been of particular importance to farmers on the ground. The introduction of a minimum wage for farm workers has also had a dramatic impact on labour practices on farms as many farmers now have to conform to a minimum wage set by institutions (http://www.southafrica.co.za/agriculture_29.html, 2007).

4.2.2 The Sugarcane Industry

South Africa is one of the leading cost competitive producers of high quality sugar in the world (South African Sugar Association, 2004). Almost 50% of this sugar is marketed in the Southern Africa Custom's Union (SACU). The remaining sugar is exported to various markets in Africa, the Middle East, Asia and North America (South African Sugar Association, 2004). In total, the South African sugar industry generates direct income of R6 billion annually and contributes up to an estimated average of R2.38 billion to the country's foreign exchange earnings annually. Direct employment in the industry is estimated at around 85 000 people. There are approximately one million people dependent on this industry (The South African Sugar Association, 2004).

There are 47 000 registered sugarcane growers in South Africa (large-, medium- and small-scale). These growers produce more than 22 million tons of sugarcane from 14 mill supply areas along the eastern borders of the country (Figure. 4.2). More than 45 000 of these growers are small-scale farmers. 1 729 large-scale growers (341 of these growers are black emerging farmers) produce 79.14% of the total sugarcane delivered for milling. "With the growth of economic development and empowerment of previously disadvantaged people, a growing number of medium-scale farmers are continuing to enter sugarcane agriculture on farms made available at market-related prices by the major milling companies" (South African Sugar Association, 2004, 5).

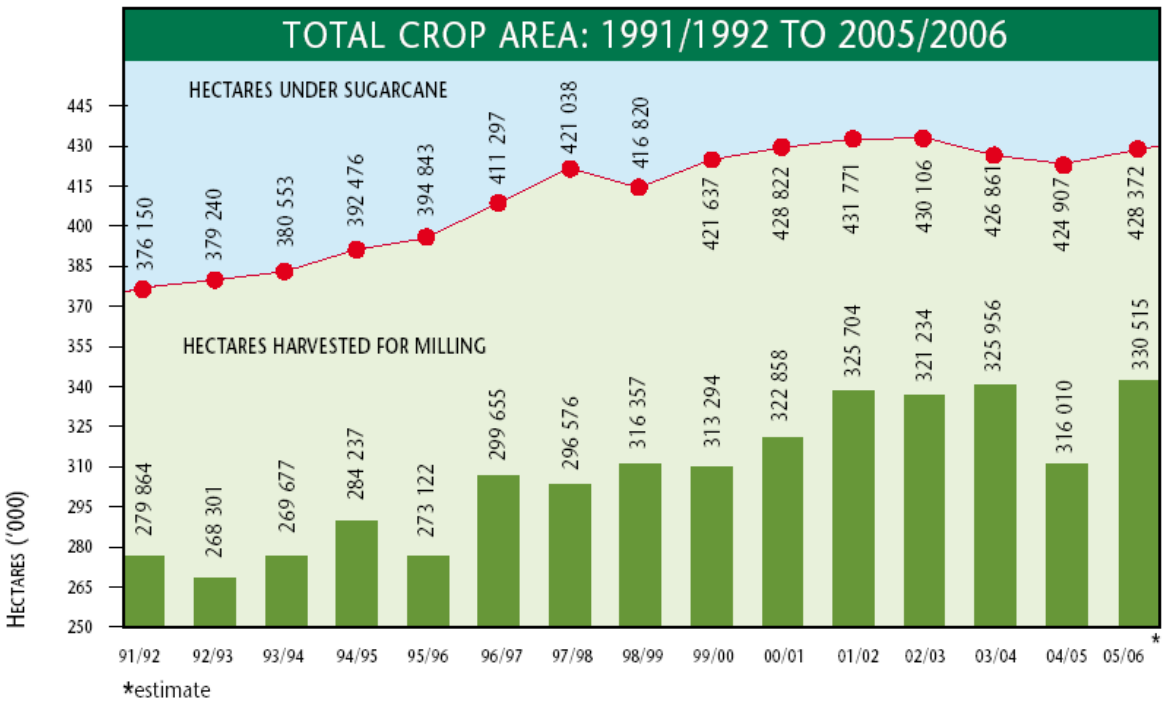

Figure 4.2: The Total Sugarcane Crop Area: 1991/1992 to 2005/2006 (South African Sugar Association, 2006).

4.3 The Eston Vulnerability Assessment

4.3.1 A Brief Overview of the Research Framework

Having outlined briefly, the wider, macro-structural agricultural context in South Africa, attention now focuses on a more detailed assessment of those factors shaping vulnerability in the Eston area. This study, as indicated in previous chapters, considers climate events in the *context of other threats and stresses* that, when combined, produce compound impacts and unveil complex, interacting vulnerabilities. The everyday, hidden realities embedded and rooted in society that enhance vulnerability or enhance resilience to global environmental change, are recognised and investigated. These elements are all crucial for understanding vulnerability (Blaikie *et al*., 1994).

For the purposes of this study, small-scale, medium-scale (emerging) and large-scale farmers will be discussed together. Particular reference is made, when needed, to the individual groups because on a number of occasions the risks faced take on different forms and operate on different temporal and spatial scales depending on the size of the farmer's activities and

operations. It should also be noted that when the dissertation mentions 'farmers' it refers to commercial farmers. Sugarcane is a cash crop and these farmers, while undertaking some subsistence farming of other crops to sustain their livelihoods, are largely commercial by nature. In some places the words farmer and grower are used interchangeably. Respondents generally referred to the sugarcane farmers as 'growers' during the research process.

4.3.2 Livelihoods Assets Enhancing Adaptive Capacity and Related Threats and Stresses

In order to assess adaptive capacity and understand the internal dimension of vulnerability as outlined in Chapter 1 and Chapter 2, one must examine the livelihood assets available to, and used by, the farmers in this context to strengthen resilience and thus reduce vulnerability to threats and stresses. These assets are investigated under the SLF (as outlined in Chapter 3), which informs the research framework of this study. This section also examines the threats and stresses acting upon the livelihoods of these farmers and which constrain the use of these assets. An examination of these on-farm and off-farm threats and stresses assists in exploring the external side of vulnerability in this study area.

4.3.2.1 Natural Assets

This type of capital refers to the natural resources that are useful for sustaining the livelihoods of the farmers and is closely linked to the ecological dimensions of vulnerability. Types of natural capital include: land, water and the natural fauna and flora of the area, which can be negatively affected by natural shocks and stresses (such as flooding and droughts).

The Eston Mill Area of this study is in a marginal sugarcane growing area with erratic rainfall (temporally and spatially) and relatively good soils (quality and depth) in most places. The farmers in this area undertake dry land agricultural activity and only irrigate during times of drought and heat stress, and generally this is only undertaken by large-scale farmers who have existing infrastructure and access to water sources (dams, rivers, reservoirs and boreholes).

One of the most important natural assets is the sugarcane crop itself. There is a major reliance on this single crop with its natural resilience to adverse weather conditions and the formal support through institutions and highly regulated market that comes with it. Sugarcane is relatively easy to plant and is a strong crop with fair returns. Sugarcane has financial backing

systems through institutions and there is opportunity to borrow money from financial institutions and source funds from mills.

A dramatic change in sugarcane sucrose quality in the area came with the introduction of new sugarcane varieties that have produced better sucrose yields and greater resilience to drought, pests and diseases. These varieties have been developed by the South African Sugarcane Research Institute (SASRI) and include varieties such N12, N21 and N24. These varieties are more resilient to drought, pests and diseases.

The growing of the correct variety of sugarcane for the soil and climatic condition is important and is done strictly on the advice of The South African Sugarcane Research Institute (SASRI) extension officers. Growing the incorrect variety can have disastrous and long lasting effects for the farmer. Access to knowledge and extension officers is critical in this case but is often not easily accessible particularly for small-scale farmers as they have little access to the institutions that provide this service. It has also been observed that some farmers grow sugarcane purely to secure inherited title to the land (even through there is no physical title). Having a crop on the land gives one's permission to occupy and serves as a 'right' to ownership even though the land is not physically owned. Sugarcane is a relatively low-cost crop to grow and is used in these cases to secure land tenure.

4.3.2.1.1 Main Threats and Stresses acting upon the Natural Assets

One of the main off-farm and biophysical threats that act on the system, increasing vulnerability and affecting all the types of assets (particularly natural assets), is that of climate change risk and climate variability. Climate change and variability affect all aspects of farmers' livelihood systems (political, social, economic, and biophysical). Risk associated with climate change and climate variability was identified as a perceived threat by the farmers of all scales (small, medium and large-scale) and was placed at the top of the list when farmers were asked, during the questionnaire and semi-structured interview process of the primary research, to rank the threats faced. This region has had a number of climate risk impacts. Recent weather patterns have been irregular with serious droughts recorded in 1967-73, 1981-83, 1986/87, 1991/92 and 1993/4 and floods having been recorded in the area particularly during 1999/2000.

Drought and difficult economic conditions have meant that some cane fields have had to be abandoned due to the deterioration of cane quality and stalk mortality. The decision was taken, for example, not to open the Umzimkulu Mill for the 1992/93 season and the sugar cane was diverted to the Sezela Mill. This increased transport costs and affected the sucrose levels in cane thereby decreasing the Recoverable Value (RV) due to long field-to-crush (as the mill) delays. Sugarcane fires associated with drought have also been a major threat in this area.

During this time good quality seedcane was also unavailable for replanting operations. Farmers who lost their cane ratoons due to drought could not plant a new crop for the new season. This was exacerbated by debts that had been accumulated with the need for more inputs to manage the drought situation. The expense of replanting, higher input costs and a drop in sugarcane quality and RV affects the next season. Debt levels rose even further. Some farmers abandoned their replant programmes. The area experienced drought again in 2003/2004 and was declared a disaster area by the South African National Government in January 2004.

Climate variability affects a number of elements of the farming system in this area. This effect is not only felt through a decrease in yield but also through a number of related and cascading impacts. Periods of climate variability such as drought, flooding, frost episodes and periods of high temperatures, affect inputs and operational costs, livelihoods assets and farm management practices. Soil and crop nutrition have been seen to suffer during periods of climate stress and, in some cases, require technology and information transfers on climate predictions, yield predictions, varieties, harvesting times, and best practice operations on the farms.

Pests and diseases (such as Thrips and Eldahna borer worm) were voiced as a large concern in this area. Climate impacts have a marked affect on the prevalence of pests and diseases through increases in temperature and rainfall which are favourable to pests and diseases. Large input costs are required during and after climate events to compensate for loss of yield and a drop in RV. The use of pest resistant varieties of sugarcane and the growing of a two-year crop assists in managing this threat, but once the rains arrive after periods of drought the

prevalence of pests and diseases increases and this requires management at a high cost to the farmers.

Climate risks have also affected yield and sucrose levels negatively. As discussed under the financial assets section, the price that farmers receive for their sugarcane is based on the Recoverable Value (RV) system. This requires that the sugarcane has a high level of sucrose that can be recovered during the milling process. Sucrose levels are affected by a number of factors including pests and diseases, water content (droughts), soil quality and possible the harvest-to-crush (at the mills) delays. Sucrose can be severely affected by periods of drought and fields have had to be abandoned in the past or replanted altogether (which is very costly when an already high level of debt is present with the dry conditions). This area is also under dryland cultivation and relies on the timeous arrival of the rains.

Heat stress is a major problem for sugarcane and cannot be managed easily by farmers. This is reflected in the interviews with the farmers. It must be remembered that in this region, drought has a prolonged effect due to the growing of a two-year sugarcane crop. There is a delayed risk in the sense that, unlike other crops such as maize, where one has a chance to start over again the following season, vulnerability is carried over and has a knock on effect.

It is particularly interesting to note that after the South African Sugar Technicians Association (SASTA) workshop on climate change (2002) it was decided that climate change is not currently a priority for the sugar industry.

"Climate change will be a priority in the future but not a priority now. Price risk and other concerns are all coming together to form a more immediate risk. Climate is on the back burner for now."

This quote was recorded by Abram Singels (SASRI) during the interview process and is reflected in feedback documents on the workshop.

This point of view is also reflected in interviews with medium-scale farmers:

"*The pressure to remain competitive focuses our attention on the short-term issues such as market prices and not longer-term issues such as climate change. A lower priority for us is adaptation to climate change."*

And again in an interview with a large-scale farmer:

"We are used to dealing with drought. We have experience with it and it is something we just have to deal with in farming. It is the new threats that are the problem. The uncontrollable external threats such as the strong Rand, fertilizer prices and the low sugar price. There is nothing we can do about this and therefore it is a very big threat to us."

Warren and Sparks (Extension officer and staff for large scale farmers in Eston (SASRI)) said:

"Droughts are part of what we live with … you learn to deal with it, change sugarcane varieties etc. You put strategies in place to deal with those things. The guys (the farmers) on the ground don't see it as a major threat. What guys see are political and economic issues which are short term and have to be dealt with now. Price decreases, and an increase in input costs and labour costs are all short term and 'in your face'. Drought is part of farming in South Africa and can present you with opportunities for improved water use, technology transfer and variety changes. There are all sorts of ways around drought. Other issues are more complex and harder to deal with. The uncertainty and unpredictability is what gets to us."

"The situation is like an iceberg bobbing in the ocean. The smaller bit that would be debt etc. can be seen above the surface. The larger more dangerous bit sits below the surface like climate changes. It's what you can't see that is more dangerous. People only pay attention to what they can see."

Another issue is that of access to water. The new Water Act has made it difficult for some large-scale and medium-scale farmers to store water on their farms and they have begun breaking down dams and reservoirs in order to avoid having to pay the tariffs for the storage of the water on their farms.

Another major threat, identified and related to natural assets available to the medium- and large-scale farmers, is that of land reform and land tenure. This threat also affects small-scale farmers (though the farmers did not explicitly mention this in the primary research phase). This is both an internal and external political, social, biophysical and economic threat. This threat incorporates aspects of access and entitlement that have been influenced by a number of both present and past political and in some cases social and economic features.

Land reform and redistribution has been a highly politically-charged process that has been cautiously undertaken within the sugar industry and to an extent within the South African Government (Department of Land Affairs). The Sugar Industry under SASA has established the Iziko Land Company to facilitate an effective land reform process and transfer of sugarcane farms to those disadvantaged by the previous apartheid regime. This has been successful in a number of places and has been largely based on a 'willing seller - willing buyer' system.

A number of land claims have been lodged, particularly in the western part of this region. These claims are being processed and they will at some point be settled but this has been slow and emotive and has caused a degree of uncertainty about the future of these large-scale farmers with their farmland under claim. Due to legislation with regards to farms under claim activity and the capacity of the farmers and farm operations until the claim is settled are restricted.

It is essential that once the farm has been transferred, the new farmer or claimant gains the necessary skills and support (Lonsdale, 2004). Once farms are handed over to new tenants, the new emerging farmers are supported by various institutions available to them through mentoring processes and they may gain a good profit from the sugarcane that may already be growing on the farm (see figure 4.3). The problem arises in the second season of growing when the direct support has ended and the farmer needs to begin the new season of growing and harvesting. This requires the new farmer to manage the financial and management components so as to acquire financial capital needed for the next season. These skills need to be built in the first season of growing and are often lacking. The new emerging farmers are also left with the inherited debt and operational problems on the farms and a number of the emerging farmers have ended up reverting to subsistence farming on the land as opposed to commercial growing which requires high input, management and maintenance.

New farmers also lack access to bargaining power on farm inputs and have difficulty securing funds from financial institutions because of the absence of long-term financial records and current farm management accounting processes. The cost of capital and the risks involved in farming are restrictive for prospective farmers, even if accompanied by the necessary support,

skills training and capacity building. This is mirrored in the quote below as part of the secondary data by de Lange (2004, 8):

"All these forms of land use require the same elements to be present, namely knowledge (knowing what to do) and skills (being able to do it); having access to land (or an agribusiness) ; access to finance (having the money to purchase the land and to buy the inputs for production); having access to production inputs (farming requisites, mechanization, transport, tradable or raw materials in the case of agribusiness); being able to market the produce (access to markets); and having a voice in determining policy issues that affect the enterprise (lobbying)."

Another particular concern has been that of land ownership. A number of small-scale growers particularly do not have security of tenure. As a member of the SASRI farmer support unit for small-scale farmers mentioned:

"Land has little value if it doesn't have title. Without title they (the farmers*) are unable to trade. Ownership of land is not very common in the tribal areas. 47% of KwaZulu-Natal is tribal land (owned by the Zulu King). There is no formal leasing structure or ownership within the small-scale sector, which has a great impact. Financial institutions have to wrestle with how they make money available for agriculture if there is no formal structure to the farming unit."*

These farmers have user rights but no title and can be evicted from the land at any time by the local chief as all tribal land is owned by him. This creates great uncertainty and insecurity.
The patches of land that the small-scale farmers have available to them are also often very small (usually 1 hectare). To make a profit with sugarcane growing one needs to have a relatively substantial plot of land and grow a large crop. These land patches are too small to be viable. One can deal with lower margins if one has a large enough area to create an income (economies of scale). Plots are often also in marginal areas (particularly in this context) with low and erratic rainfall and poor soils. These farmers are regarded as commercial as sugarcane cannot be used as it is to sustain the family. It needs to be sold to the mill for money that is then used to buy food and other supplies

Figure 4.3: A typical large-scale sugarcane plantation, Cato Ridge (Massey, 2005).

4.3.2.2 Financial Assets

In the case of the farmers in this context, the financial assets available to them include: loans from banks and agricultural organizations (L), grants from the Department of Agriculture (DoA) (S, M), money earned from other economic activities such as the running of local goods stores, small consultancy businesses or working on farm jobs (A), profits from sugarcane sales (A), capital and investments (L), savings schemes (L,M) and credit with local suppliers (L).

(Key: L = large-scale, M = medium-scale, S = small-scale farmers and A = All).

4.3.2.2.1 Main threats and Stresses acting upon the Financial Assets

This is particularly a problem for the medium-scale emerging farmers. Once they have acquired the land and it is paid for, the farmer still needs working capital to run operations on the farm. Financial institutions insist on security and financial statements. Many emerging farmers do not have these and are denied access to loans and overdrafts due their scale and experience in the commercial farming sector. There are also access issues around the lack of financial management skills, high input costs (this is also linked to climate risk) and difficulty accessing capital to undertake diversification strategies such as eco-tourism companies or tuck shops to subsidise the income of the farm. Amongst small-scale farmers there is a

definite difficulty in accessing funds due to the size of their operations and lack of bargaining power.

The low domestic and world sugar price and the strong Rand are a prime concern for these farmers. Large-scale farmers during the focus groups are recorded as saying:

"You can take the drought which is not nice but usually if the price is good it is alright. This year (2005) *we were smacked with the lower price and smacked by the drought. We got it from both sides."*

Off-farm economic and political (land reform etc.) threats affects profits, input costs and the ability of farmers to sustain their livelihoods and agricultural production, thereby reducing their resilience and increasing social vulnerability. They are rooted in a number of local and global dynamics that are affected by wide social, economic, biophysical (resource limitations) and particularly political factors (land and law reforms processes). This off-farm threat/stressor was identified by all scales of farmers (small, medium and large-scale farmers).

Sugar is a profit-sharing industry. The farmer gets a portion of the total sucrose value for the season for the portion of sugarcane delivered. Locally the sugar price is set and calculated under South Africa's Sugar Act of 1978. This Act affords certain rights and responsibilities to the South African Sugar Association (SASA) who play a prominent role in the management of the sugar industry in South Africa. The total proceeds from the sale of local market and export market sugar as well as molasses are accounted for to the SASA. Industrial charges are deducted from the proceeds and then the nett divisible proceeds are shared between growers, millers and refiners. This is done in terms of a fixed division of proceeds, which is provided for in clause 166 of the Sugar Industry Agreement. Alongside this, a provisional recoverable value price is declared monthly throughout the season. This is applied to all cane delivered to date. The final RV price for the season is declared in March of each year (http://www.sacanegrowers.co.za/RV_price.asp, 2007).

The Recoverable Value (RV) system of payment replaced the sucrose-based payment system and is regulated under the Sugar Act. The RV system is based on the amount of sucrose that is recovered from the sugarcane delivered to the mills (Stranack, 2002). RV is measured on

the yield of three seasons. Good years arrive but the RV is still low. RV has however improved the situation for a number of farmers who have benefited from the change to the RV payment system, particularly those who have followed correct procedures and farming methods to ensure maximum sucrose levels in the crops to ensure good returns as payment for the sugarcane at the sugar mill is dependent on the level of sucrose in the sugarcane delivered.

The RV system is dependent on the sugarcane being of top quality and requires specific farming methods and procedures as well as strict scheduling of inputs to ensure high sucrose content. It also requires that the time between harvesting and delivery to the mill is kept to the minimum as sucrose decreases dramatically after cutting of the cane. This has proved to be a difficulty for some farmers, particularly small-scale and medium-scale farmers. Their inability to maintain high levels of production due to limited land space, distance from the mill, difficulty in servicing high input costs, lack of knowledge, difficulty accessing extension services, and means of transporting their sugarcane to the mills, has meant that their RV is low. Dry spells in the area also decrease the RV, exacerbating other factors, such as need for increased farm input during these times. New varieties introduced to the area have however assisted in increased sucrose levels.

"Over the long term, rising farm input costs could mean that certain farmers are forced into bankruptcy, which reduces production capacity and lowers supply levels, which could increase price" (Farmers Weekly, 2004, 26).

This is particularly true for farmers in the sugarcane sector. The price the farmers are paid is set by the Sugar Industry through a formula that takes into account the world sugar price and other variables. The farmers have no say or influence over the sugar price (except to make every effort to deliver good quality sugarcane) and no other market where they can take their sugarcane. This does however have its advantages in that, unlike vegetables for example, they do not have to find a market to sell their produce and do not have to rely on negotiation and bargaining skills. The market is also a stable one, available, well managed and regulated under SASA and the South African Sugar Act.

Globally there are a number of complex and interacting factors that have affected the sugar price. These include continuing high import tariffs, pressure from Brazil and other leading

sugar producers, the reform of the European Common Market Agricultural Policy (CAP) and the European Union Sugar Regime. Continuing trade liberalisation has also put upward pressure on world prices and the impact of low cost exporters (particularly Brazil which increasingly dominates international trade) has put downward pressure on sugar prices (Innes, 2004). A surplus in the sugar produced globally by large sugarcane producing countries, such as Brazil, has also assisted in decreasing the sugar price.

Other factors include subsidies that are paid to sugar producers in other countries, which play a major role in keeping the world prices low, as well as, the rand-dollar exchange values (which also puts pressure on the price of farm inputs). As discussed in the semi-structured interview with an employee of SASA:

"The world market price is abnormally low because of subsidies in developed countries. This creates distortion. They are not driven by supply and demand but rather are encouraged to produce or over produce which leads to an over supply and a depressed world market."

However the Rand/Dollar exchange varies and can in some instances be an advantage to farmers.

While subsidies continue to assist other countries (for example Europe and the United States of America), the South Africa government has stopped all subsidisation across the board, making it expensive to continue farming. All the expenses and risks rest on the individual farmer. Subsidised farmers in other countries are encouraged to grow certain crops and are assisted with infrastructure and transport costs. Agriculture has also "been excluded from the new Southern Africa Customs Union (SACU) trade remedies, which are often used to protect farmers against imports" (Kupka, 2004, 15).

The decrease of the value of the Rand against the dollar can increase export Rand earnings but also can increase import costs such as fertilisers and chemicals, farm equipment and machinery as well as various services such as those rendered by contractors (all affected by imports and the exchange rate). The Rand is affected by a number of global dynamics including political stability in neighbouring and trading countries, markets and in some cases investor confidence (Figure 4.4).

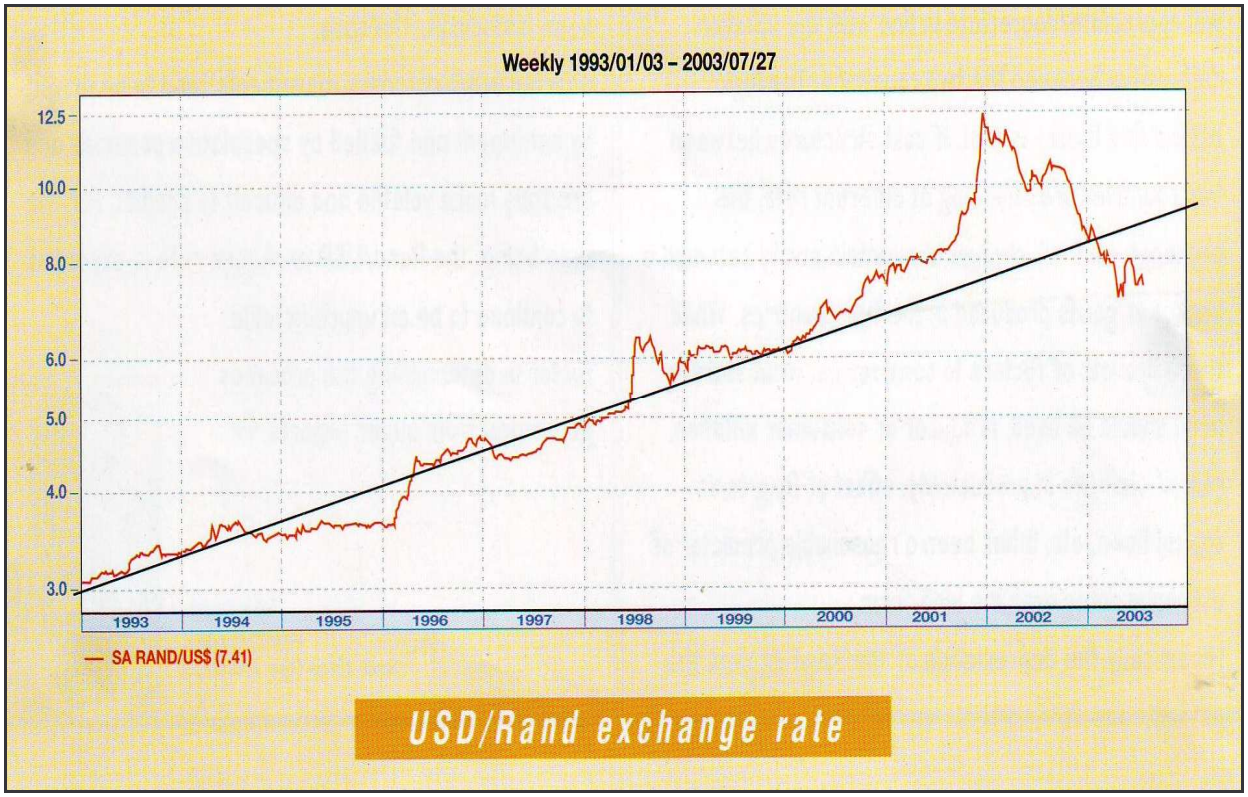

Figure 4.4: The US Dollar / Rand exchange rate from 1993- 2003 (South African Sugar Association, 2003).

The interest rate of South Africa has also added to the financial stress experienced by the farmers. Many farmers must borrow money from banks and lending institutions in order to get through difficult economic times and a high interest rate adds financial stress

A number of the aforementioned factors do not directly impact on the day-to-day lives of the farmers but affect their financial bottom line, their profits, and their means of production. These types of threats and stresses are detached from the context physically but have a cascading effect on the farmers. They have an impact but cannot be directly managed. These types of threats and stresses are also ever-evolving and are unpredictable. They are controlled by external forces, which are themselves affected by other complex and interacting global forces (particularly social, economic and political forces) (www.dti.gov.za/publications /SugarAct/4DeregulationoftheSugar.pdf, 2006).

4.3.2.3 Physical Assets

These assets include the basic infrastructure, tools, machinery and equipment used in supporting farmers' livelihoods. In the study area the assets available to farmers include: transport systems and infrastructure (tractors, trucks and trailers, cars, access to public transport) (L, M), buildings (homes, warehouses, sheds) (A), water management systems (dams, weirs, boreholes, irrigation equipment etc.) (L), communication systems (telephones, internet and e-mail) (L,M), tools and machinery (L), roads and power lines (L), pesticides and herbicide stocks (L,M), fuel (Farm Diesel) (L) (M), basic services (water, sanitation, electricity) (L) (M) and health care facilities (L) (M).
(Key: L = large-scale, M = medium-scale, S = small-scale farmers and A = All).

4.3.2.3.1 Main threats and Stresses acting upon the Physical Assets

There are a number of basic infrastructural concerns. Currently, poor road maintenance in a number of areas makes transport of sugarcane to the mills difficult, and issues of poverty and food security, as well as, access to basic service (water, electricity and sanitation) continue to be of concern to small-scale and some medium-scale farmers. A lack of basic production capital (mentioned under financial assets) makes the purchase of equipment and machinery difficult and purchase tax on various items restricts buying.

Fuel is one of the largest input costs. The price of fuel, particularly farm diesel, has risen sharply and steadily in the past years due to a number of political and economic factors acting on the global oil markets. The increase in the fuel price has meant an increase in the cost of sugarcane haulage, transport between farms and on farms, and an increase in costs associated with the delivery of produce and supplies needed for general on-farm activities such as repair work and crop maintenance. The majority of small-scale growers are situated far from mills. This can be ascribed to Government planning and development parameters, which restricted small-scale grower development to within a maximum of 40 kilometres of a mill in the days of the previous government (pre-1994) (Bates, 1997). The increased cost of delivering the harvested sugarcane to the mill often outweighs the return. During drought periods some mills are not opened due to a shortage of millable sugarcane and farmers have to reroute their sugarcane to other mills further away from the farms thus adding to fuel costs. With the move

to the RV system of payment mentioned above, it is also imperative to get the sugarcane to the mills quickly after it is harvested.

Sugarcane crops are also highly dependent on large inputs of fertilisers and pesticides. While this is not necessarily environmentally sustainable, it is the way that farmers are advised to grow their crops in order to get the best sugarcane quality and highest sucrose yields. Many large-scale commercial farmers have had long-standing relationships with the chemical suppliers and are able to open accounts that are payable over a certain number of months. They are also able to get advice from these suppliers on timing and quantity to be used and are able to negotiate the best prices and buy in bulk. Small-scale growers and some medium scale (emerging) growers still need to form these partnerships and are often unable to buy in bulk due to the size of their farms and the economics involved. This limits their ability to negotiate competitive rates and to open new accounts with suppliers (Bates, 1997). The need for, and quantity of, fertilisers and pesticides used is also affected by climatic conditions.

Rainfall after a drought increases the need to manage crops in terms of pests, diseases and weed prevalence. Nutrient deficiencies in the soil and crop following a drought tend to increase the need for fertilizers and other inputs. Drought-affected sugarcane crops also require special attention during harvesting, and the crop is particularly difficult to cut once affected by drought. This increases the time needed to cut the cane as well as the number of labourers needed to complete the task. This also delays the time it takes to deliver the cane to the mills. As mentioned above, this lowers sucrose levels in the harvested crop and affects the resultant RV negatively. It is sometimes necessary in these cases to bring in contractors either to assist with or, in fact, complete the entire sugarcane cutting process and delivery to the mills.

Contracting systems such as sugarcane harvesting are a high input cost. As the small-scale farmers' extension officer from SASRI commented:

"*For small-scale growers, by virtue of the size of their holdings (dryland and less than 1 hectare) they are unable to support the infrastructure and do not have the capacity to purchase equipment and/or machinery therefore they are dependent on people to do the work for them. The contracting services used for these tasks are however flawed in that they do not*

operate business properly and do not know what their costs are and therefore are unable to give small scale growers an efficient service at a reasonable rate therefore they generally overcharge the farmers, thereby driving them out of business. Farmers will use contractors for all their inputs. Many small-scale farmers are elderly women with small plots of land, children to care for and only a pension as a stable source of income."

Contracting services for the cutting and hauling of a small- and medium-scale farmer's crop are generally very expensive and do not allow the farmers to negotiate on the price of the service. Because of the lack of capital and physical assets that these farmers have access to, they must rely on the services of these contractors to cut and deliver the cane to the mills. A number of the contractors charge high prices because they know the farmers have little experience in the going rate for the services offered (Ballot, in Kupka, 2004). There is a lack of competition amongst small-scale contractors. The system for establishing prices is not related to the constraints of demand and supply. Small-scale growers appear to have little or no bargaining power in the situation and often pay far more than they should for contracting services.

4.3.2.4 Human Assets

Human assets include available and skilled labour and human resources. Reid *et al.* (2006, 200) argues that human capital "is required in order to make use of the other four types of capital (social, physical, financial and natural)". Human assets (capital) were investigated at farm level. There are a number of human assets available to the farmers in the research area. Within households themselves there are a number of people who are able to help with the farm operations (Figure 4.5 and Figure 4.6). This is however dependent on the health of the household member, employment status and gender issues around work allocation. Farmers do employ a number of skilled and unskilled labourers on a part and full time basis and receive advice from advisors, sales representatives and extension officers, technicians, SASRI, SASA (this is available and is also used by farmers at all scales).

In 1996 an agreement was signed between SA Sugar Association and KwaZulu-Natal Department of Agriculture (KNDA). This joint venture provides small-scale cane growers with extension services (see Figure. 4.7). Seconding of extension officers to KNDA and KNDA has provided the services of trained Agricultural Technicians (ATs) and Agricultural Assistants to the farmers (The South African Sugar Association, 1999). A number of the

farmers (especially large-scale farmers) have business and management skills (either from formal institutions or acquired from day to day work on the farm).

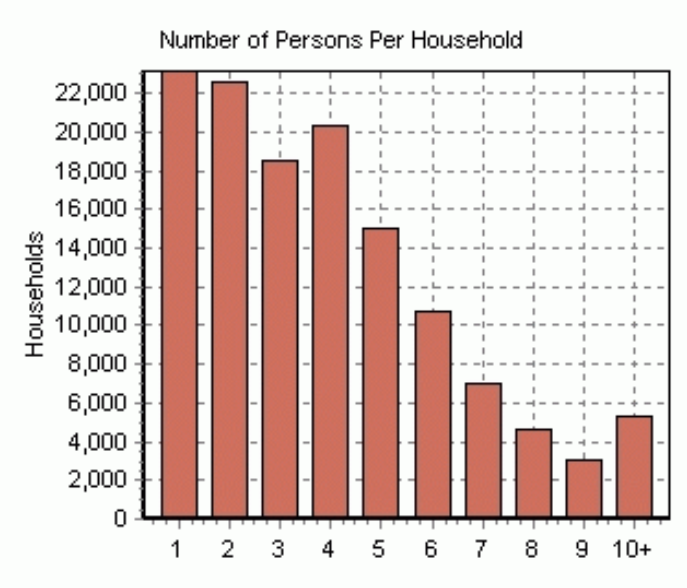

Figure 4.5: The Number of persons per household in the Research Area (Statistics South Africa, 2001).

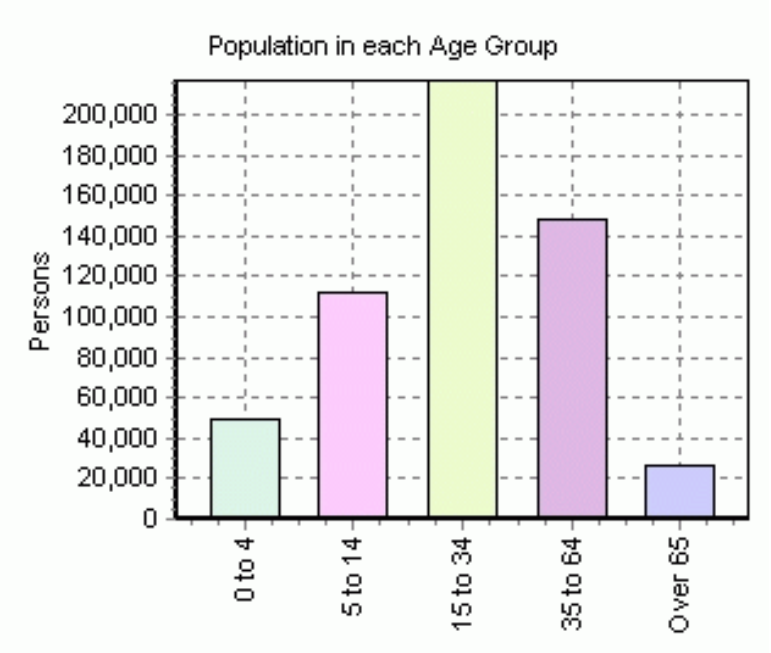

Figure 4.6: Population in Each Age Group in the Research Area (Statistics South Africa, 2001).

Figure 4.7: Small-scale farmers observing soil sampling techniques as demonstrated by a SASRI extension officer during an information field visit, Guquma (Massey, 2005).

4.3.2.4.1 Main Threats and Stresses acting upon the Human Assets

Farm labourers are an important asset for the farmers but a number of dynamics within this livelihood asset have proven to be a threat and stress, which enhance social vulnerability and are eroding resilience. This stress is linked to social and biophysical conditions as well as some political and economic factors (legislation and minimum wage issues).

Labour shortages are a prime risk. Those with a higher level of education (for example a senior certificate) are leaving rural areas for work in the urban areas. Some are finding employment closer to home. They are reluctant to spend money to travel to KwaZulu-Natal to cut sugarcane during the harvesting season. Sugarcane cutting is an intensive and strenuous activity one that requires well-trained and skilled labour, particularly for cutting cane affected by drought. Concerns were raised during interviews with extension officers and large- and medium-scale farmers. As one medium scale farmer said:

"I went with my vehicle and drove all around the Transkei trying to find labourers but I did not succeed. The sugarcane is sitting in the fields. It is ready to be cut but there is no one to cut it."

The longer the sugarcane grows in the field the more sucrose it loses. This negatively affects the RV of the crop.

The impact of HIV/Aids, particularly in KwaZulu-Natal, is also a labour concern. As fast as the farmers train the cane cutters, they either become too weak to work, or return home to be looked after by, or to look after, relatives infected and affected by this disease. These labour issues do not apply only to sugarcane cutters but also to those who drive the tractors and operate the machinery, as well as those in the junior management roles. The farmers interviewed were expecting this situation to get progressively worse as the number of deaths related to HIV/Aids infections increases in rural areas.

New labour legislation (based on minimum wage standards) has been another hurdle and has complicated the employment of labourers. It has lead to the large-scale and medium-scale farmers reducing the number of people employed and finding ways of mechanizing the process. The traditional system that was in place of incentive and payment to cane cutters is now not compatible with minimum wage standards. In some cases, the minimum wage has been increased a number of times since the legislation has come into force and concerns have been expressed by farmers with regards to this.

"Sugarcane can be mechanised to a certain extent to get over the problem with labour but this is only possible in some areas. Labour needs to be paid more. It is not pleasant to cut (sugar) *cane. There is an aging work force and their health is deteriorating. We are also taking on seasonal labour and not permanent labour to get around having to pay the high minimum wages every month"* (Medium-scale emerging farmer during transect walk).

Strategies to manage this threat include combined farming to pool human (and other) resources, as well as the use of social networks to help at busy harvesting and planting times. Other strategies to cope with this stress have included the use of fewer labourers and opting for a mechanised system where possible. A number of emerging farmers (medium-scale) have sought training and advice from the SASRI, the DoA of the SASA and CANEGROWERS

Association. The training comes from an agreement between The SA Cane Growers Association and The Primary Agricultural Education Training Authority (PAETA).

4.3.2.5 Knowledge Assets

Knowledge assets include all forms of knowledge capital used by the farmers in supporting their livelihood. A number of the larger-scale farmers have formal training (degrees, diplomas and certificates in agriculture and financial management) as well as the advantages of knowledge gained from years of experience. Smaller-scale farmers and emerging farmers are receiving both formal and informal training made available through various institutions (such as SASRI under SASA), the CANEGROWERS Association, and mills). SASRI also offers training services for farm labourers and farmers.

SASRI works to develop new sugarcane varieties and improved crop management and cane delivery practices and transfers this information to the sugarcane farmers to improve their profitability. They offer a knowledge and skills base, advice, training programmes, research and extension services. They also offer sugarcane testing services, variety improvement programmes and crop optimisation as well as agronomy services, pathology, crop nutrition and soil testing, entomology and agricultural engineering.

Information is available to farmers from SASRI on the estimated crop. The seasonal climate forecast from sugarcane mills and SASRI is accessed through telephone, e-mail and internet services as well as extension officers and regular publications. This service is mainly used by large-scale and medium-scale (emerging) farmers as they have access to communications infrastructure. SASA offers various services to the sugarcane farmers such as leaf sampling, soil testing, crop modelling, yield predictions, weather and seasonal climate forecasts etc. A number of publications are available for sugarcane farmers. The Link magazine is published by SASA, which gives information on pests and diseases; their treatment and control, seasonal advice for crop planning, information on varieties, as well as climate updates; rainfall data and predictions.

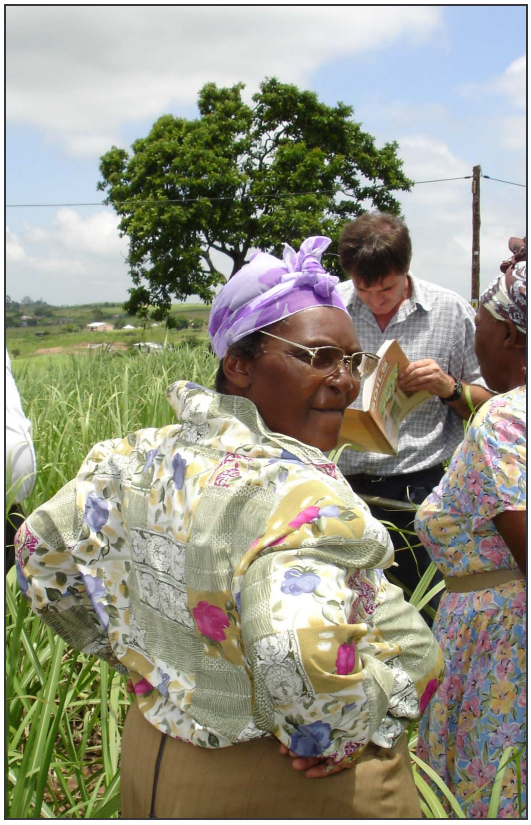

Figure 4.8: Small-scale farmers during an information field visit with the SASRI extension officer, Guquma (Massey, 2005).

The South African Sugar Journal is also published by the Association and gives all those involved in the sugarcane industry information on issues that are more institutional than operational. Issues such as the role of global markets, black economic empowerment initiatives, land reform processes and news about the operations and activities of the association and its services, as well as rainfall and other climatic data for the industry, are supplied.

Information sheets are also provided by SASA and distributed through the extension officers (see Figure 4.8). These fact sheets have information on issues such as husbandry, climate, RV etc. with detailed step-by-step advice on operational themes such as management, harvesting, transport and selling of sugarcane crops. Services such as FieldWatch (a security committee that ensures farm safety) are also offered. The KwaZulu-Natal Department of Agriculture and Environmental Affairs also publish the Agri Update with information from the Directorate of Technology Development and Training and the SASRI.

4.3.2.5.1 Main Threats and Stresses acting upon the Knowledge Assets

New threats require new information sets. Many stresses presently faced have not been faced in the past. Information is sometimes inaccurate or misinterpreted and there are concerns with regards to access to means of communication (especially for the small-scale farmers). Many of the small- and medium-scale farmers are new to the sugarcane industry and have little experience managing risks. Low literacy and basic education rates are also seen to weaken adaptive capacity as farmers find it difficult to access information in appropriate ways (eg. trouble with reading labels on pesticides and understanding scheduling sheets). The level of basic education is relatively high in the area (Figure 4.9) but smaller scale farmers are struggling with barriers to the use and understanding of secondary knowledge available to them.

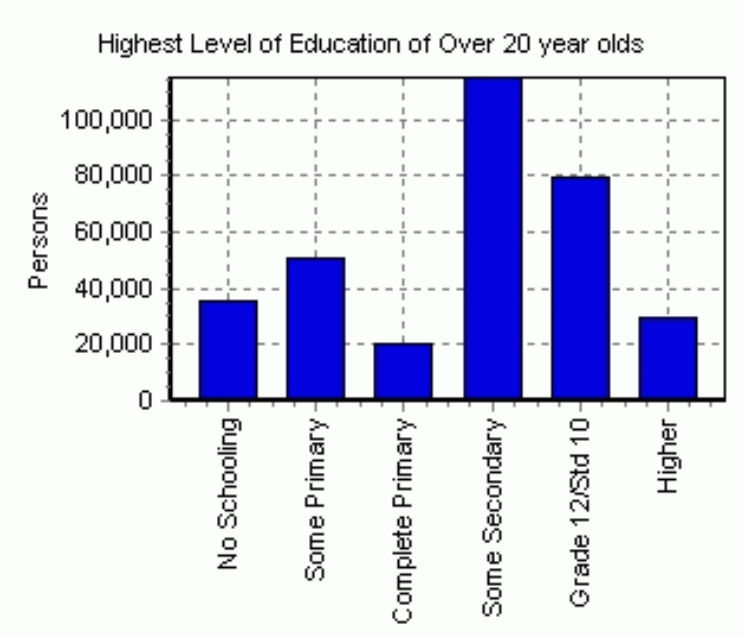

Figure 4.9: The Highest Level of Education of over 20 year olds in the research area (Statistics South Africa, 2001).

4.3.2.6 Social Assets

Social assets are the social resources that the farmers use to sustain their livelihoods and include the informal social networks (see Figure 4.10 and Figure 4.11) formed within communities, farmers groups and associations, as well as mill group boards (mostly involving large-scale farmers) and mentors. The large- and medium-scale farmers in Eston mill area organise farm visits and networking sessions. These farm visits happen monthly and give

neighbouring farmers a chance to see some of the activities happening on other farmers' land. These are learning as well as problem-solving opportunities for the group. These visits are also used as a support system for farmers in the area and as a chance for social gatherings.

Family members and neighbours are also valuable social assets available to the farm, particularly the small-scale farmers who live within close proximity of each other and within extended households. Regular community forums and social gatherings are also important in reinforcing this capital. Good relationships with the extension officers within the area as well as contractors and suppliers have proven to be helpful in building resilience. Once the extension officers know the farmers, the area and the community, they are better able to help with knowledge, information and support. Community policing forums and farm watch programmes have been run in the past and some still operate within this area to assist in mitigating threats of crime, violence and arson.

Figure 4.10: Local small-scale farmers discussing cropping issue in a neighbour's sugarcane field, Guquma (Massey, 2005).

Figure 4.11: Small-scale farmers gathering for a local farmers' group meeting, Guquma (Massey, 2005).

4.3.2.6.1 Main Threats and Stresses acting upon the Social Assets

Because of past political divisions and the scarce financial, physical and natural resources in some areas, mistrust exists in some of the small-scale farming communities as well as between the small, medium and large-scale farmers. Farmers are seen to be less interested in getting involved in cooperatives and formal farm groups. This has led to weakened formal organisations and difficulties with internal politics, and a breakdown in collective social and economic activities. HIV/AIDS causing labour pressures and migration of young people to pursue employment opportunities in urban areas has also meant that a number of households are disaggregated and often it is the women (more often the elderly women) and children who are left in the rural areas. This breakdown in the family unit has also weakened social assets and adaptive capacity and weakened resilience to threats and stresses that have been mentioned in this section.

4.3.3 The Main External Threats Faced

The previous section identified a number of threats and stresses as it investigated the livelihood assets and adaptive capacity of the farmers and the issues around vulnerability.

These perceived threats and stresses emerged during the interview process. Farmers were asked to discuss whether or not these were seen as threats to their livelihoods and what they considered to be the biggest threats and stresses. Table 4.1 shows the results of this exercise (1 being the stress ranked as most important by the farmers). Stresses were also added to this list after interviews with farmers and institutions during the research time spent in the study area.

Having identified the main threats and stresses (research question one: What are the main external threats (hazards and risks) that commercial farmers face?) attention turns to identifying whether or not climate risk is considered a major contributing factor to the vulnerability of commercial farmers in this study area. This study examined all the multiple threats and stresses (both on-farm and off-farm) acting on the system, particularly perceived threats. A number of threats and stresses driving social vulnerability in this region were exposed while gathering data on the adaptive capacity of the farmers and their access to assets. The farmers were asked to rank these threats and stresses in order of importance. The outcome of this process showed the following:

Table 4.1: Main perceived threats and stresses identified by farmers in this context.

Perceived Threats and Stresses (Both internal and external, climatic and non-climatic, macro and micro)	**Small-scale**	**Medium-scale (emerging farmers)**	**Large-scale**
1. Climate change risk (explained as a change in temperature and rainfall over the long term) and climate variability (shorter term) (off-farm)	X	X	X
2. The low domestic and world sugar price (off-farm)	X	X	X
3. The Variable Rand (South African Currency) (off-farm)	X	X	X

4. High input and operational costs (off-farm and on-farm)	X	X	X
5. Lack of access to start up and production capital (financial) and high levels of debt (off-farm and on-farm)	X	X	
6. Land issues (tenure and ownership, land reform and land claims, quantity and quality size) (off-farm and on-farm)	X		X
7. Labour issues (minimum wage, migrant work force, HIV/Aids etc.) (on-farm)		X	X
8. Lack of access to skills, planning tools, networks, support and knowledge (on-farm)	X		
9. Crime and violence (arson, sugarcane theft, farm violence) (on-farm)	X		
10. Conflicting and restrictive government legislation and policy decisions (minimum wage, municipal rates) (off-farm)			X

During the primary research it was found that the stresses most common among the small-, medium- and large-scale farmers were climate change risk and climate variability, the low domestic and world sugar price, high farm input and operational costs, and the variable Rand value (all farmers found these to be stresses). All the farmers ranked climate change risk and variability as one of their biggest stress, however as mentioned in Chapter 6 the discussions with the farmers during the research and communicated intention of the study may have lead to the response by farmers that climate change and climate variability are one (if not the) greatest stress faced. The low domestic and world sugar price and the variable Rand were also ranked as high on the list particularly for the medium and large scale farmers.

Labour and land issues were also identified as being of particular concern for both medium and large scale farmers. A lack of access to start up and production capital (financial) and high levels of debt; crime, violence and conflicting as well as restrictive government legislation and policy decisions, were all identified as stresses amongst the small and the medium scale farmers. A lack of access to skills, planning tools, networks, support and knowledge were also recognized as elements that made particularly small scale farmers vulnerable.

4.3.4 Discussion

This section discusses some of the main themes that emerge from the primary research findings, particularly those of multiple and interacting stresses and asset usage and management.

One particular dynamic that was observed in the research findings is that as other stresses are heightened so climate impacts tend to become more of a concern. This is particularly evident in comments made in the focus groups and in interviews with the extension officers. They made it quite clear, on a number of occasions, that when the climate is stable then other issues such as land and labour seem to be less of an issue. When they find themselves in a drought situation, however, impacts such as the low sugar price become a much bigger concern. This is shown graphically in Figure 4.12. As the Off-Farm circle (with its 3 examples) expands (as the impacts become bigger) so does the On-Farm circle. As the On-Farm circle decreases (as the impact becomes less of a threat for example the end of a drought) so the impact of the threats in the inner circle decreases.

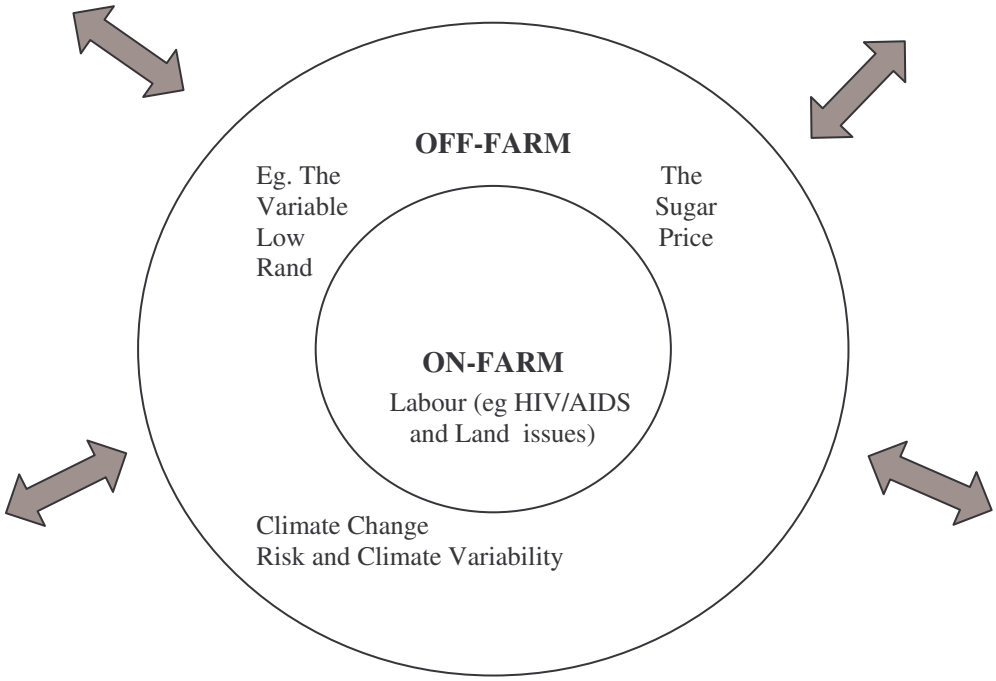

Figure 4.12: The relationship between on-farm and off-farm threats and stresses

The threats and stresses experienced by these farmers are multiple and interacting. These threats and stresses enhance each other and are a combined force in driving local social vulnerability. Individually these threats and stresses appear to be manageable (such as cutting the labor force due to restrictive legislation and financial constraints) but when combined they play off each other and enhance the total impact acting on the system.

A noticeable trend in the findings is that most respondents initially ranked climate change risk and climate variability as their biggest threat and stress; however, as the interviews and discussions continued the farmers (at all scales) focused on other issues such at the Rand, the sugar price and high input costs, discussing these at great length and while they mentioned climate risk they did not elaborate further. They did not return to the topic of climate except to refer to the effect that climate impacts have on exacerbating other stresses.

Farmers talked more about the immediate, short-term, macro, and variable threats that affect them. Climate change risk and variability were seen to be threats of the future; a creeping and long-term concern that has been (in many cases) sidelined in the attempt to manage more immediate and short-term threats such as the low world and domestic sugar price. Climate

risk is also seen to be a threat that farmers have had to deal with in the past. They have experience with this risk and know how to manage it. The focus therefore fell specifically on the concern over the uncontrollability and unpredictability of off-farm threats within a continually changing political and economic environment. It appears that with the number of other stresses that farmers face, the hypothetical removal of climate change as a stress would still render the farmers vulnerable. Climate change simply exacerbates an already (in some cases) chronic state of vulnerability. Even during times of good rain the farmers still struggle due to the number and nature of these other multiple and interacting stresses.

It is particularly interesting to observe that these threats and stresses are all linked in some manner to assets and access to these assets as well as to institutions. It is also noted that a number of these threats are seen to be unmanageable, beyond their control and removed from the immediate geographical context of the farm. On-farm threats were generally ranked as secondary. There is seen to be more control of these risks when they are on-farm and there is a better understanding of and more experience in dealing with these threats. They can also be directly managed and are visible to the farmer. These threats and stresses are also both biophysical and social in nature. The interface between the two is a dynamic that has been picked up in other work on vulnerability (see Adger *et al*., 2003).

Figure 4.13 shows this interaction graphically (the shaded circles are those stresses that where ranked highest by farmers. The size of the circles bears no relation to importance in this case. The arrows show the connection between the threats and stresses). An example of this interaction would be: A farmer is faced by a **climate** impact such as a **drought**. On its own this can be managed through irrigation and increased inputs (such as irrigation and fertilizers) but the **variable Rand** had made the cost of inputs very high and the effect of **conflicting and restrictive legislation** such as the National Water Act has restricted access to stored water resources. **The low domestic and world sugar price also** means that even if he or she manages the crop well through the drought, the profit will be so low it cannot service the **high debt** accumulated due to the need for increased (and expensive) inputs brought on by the **drought**. Responses to these threats and the direct impact that they have are intrinsically linked to the farmer's access to assets and institutions that govern some of these assets.

Adaptive capacity and the coping and adaptation strategies used are determined by this level of access.

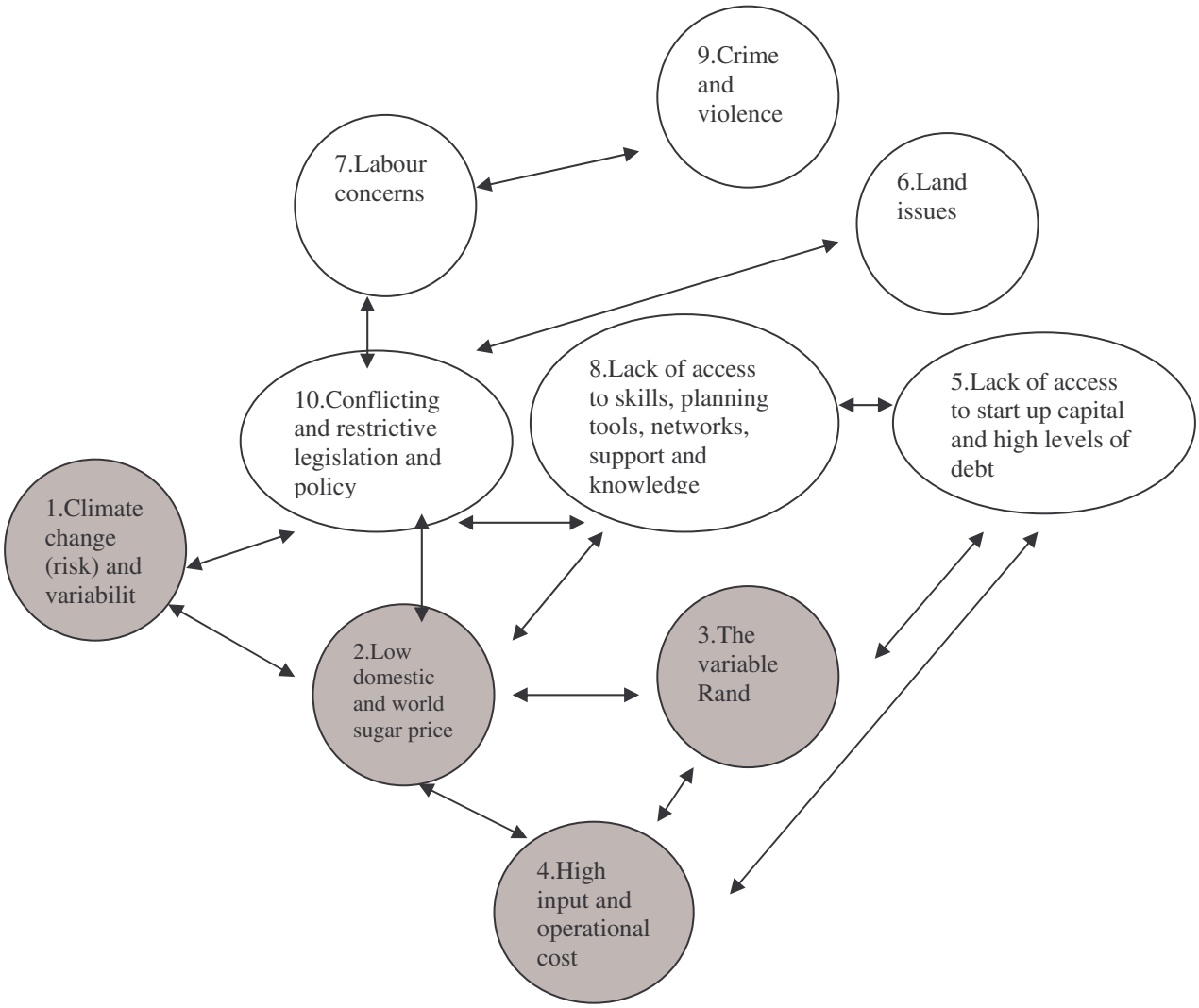

Figure 4.13: The dynamics of interacting and multiple stresses in this study area (the grey shaded shapes are those threats and stresses ranked highest by farmers).

This analysis ties in closely with the "double exposure" framework used to analyse the interactions between global environmental change and globalization, and their implications for food systems (O'Brien and Leichenko, 2000) in that it is based on the understanding that both these processes create uneven outcomes (winners and losers). These outcomes are influenced primarily by differential exposure to both immediate shocks and gradual changes and secondarily by differing capacities to respond to these changes. In this case both the

exposure and the capacity for response are functions of the contextual environment. This can include the biophysical, social, economic and institutional characteristics of a geographical area, region, community, social group or household (O'Brien and Leichenko, 2000). The outcomes of the continual process of global environmental change and globalization will change this contextual environment and influence both the exposure and response to change in the future. The double exposure framework highlights the co-occurrence of both the shocks and the structural transformations, which relate to the two processes. It also identifies the pathway and the dynamics of the interactions (O'Brien and Leichenko, 2000).

Figure 4.14 gives a graphical summary of the discussion above. It shows the case that is most true for the research findings. All threats and stresses as shown to be equal (equal parts of the "pie") giving due importance to each threat. Vulnerability is seen here as a starting point with the threats and stresses acting upon the already vulnerable system. This figure shows an approach that is not climate driven but takes all multiple stresses into account. Figure 4.15 shows an approach, which is untrue for this study area and the research findings. Climate change is seen as the overall driver of vulnerability with other multiple stresses contributing to a lesser extent. Vulnerability is seen as an end point, a situation that the farmers find themselves in after the impact of the threats and stresses.

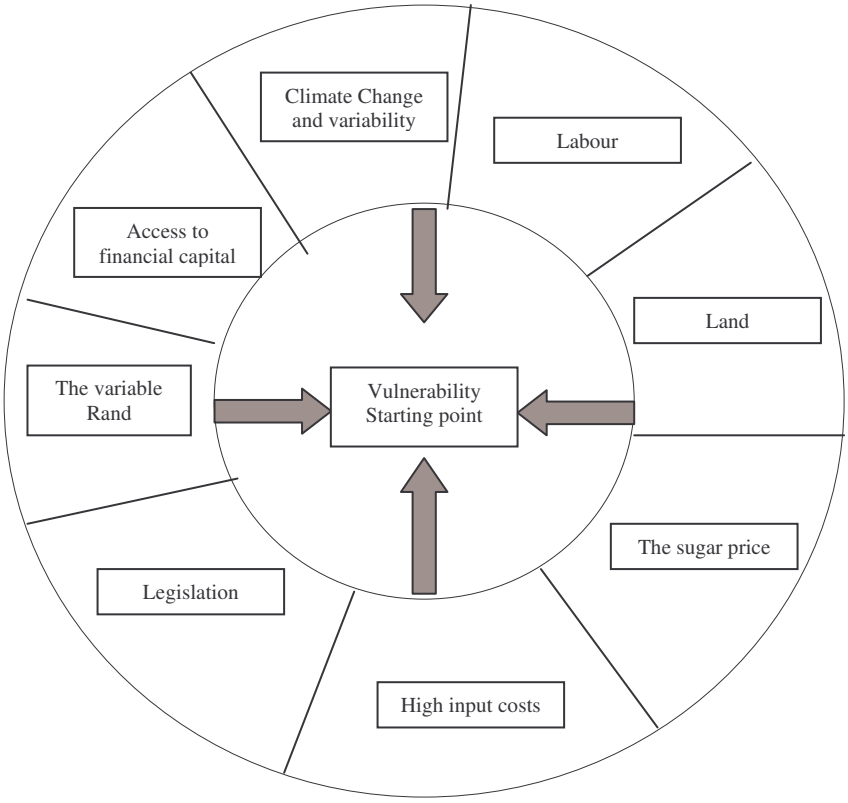

Figure 4.14: A multiple stresses approach to vulnerability in this study area (showing vulnerability as a starting point).

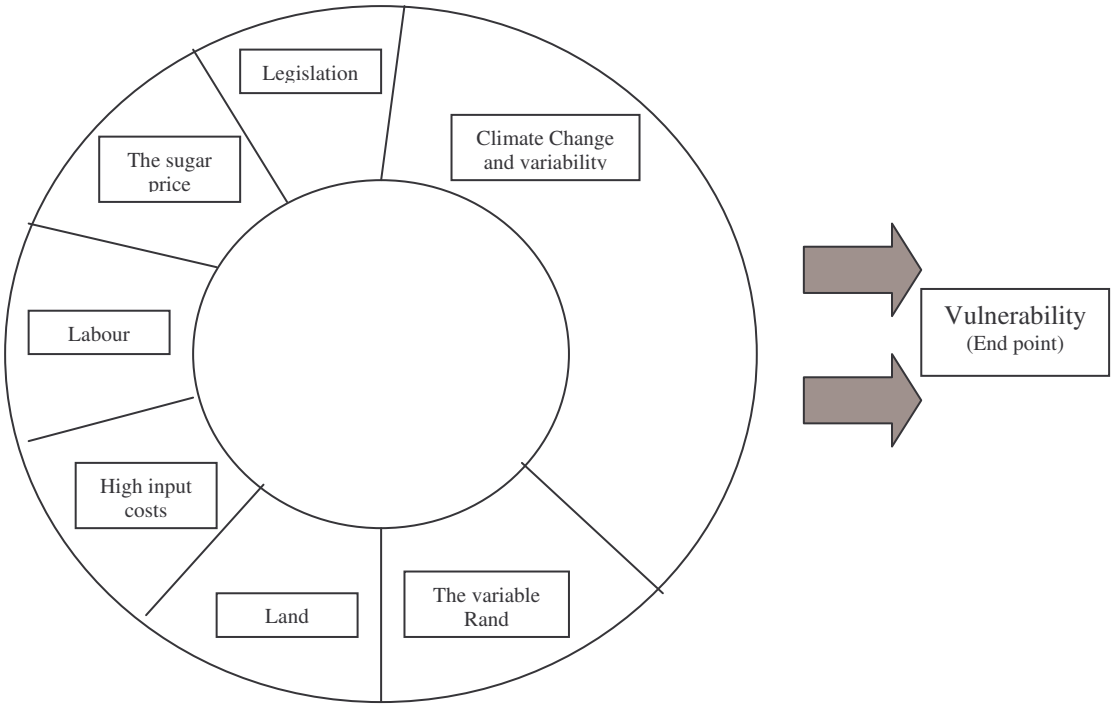

Figure 4.15: A climate change and variability driven approach to vulnerability in this study area (showing vulnerability as an end point of impacts).

4.4 Summary

The real world of vulnerability is dynamic, organized by actors, in social networks, at various multiple scales. Even though analysis may highlight climate change impacts, the real world is one of a multitude of threats, risks and vulnerabilities. This chapter investigated the assets available to farmers to support and build their resilience to threats and stressors. It also explored the main threats and stresses acting on these livelihood assets and increasing vulnerability

There are a number of assets that farmers have access to and use in their livelihood strategies. These assist in increasing the adaptive capacity and resilience of the farmers. The main livelihood assets available to these sugarcane farmers are: natural assets (their land, good soils), water and water sources, the sugarcane crop itself, the natural fauna and flora); financial assets (loans from the banks and agricultural organisations, grants from the Department of Agriculture, money earned from other economic activities besides farming, profit from sugarcane sales, capital and investments, saving schemes and credit with local suppliers) and physical assets (transport systems and infrastructure, buildings, water management systems, communication systems, tools and machinery, roads and power lines, pesticide s and herbicide stocks, fuel, basic services an health care facilities). Other assets include: human assets (household members, skilled and unskilled labour, advisors, sales representatives and extension officers and technicians (SASRI, SASA, DoA); Knowledge Assets (formal and informal training, knowledge from experience, education and training services, SASRI advice and information services through the Institute and the extension officers as well as websites and communication programmes) and social assets (informal social networks, farmers groups and associations, Mill Group Boards and mentors, farm visits, family members and neighbours, community forums and social gatherings, community policing and “Farm Watch” forums).

The stress factors that shape vulnerability in the Eston Mill area within the KwaZulu-Natal Midlands South Area have been found to be a combination of both on-farm and off-farm social, economic, and political factors and not just climatic factors. These include: Climate change risk and climate variability (off-farm), the low domestic and world sugarcane price (off farm), the variable Rand (off-farm), high input and operational costs (off-farm and on-

farm). Other threats and stresses include a lack of access to start up and production capital and high levels of debt (off-farm and on-farm), land issues (such as land tenure, land reform and land claims, the quantity and quality of the land) (off-farm and on-farm) and a lack of access to skills, planning tools, networks, support and knowledge systems (on-farm) as well as crime and Violence (including arson, sugarcane theft and farm violence) (on-farm), conflicting and restrictive government legislation and policy decisions (minimum wage, municipal rates with no services etc) (off-farm) and labor issues (minimum wage, migrant labor force, HIV/AIDS etc) (on-farm).

It is seen that climate change risk is a major but not the only contributing factor to the vulnerability of commercial farmers in this study area. As off-farm threats and stresses grow so do on-farm threats and stresses. The risks are multiple, interacting and interconnected all combining to compound already existing vulnerabilities. They operate in a complex environment along temporal, spatial, geographical, sectoral, gender, age and racial lines. These threats and stresses interact at a number of different levels. They crosscut and compound each other often exposing continual vulnerabilities. Climate change must be viewed as one of many threats and stresses exacerbating already present vulnerability in the system. This chapter also concluded that as uncontrollable, external, on-farm threats increase so off-farm threats become more of a concern. They compound each other weaving a complex web of continual and changing vulnerability in the study area

The next chapter discusses the main coping and adaptation strategies employed by the farmers in response to the threats and stresses discussed in this chapter. It also investigated the issue of access to the livelihoods assets mentioned here and the role that institutions play in the access to these assets.

CHAPTER 5

"'n BOER MAAK 'n PLAN" *: COPING, ADAPTATION AND ISSUES OF ACCESS

5.1 Introduction

Having examined the livelihood assets that farmers have access to and the multiple interacting threats and stresses that farmers face, attention now turns to some of the response strategies that these farmers use to reduce their vulnerability and heighten resilience to threats and stresses that they face. In this chapter these strategies are argued to hold potential as adaptation strategies to assist in building resilience to climate change. This chapter also explores issues of access to the livelihood assets that farmers use in the adoption responses (including coping and adaptation strategies) and the role that institutions play in access and entitlements. This Chapter gives answers to research question two: What response, coping and adaptive strategies have commercial farmers adopted in response to climate risk and climate variability?

5.2 Coping and Adaptation Strategies Adopted

In order to investigate the coping and adaptation strategies adopted by farmers, semi-structured interviews, focus groups and transect walks were organised with local farmers (at all scales) and those involved in the support of the sugarcane industry (SASA, SASRI). Secondary data were also gathered through SASA and SASRI. The response and potential adaptation strategies shown are used to varying degrees by different scales of farmers at different times of the year. They are undertaken in response to threats and stresses present that impact the system to varying degrees across temporal and spatial dimensions and reduce adaptive capacity and resilience thereby increasing the social vulnerability of the farmers. These strategies have either been undertaken under advice from various groups or undertaken as their own response strategy. Different groups experience threats in different ways and react differently to these threats. Their reaction depends on the effective use of coping and adaptation strategies and the adaptive capacity present. Coping refers to short- term responses to threats and stresses while adaptation refers to longer-term measures undertaken and changes made to address the impact on the system.

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* A popular Afrikaans idiom directly translated as: "A farmer makes a plan".

5.2.1 Diversification

Diversification is undertaken in response to issues of climate change risk and climate variability, the low domestic and world sugar price, the variable Rand, high input and operational costs, conflicting and restrictive government legislation and policy decisions and labour issues (migrant work force, HIV/Aids) are highlighted as stresses.

The reliance on a single type of crop and on a single farming technique has become a non-option over the years. This is due to the continued impact of climate and external stresses. Sugarcane is not a subsistence crop. It is important that farmers, particularly small-scale growers, seek alternative sources of income to subsidize the income from the sugarcane crop. A number of small-scale farmers in the research area use the sugarcane as an extra income, to build houses with or assist their other businesses (basic supply stores and other small business generally run by the women in the community). Other larger-scale farmers have opened eco-tourism businesses on their farms or have opened adventure trails. Some have begun to run their own consultancies (engineering and farm practices) or work for other businesses in nearby urban areas to subsidise the farm income. Others have begun to grow alternative crops, particularly small-scale growers who either use the yields from these crops for subsistence or extra income in times when the sugar cane is still growing. These crops include litchis, macadamia nuts, citrus, paw-paws, flowers, bananas and vegetables where there is additional water available. These crops however are at high risk from adverse weather conditions such as frost periods and high temperatures. Markets are often difficult to access but they do offer opportunities for much better returns than sugarcane and may allow for more employment opportunities for the communities. This is also reflected in secondary data from Wise (1999).

Inter-cropping and multi-cropping practices also make it possible for cane growers to produce both food and cash crops between the rows of cane. Within three to five months of planting the cane growers should be able to produce yields of intercrops. Varieties can include cabbage, beans and sweet potatoes and in some cases maize. It is however necessary to manage this process carefully ensuring that the crop is clean, receives it own fertilizers and lime, and are weed and pest free or this may be detrimental to the cane crop thus reducing yields. Rearing of livestock (cattle in particular) is a common practice with small-scale growers as this is part of their capital and wealth. Large-scale sugarcane farmers also rear

livestock, not as the main source of income, but as part of their land-use practices and to subsidise the other farm activities and income. There is however little incentive to diversify. It is often very expensive and risky to undertake diversification activities and solid knowledge and advice is needed in order to make wise and calculated decisions. Access to this support is often difficult to access (particularly for small-scale growers) and can be expensive and limited.

Seedcane planting and selling has been an especially helpful adaptation strategy. This is a strategy that has been introduced by extension officers of SASRI. It is a more recent response strategy and presents itself and a basic technology transfer along with training and mentorship programmes to assist new farmers in this venture. The objectives of seedcane schemes are to ensure a regular and adequate supply of good true-to-type and disease-free seedcane for the grower group (Brenchley, 2003). If cared for during dry spells and drought and protected from pests and diseases, it can greatly assist with getting farmers back on their feet after impacts. The seedcane can be used on the farmers' own farms or sold to neighbouring groups for monetary gain thereby increasing capital. The quality must be checked by SASRI authorities before it is used or sold to prevent the spread of pests and diseases. This is usually done by the authorities at SASRI.

A group of emerging farmers, with the help of extension officers from SASRI have grown a seedcane demonstration plot in the Umzimkulu Region. During the research, the group of farmers were interviewed individually and together in a focus group. This programme has afforded the opportunity to supply clean good quality sugarcane to their fields as well as selling much of it to neighbouring farmers for profit (also enabling the use of social capital). Farmers also acquired skills in seedcane growing and harvesting which can be applied to other seedcane plots in the future. Having good quality cane on their fields from using the seedcane and also acquiring monetary gain from selling excess sugarcane, has meant that many of them have coped better with the multiple impacts the previous couple of years might have brought (dry spells, frost and the strong rand). This is a sustainable adaptive strategy that lowers vulnerability and increases the adaptive capacity of these farmers.

While it is generally standard practice for large-scale farmers to grow their own seedcane it is difficult for small and medium scale farmers to do the same. This is due to space constraints and the costs involved in this process. Small-scale growers can collectively work together, combining resources, or can access seedcane at competitive prices through demonstration plots. These plots have also assisted in demonstrating correct farming practices for maximum profit by introducing new varieties of cane to local small-scale growers and by introducing a model of propagating affordable seedcane which small scale farmers in other areas can duplicate. "A good supply of quality seedcane is our most important critical success factor if we wish to stay in business" (South African Sugar Association, 1992, 3) and;

"Farming is a business where variables are out of your control and you need to plan with this in mind. Running a farm is as much about work behind the desk as it is in the field." (Suresh Naidoo, a successful small scale farmer in Crawford, 2003, 12).

This diversification strategy has produced a number of positive outcomes and has increased the resilience of a number of farmers in the study area. Outcomes include: an increase in additional income, spreading the risk, an increase in farm-level risk management and reducing the risk of total crop damage and crop failure. There has also been an increase in financial, natural and physical capital as well as an increase in financial security and yield (both in quantity and quality of the crop). This strategy has also brought about improved resource management and location specific solutions to vulnerabilities.

Farmers, when questioned on what they would do should climate change impacts hit (for example increased temperatures and an increase or decrease in rainfall etc.), almost always chose elements of this strategy. Diversification through a change in the crops grown, undertaking different activities on the farm, different land use strategies and farming practices and undertaking different livelihood strategies shown in this section were viewed by farmers as strategies they would undertake.

5.2.2 Changing Land Use and Farm Practices

As with diversification strategies, changes in land use and farm practices strategy have been adopted in response to issues of access to livelihood assets and threats and stresses from climate change risk and climate variability, the low domestic and world sugar price, the

variable Rand, the high cost of inputs and inflated operational costs, land issues (ownership, tenure, land reform, land quality and size), conflicting and restrictive government legislation and policy decisions and labour issues (such as a migrant work force and HIV/Aids).

Growing of correct varieties of sugarcane to cope with soil, pests, disease and weather conditions is one of the most important decisions a cane grower has to make (Turner *et al*., 1993). Once the decision has been made the farmer is stuck with that variety for many years. A farmer can either lose a lot of money or increase the income received by a considerable amount. An example: in the Midlands the growers made an estimated additional R60 million Rand in the 1991/92 season alone with the change from Nco376 to N12. This put them in a very good position for the drought years that followed (Turner *et al*., 1993). A decision like this requires that farmers have access to information and advice on the correct variety to grow. A number of small-scale growers were still growing old varieties of sugarcane that were unsuitable for the area and were suffering under the existing climatic conditions. They did not have access to an extension officer who would have advised them and assisted with financial and farm planning so they could change to a more suitable variety thereby increasing yield and RV.

Environmental sustainability and management of natural resources are also important for increasing resilience to adverse conditions. A particular change adopted by the large-scale farmers (advised and implemented by the SASA) is the move from burning of crop to the removal of the leaves by hand, known as trashing.

Burning affects soil negatively through adding burnt material to the soil structure and depletes natural capital needed in the production of good quality sugar. The benefits of trashing include a reduction in soil erosion and water run-off. It also assists with increased infiltration and moisture conservation as well as weed suppression. The left-over trash blanket can be used as cattle feed or can be left on the field to assist with water retention in the soil. This brings with it an increase in yields and an improvement in sugarcane quality. Trashing increases sustainability and decreases vulnerability due to the increased resistance of the resources on the farm to climate impacts. A number of farmers in the area have changed to this practice (personal communication with SASRI extension officers, 2006).

Other environmental practices such as “no till or minimum tillage” help to reduce soil erosion and improve the ground’s water absorption capacity. In July 2002, SASRI released the Standards and Guidelines for Conservation and Environmental Management in the South African Sugar Industry. This document directs farmers and other groups on field practices (soil conservation, cane extraction, management practices), water (wetlands and watercourses, irrigation, drainage), air pollution, the soil and cane spillage as well as management and utilization of natural resources, cultural assets, and public recreational facilities. Procedures for environmental management system audits are also given in the document. Key environmental issues affecting the sugar cane industry include the protection of soil resources, preservation of wetlands, re-establishment of indigenous flora and fauna in riverine areas, reduction of air and water pollution arising from activities such as cane burning, factory emissions and the use of pesticides and reduction of sugarcane spillage. Local environmental committees have been established in all mill areas. Representing both growers and millers, they deal with regional environmental issues. The committee’s representatives meet jointly at regional environmental seminars and field days to discuss action plans for current issues. Local sugar cane growers and millers have formed an Environmental Committee, and one of the objectives is the implementation of the concept of Multiple Resource Utilization (MRU). The Eston Environmental Committee meets monthly to discuss environmentally friendly farming methods and issues (Phillips, 2004):

“The results farmers get are less dependent on their own actions than on uncontrollable factors. So doing the right thing will not always guarantee the right result. Experienced farmers know this and that is why they are more conservative in their estimates of future profits”(Coetzee, 2004, 24).

“Producers will have to spend more time collecting and evaluating data if they want to remain successful in the agricultural sector” (Coetzee, 2004, 28).

Crop planning and programme planning are an essential response strategy that a number of larger commercial growers (often 3rd and 4th generation sugarcane farmers) employ to manage climatic and other internal and external stressors. These could be upgraded into a longer-term adaptation strategy. Strict schedules are followed in terms of when and where to plant, fertilise, cut and transport to ensure good yield, efficiency and economical farming. This

schedule is passed on as detailed timetables by extension officers when supporting, training and mentoring the small and medium scale farmers.

This schedule, however, does not allow for much flexibility. The onset of climate change impacts such as later rains or earlier frost periods may impact on this tight schedule in which case the order of activities will have to be modified. This will particularly affect the time that the sugarcane crop is harvested and sent to the mill and may also affect the RV if the cane has to be cut early to meet the milling season opening and closing dates. However, if widespread impact occurs, the mills may be forced to alter their opening and closing seasons, which would negatively affect those farmers who managed better with the climate impact.

Land use plans combine factors such as agronomic practice, mechanisation, climate, soils, water and topography to obtain the best possible economic yield, while conserving the environment. Land use planning recognizes that different areas of the farm require different management practices (thereby extending the life of the farm and increasing the yields and profit allowing a cushion for times of risks and difficulty). These plans make operations easier and more efficient and improve the growth of the cane thereby increasing yields and ensuring environmental sustainability. Reducing soil erosion and enhancing surface water management is also important particularly in enabling the crop and farm to withstand drought more effectively (personal communication with SASRI extension officers, 2006).

Crop rotation is another well-used response strategy, particularly in larger operations of medium-scale (emerging) farmers and large-scale ones that could be enhanced. It is also an effective method in reducing harmful pests and disease and in improving yields (van Antwerpen, 2002). One farmer in the Eston Mill area, for example, has adopted the approach of planting a maize crop every ten to 14 years immediately after ploughing in an old ratoon cane field. It also assists in spreading production risk between crops and breaks the monoculture cycle. It enables chemicals to be used more efficiently and reduces the potential of herbicide resistance in the crop (Gleason, 2004).

It is important that when the good times come that farmers get back into production as soon as possible. They need to plan for the drought years during the good years and for the good

years during droughts. Problems associated with this include the fact that debt has to be kept to levels, which can be serviced by the farm as mentioned above. It is also important to put away the money saved on things such as herbicide and pesticides during dry spells for use during times of better rain. Harvesting sequences are particularly important during times of drought (Lonsdale, 1993).

The situation is appropriately summed up by this quote from a large-scale farmer during a transect walk:

"You have to be a jack of all trades: administrator, farmer, mechanic, PR, payment, filing, forms, orders, finances, meetings and appointments, financial planner. Farming is a business. You need to spend money to make money and spread your risk. You also need to help each other out, make friends and form partnerships between farmers and work together. Learn from your and each other's mistakes. You need to read as well. There is always new legislation and forms to fill in. This becomes difficult without help or extension officers."

Changing land use and farm practices have assisted in increasing yield and income (through improved quantity and quality of the crop), reducing the risk of total crop damage and crop failure, increasing financial, natural and physical capital and improved natural resource management and sustainability (water, soil etc). Other outcomes include a reduction in the degradation of natural assets and capital (soil erosion, soil leaching), protection against and improved management of pests and diseases, an increase in farm level risk management and an increase in crop resilience to drought. These practices reduce the negative impacts of climatic and non-climatic stresses particularly.

5.2.3 The Use of Social Networks and Support Systems

The use of social networks and support systems is in response to the main threats and stresses identified when investigating the livelihood assets and adaptive capacity of the farmers in this area. The strategies are undertaken in response to a range of current and potential stressors including: Climate change and climate variability, the low domestic and world sugar price, the variable Rand, high input and operational costs, the lack of access to start-up capital and high level of debt as well as the lack of access to skills, planning tools, networks, support and knowledge, all of which threaten the livelihoods of the farmers and contribute to increased social vulnerability.

The use of social networks and support systems includes making use of cooperatives, social functions, sharing experiences, empowering new farmers, decision-making structures, and assisting with solving problems. These are mostly available to large-scale farmers. Large-scale farmers also attend monthly meetings with the Eston Study Group, undertake consultations with the local SASRI extension officers and technicians from the Department of Agriculture (variety choices, fertilizers, scheduling etc.), discuss issues and seek advice from fertilizer and chemical representatives. These strategies are only really available to large-scale farmers who have long standing relationships with the representatives.

Some participate in the Eston Environmental Committee (mostly consisting of the large-scale growers), attend information exchange days and farm visits (sharing experiences; offering of advice, assistance, ideas and knowledge). Large- and medium-scale farmers make best use of this strategy and of the advice, support and training of SASA. Partnerships with and mentoring of emerging farmers by larger established farmers are also undertaken.

Mentoring has also become a key strategy to assist new emerging farmers in the area. Mentors (generally neighbouring or previous large-scale farmers) assist with training in correct business procedures on the farm, as well as assist in helping the new farmer keep proper filed records and stock audits. Suppliers often do not know the new farmer and so will not open accounts for them. The mentors assist in introducing the new farmer to these suppliers and vouching for them financially (Powell-Joubert, 2004). “We have thrown ourselves into the sugar industry and are farming a crop that is resilient. We, too, must be resilient. The sugar industry is being run efficiently, and lots of support is available” (Linda in Powell-Joubert, 2004, 67).

The use of social networks has assisted in spreading risk and increasing farm-level risk management. It has increased financial and physical capital, improved resource management and expanded knowledge systems, thus building capacity and experience. It has also ensured better farm practices in some instances and assisted with improved access to assets and capital with increased financial and environmental sustainability through the sharing of knowledge and the support of other experienced farmers and extension officers. This strategy is closely linked to combined farming and overlaps in a number of ways.

5.2.4 Combined Farming Practices

The strategy of combined farming has assisted the farmers (particularly small-scale farmers in this case) in managing risks associated with climate change risk and climate variability, low domestic and world sugar price, the variable Rand, high input and operational costs and the lack of access to start up capital. It has also assisted in dealing with threats related to land (mentioned earlier and which include issues of quality and size of the land), the lack of access to skills, planning tools, networks, support and knowledge and labour concerns.

Combined farming is directly linked with the use of social networks. A number of combined farming schemes have been initiated under the guidance of SASRI Extension staff and have been successful in areas such as Gqugquma. This area was visited and the local small-scale farmers interviewed. A public meeting was attended and an informal discussion and farm visit were undertaken in a small-scale farming community within the study area. The local extension officer overseeing this process was also interviewed. Small-scale farmers in particular struggle with small plots of land (not viable for making a profit from sugarcane in areas as small as 3 hectares) and are required to hire contractors at currently over-inflated prices because of their limited ability to access tools, machinery, infrastructure and transport equipment.

The idea of combined farming provides for the voluntary association of individual farmers. They are able to consolidate their arable allotments and create economically viable and continuous units farmed according to good commercial agricultural principles. The success of combined farming models in the small-scale growing sector, such as the Gqugquma Project in Noordsberg, has created interest among other small-scale growers with a view to similar development in their regions. This has also sparked interest from commercial banks more willing to finance such projects.

This form of cooperative farming has a number of advantages including the improved economies of scale, improved yields, smoother farm operations and profits split between participants. Stronger bargaining power is possible due to the size of the operation, which is often lost to small-scale growers who have little power in securing well priced and competitive fertilizer and chemicals as well as haulage contracting rates. Many of these

projects (if supported by SASRI) are accompanied by training and mentorship programmes. We also see improved conservation practices in this strategy. Extension officers guide farmers to ensure proper planning of the contours, waterways and roads.

Combining the community members' individual livelihoods assets through initiatives such as these assists in strengthening resilience in a number of ways:

- Enhanced social assets: Family groups and neighbours combine in working together on farming activities. Farmers groups and associations are formed through these schemes for the management of operations. Study groups, mentors, extension officers, community structures and chemical and herbicide representatives are all better accessed through larger more formal and managed operations.
- Enhanced financial assets: combining monetary wealth in formal bank accounts and funds assists in strengthening resilience and accessing loans from formal institutions. Savings schemes and grants are also easier to access in larger groups. Financial groups and commercial banks are more likely to finance an organized group of farmers with "demonstrable viability" (Armitage, 2004).
- The availability of natural assets: larger amounts of arable land are available through combining individual plots. Access to water is improved through the sharing of resources and improved economies of scale.
- Wider access to physical assets: infrastructure is more easily bought through combined initiatives. One tractor can be bought for all the plots rather than one tractor for each plot, which is economically viable. Transport systems are improved as farmers can transport all their sugarcane to the mills in one or two consignments rather than each farmer and their individual plot hiring contractors to harvest and transport their sugarcane (this also reduces input costs such as fuel). Municipal infrastructure, buildings, water management systems, farm equipment and fuel are also more readily accessed. The sharing of production costs such as electricity, project administration, water, bookkeeping and irrigation are also easier.
- Human assets: access to extension officers and technicians is improved. It is more effective and efficient for extension officer to offer services and advice to larger groups rather than each individual small scale-farmer. Labour is shared in the scheme and there are more people available to assist with crop maintenance, financial and farm

management as opposed to a number of farmers all running every aspect of their own plot of land.

- Knowledge and information: sharing of knowledge is easier in combined farming schemes. Some farmers may have been planting sugarcane longer than others and are able to offer advice to the group. Information from extension officers, technicians and other formal institutions can be easily disseminated to groups rather than individuals. There is also improved technology transfer. The use of bigger and, in some cases, more experienced commercial groups in the planning and re-engineering of small-scale grower areas is important particularly for social, business and agricultural development of the grower community.

This strategy of combined farming has the potential, in particular, to increase resilience to external threats such as market prices and climate variability in both the long and short term thus reducing the vulnerability of small-scale farmers in particular. Combined farming development initiatives do, however, require infrastructure for development and a legal framework for the protection of land use rights and securing institutional finance. Careful farm plans, financing structures and signed agreements are also needed. Support services are essential for such projects to reach their potential however access to these support services can be limited in some areas (Armitage 2004).

Farmers have, however, voiced concerns about losing their individual piece of land in these initiatives. Land is a very sensitive topic among farmers in this area. Much of it is tribal and they only have tenure right. By holding on to their land as individuals they hope that at some time they may come to own it themselves. There are also problems of mistrust, the need for approval from the chief (which can involve lengthy negotiations), getting the farmers to spread work evenly, problems of self-organization and sustainability once the formal support of extension officers has ended.

The success of combined farming is based on its ability to use social networks and assets to mobilise other assets such as knowledge, physical assets, for example tractors and agricultural equipment and natural assets, for instance land and water resource. These are assets that may not have been accessible to individuals in the collective if they were to operate as separate

entities. This strategy relies heavily on both formal (SASRI, DoA etc) and informal institutions (chiefs and community groups) and the access that they afford. The success of these schemes is built on the ability of the group for self-organisation and on the use of social capital and social networks to access other assets (linked to adaptive capacity literature). Collective action and governance are key in sustaining macro and micro networks and strengthening linkages and types. The functioning of this strategy (and network) will be put to the test, however, during times of stress when the complexities of the system and resilience are exposed. This strategy, like a number of others, often requires incentives to be present for communities to get involved. In this case, the prospects of higher yields and profits have encouraged farmers to pool resources. Combined farming has emerged as a strong adaptive strategy for coping and adapting to climate change and other threats.

5.2.5 The Use of Crop Modelling and Seasonal Climate Forecasts

Climate change and climate variability, the low domestic and world sugar price and the variable Rand as well as a lack of access to skills, planning tools, networks, support and knowledge are all threats and stresses acting on this system that farmers have attempted to address through the use of crop modelling and seasonal climate forecasts. Crop modelling and seasonal forecasts are used, mainly, by large-scale and medium scale (emerging) growers and in limited ways by small-scale growers. Access to this strategy is largely through SASA and SASRI and is facilitated by extension officers and various support and scientific departments within SASRI. SASRI offers forecasts, crop and climate modelling systems, yield and RV estimates as well as early warning system. Information is available through an internet website, through the SASRI extension officers and literature available to those using the services of SASA.

A number of farmers who have access to the internet and cellular phones or who have regular updates through newsletters and visits from SASA extension officers are able to obtain yield and pricing estimates, climate and crop prediction data and information on sugarcane varieties. This assists the farmers in their financial and farm planning. Estimating yield with crop modelling based on soil and climatic data is a service offered by The SASA's experiment station.

CANEGRO is a computer crop growth model which gives information related to irrigation scheduling and design as well as crop cycle optimization and assessing climatic yield (The Link, 1994). This service is available through the SASEX website and through local extension officers. This ensures better crop management and farm operations as well as tailored agronomic practices to suite expected climate impacts. This again requires that farmers have access to technologies such as computers and the internet or at least a good extension officer in their areas.

Forecasts are often difficult to interpret and the models do not always integrate all the relevant information. Uncertainty and dissatisfaction exist over the accuracy of forecasts and additional information is necessary before decisions can be made. There is a lack of procedures for integrating forecasts with decision-making processes and there are concerns over how to effectively communicate the information from forecasts. It is also crucial that information is presented in a user-friendly, short and simple way. Abram Singels (SASRI) commented on this during the interview process:

"You can't give a model to a farmer to work it out, study, calculate from. They are not interested and do not understand it and therefore they are not using it. We run the models for them and then sms (short message system via cellular telephones) *them instructions. The sms says for example "stop" or "start" irrigation (in different languages). We are looking at conveying other information this way as well. This works for the small-scale farmers as they have one field but it's difficult to do for the larger farmers as they may have 30 to 40 fields. Some of these systems have been incorrect in the past and we have lost the trust of farmers. The programmes can become too complicated and can be incorrect. They have to be simple and need to be supported by the extension staff."*

Seasonal forecast are available to the farmers but are limited in their scope and not often used by farmers due to issues of accessibility and easy understanding and use of the forecasts. Larger scale farmers have access to these forecasts but did not indicate that they were of particular use to their day to day activities.

This strategy, though somewhat limited in its current use, has assisted farmers (at every level) with preparedness and early action to prevent further vulnerabilities. It has assisted with financial and farm management plans, reducing risk of total crop damage and crop failure and increasing yields (both in quantity and quality of the crop). It has also resulted in outcomes

such as improved resource management and sustainable resource use (particularly of natural resources).

5.3 Discussion: Access and Institutions

Resilience to threats and stresses is often coupled to assets and entitlements that individuals and households can mobilise and can manage when facing hardship (for example Chambers, 1989). The more assets that the farmers can control, the less vulnerable they are likely to be and the greater their capabilities to cope successfully with risk, stress and shocks. A closer analysis of asset ownership in this study tests these notions and provides useful information in exploring and measuring the social vulnerability of these farmers.

This access is directly related (in a number of ways) to the role of both formal and informal institutions. "In the livelihood approach, institutional arrangements (understood in the very broad sense of rules and norms which govern individual and group behaviours) and organisational forms play a crucial role, since they determine the access of individuals and households" to livelihood resources (Swift *et al*., 2001, 85). Institutions are arranged around values, norms, beliefs, and both formal and informal laws (IPCC, 2001).

5.3.1 Access to Land and other Natural Resources

Farmers are traditionally resource dependent. Their livelihood activities depend on their access to assets such as good soil (quality and depth), a viable amount of land to farm on and access to water. Land is one of the most valuable assets to the farmers in this area. The issue of land has become highly politicised owing to past histories and inequalities during the previous apartheid regime and days of colonialism.

The land reform and land redistribution process is a particular case in point. The Iziko Land Company was established by SASA (facilitated by national government departments) to facilitate the process of land hand-over to previously disadvantaged groups. It is being done through a willing-buyer, willing-seller process and is accompanied by support for one year from a mentor. The process is facilitated by SASA. It has been set up in order to assist new farmers with successfully entering the large-scale agricultural production economy. This institutional management of land reform has managed to avoid the threat of 'land grabbing'

that has become the norm in some neighbouring countries (such as Zimbabwe). The process has, however, been slow and the bureaucratic institutional set up has frustrated a number of prospective farmers.

A number of farms in the area are under claim in the national land-claims process. This is overseen by the National Department of Land Affairs who make the final decision as to whether or not the land is handed over to the claimant. Claimants are allowed to lodge claims if they believe that they have a right to the land due to past land use practices by ancestors (including the use of the land for grazing before it was taken over by current commercial farmers). The large-scale farmers who are keeping the land under commercial production do not have a voice in the claim process and often have to employ external legal advice.

Once the new farmer has taken over the farm from the large-scale farmers, they often do not have access to a number of assets that were available to the previous tenants. These farmers struggle with access to financial institutions since they do not have farm and financial records nor do they have a relationship with the financial institutions that the previous large-scale farmer may have had. They also do not have access to knowledge systems and information concerning production activities on the farm. Relationships need to be built with local extension officers and neighbouring farmers in order to access social networks, support, and knowledge. New farmers also lack access to bargaining power on farm inputs and have difficulty setting up accounts with chemical suppliers.

Water is another vital natural resource for these farmers. As much as the area relies on rain-fed crops, water is still used for other farm activities and for the irrigation of crops during dry spells and times of heat stress. Amendments to the National Water Act have meant that water is now considered a shared resource wherever it may be and farmers (particularly large-scale farmers) have stopped storing water on their farms because they are charged for water or the capacity for water stored (even if dams or reservoirs are empty). A number of farmers have also begun to break down their dams and reservoirs in order to avoid being taxed under the Act. This may increase vulnerability in times of climate stress when water may be needed to mitigate the effects of, for example, drought on the farm.

With the impact of climate change (such as an increase in temperature and a decrease in rainfall) and climate variability, as well as other threats and stresses, farmers need access to appropriate knowledge on the management of the natural resources available to them. Without appropriate technology and knowledge systems accessed through formal institutions, and in some cases through social networks, the farmers may be more vulnerable to the effects of change. Growing the correct sugarcane variety for soil type, climate conditions and pests and diseases in the area are very important and require the guidance of extension officers. Those who have had access to this knowledge and technology and have used it effectively have seen marked improvements in the quality of their sugarcane crop and have been more resilient to climate change risks and other shocks affecting the system (SASA). Input costs to maintain the standard of the natural resource base are affected by the variable Rand and farmers need to have bargaining power and the ability to negotiate well-priced chemicals through company representatives.

5.3.2 Access to Financial and Physical Assets

Access to financial and physical assets is also key to the adaptive capacity of the farmers. Financial capital in particular was identified by farmers (at all scales) as one of the most important assets next to natural assets such as land. Sugarcane is a profit sharing industry. The price received for the sugarcane produced is decided by a central body, SASA, and is affected by a number of global and local institutions and processes (for example surplus sugar on the world market as discussed in detail in the previous chapter). The farmer in this situation is a price taker in that he or she has no say in the price they receive for the sugarcane. The cascading effect of this process means that farmers on the ground cannot directly impact the price they receive for their crop except to ensure good farm practice and the delivery of quality cane to the mill to ensure a good RV return.

A number of farmers (particularly small-scale and medium-scale (emerging farmers) have difficulty accessing loans, credit, start-up and production capital through formal financial institutions due to their economies of scale and their difficulty in accessing farm financial records. Large-scale farmers (and to some extent the small- and medium-scale farmers) have also had difficulty accessing grants and drought relief in times of climate stress. By the time the forms are filled in and the process completed, the immediate climate impact (for example

drought) is over and the damage has been done. A number of farmers also voiced concern over the lengthy process of applying for funding through government departments due to time consuming and bureaucratic processes that have substantial administration costs. A low level of literacy amongst small-scale growers has also made the process lengthy and difficult. A number of these farmers rely on extension officers from SARI.

The move to the RV system of payment has benefited a number of farmers. However in order for farmers to get the best out of the RV system they must ensure high sucrose levels by undertaking strict farming practices. Many of these practices are undertaken under the guidance of extension officers and technicians. These practices include adequate nutrition, the growing of the correct sugarcane variety for the area, correct harvesting and planting practices and quick delivery to the mill. Access to extension officers has been facilitated through an agreement between SASA and the KwaZulu-Natal Provincial Government so that more farmers receive extension services. A number of small-scale farmers however still have difficulty accessing extension officers, information and guidance, which puts them at a distinct disadvantage.

5.3.3 Access to Human Assets, Knowledge Systems and Social Structures

Sugarcane farming is a labour intensive industry, which requires physically strong and skilled labourers. A number of restrictions block access to this resource but the National Minimum Wage Legislation in particular has made access to labour acutely difficult for medium- and large-scale farmers. Due to minimum wage increases during particularly difficult climatic and economic times on farms, a number of farmers have resorted to reducing the number of labourers that they hire on a permanent basis and have opted to bring contract workers in. Minimum wages are increased regularly without consultation with the farmers. This has also affected job security and the livelihoods of those labourers already employed on the farm.

Knowledge systems are available to farmers and the sugarcane industry is relatively fortunate to have an institutional group who has staff members dedicated to improve the technology and knowledge base for this industry through SASRI. SASRI also provides training and information days through extension officers. The information exists but it is often up to the farmers themselves to ask for crop forecasts and yield prediction data, if they do not have

access through technologies such as a computer and the internet (the SASRI website is frequently updated with new information). Farmers must know firstly that the relevant information exists and secondly how to access it as well as how to understand and use it. Forewarned is, however, forearmed and farmers who make use of this information through their adaptive strategies are seen to be more resilient.

Social assets are a tremendous plus for farmers. “Social capital refers to networks of relations linking individuals for mutual benefit. The basic idea of social capital is that an individual’s relationships with family, friends and associates constitute important assets which can be leveraged for material gain” (Bayat, 2005, 1). The farmers in this district have a number of social assets between them that are used to varying degrees, enabled mainly through formal and informal institutions. Extension officers from SASRI are available and a number of farmers have access to these officers in the region. Isolation in itself is a threat. Farmers groups, associations and mill boards are active in this area but are really only accessed by large-scale farmers and occasionally the medium-scale emerging farmers. Farm visits and networking days are organised through these local groups but it is essentially up to the farmers to make an effort to be at the networking days and give input. Here an asset is available through an institution but it is not fully utilised. Family members also form a strong social network base, however due to economic, social and specifically health issues, the nuclear family no longer exists as it once did.

This study considers social capital as a critical asset that needs to be strengthened and used in reducing the social vulnerability of the farmers in this area. Social assets are enabling assets. The use of social networks is an activity that can free access to other assets and facilitate entitlements. An example would be a new and emerging farmer who does not have access to bargaining power and the ability to open an account with a chemical supplier. A farmer who does have this access is able to introduce the new farmer to the chemical supplier through his social network. Another example would be a small-scale grower who does not have knowledge of the climatic conditions and correct procedures for growing a successful crop of sugarcane. Through a larger-scale, more experienced farmer, this small-scale grower can gain knowledge and information assets where access was previously constrained.

Mentorship programmes in the area have been a successful way of sharing information through social networks. Larger more experienced farmers assist small-and medium-scale emerging farmers with farm practices and general management and teach them through practical work in the field. The successful use of the assets within the adaptation strategy of combined farming has been seen time and time again in the results. Using social networking and pooling assets that are found collectively in the farming community are key to this strategy. Combined farming is discussed later in this chapter as an existing strategy that, if enhanced and supported by formal and informal institutions at appropriate levels, could greatly assist in reducing social vulnerability.

Institutions are closely linked to social capital (IPCC, 2001; Swift *et al.,* 2001). Social capital is a public good and can be viewed at a macro-economic level as a social network, which includes political regimes and government policies (IPCC, 2001).

5.3.4 Access and the Role of Institutions

"In a livelihood approach, institutional arrangements (understood in the very broad sense of rules and norms which govern individual and group behaviour) and organisational forms play a critical role, since they determine the access of individuals and households to the five types of livelihood assets" (Devereux *et al*., 2001, 85). The role that informal institutions play is often hidden and not easily identified. However they play a critical role in enhancing vulnerability as well as improving resilience. The institutional arrangements bring about links and repositories of power. Institutions interact at a number of different levels: International, national and local/regional level. They can be private entities or public groups and can be both formal and informal. Institutions are not static. "Their influence over the distribution of capital and access to strategies is very significant, not least in how they respond and adapt to changes in the contextual setting, whether dramatic such as drought and food security crisis, or more measured such as the demographic transition" (Devereux *et al*., 2001, 86).

Core aspects to assess when exploring institutions are issues of fit, interplay and scale (www2.bren.ucsb.edu/~idgec/science/themes.html, 2007). The concern of fit revolves around a core idea that the effectiveness of social institutions is a function of match between institutional characteristics and biogeographical systems characteristics with which they

interact (www2.bren.ucsb.edu/~idgec/science/themes.html, 2007). In terms of interplay it is seen that the effectiveness of an institution primarily depends not only on it is own features but also on it is interaction with other institutions. This includes a number of linkages and interactions among institutions at the same or on different societal levels. There are both functional and political dimensions of interplay (www2.bren.ucsb.edu/~idgec/science/themes.html, 2007) that need to be addresses when investigating institutions. The problem of scale is unlike interplay in that it centres on the rate to which it is possible to either scale up or scale down propositions regarding the role of institutions (www2.bren.ucsb.edu/~idgec/science/themes.html, 2007).

A key finding, found in this research, is that institutions seem to enable adaptation strategies in this context rather than constrain them. Preliminary work in this study has now shown that formal and informal institutions and social networks are key in shaping social vulnerability. Institutions are not static. "Their influence over the distribution of capital and access to strategies is very significant, not least in how they respond and adapt to changes in the contextual setting, whether dramatic such as drought and a food security crisis, or more measured such as the demographic transition" (Swift *et.al*., 2001, 85). Both formal and informal institutions exist within the study area. For the purposes of this part of the discussion we will look specifically at formal institutions mainly SASA, SASRI, and the Cane Growers Association (CANEGROWERS). This is because of the impact that these formal institutions have on access to livelihood assets and coping and adaptation strategies.

The sugar industry is highly regulated through institutional structures. This is required to facilitate the relationship between the millers and the sugarcane growers and also to protect the industry against trade distorting measures that may be practiced by some major sugar producing countries such as Brazil. The Sugar Act provides for an agreement, which regulates the affairs of the sugar industry. The Sugar Industry Agreement covers the administration of cane production, co-ordination of the supply of the sugarcane to the mills, dispute resolution structures, the pooling of the proceeds from the sale of sugar and molasses and the division of the net proceeds between the growing and milling sections. The agreement also covers the calculation of the price payable for cane deliveries, the imposition of levies to

cover the cost of the administration of the industry by the South African Sugar Association and the control of pests and diseases (South African Sugar Association, 2004).

SASA administers the partnership on behalf of the South African Cane Growers' Association and the South African Sugar Millers Association Ltd. As equal partners, each member elects eleven councillors to sit on the SA Sugar Association Council which meets monthly. The Chairmanship and Vice-Chairmanship of the Council alternates every two years between a grower and a miller. SASA is an autonomous organisation and operates free of government control. In terms of the South African Sugar Act and Sugar Industry Agreement, statutory power of self-government is granted to the sugar industry (South African Sugar Association, 2004).

The Cane Growers Association (CANEGROWERS) was established in 1927 to administer the interests of independent sugarcane growers in South Africa. It is a Section 21 Company consisting of 38 grower groups. The Local Farmers' Association, to which a number of farmers belong, offers various services, information and statistics to farmers and industry members as well as development, empowerment, training information and support (South African Sugar Association, 2006). The South African Sugar Research Institute (SASRI) undertakes research and offers scientific services to the sugarcane industry particularly on sugarcane varieties, crop protection and resource optimization. They also offer the services of extension offers deployed in various sugarcane growing areas (South African Sugar Association, 2006) (see the organization of the South African Sugar Industry in Figure 5.1).

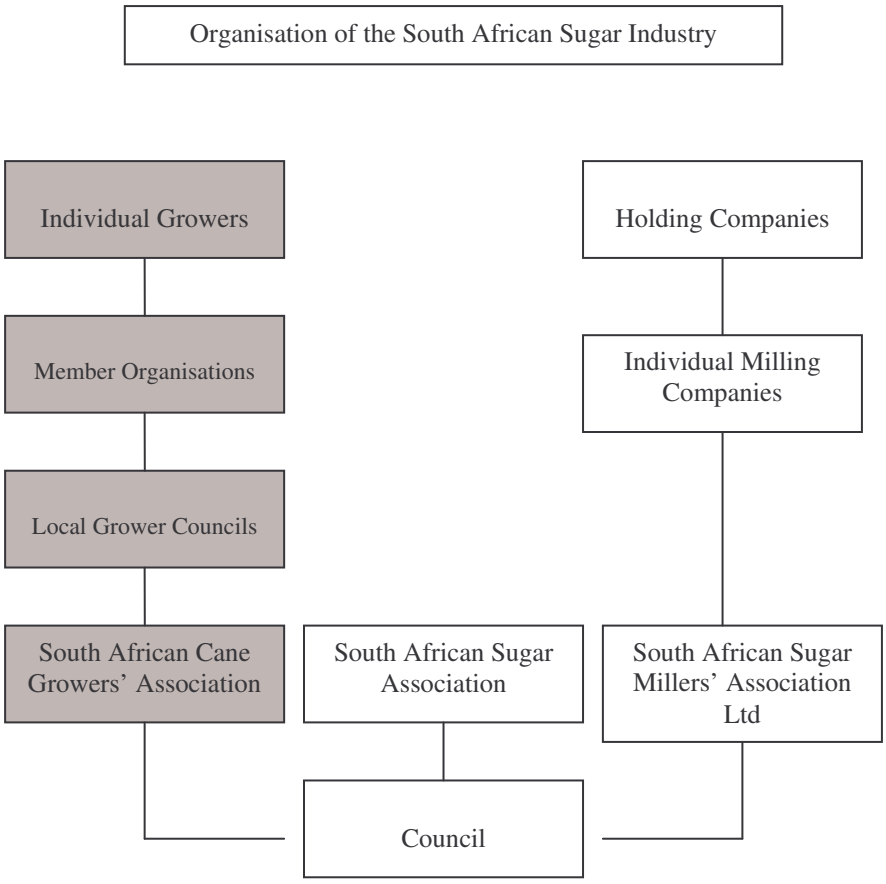

Figure 5.1: Organization of the South African Sugar Industry (South African Sugar Association, 2006).

The fact that this industry is well regulated and farmers are well supported has assisted the farmers in building their resilience and has enabled the use of a number of livelihood assets. Farmers have access to permanent and regulated markets and are sure of the price that they will receive for their crops. SASRI is seen to represent a type of insurance policy for the farmers. It also acts as a source of assistance, support and expert knowledge during times when farmers do not have the expertise to manage threats or are faced with new threats, which need updated knowledge and skills. Having a formal social network through the main institutions has helped to mobilise previously inaccessible assets such as knowledge about correct sugarcane varieties and crop scheduling.

There are, however, a number of dangers associated with the tight control of access through institutions. A farmer only has SASRI (and in some cases the Provincial Departments) to call on for assistance. Farmers have very little say in the operation of the institutions (except

through CANEGROWERS) or the sugar price and markets. SASRI and SASA (and in turn the National Government through its partnership) govern a significant number of the livelihood assets available to the farmers. SASRI is the main institution through which sugarcane farmers (especially large scale farmers) gain access to knowledge, information, technology, social networks and assistance (on the ground through extension officers). On the ground assistance includes soil sampling, advice on sugarcane varieties, yield and weather estimates and forecasts as well as crop modelling systems through extension officers and support service.

It can be argued that through the adoption of response strategies (leading to adaptation) and through improved access to livelihood assets via institutions and adaptation responses that vulnerability can be reduced.

5.4 Case Studies

This study is similar to that of Reid *et al.* (2006), which states that "it is not only stresses associated with climate that are factors undermining community (and household) adaptive capacity and undermining local development in KZN. A number of other factors, including institutional organization, access to information and governance in the area, are also reducing the ability of farmers to secure sustainable livelihoods" (Reid *et al*., 2006, 204). These findings also concur with those of Working Group 2's contribution to the Intergovernmental Panel on Climate Change Fourth Assessment Report (2007) (Climate Change 2007: Climate Change Impacts, Adaptation and Vulnerability).

This research is also supported by findings documented in "Adapting to climate variability: Pumpkins, people and policy" (Ziervogel *et al*., 2006) which investigates local adaptation to climate change variability and agricultural vulnerability and reiterates that climate change is only one stress in a complex system and focusing on climate stress alone will not reduce vulnerability. It mentions that work on adaptation needs to explore vulnerability to climate stress within the context of multiple stresses as well as highlighting "the need to understand the complex nature of adaptation in the balance between climate variability, climate change, social and economic stresses, and poverty and resource endowments" (Ziervogel *et al*., 2006, 303). This study is also similar to that undertaken by the project on "Climate Change,

Vulnerable Communities and Adaptation" (IUCN, iiSD, SEI and the Swiss Organization for Development, 2004) which, investigated how sustainable livelihood activities might enhance or reduce vulnerability to climatic hazards.

Examples of the application of and studies using the sustainable livelihoods framework methodologies include the work of Livelihoods Connect (IDS and FAO) and studies such as the University of Cape Town's Disaster Mitigation for Sustainable Livelihoods Programme work on "The Role of Local Level Institutions in Reducing Vulnerability to Natural Disasters and in Sustainable Livelihood Development. Case Study of South Africa". Another example that is directly related to this study is that of Osman *et al*. (2004). This study's research methodology was based on the sustainable livelihoods conceptual framework and applied to case studies in Sudan to evaluate the performance of sustainable livelihoods.

There are a number of other studies on vulnerability (particularly social vulnerability) to climate change, which often include an investigation into the role and nature of entitlements (linked to SLF and Political ecology) (Adger *et al*., 2004). More specifically in Africa – Downing *et al*. (2006) have studied in depth the topics of vulnerability and adaptation while undertaking case studies of impacts on agriculture and water. Other research on this topic includes Adger (2003) and Leichenko *et al*., 2004.

5.5 Summary

Farmers are not passive victims. They undertake a number of coping, response and potential adaptation strategies in response to singular or combined threats and stresses acting on the system. Within this study area these strategies include: diversification (in type of farming and in the activities undertaken besides farming in order to generate an income), changing land use and farm practices, the use of social networks and support systems, combined farming practices and the use of crop modelling and climate forecasts

These strategies make use of the livelihood assets that farmers have access to. Issues of access, central to this study, were discussed in this chapter. It is argued in this case, that the more strategies that are available to the farmers and the more access they have to livelihood assets, the higher their potential to adapt to those threats acting on and within the system

which drives risk and social vulnerability. Some of these strategies are the farmers own (such as some forms of diversification) others have been adopted following advice from external advisors and gained through access to social networks and partnerships (formal and informal institutions) for example the strategy of combined farming. A number of the strategies are heavily dependent on the strength of both formal and informal institutions that govern access to livelihood assets. The success of these strategies is based on assumptions of the strength of the institutions involved. Institutions in this case appear to constrain some livelihood assets such as finances (sugar prices and Rand value) and natural (land reform and management processes) assets but enable other such as social and human assets.

Combined farming was identified as a particularly important adaptation strategy. It enabled the use of a number of available strategies and enabled access to a number of assets and strategies previously not available to the community as a whole. Combined farming strategies made particular use of social assets, which farmers often did not note as a particularly important asset (useful but not used) but one that enables and frees up other assets. It is an asset used in almost all the adaptation strategies.

Critical in the context of this research is the need for options, flexibility and adaptation to change quickly to spread risk. Farmers need to be given more options in order to reduce their vulnerability. Farmers in this context use a number of different strategies in response to threats and stresses. Some are used only at particular times of the year to address specific threats and shocks present at that time. Options are, however, again dependent on access to livelihood assets.

In conclusion it is observed that those farmers, who use different ecological niches, diversify their economic activities, use different economic contexts, use different social networks and institutional/political jurisdiction and who combine adaptation strategies are the most successful in coping and adapting to current and future threats and stresses acting on the vulnerability of the farmers.

The next chapter presents a summary of the dissertation beginning with a recap of global environmental change and climate change and then briefly revisits the conceptual framework.

An overview of the methodology used is given showing the basic elements of the primary and secondary research. The main findings and conclusions from the study are then presented. This is followed by a S.W.O.T analysis investigating the key strengths and opportunities, weaknesses and threats of the work. Recommendations pulled from the study are given along with a section on areas for further research. The chapter then closes with an overview of the main conclusions of the study and a glimpse into the future of this sector.

CHAPTER 6
CONCLUSIONS

6.1 Introduction

This chapter gives a summary of the dissertation beginning with a recapitulation of the main topics explored including global environmental change, climate change, vulnerability and adaptation. The chapter then gives an overview of the methodology used showing the basic elements of the primary and secondary research. The main findings and conclusions from the study are then presented. This is followed by a S.W.O.T analysis of the work. Recommendations pulled from the study are presented, with a section on areas for further research. The chapter closes with a glimpse into the future of these farmers and the main conclusions of the study.

6.2 A Recapitulation

6.2.1 Global Environmental Change, Climate Change, Vulnerability and Adaptation

Climate change is one of the most significant elements of Global Environmental Change currently under investigation. Climate change is expected to bring changes in rainfall, temperatures (among other changes) and will impact a number of social, biophysical and economic systems both globally and locally. Even if we undertake immediate and drastic mitigation activities, the earth is still committed to some degree of climate change (IPCC, 2007). Vulnerability is viewed as a starting point in this study and is seen as a function of three components: Adaptive capacity, sensitivity and exposure.

There is both an external and an internal dimension to vulnerability. The internal dimension examines the capacity of a system to anticipate, resist, cope with and recover from a shock and in the long term adapt to it. The external dimension examines the exposure of a system to an external threat such as climate change impacts. Adaptive capacity refers to the ability of a system to adapt to either actual or expected stresses and cope with the consequences it brings. Coping is viewed as a short-term response to stresses while adaptation involves longer-term strategies put in place to reduce sensitivity and vulnerability to a hazard. This involves changes in process, practices, or structures to mitigate or offset potential damage or take advantage of changes.

6.2.2 Methodology

A number of early 'impact' approach studies were based on the assumption that there was a direct cause and effect relationship between the climate event and the response of the system studied. Since then vulnerability studies have evolved from a research paradigm focused primarily on the 'impacts' of climate change and variability to a point where the research methodology has recognised that vulnerability is a biophysical as well as a social characteristic and these elements cannot be studied in isolation from each other.

The following hypothesis was tested: That farmers' ability to cope with and adapt to changes, such as those associated with climate change, is either constrained or enhanced by the context in which they find themselves and in which they undertake farming activities (i.e. vulnerability determines overall adaptive capacity). The influence of climate as a risk was thus considered together with a careful investigation of the influence and role of other stresses on farmer's livelihoods. A key element was thus improving the understanding of the livelihoods of sugarcane farmers (small-, medium- (emerging) and large-scale) in the KwaZulu-Natal Midlands area of Eston and its surrounds. This involved the undertaking of a social vulnerability assessment under the Sustainable Livelihoods Framework.

This study also explored perceptions of climate risk and variability and what internal and external, past and future risks and shocks farmers face in this case study area. It also examined coping and adaptive strategies used in response to shocks such as climate events (e.g. droughts). Assets and access to these assets as well as the ability to put these assets into productive use was explored. The role that various institutions, policies and organisations have in determining this access and in shaping agricultural strategies was also investigated.

Five stages of the primary research methodology were undertaken. These included the following: research design (Stage 1), scoping and testing of methodology in the field (Stage 2), review and further research design (Stage 3), principal research in the field (Stage 4) and analysis and interpretation of data (Stage 5). The activities undertaken at each stage and the analytical and conceptual approaches informing each stage were also shown. The framework is flexible and dynamic and in line with the research framework. It was designed in order to

capture the information and data and to adequately investigate the vulnerability, adaptive capacity, and adaptation in the research context.

Semi-structured interviews and focus groups were conducted with commercial large-scale and medium-scale (emerging) growers. Focus groups were conducted with small-scale growers. Focus groups were also held with emerging medium-scale growers, the Eston Mill Group Board and the Umbumbulu small-scale growers who wanted to start a combined farming project. Different generations of farmers were interviewed. This provided a picture of past, present and future threats and adaptive strategies. Various grower representatives for the area were also interviewed. Site visits were undertaken to small, medium and large scale growers' farms, to mills and to demonstration seed cane crops.

Members and staff of the South African Cane Growers Association were interviewed as well as staff of the South African Sugarcane Research Institute (SASRI). The chairperson of the SA Cane Growers Association was interviewed as well as the SASRI extension officers for the small and large-scale growers both at management level and at regional levels. Some of these extension officers from SASRI work closely with the KwaZulu-Natal Department of Agriculture and Environment and technicians from this Department were also interviewed. Secondary information was gathered from government departments and local councils, academic research, international and local non-governmental organisations (NGOs), government gazettes and web sites, historical information from archives and information from key informants.

6.3 A Summary of the Findings and Discussion

6.3.1 Vulnerability

- There are a number of assets that farmers have access to and use in their livelihood strategies. These assist in increasing the adaptive capacity and resilience of the farmers.
- The main livelihood assets available to these sugarcane farmers are: Natural Assets (their land (good soils), water and water sources, the sugarcane crop itself and the natural fauna and flora); Financial Assets (loans from the banks and agricultural organisations, grants from the Department of Agriculture, money earned from other

economic activities (besides farming), profit from sugarcane sales, capital and investments, saving schemes and credit with local suppliers) and Physical Assets (transport systems and infrastructure, buildings, water management systems, communication systems, tools and machinery, roads and power lines, pesticides and herbicide stocks, fuel, basic services and health care facilities). Other assets include: Human Assets (household members, skilled and unskilled labour, advisors, sales representatives and extension officers and technicians (SASRI, SASA, DoA)); Knowledge Assets (formal and informal training, knowledge from experience, education and training services, SASRI advice and information services through the Institute and the extension officers as well as websites and communication programmes and weather and climate information) and Social Assets (informal social networks, farmers groups and associations, Mill Group Boards and mentors, farm visits, family members and neighbours, community forums and social gatherings, community policing and "Farm Watch" forums).

- The stress factors that shape vulnerability in the Eston mill area within the KwaZulu-Natal Midlands South Area are found to be a combination of both on-farm and off-farm social, economic, and political factors and not just climatic factors.
- These threats and stresses include: Climate change risk and climate variability (off-farm), the low domestic and world sugarcane price (off farm), the variable Rand (off-farm), high input and operational costs (off-farm and on-farm). Other threats and stresses include a lack of access to start up and production capital and high levels of debt (off-farm and on-farm), land issues (such as land tenure, land reform and land claims, the quantity and quality of the land) (off-farm and on-farm) and a lack of access to skills, planning tools, networks, support and knowledge systems (on-farm) as well as crime and violence (including arson, sugarcane theft and farm violence) (on-farm), conflicting and restrictive government legislation and policy decisions (minimum wage, municipal rates with no services) (off-farm) and labour issues (minimum wage, migrant labor force, HIV/AIDS) (on-farm).
- As 'uncontrollable', external, on-farm threats increase so off-farm threats become more of a concern. They compound each other weaving a complex web of continual and changing vulnerability in the study area

- The risks are multiple, interacting and interconnected all combining to compound already existing vulnerabilities. They operate in a complex environment along temporal, spatial, geographical, sectoral, gender, age and racial lines. These threats and stresses also interact at a number of different levels. They crosscut and compound each other often exposing continual vulnerabilities.

6.3.2 Adaptation and Adaptive Capacity

- Farmers have undertaken a number of coping and response strategies including some emerging adaptation strategies in response to singular or combined threats and stresses acting on their livelihoods and the contextual environment in which they operate. Within this study area these strategies include: Diversification (in type of farming and in the activities undertaken besides farming in order to generate an income), changing land use and farm practices, the use of social networks and support systems, combined farming practices and the use of crop modelling and climate forecasts
- These strategies make use of the livelihood assets that farmers have access to. It is argued that the more strategies that are available to the farmers and the more access they have to livelihood assets, the higher their potential to adapt to those threats acting on and within the system which drives risk and social vulnerability. Some of these strategies are the farmers own (such as some forms of diversification) others have been adopted following advice from external advisors and gained through access to social networks and partnerships (formal and informal institutions) for example the strategy of combined farming.
- A number of the strategies are heavily dependent on the strength of both formal and informal institutions that govern access to livelihood assets. The success of these strategies is based on assumptions of the strength of the institutions involved. Institutions in this case appear to constrain some livelihood assets such as finances (sugar prices and Rand value) and natural assets (land reform and management processes) but enable other such as social and human assets.
- Combined farming was identified as a particularly important adaptation strategy. It enabled the use of a number of available strategies and enabled access to a number of assets and strategies previously not available to the community as individuals. Combined farming strategies made particular use of social assets, which farmers often

did not note as a particularly important asset (useful but not used) but one that enables and frees up other assets. It is an asset used in almost all the adaptation strategies.

- Critical in the context of this research is the need for a variety of options. Farmers need to be given more options in order to reduce their vulnerability.
- Farmers in this context use a number of different strategies in response to threats and stresses. Some are used only at particular times of the year to address specific threats and shocks present at that time. Options are, however, again dependent on access to livelihood assets.
- It is observed that those farmers, who use different ecological niches, diversify their economic activities, use different economic contexts and use different social networks and institutional/political jurisdiction. These combined strategies are the most successful in coping and adapting to current and future threats and stresses acting on the vulnerability of the farmers.

6.4 S.W.O.T (strengths, weaknesses, opportunities and threats) Analysis of the Research

The use of the Sustainable Livelihoods Framework (SLF) was a strength of this study. The SLF builds on advances in a wide variety of specific fields of enquiry – inter-household issues, gender, farming systems, governance and others – and provides a framework within which they can be related to one another. It offers a holistic approach, explores interacting and multiple threats/stresses and is the most effective framework under which adaptive capacity, adaptation strategies and livelihood assets can be examined.

Another strength is that farmers were interviewed on their farms and in a context which allowed for solid gathering of primary data. The research was undertaken in a participatory process using both RRA and PRA. This was particularly effective in this context where time and resources were constrained. The flexibility of the methodology and research process (between stages) was another strength which allowed for the validation of data and methodology techniques

Pitfalls were avoided in this research through the use of various methods such as personal involvement in the community, carefully structured questions during semi-structured interviews and focus groups, confidentiality guarantees and the use of both written and

recording techniques to ensure that a fair representation of what informants said during interviews was given. Information was cross-checked and information from interviews was backed up by information gathered during observational studies, transect walks and through secondary information gathered (Finan *et al*., 1998). The secondary information was also verified through the primary research.

There were a number of weaknesses of the research as well as a number of elements that threatened the validity of the work. Climate change and variability were not adequately distinguished from each other during the data gathering process which led to some confusion. This was countered by the follow up discussions that followed, as well as farmers' exposure to these debates via other interactions they have had. In some cases a degree of 'leading' responses may have occurred (e.g. dwelling too much on a topic such as climate change, farmers soon realised that this was a key issue being investigated and this may have biased the outcomes), One way to possibly avoid this problem in the future, is to give farmers some downscaled scenarios to engage with, but this approach, as articulated earlier is also not without its challenges and problems.

A number of other weaknesses were observed. These were largely avoided but some weaknesses were unavoidable due to the nature of this research. Due to time and resource limits this study only gave a snapshot of vulnerability, which does not give enough information over an extended period of time to assess long-term vulnerability. More time was needed to assess all elements. There were also a number of language limits as a number of farmers spoke isiZulu, a language of which the researcher has only limited knowledge. To counter this interpretation was used but nuances of expression, tone and other language and discourse elements were not always captured.

6.5 Recommendations

There are a number of recommendations that emerged from the study. These recommendations are for adjustments in the system by external (off-farm) agents and internal (on-farm) actors.

6.5.1 Internal (on-farm) adjustments

- Make better use of livelihoods assets that farmers already have access to and are useful, but are not used, for example, social assets.
- Use a combination of strategies to cope with and adapt to the impact of multiple and interacting threats and stresses impacting on the system.
- Forge more and stronger mentorship programmes between larger established growers and small-scale and emerging growers.
- Take into account climate change and multiple political, social, economic and biophysical stresses when putting structures in place to reduce vulnerability.
- Undertake more activities such as combined farming which shares and spreads access to assets through the use of social networks and cooperative responses to threats and stresses.

6.5.2 External (off-farm) adjustments

- A closer examination by government institutions of various taxes and rates imposed as well as policies and legislation that are not aligned.
- Better management by formal institutions, both national and international, of subsidies and world sugar prices.
- Land reform management and correct procedure as well as mentorship for those farmers receiving farms.
- Encourage and enable diversification.
- Make provision for flexibility and options in terms of adaptation strategies.
- Facilitate improved access to livelihood assets such as financial and physical assets.
- Provide ongoing monitoring of vulnerability in the area.
- Introduce, support and encourage place-specific and needs-specific adaptation strategies.

6.6 Areas for Further Research

There are a number of aspects highlighted in this study that could be explored further in future research and analysis. A further investigation is needed, for example, into the improved understanding of and sustainability of current and emerging adaptation strategies and the appropriateness of some of these strategies in different contexts. For example: Can one improve or intervene in some ways to improve those strategies that appear to be currently

undermining farmers' capacity to cope with change? A more in-depth look is required into the sustainability of current agricultural strategies and development pathways. This study gave a snapshot of vulnerability in the area. A longer, ongoing vulnerability assessment is needed over an extended period of time in order to gain more insight into vulnerability in the study area. Further investigation is needed into the role that institutions play in shaping vulnerability and access to assets and adaptation options. There are a number of both formal and informal institutions operating within the study area weaving a complex web which needs to be dissected further in order to understand some of the interactions and dynamics present.

6.7 A Glimpse into the Future

According to Professor Nick Vink, in the Farmers Weekly publication, the farmers' situation over the next ten years will depend largely on the external environment made up of different facets of the agricultural sector. "Standards such as minimum wages will cause industries to move out of the country. Local producers will therefore face increased competition from Asia and Brazil, as well as other African countries" (Vink, 2004, 8). "In Africa, small-scale farmers will not be able to meet the new and stricter requirements of more sophisticated local and foreign consumers, in the absence of collective action and contracting arrangements. The main obstacle to expansion will be the lack of infrastructure and the increasing scarcity of water" (Vink, 2004, 8).

Climate change may trigger the overproduction of those crops that cope better with climate change thus creating a surplus of one crop and a deficit of others such as wheat and fruit in some areas (Vink, 2004). This may happen with sugarcane where new drought resistant varieties, which are currently doing very well, are introduced.

Other future concerns include the political situation and uncertainty in terms of land claims and conflicting legislation and concerns over an increase in the number of taxes imposed especially water tax, which strains financial resources. An increase in input and production costs will also continue to put further strain on the farmers. The sustainability of small plots of land for sugarcane growing in terms of profit, getting maximum production and environmental sustainability, is another future threat.

Vulnerability will continue to be a product of the co-incidence of biophysical impacts of climate events as well as the structure and the resources of the farmers' units. It will also be a product of the institutional and policy environment in which farmers are operating.

6.8 Conclusion

This study involved testing the hypothesis that farmers' ability to cope with and adapt to changes, such as those associated with climate change, is either constrained or enhanced by the context in which they find themselves and in which they undertake farming activities (i.e. vulnerability determines overall adaptive capacity). The influence of climate as a risk was thus considered together with a careful investigation of the influence and role of other stresses on farmer's livelihoods. The study involved an investigation into the multiple stresses (both external and internal, on-farm and off-farm, climatic and non climatic) acting on the system in order to determine the role that livelihoods and operating context play in responding to current and future risks such as climate risk. It is clear, that climate change risk and variability are significant factors in both current and future farmer operations, but, as this study showed it needs to be co-managed with a range of other factors shaping change in the area. Climate change and climate variability thus, need to be effectively managed. This research shows that management will be best when combined with the management of other multiple and interacting threats and stresses identified in this study. What such co-management or combined strategies may be or how they might be effectively configured is the focus of much more detailed research. Climate change and vulnerability, as well as the other multiple stresses, are acting on an already vulnerable system, exacerbating and compounding present risks.

This research also explored a number of coping and emerging adaptive strategies that commercial farmers have and are using in response to the threats and stresses investigated. Attention was also given to enhancing or restricting elements (both on-farm and off-farm) on such practices. It was found that the issues of access to livelihood assets (social, financial, natural/environmental, physical, human, knowledge assets and capital under the Sustainable Livelihoods Framework) is key to the adaptive capacity and the adaptation strategies that farmers employ. Institutions (both formal and informal) also play a pivotal role in this access

to livelihood assets both enabling and restricting this access. Such findings confirm those found in similar cases (e.g. Eakin *et.al.*, 2003).

In conclusion we can determine that a focus on only one element, such as climate change, will not significantly reduce the vulnerability of commercial farmers to change. There is an interactive, dynamic and multifaceted network present with a number of factors acting within and from outside the system. Political, biophysical, social and economic factors interact and combine to compound vulnerability. Such interactions further frustrate simple, 'one-size-fits-all' policies and other response options.

APPENDICES

APPENDIX 1: FINAL QUESTIONNAIRE USED IN THIS RESEARCH

1. Individual farmers: Semi-structures interviews

General

- How long have you farmed on this land?
- What are your main economic activities?

Vulnerability and adaptation context

- Is climate change (a change in temperature and rainfall) and climate variability (shorter term) a particular concern to you? Yes or no
- Are droughts and floods of particular concern to you? Yes or no
- Are there things that cause more problems for you than the climate change and climate variability? What main external and internal threats (risks/hazards) do you face? What are the top five (rank them)
- When was the last major drought/flood? (years/months)
- Were you warned about the drought/flood?
- What happened during this event?
- Were you helped by anyone?
- How did you cope with the losses? What strategies did you or have you put in place to cope during and after the event?
- How effective were these strategies? Were you able to recover fully from these events?
- What measures/strategies did you/ have you put in place to make sure that the problems caused by the last event do not happen again?
- Were these changes made personally (by you) or were you advised to make these changes? If so, by who?
- Have you made these changes permanently? Could you sustain these change strategies in the future?
- What have the outcome of these strategies been?
- What restricts these strategies
- What other activities do you engage in to supplement the income from the farm?

- What do you feel will enhance your farming and ability to cope with climate variability?
- Has your type of farming and type of crop grown changed over the years? Why?
- Were you advised to change the type of crop grown? By who?
- Has the quantity of crops changed to what you used to produce?
- Have you had to change the time you plant and harvest your crops?
- What are the likely future shocks and stressors that you may experience? What are the major threats of the future? (climatic and non-climatic)
- What would you do if the temperature rose or the amount of rain received decreases due to climate change?

Assets, adaptive capacity and adaptation strategies

- What are the main livelihoods assets available to you (that enhance adaptive capacity)?
- What are the limiting and restrictive factors?
- What are your coping or adaptive strategies to deal with these?
  (In line with the SLF)

Livelihoods Assets	Limiting and restricting factors	Adaptive Strategies employed in response to factors
Human Assets		
Natural Assets		
Financial Assets		
Physical Assets		
Knowledge and Information		
Social Assets		

- What would you say is your biggest/ most important asset?

Institutional processes

- What main groups and organisations do you deal with on a regular basis (formal and informal)?

- Do you feel you have access to and influence in institutions and decision-making forums?
- What opportunities and constraints do you experience with regard to the institutions and organisations?

Water usage

- What constrains your use of the water?
- Do you ever have problems with the water or water services?

2. Focus Groups: Discussion questions

- What main climate related threats do you face?
- Are you able to mitigate the affects of these threats and/or recover from them?
- Is climate risk and variability a particular concern for you (define climate risk)?
- Are there things that cause more problems for you than drought/flood and general climate variability? (list the top five, then rank them)
- Has your type of farming and type of crop grown changed over the years? Why?
- Were you advised to change the type of crop grown? By who?
- Has the quantity of crops changed to what you used to produce?
- Have you had to change the time you plant and harvest your crops?
- What are the main constraints and opportunities that you face?
- What do you feel will enhance your farming and ability to cope with climate variability?
- What are the likely future shocks and stressors that you may experience (climatic and non-climatic)? (What are the major threats of the future?)
- What main groups and organisations do you deal with on a regular basis (formal and informal)?
- Which organisations and groups control and enable you to gain access to assets (e.g. water, infrastructure, and services etc.)?
- Do you feel you have access to and influence in institutions and decision-making forums?
- What opportunities and constraints do you experience with regard to the institutions and organisations?

APPENDIX 2: A SUMMARY OF RESULTS ON LIVELIHOOD ASSETS, LIMITING AND RESTRICTING FACTORS AND RESPONSE STRATEGIES

Livelihoods Assets and capital identified by farmers in the study area	**Limiting and restrictive factors (Access and entitlements)**	**Response strategies to these limiting and restrictive factors**
Human Capital - Skills (business and management) (L,M) - Labour (skilled and unskilled) (L,M,S) - Health and the ability to do work (L,S,M) - Advisors, sales representatives and extension officers (L,S,M)	Skills sometimes out dated in terms of addressing future threats (such as climate change) (L) HIV/Aids (L,M,S) Farm violence (L,M,S) Legislation such as minimum wage restricts the ability to hire laborers (L,M) Lack of access to help via extension officers and other groups is difficult (S,M) Lack of access to training in terms of business and management skills (S,M)	Combined farming to pool human (and other) resources (S) Cutting of labor force (L,M) Seeking training and advice from the South African Sugar Research Institute, the Department of Agriculture of the South African Sugar Association and Canegrowers Association. (S,M) Self teaching (L,M,S) Using neighboring farmers as mentors (S,M)
Natural Capital - Good soil in this region (quality, depth and condition of) (A) - Sufficient rainfall for most of the season although the area is marginal (A) - The Sugarcane itself (A) Easiest to grow and most	The area is marginal so rainfall is infrequent In some cases Pest and Diseases pose a threat The incorrect Cane variety grown for the soil and climatic conditions in some regions (S) Taxing of water and water use	Combined farming in order to pool resources such as land and crops (S) To avoid water taxes and taxing of dam water and capacity farmers have broken down dams and storage areas (L)

profitable of crops - Good quality water available through rivers, dams, storage tanks and bore holes (L) -Natural Fauna and Flora (L,M) - Relatively stable climate (few extreme events) (A) - Stable natural environmental (little severe environmental degradation) (A) - Sufficient amount of land to grow profitable crops (L)	(L,M) Concerns over the amount of land available. Large areas needed top break even or make a profit (S,M) Much of the land is not owned by farmers themselves (S) Environmental degradation and lack of environmental management (S,M) Climate Change and variability (drought, frost, flooding) (S,M,L) Access to available water (S) Land claims and land redistribution (L) Crime and arson (cane theft and burning) (L,M)	Strict management of pest and diseases as well as strict weeding and fertilization of crops (S,L,M) Growing of the correct variety for the soil and climatic condition strictly on the advice of The South African Sugarcane Research Institute (S,L,M) Smart farming (trashing, minimum tillage, resting of soils, soil testing etc.) Good farm planning and management with the help of extension officers and consultants (S,L,M)
Financial Capital -Loans of banks and agricultural organisations (L) -Grants from the Department of Agriculture (DoA) (S,M) -Money earned from other economic activities such as the running of tuck shops and day care centers. Some farmers hire themselves out as consultants or work in off farm jobs) (A) (available opportunities) -Profits from Cane sales (A) -Capital and investments (L)	Debt (L,M,S) Perceived lack of assistance from DoA for larger scale farmers (L) Lack of access to grants (L,M,S) Lack of financial management skills (S,M) Lack of capital to start activities other than farming to support the farm (e.g. Eco-tourism companies or Tuck shops) (L,M,S)	Managing of debt. Combined farming. Larger economies of scale, greater bargaining power and better investor confidence due to better viability of the farm. Also larger profits and therefore better savings and access to funding mechanisms for the purchase of infrastructure (S) Help from extension

-Savings (L,M) -Credit with local suppliers (L) -Insurance (crop and general infrastructure) (L)	Lack of access to various funding mechanisms due to size of farm and lack of investor confidence (S) Access to credit with suppliers especially for new farmers (S,M) Lack of bargaining power (S)	officers in terms of filling out forms and gaining access to grants and financial assistance (S,M)
Physical Capital Transport systems (tractors, trucks and trailers, cars, access to public transport) (L,M) Buildings (homes, warehouses, sheds) (A) Water management systems (dams, wears, boreholes, irrigation equipment etc.) (L) Communication systems (telephones, internet and e-mail) (L,M) Tools and machinery (L) Roads and power lines (L) Pesticides and herbicide stocks (L,M) Fuel (Farm Diesel) (L) (M) Basic services (water, sanitation, electricity) (L) (M) Health care (L) (M) Security systems and policing units (L)	Old equipment Bad maintenance of roads Lack of capital to buy equipment and machinery Tax on various items restricts purchase Lack of access to electricity, telephone lines and running on site drinking water (S) Lack of access to water systems (S) High fuel, pesticide and input prices. Lack of access to infrastructure available (S)	Loans from banks and other institutions (L,M) Combined farming. Many small scale farmers club together to buy a tractor which services all plots of land (S) Use of extension officers for communication between them and various institutions
Knowledge and Information - Formal training (Degrees,	New threats require new	Mentorship programmes

diplomas and certificates in Agriculture etc.) (L) - Knowledge gained from years of experience (L) - Information on crop estimated and climate forecast from Mills and SASRI. (L,M) - Information via telephone, e-mail and internet services (L,M) - Knowledge gained through training from other farmers (mentorship programmes) and extension officers (L,S,M)	information sets. Many stresses faced presently have not been faced in the past (e.g. Minimum wage and HIV/Aids) Information is sometimes inaccurate or misinterpreted Lack of access to means of communication (S) Lack of access through extension officers Many farmers are new and have little experience managing risks (S,M) There is little formal training available (S,M)	are run often but need willing farmers and willing teachers (S,M) Seeking out of information and knowledge Use of the information available through institutions Farm visits to other farms by neighbors helps share information on various stresses presently affecting the area (L,M) Setting up of social networks
Social Capital - Social networks (A) - Farmers groups and associations (L) (M) - Mill group boards (L) (M) - Mentors (M) - Farm visits and networking sessions (L) (M) - Social gatherings (A) - SASA, SASRI (A) - Farmers meetings (L) - Family members (A) - Community forums and gatherings (A) - Contacts with suppliers and – contractors (L) - Good relations with extension	Lack of access to these formal social networks (S,M) Lack of interest in getting involved by other farmers. This weakens organisations Non-attendance at meetings Requires driven individuals Mistrust among neighbors and fellow farmers Internal politics within the associations and forums Institutional difficulties Access to mentorship programmes is difficult in some cases (S) The break down of family units	Forming of own independent forums and unions Forming of own family units (S) through joining with other families Effort made to join organisations and to be inclusive within organizations

officers from SASRI (L) (M) - Neighboring farmers (L) (M) - Civil society and community groups (L) - Social services (S) (M) - Extension officer (SASRI) and technicians from the Department of Environment and Agriculture (Provincial) - Combined farming practices (S) (M) - Group action and self protection (community policing forums, neighborhood watch, safety and security committees) (L) (M) - Bargaining power from long standing relationships with suppliers (L)	due to HIV/Aids and urbanization (S) Ability to engage in collective social and economic activities	

Key:

(L): Large-scale farmers

(M): Medium-scale (emerging) farmers

(S): Small-scale farmers

(A): All

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