Adapting to climate, water and health stresses: insights from Sekhukhune, South Africa

CAVES: Complexity, Agents, Volatility, Evidence and Scale
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Sekhukhune District, South Africa, Case Study Report

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The views expressed here are our own and we would value feedback.

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EXECUTIVE SUMMARY

Sustainable development and poverty reduction policy needs to be better supported by science that is policy relevant and focuses on the needs of the poor and marginalised, and those that are vulnerable to a range of environmental and socio-economic stresses. Traditional interventions (such as food aid or project interventions in the form of external credit schemes or infrastructure) are increasingly being questioned as to their appropriateness and effectiveness in improving rural livelihoods. Although there is considerable emerging research that highlights the need to consider multiple threats to livelihoods, there is to-date only a limited understanding of the mechanisms of individuals, communities and authorities to respond to multiple stresses and of the factors enabling or constraining them. It is therefore necessary that a shift in development policy and intervention is supported by research that uncovers the nature of existing complex adaptive systems so that existing capacities and opportunities for adaptive actions can be supported rather than new measures being imposed.

The work presented in this report is aimed at improving the understanding of vulnerable and complex adaptive systems. The findings are based on fieldwork that focused on the district, municipal and village level in Sekhukhune District, South Africa. Previous research enabled the selection of two rural villages and associated municipalities to be the focus for exploring the interacting impacts of climate variability, water scarcity, and health issues. In order to identify and assess integrated and cross-sectoral adaptive management opportunities, an integrated analysis was undertaken of the exposure of livelihoods of vulnerable rural groups to water scarcity, climate variability, food insecurity and health risks and the impacts of these stresses at the individual, village, municipal and district levels. The study was framed by the following research questions:

- How do people (at the village and municipal level) prioritise responses to multiple stresses?
- How does the perception of the best response to stresses differ between the village and municipal level?
- How can adaptation to stresses be linked to sustainable development initiatives?
- How can an understanding of complex adaptive systems support more appropriate intervention in future?

In order to address these questions, an innovative and integrated methodological approach was developed that allowed the consideration of vulnerability to multiple stresses within an integrated assessment framework. This approach enabled us to explore how stresses interact at different scales and affect livelihoods as well as district development opportunities. It also led to adaptation strategies being elicited, both from an agency perspective at the individual/local scale and from an institutional perspective at the village and district levels, as well as the broader national context.

The methods used included both qualitative and quantitative approaches. The villages for in-depth research were selected from previous household surveys undertaken as part of FIVIMS (Food insecurity and Vulnerability Information Mapping System), a project commissioned by the South African Department of Agriculture. Semi-structured household interviews were undertaken with the identified households and then focus group meetings, Discrete Choice Analysis (DCA), Stated Preference (SP) technique were undertaken at the village scale. Using DCA and SP methods supported by participatory methods were found to be an appropriate basis for the development of a methodological approach to assessing adaptation actions. Semi-structured interviews were used with key stakeholders at the municipal and district level government authorities. Combining qualitative and quantitative research methods and working at both the village and municipal scale addressed some of the methodological weaknesses inherent in each approach and therefore strengthened the results.

We engaged with a range of South African organisations including those involved in FIVIMS and two locally based organisations, RADAR and AWARD and established strong linkages to the EU-funded

CAVES (Complexity: Agents, volatility, evidence and scale) project that addresses the complexity of social and environmental systems in a case study in Sekhukhune District. Working in close partnerships with communities, researchers and policy/decision-makers was found to be a good way to facilitate the communication of different perceptions of, and means of adaptation to, multiple stresses between a range of stakeholders and to encourage and enable better co-ordination and integration of adaptation responses.

This work has generated a number of insights, both in terms of the perception of stakeholders at different levels as to their vulnerability to multiple stresses, what appropriate coping and adaptation mechanisms might be, and in terms of developing appropriate approaches and methodologies to assess vulnerabilities and adaptation decision-making. The results of this work are expected to be of considerable value to the South African Social Cluster on Food Security that brings together key representatives from different government departments as to the kinds of interventions likely to be appropriate to reduce vulnerability, support positive change and increase resilience.

Even though water stress is one of the key manifestations of climate variability and change in Sekhukhune District, it is generally not perceived as a climate issue alone. Rather, water scarcity is considered to be the result of a combination of insufficient and highly variable rainfall conditions, issues of equitable water resource management, and the absence of drinking water, bulk water and irrigation infrastructure that would enable the distribution of water to all rural villages and hospitals. Many of the development issues in the district – the supply of basic services, irrigation for subsistence, small-scale market-oriented agriculture and commercial agriculture, and the expansion of the commercial mining sector - are highly dependent on water availability. The management of water resources is linked to livelihood security through direct impacts on agriculture and livestock at the individual and communal levels, and indirect impacts on employment opportunities and food prices. Food insecurity and a lack of money were identified as key concerns by many households. Most people interviewed highlighted the need to create employment opportunities and to improve water supplies for agricultural activities. However, the decisions relating to water use and distribution are made by stakeholders at the provincial and district levels and prioritise the growth of regional economic activities that do not necessarily reduce the high levels of poverty in rural communities, at least not in the shorter-term.

At the national and provincial levels there is awareness of the need to address climate impacts and adaptation and some assessments have highlighted the need for the development of adaptive strategies. However, no climate change impact and adaptation assessments have been undertaken at the district level to determine the implications for the water sector. At the local level there is evidence that people are developing adaptation strategies to changing patterns of water availability and the ever-prevalent stress of limited finance. People always have and will respond to stress in different ways but establishing the key adaptation strategies and set of actions associated with these strategies can help to provide a point of entry where support can be best utilized. If climate change accelerates, stress on rural livelihoods is likely to increase and it is critical that measures are put in place that support adaptation strategies that are climate-sensitive.

Because of an increase in the frequency of crop failures, many people are moving away from agriculture/horticulture and are instead seeking to engage in wage earning activities as an adaptation to water and climate stresses. As a consequence, less food is directly available to the household. People in the villages linked changes in food production and availability to decreased health, which is in turn linked to climate, water and economic/financial stresses. The price and availability of food on the informal and formal market fluctuates (often linked to climate variability) and can decrease the accessibility and affordability of (nutritious) foods. Households spending patterns have changed and this can impact on the quantity and quality of food consumed (which is a particular concern for people living with HIV). Although HIV/AIDS was mentioned as a key stress at the municipal level, it was not

mentioned as a key stress in the villages where we worked. However, people did talk about the increase in home-based carers in response to increased health-care problems. If this could become a paid, regulated and better supported system this might be a very effective and beneficial sector for job creation.

An important response to lack of employment within the village is to migrate, even though it is seen by many as a last resort. Young people particularly tend to migrate in the hope of finding employment in one of the cities or mining areas. Whilst many people still living in the villages are considering migration, some do not have the opportunity to do so due to financial constraints or the lack of social networks in the target areas. Widespread rural-urban migration contributes to the generation of a range of urban risks through the growth of unplanned informal settlements on marginal land and the implications this entails, such as fire and flood risks, health and safety concerns, the erosion of traditional social networks, and the additional strain on urban municipalities to meet basic services for a rapidly growing poor urban population. Migration – as a rural adaptation strategy - is therefore generating new vulnerabilities or exacerbating existing vulnerabilities elsewhere. These linkages have not yet been investigated in South Africa and need to be investigated further in future research.

Adaptation strategies often occur in highly constrained circumstances and municipal support is needed to build adaptive capacity and to facilitate village-level development. Improved social safety nets and micro-finance schemes that empower people and are sensitive to their needs rather than generating increased dependency might be one way to achieve this. At the same time economic opportunities need to be created locally. This could be done by stimulating local businesses, adding value to locally produce, and creating markets.

HIV/AIDS is of considerable national concern as it has many links to poverty, livelihood security and economic development. In Sekhukhune the figures are lower than the national average, yet much remains to be done to curb the spread of the disease. Due to the limited duration of this study, we were not able to gain much information about these issues at the village level. The government recognises the potential scale of the challenge, especially in the areas where the mining is expected to grow rapidly. It is critical that measures are put in place now to curb/minimise the potential negative impacts of the disease, otherwise it will undermine development in the long term.
There are differing perceptions regarding the nature and scale of challenges and how they should be addressed. While some of the prioritised issues are the same (e.g. the need for employment, addressing water constraints and the continued roll-out of basic services) the scale at which they are viewed and sought to be addressed is very different and there are limited attempts to bridge these scales.

The findings indicate that water scarcity and limited economic opportunities are two major constraints to development at both the village and district scale that undermines adaptive capacity. People to a large extent relate both climate stress and food insecurity back to these two dominant stressors. This highlights the need for integrated responses to support local adaptation that departs from hegemonic sectoral approaches. It also requires improved and increased communication between government and local communities to facilitate the integration of strategies being implemented at different scales and better align expectations. Municipal government needs to carefully assess the likely environmental, social and economic impacts of investing in different sectors, incorporating a view on climate change and prioritizing water saving and wealth distributing options with the aim of minimizing future vulnerability.

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This work is also part of the Sida-funded SEI Poverty and Vulnerability Programme which undertakes applied research and policy support to address the challenge of reducing human vulnerability to environmental and socio-economic change and to support the overall goals of poverty reduction and sustainable development. For more information please go to www.sei.se or www.vulnerabilitynet.org.

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1. INTRODUCTION

Vulnerability to environmental stresses and disasters has the potential to undermine poverty reduction efforts through decreasing livelihood security, reducing health status, and constraining the potential of the poor to participate in economic activities. Among the many areas where poverty reduction and vulnerability management efforts interact, three areas stand out as having far reaching consequences independently and in combination with each other: climate vulnerability and adaptation, water resource management and health impacts. The Sida-funded Poverty and Vulnerability (P&V) Programme is concerned with developing an understanding of these issues that contribute to vulnerability, in order to explore ways to address them. In the first phase of P&V, the interaction of stresses around climate and food insecurity was explored at a conceptual level. In Phase 2 we identified the need to develop a better understanding of the impact of multiple stresses on vulnerable groups based on local experience, and to feed this into various policy arenas. The South African element of this work investigates complex adaptive systems and the links between climate variability, water resource management and health. The study was framed by the following research questions:

- How do people (at the village and municipal level) prioritise responses to multiple stresses?
- How does the perception of the best response to stresses differ between the village and municipal level?
- How can adaptation to stresses be linked to sustainable development initiatives?
- How can an understanding of complex adaptive systems support more appropriate intervention in future?

In order to assess adaptive management opportunities to multiple stresses, it was necessary to first ascertain what impact these stresses have at the individual/village and municipality/district level and then explore options for addressing these stresses.

Given this, the aims of this project are to:

- Conduct an integrated analysis of the exposure of rural livelihoods of vulnerable groups to climate variability, water scarcity, food insecurity and health risks and people's responses to these stresses;
- Document an integrated methodological approach for understanding the ability of vulnerable groups to adapt to multiple stresses in South Africa;
- Improve understanding of how a focus on adaptation to stress can improve sustainable development initiatives
- Inform cross-sectoral planning and other key development initiatives.

This research is aimed at feeding into other ongoing work in the district. The lessons from the fieldwork are expected to help inform policy that currently tends to be sector specific. This research provides an opportunity to look across sectors. Rural livelihoods are affected by responses to a range of stresses and therefore an integrated policy response is needed to support them. This work aims to inform government agencies and practitioners involved in developing and implementing such strategies. As discussed further below, this research feeds into the Social Cluster on food security that brings together key representatives from different government departments. This provides a unique opportunity to feed this work into a developing policy area where vulnerability and food security are being dealt with in an integrated way. This has the potential to benefit the rural people through appropriate policies that reflect their realities and needs.

At the same time, it is hoped that there will be increased communication of perceptions of, and means of adaptation to, multiple stresses between a range of stakeholders through the process of sharing

research outcomes. Links exist with the Food insecurity and Vulnerability Information Mapping System (FIVIMS) project that was commissioned by the South African Department of Agriculture and therefore has the potential for engaging at the policy level. At the same time it is intended to reach a wide audience and promote further dialogue on these issues. It is hoped that this dialogue will help to contribute to policy development that acknowledge adaptive management and the interconnected of issues. This ties in well with existing work in the broader southern African region that has recognized the need to understand the dynamics of vulnerability and in particular food insecurity, adaptive water resource management, response to HIV/AIDS and adaptation to climate change.

Part of the rationale for this study is to develop methods to assess vulnerability and adaptation to multiple stresses. Previous survey data was drawn upon to select individuals for further semi-structured interviewing. Livelihoods and stakeholder perceptions of stresses guided this information collection. Focus groups were used for qualitative village level investigation and stated preference (SP) technique (a surveying method) and discrete choice analysis (DCA, a post-survey analytical technique) were used for quantitative analysis based on the outcomes of the qualitative research. This was supported by qualitative interviews with key stakeholders at the municipal and district level. The research intended to contribute to the methodological development of linked methods including vulnerability assessment and livelihood-based adaptation decision-making. The intent is to explore the strengths and weaknesses of the combined qualitative and quantitative approaches and to present the framework of investigation as a method for assessing vulnerability and adaptation to multiple stresses. The P&VII project also links to the EU-funded CAVES (Complexity: Agents, volatility, evidence and scale) project that addresses complexity of social and environmental systems drawing on the Sekhukhune fieldwork. Social network analysis has begun on the project, which contributes towards an understanding of support for adaptation to multiple stresses.

The document is structured in the following way. First, the theoretical underpinnings of the research are presented and how it fits into past and ongoing work. The case study of Greater Sekhukhune District is introduced, giving a background to the physical, socio-economic and institutional characteristics of the area. Details of the methodology are provided, explaining the combination of qualitative and quantitative methods used. The analysis section starts by presenting the findings from the district level that were gained from semi-structured interviews conducted with municipal officials. Their perceptions of key stresses and approaches to address these stresses are analysed and summarized to highlight the areas of concern at the municipal level. The results from the two village sites are then presented. First the qualitative information that gives insight into individuals' and groups' perceptions of key stresses, on-going activities, support and potential future options is explored. This information was used to inform the surveys and quantitative analysis addressing adaptation choices, which is presented next. All the findings are then drawn on for a broader discussion and a presentation of key findings, ending with a brief conclusion.

2. CONTEXT AND APPROACH

2.1 Conceptual framework

In order to frame the fieldwork and analysis, vulnerability and livelihoods concepts were integrated with an institutional analysis approach as shown in Figure 1. The aim was not to validate this approach but rather to provide an initial framing in which to assess the fieldwork, and comment with respect to these various fields. The underlying conceptual framework is that of vulnerability from the hazards perspective, where vulnerability is a function of the external hazard or stress and the internal capacity to manage and cope with or adapt to stress. This perspective is combined with a livelihoods approach, that assesses individuals' vulnerability through a livelihoods lens that enables the different assets, activities and capacities to help compile a picture of how individuals are vulnerable to different stresses (Scoones,

1998). An institutional analysis approach is engaged in order to situate the local individual activities and dynamics within the broader institutions that constrain or enable livelihood activities and entitlements. These approaches supported investigation into a number of key areas (Kasperson and Kasperson, 2001):

- Multiple stresses
  - How people perceive prevailing risks (local and municipal levels)
  - Prioritisation of responses to dynamic risks
- Scale issues
  - How household, village and district level perceptions of various stresses differ or agree
- Adaptation to and coping with stresses
  - Opportunities and constraints for managing stress
  - Possibilities for integrated adaptive response to stress within and between scales.

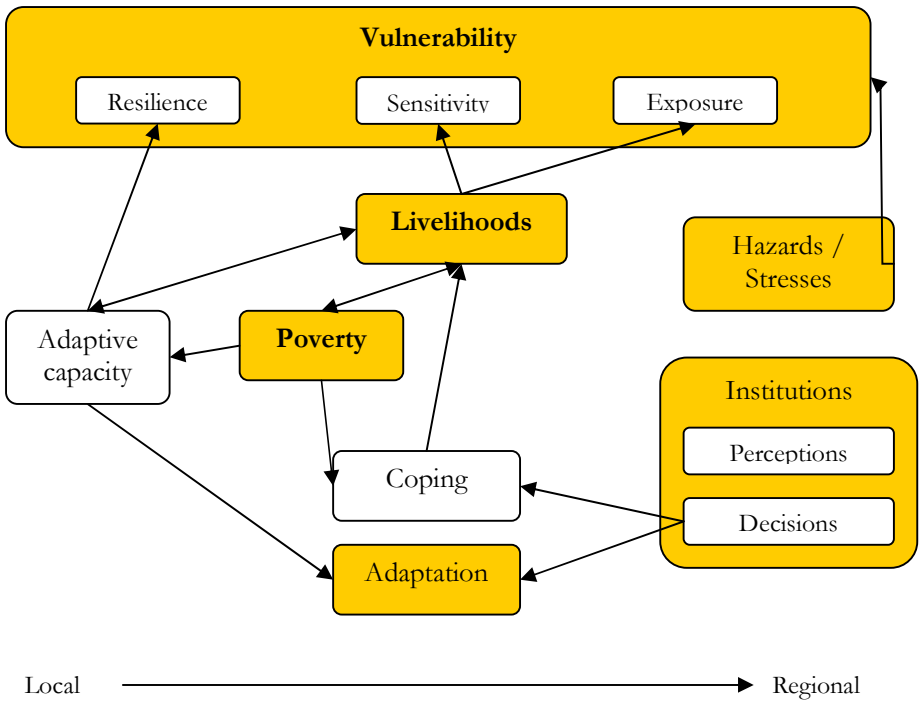

Figure 1: Conceptual framework for exploring vulnerability and adaptation to multiple stresses in Limpopo, South Africa.

2.2 Understanding vulnerability and linkages with poverty

Vulnerability has a multitude of definitions and understandings, varying both across and within disciplines (Bohle et al, 1994; Kelly and Adger, 2000, O'Brien et al, 2004; Wisner et al, 2004; Ionescu et al., 2005; Füssel and Klein, 2005; Adger, 2006). Much of the distinction is tied in with slightly different language usage, words being used to mean slightly different things, or different words used to mean the same thing. In this work vulnerability is understood not only to mean an exposure to stresses either experienced or anticipated, but also involves the sensitivity and resilience of the system to these stresses (Kasperson and Kasperson, 2001; Turner et al, 2003; Segnestam, 2004; Downing et al, 2006). Within this understanding of vulnerability, the term 'stress' includes slow stress, such as land degradation, recurrent

stress, such as drought, and sudden shocks, such as floods and landslides (Ziervogel and Calder, 2003; Segnestam, 2004). Using a definition that includes concepts of sensitivity and resilience as well as exposure means that the internal characteristics of the group, their capabilities to resist and recover from damage and to learn from experiences and avoid future damage, can be explored together with the external situation of exposure to a hazard (Turner et al, 2003; Segnestam, 2004), thereby highlighting the socio-economic and political dimensions associated with the risk of environmental stresses.

The concept of vulnerability is seen as central to understanding poverty, and reducing vulnerability to environmental stresses is fundamental to enabling sustainable livelihoods and thereby reducing levels of poverty (OECD 2001; DfID et al, 2002; Downing et al, 2006; Pelling, 2003). If poverty is understood not purely as an economic condition but rather as a multidimensional concept including dimensions of economic, human, political, socio-cultural and protective capabilities (OECD, 2001, pp.38), and vulnerability is understood in terms of exposure, sensitivity and resilience to stresses and shocks, then important interactions between them become clear (Segnestam, 2004). Conditions of poverty usually result in increased vulnerability, while this same vulnerability reduces peoples' ability to improve their position and reduce their levels of poverty, often pushing people into situations of chronic poverty (Segnestam, 2004; Parker and Kozel, 2004). Poor communities often live on marginal land, with limited productive capacity and inadequate infrastructure, and are therefore more exposed to stresses such as droughts and floods *(exposure)*. Living with few physical and financial assets, limited income and poor access to services such as health care means that poor people are likely to be more significantly affected by environmental stresses than those that have, for example, insurance and greater financial capital *(sensitivity)*. This is closely linked to the *resilience* of individuals, households and communities, their ability to cope with, recover from and adapt to environmental stresses and shocks, influenced not only by economic endowments but also aspects such as nutrition and health status, political influence, access to decision-making and social networks (Wisner et al, 2004; Segnestam, 2004).

2.3 Interacting stresses & complex adaptive systems

There are a number of social, economic, political and biophysical factors that interact to generate vulnerability and affect the decisions people take in response. It is some of these interactions that are interesting to explore. There has been a history of disaggregating different identified stresses to explore them in isolation. For example one might look at the vulnerability of a rural farming community to the threat of a drought or of a drop in crop prices. Now however, focus is being placed on re-aggregating stresses to explore how they interact to affect livelihoods and how people respond when having to make decisions in these highly complex and dynamic situations (Reid and Vogel, 2006; Kasperson and Kasperson, 2001; Adger, 2006). This will in turn help inform the planning of multi-sectoral interventions that support existing successful coping and adaptation strategies and enable the implementation of new strategies as locally identified and prioritised.

Environmental stresses have always existed in different forms and to varying extents. Consequently, societies and economies have developed ways of responding to cope with climate variability, climate extremes and other natural hazards, including strategies such as migration, certain patterns of trade, credit systems and emergency food reserves (Smit et al, 1999; NRC, 1999). In times of extreme stress people may be forced to sell off possessions as a way of coping in order to purchase food, but these actions may undermine the sustainability of their livelihoods, making them more vulnerable and increasing levels of poverty in the medium to long term (AfDB et al., 2002; Watts 1983). With changing patterns of climate variability and environmental stress occurring in a context of economic liberalisation, the progression of the HIV/AIDS pandemic and existing water resource limitations, there are major deviations from historical experience, with people being exposed to new and often unfamiliar conditions. It is therefore not unlikely to expect an increase in the frequency and severity of incidents in which poor peoples' ability to cope is exceeded (AfDB et al., 2002; Thomas et al., 2005).

Responses to impending threats and experienced stresses and shocks are classified in various ways. Useful distinctions are made between coping and adapting and between those activities that are undertaken in preparation for expected impacts (anticipatory) and those measures implemented in response to experienced shocks and stresses (reactive). Coping is considered to be a temporary action undertaken in response to either a familiar or transitory threat (Thomas et al., 2005) while adaptation is understood to be an adjustment in the ecological, social or economic systems in response to observed or expected changes and their effects and impacts in order to alleviate adverse impacts or take advantage of new opportunities (Smit et al, 1999; Kelly and Adger, 2000; Brooks, 2003; Adger et al., 2005; Smit and Wandel, 2006).

Much of the recent adaptation literature has been generated within the field of climate change. It is increasingly being recognized that the act of adapting to climate change is in reality not purely a response to climate variability impacts but rather a complex set of responses to a range of interacting and dynamic stresses, of which climate is one. Adaptation to climate change is undertaken at a number of different geographic scales and involves a variety of social institutions (Thomas et al., 2005). In response to a change in climate, individuals might change their planting dates due to the late onset of seasonal rains in a particular area, government agencies might prepare for increased incidence of droughts in the country and international bodies, such as the UN Framework Convention on Climate Change (UNFCCC), could encourage governments to adapt (Adger et al., 2005).

The variety of stakeholders involved in making adaptation decisions come from varied backgrounds, economic sectors, settlements, communities, cultures and ecosystems, and their complex relationships and interactions are important to include when analyzing vulnerability, making policy decisions and designing future intervention strategies (Reid and Vogel, 2006). Studies that have looked at adaptation to climate change are made more complex and challenging by exploring stresses additional to climate variability and change, such as limited water availability, high levels of unemployment, inadequate basic services, HIV/AIDS and over utilized land, which affect the vulnerability and adaptive capacity of socio-ecological systems (Parry et al., 2005). Adaptations to climate conditions are therefore not isolated or separate from decisions or actions triggered by other social, economic, political and environmental events but rather occur in a context of global change (Adger et al., 2005). The significance of contextual factors highlights the need for an integrated approach to examining vulnerability to multiple stresses and developing a range of suitable methodologies that can help to facilitate appropriate and successful adaptation.

2.4 Multiple stress environments in South Africa: linking climate, water and health

It is increasingly recognized that examining the impacts of stresses in isolation is of limited value in terms of developing a full understanding of local realities and the range of factors contributing to and aggravating vulnerability (Reid and Vogel, 2006). In this particular study we are interested in exploring the interactions between climate, water and health stresses, the stresses of which are major contributors to poverty in the South African context.

Within South Africa there exist a number of climatic zones, with different characteristics. The common trait however is that they all display a high degree of variability and climate extremes are a widespread threat (DEAT, 2004). Both droughts and floods are features of the South African climate, each recurrence having devastating and costly impacts. For example, in the February 2000 floods that affected northern South Africa, Mozambique and Zimbabwe, 600 people died and 200 bridges and 1000km of road were destroyed in South Africa (Fauchereau et al., 2003). Evidence shows that rainfall variability in the region has notably changed since the 1960s, with increased interannual variability, predominantly in the form of more intense and widespread droughts; and large parts of South Africa have experienced a

significant shift toward increasing probabilities of extreme rainfall events (Fauchereau et al., 2003). These climatic changes are likely to have a wide range of impacts in sectors including water, agriculture (food production) and health, some of which are already being felt.

Variability and changes in rainfall and temperature patterns impact all aspects of water resources development and management from supply, through distribution to demand. In much of the country, bulk water supply is based on the use of large storage dams, which are greatly affected by changes in rainfall amount, timing and evaporation rates (DEAT, 2004). Where this infrastructure is less developed or insufficient, groundwater extraction is common. In this case water-table levels and recharge rates are much affected by climatic changes (Bouraoui et al., 1999). Hotter and drier conditions are usually associated with increases in water demand, creating a double impact problem. South Africa's National Water Act is considered one of the most comprehensive examples of water legislation in the world, based on equitable water allocation as an integrated approach to addressing past social injustices, promoting economic growth, environmental integrity and poverty reduction (Hope, 2006). Despite this, much of the country, especially in rural areas, remains under- or un-served with the benefits of the Free Basic Water Policy failing to reach or reflect the needs of these communities (Hope, 2006).

For the agricultural sector the amount and timing of rainfall received and the availability of water to irrigate is fundamental to the success of crops, both in subsistence and commercial farming, creating knock on effects for levels of food production, affecting availability and prices (affordability) of food. These combined impacts place enormous strain on households that are already in survival mode. Extreme weather events can also intensify soil erosion and degradation, affecting the viability of agriculture. Water is not only an essential input to many livelihood activities but is also integral to the functioning of ecosystems on which resource-limited households depend (Poverty-Environment Partnership, 2006).

The health impacts of climate change in South Africa are expected to include an increase in the occurrence of water-borne diseases such as cholera and diarrhoea, water-related vector-borne diseases such as malaria, as well as strokes, non-melanoma skin cancers, skin rashes and dehydration (DEAT, 2004). This comes on the back of enormous existing health problems facing the country, particularly that of HIV/AIDS, making people more susceptible and less resilient to opportunistic infections and limiting peoples ability to respond effectively to other stresses and shocks. This feeds into issues around food security and nutrition, as direct factors affecting immunity levels, and thereby agricultural production and water resources and ultimately economic development and political governance, creating a complex system of feedback processes. Water is central to reducing vulnerability to many of these health threats. Providing access to sufficient safe water reduces the risk of water-borne diseases and water-related vector-borne diseases, reducing the frequency and severity with which people are ill and thereby enabling people to be more productive and use less of the household income on health care related activities and medicines (Poverty-Environment Partnership, 2006).

High HIV/AIDS prevalence in South Africa of around 18.8% among adults (aged 15-49) resulting in around 5,5 million people living with HIV, make AIDS an important stress to consider in South African societies (UNAIDS, 2006). The associated life expectancy at birth of 49 for women and 47 for men is significant, especially when the working age group has the highest number of infections (Drimie and Mousseau, 2004). When these people die, they leave behind dependants including children, elderly and other sick dependents. The death of working adults has significant implications for household income. Not only is household income often lost, if the member had a job, but household resources and savings are spent on caring for the ill, funeral costs and other expenses, often leaving households worse off than before and in 'a downward trajectory of struggle' (SADC FANR, 2003). This has implications for how climate variability and water stress is experienced, as households that have lost members and those that

have few resources, might be unable to cope with small shocks. Women assume a disproportionate burden of the impacts of HIV/AIDS (Chapoto and Jayne, 2005) as they die at younger ages and the death of women has particular impacts on household activities and children's wellbeing. For example, an outbreak of diarrhoea, that might have been easy to treat by taking the children to the nearest clinic, might not be possible if the mother, who would have taken the children, is ill and there is no money for transport to the clinic.

It is clear that HIV/AIDS affects all aspects of rural livelihoods (Haddad and Gillespie, 2001), and radiates from impacting directly on individuals to affecting all around. It has been shown to increase vulnerability to food insecurity directly through decreased production or indirectly through means to acquire food (Boudreau and Holleman, 2002; SADC FANR, 2003). What is also evident is that HIV/AIDS affects rural development and rural development policies and programmes also affect the epidemic (Abbot, 2004). The 2005 Human Development Report 2005 (UN, 2005), suggests that AIDS has resulted in the single greatest reversal in human development. In a country that has very high HIV infection rates, it is therefore appropriate that any research around development considers the impact of HIV/AIDS.

This research aims to support policy development and highlight the need for integrated policy responses that build on the idea of supporting people, organisations and institutions responding to multiple stresses. One of the mechanisms already established to enable this in South Africa, which this work could potentially feed into, is a government entity called the Social Cluster. This organization brings together a number of government departments to work on achieving poverty alleviation by addressing income, human capital and asset poverty (South African Government Information website). It incorporates programmes that address comprehensive social security, housing, land reform, integrated sustainable rural development, urban renewal, and expanded public works (Skweyiya, 2006). One of the focus areas of the Social Cluster important to this study is that of integrated food security, which involves working on a broad range of issues including food distribution and trading, nutrition and emergency food provision as well as employment and income generating activities, stakeholder dialogue and information generation and dissemination (Department of Agriculture, 2002). Through the FIVIMS-ZA (Food Insecurity and Vulnerability Information Mapping System) process the Cluster broadened their engagement with food insecurity by drawing on both qualitative and quantitative results from Sekhukhune (http://www.agis.agric.za/agisweb/FIVIMS_ZA). Phase II of FIVIMS, undertaken in 2006 has engaged further with the Cluster (for more information on the Cluster go to www.info.gov.za) although its future pathway is uncertain. However, it is clear that there is the desire for this type of integrated socio-environmental analysis at the policy level.

At the district municipal level there has been a move to develop plans that integrate across sectors and strengthen the developmental role that the contemporary district level government plays. Some of these processes could also be informed by this work. The Integrated Development Plans (IDPs) are the principle strategic instruments that guide all planning at the district level and facilitate integration with the plans of all other spheres of government, including the provincial and national development plans. The IDP has to include: an assessment of the existing level of development in the municipality; development priorities and objectives, including economic development aims and internal transformation needs; development strategies; a spatial development framework; operational strategies; disaster management plans; a financial plan; and key performance indicators and targets (Greater Sekhukhune District Municipality, 2005). Usually 5 year IDPs are adopted and these have to be reviewed for each municipal financial year. Another requirement at the district municipal level is the preparation of Local Economic Development (LED) Strategies. These LEDs map out priorities and operational strategies with respect to facilitating sustainable economic growth in the area, integrating the second economy with the first economy, and creating job opportunities to address high levels of unemployment

(Limpopo Local Economic Development Programme website). In addition to all this, Sekhukhune has been selected as an Integrated Sustainable Rural Development (ISRD) node. The Integrated Sustainable Rural Development Programme (ISRDP) was developed by the national government as a mechanism for coordinating activities of the three spheres of government and enabling district municipalities in largely rural areas to engage with the Integrated Development Planning process (Department of Provincial and Local Government website). Thirteen nodal points are being targeted in the ISRDP, including some of the poorest municipalities across the country. These have become priority areas for systematically tackling poverty through undertaking development activities as locally prioritised and improving the efficiency of the application of public funds in these rural areas. It is not yet clear what impact there has been through prioritising these nodes. Also, although the LED and ISRDP might have complementary impacts, bureaucracy and lack of coordination inhibits possible achievements.

There are also a number of non governmental organizations working in the region to address development and health issues. The Rural AIDS and Development Action Research (RADAR) programme is one such initiative working to better understand various aspects of the HIV/AIDS pandemic, to curb the spread and minimize the negative impacts. Members of the programme were interviewed as part of this research and efforts are underway to build on some of their work in the next phase of this project. A collaboration between the School of Public Health at the University of the Witwatersrand (WITS) in Johannesburg and the London School of Hygiene and Tropical Medicine, the programme consists of both clinical and social intervention research on HIV/AIDS (RADAR website). The clinic interventions include improving and expanding voluntary counselling and testing, prevention and management of opportunistic infections, HIV/AIDS wellness service, addressing the Tuberculosis epidemic and issues around the administration of anti-retrovirals. The social intervention research focuses on the social determinants and impacts of the HIV/AIDS epidemic. One of the main activities is the Intervention with Microfinance for AIDS and Gender Equity (IMAGE) study, which seeks to evaluate the potential role of a microfinance-based poverty alleviation and empowerment strategy in behaviour change and the prevention of HIV and gender based violence, by administering a micro-lending scheme together with a Participatory Learning and Action Curriculum for loan recipients and using various evaluation tools to capture and analyse both the process and the outcomes. This is being undertaken in 8 villages within the Sekhukhune district, generating a large amount of very detailed qualitative and quantitative data on household characteristics, assets and economic strategies, knowledge, attitudes, practices, life histories, etc. This project provides important contextual information for the P&V project as their rich qualitative and quantitative data collected over a number of years provides insight into sensitive issues that are difficult to address through rapid research methods. Also, individual health determines how people are able to respond to certain stresses and poor health often impacts resource distribution.

2. BACKGROUND

Sekhukhune: the place and the people

2.1 History

The broader Sekhukhune area has a history filled with conflict, predominantly based on disputes over land rights and the power to govern. The name Sekhukhune comes from the once powerful leader of the area, a king of the Marota or Bapedi people who originate from the area between the Vaal and Limpopo rivers (ANC website). By the mid-19th century Sekhukhune and his family had built up an empire, uniting people of many different origins in a struggle against colonial powers (ANC website). After defeating the Dutch on numerous occasions, came a number of battles with the British. Eventually in 1879 the Matora people, fighting under Sekhukhune, were defeated and the area came under British

rule. Sekhukhuneland was divided up into small 'tribal' units governed by Native Commissioners, and people were forced to seek employment on white owned farms, mines and factories (ANC website).

Under apartheid a portion of Sekhukhune formed part of the Lebowakgomo homeland (Aird and Archer, 2004; Zanner et al, 2004). This has significant implications not only politically and demographically but also economically and environmentally, both in terms of the natural environment (due to population pressure and limited access to resources much land degradation took place) and the built environment (limited infrastructure, physical access and service provision).

2.2 Physical

Until 2006, Sekhukhune District straddled a provincial boundary, divided between the Limpopo and Mpumalanga Provinces. This boundary has now been redrawn so that Sekhukhune falls exclusively within the province of Limpopo (see map in methodology section below). The district of Greater Sekhukhune covers an area of approximately 1,326,437 ha (13 264 km^2), the majority of which is rural (Aird and Archer, 2004). The District Municipality is subdivided into five local municipalities, namely: Fetakgomo, Greater Groblersdal, Greater Marble Hall, Greater Tubatse and Makhuduthamaga. The villages of Mohlotsi and Ga-Selala, selected for fieldwork, fall within Marble Hall and Greater Tubatse respectively. The major rivers in the district are the Olifants River, the Tubatse (Steelpoort) River and the Elands River, which supply a number of large dams.

With more than 2200 indigenous species of vascular plants recorded in the area, Sekhukhune is an area of exceptionally high biodiversity and has been formally designated as the Sekhukhuneland Centre of Plant Endemism. Of these 2200+ recorded species almost 70% are herbaceous and are used directly for medicinal, cultural and consumptive purposes but as a result of the proliferation of mining activities in the area and practices of intensive grazing, many of these plant species are threatened with extinction (Aird and Archer, 2004).

2.3 Climate

Sekhukhune is located within the summer rainfall region of South Africa, receiving more than 80% of its rainfall between November and March. The southern part of the district has a mean annual rainfall of between 600 and 800mm while the northern part is drier, between 500 and 600mm (DWAF, 2005). The rainfall patterns are however recognized as being highly variable over intra- and inter-annual time scales. Both El Niño and La Niña events appear to have a significant influence on the amounts of rainfall received in this area, El Niño events most frequently associated with below average rainfall and La Niña with above average rainfall, although this relationship appears more complex (Aird and Archer, 2004). In terms of temperature, the area experiences high daytime temperatures in the summer (up to 38°C), while winter is generally mild (ranging between 7 and 28°C).

2.4 Economic activities

The main economic activities in Sekhukhune are mining and irrigated agriculture. Platinum, Chrome, Gold and Palaedium mines are situated in the eastern part of the district, around the Leolo Mountains (DWAF, 2005). The rocks and soils of the Sekhukhuneland region hold some of the highest concentrations of heavy metals in the world including chromium, platinum, titanium and vanadium. This has led to an enormous growth in the mining sector, with many more mines planned for the area (Aird and Archer, 2004). Development of the Dilokong Corridor, an area rich in mineral deposits that stretches across the north east of Sekhukhune through Fetakgomo and Tubatse, is expected to provide increased economic opportunity in the district.

There are commercial irrigated farms near Groblersdal and Marble Hall in the south west and Zebediela in the north (DWAF, 2005), however only 30% of the land area of the district is under commercial

farming (Greater Sekhukhune District Municipality, 2005). What hampers the growth of the agricultural sector is the scarcity of water and the uncertain status of land ownership, with 75% of the land in Sekhukhune being under land claims (Greater Sekhukhune District Municipality, 2005).

Despite large-scale mining and commercial agriculture activities in the area there is a very high poverty level, with 84% of people defined as poor (having less than R1500 per household per month) and 66% defined as very poor (having less than R550 per month) (DWAF, 2005). Sparse rainfall and high evaporation rates limit the success of subsistence farming activities, which involve mainly growing maize, pumpkins and sorghum and rearing cattle, goats and chickens (DWAF, 2005). Employment levels are very low in Sekhukhune and large numbers of people are not economically active. Unemployment in Sekhukhune currently stands at 69%, much higher than the provincial average of 49% (Greater Sekhukhune District Municipality, 2005). It is estimated that the economy in Sekhukhune needs to grow in such a way so as to create 2800 new jobs per year if the unemployment rate is to be reduced by 1% per year (Greater Sekhukhune District Municipality, 2005). Currently the government employs 16% of the population, the public sector therefore playing an important role in the economy of the district (Greater Sekhukhune District Municipality, 2005). Many people who have no formal income rely on government grants and remittances from family members working in other areas, while others engage in activities in the informal economic sector with varying degrees of success.

2.5 Population

According to the 2003 census the Sekhukhune District has a population of 1,121,126 residing in 546 villages and 5 towns (DWAF, 2005). This translates into an average population density of 85 people per square kilometre, which is high compared to the national average but still qualifies as sparsely populated in terms of global demographics (Zanner, 2004). Of this total population over 90% live in rural areas (Aird and Archer, 2004). The population is a largely youthful one with approximately 50% of the population under the age of 18 (DWAF, 2005). HIV/AIDS is having a significant impact on the growth rate of the district, as in the rest of the country. The current growth rate is just over 1% per annum, compared to a growth rate of about 3.4% per annum in the early 1980's before the AIDS pandemic (DWAF, 2005). This growth rate is expected to drop even lower in years to come. There is currently a higher proportion of women than men in the district, partly related to high levels of male absenteeism. Many men have migrated in search of work mainly to the Mpumalanga coal fields and Gauteng (Aird and Archer, 2004; DWAF, 2005). Their destination may however change due to the influx of workers to the Dilokong Corridor as new job opportunities are created with increased mining operations.

2.6 Education

From the Census 2001 statistics, as shown in Table 1, it is clear that there is a considerable number of people in the district with little or no formal education. The resulting high level of illiteracy is part of what makes undertaking conventional survey exercises difficult in these communities. There is however a strong generational differentiation in terms of levels of education with many of the older generation not having had any schooling while the young generation have a much higher school attendance rate and more people complete schooling to a higher level. School facilities are not adequate in many areas with 335 schools out of a total of 737 schools in the district not having acceptable levels of water availability (DWAF, 2005).

Table 1: Education profile of the Greater Sekhukhune District Municipality as captured in the Census 2001 (Source: Aird and Archer, 2004)

Municipality	No schooling	Completed primary	Std 10/Grade 12	Higher	Total no of People
Greater Marble Hall	21710	3109	7176	2457	**34452**
Greater Groblersdal	46194	4230	12386	4685	**67495**
Greater Tubatse	47791	6067	12010	4940	**70808**
Makhuduthamaga	51415	4781	13067	6004	**75267**
Fetakgomo	18646	1715	4234	2395	**26990**
Total	**185756**	**19902**	**48873**	**20481**	**275012**
% of distribution	**67.5%**	**7.2%**	**18%**	**7.5%**	**100%**

2.7 Infrastructure services

An assessment of levels of water provision in Sekhukhune using the legislative standards as set out in Water Services Act reveals that 46.9% of the population is receiving below basic RDP level water services (Greater Sekhukhune District Municipality, 2005), as illustrated in Table 2.

Table 2: Level of water provision services by locals municipalities in the Sekhukhune district (Greater Sekhukhune District Municipality, 2005)

Municipality	Below Basic RDP level					Basic Access	Intermediate access	Full access
	Tanker	Borehole	Natural	Other	Unspecified	Public tap	On site	Inside dwelling
Fetakgomo	108	1069	5580	79	121	8202	1319	856
Makhuduthamaga	318	4533	21832	692	295	14178	5112	2997
Greater Tubatse	397	4504	13459	1054	320	17734	2552	2515
Greater Groblersdal	3076	4798	10019	461	445	13069	5687	4790
Greater Mabel Hall	306	2257	4457	234	108	4225	4861	2962
Sekhukhune District	4205	17161	55347	2520	1289	57408	19531	14120
%	46.9%					33.5%	11.3%	8.3%

Many households are extracting water from rivers, springs and wells and this generates increased levels of risk to disease, particularly cholera, bilharzia and diarrhea (DWAF, 2005). It is estimated that 78% of

rural villages in Sekhukhune do not have access to basic RDP level sanitation and this constitutes a large threat in terms of the contamination of groundwater (DWAF, 2005).

There is enormous concern around the issue of affordability at the household and government level for meeting water and sanitation service targets. With many households unable to pay and existing government subsidies falling short of required amounts, eradicating the backlog by 2010 is considered difficult, if not impossible (DWAF, 2005), as emphasised during an interview with the government official responsible for water services in Sekhukhune. Enormous investments are however being made to continue the water and sanitation services rollout programme. In the 2004/5 financial year over R170 million was committed on water and sanitation projects in the district (Greater Sekhukhune District Municipality, 2005).

Sekhukhune has an extensive road network, but road quality is a problem (Greater Sekhukhune District Municipality, 2005). Many roads are poorly surfaced and conditions become even worse in the rainy season when large gullies form. Public transport is limited in many parts of the district. Only a few minibus taxis pass daily and tarriffs are high considering the low income levels.

2.8 Housing

While many households do reside in formal houses on separate stands there are still significant numbers in backyard dwellings and informal structures or shacks, as shown in the table below. In Greater Tubatse for example (the district in which Ga-Selala is located), 8.9% live in informal dwellings or shacks, which translates into 3366 households. Even the figures given for households living in a formal dwelling can be misleading as there is no indication of the quality and size of these dwellings. Many are structurally unsound and are very small for the number of people that inhabit them. There has recently been a large stock of RDP housing built in Sekhukhune and much more is planned for the coming years.

Table 3: Dwelling type as a percentage of households in each of the local municipalities, adapted from Census 2001 data as presented in Aird and Archer (2004)

Type of Dwelling	Greater Groblersdal	Greater Tubatse	Makhuduth amaga	Fetakgomo	Greater Marble Hall
House or brick structure on a separate stand or yard	73.4%	69.6%	75.2%	79.1%	73.3%
Traditional dwelling/hut	15.2%	18.4%	16.6%	14.3%	15.8%
Flat/town house/cluster house/semi-detached	1.8%	1.1%	0.8%	0.4%	1.7%
House/flat/room in back yard	2.4%	1.0%	2.2%	1.0%	3.2%
Informal dwelling/ shack/backyard shack	5.2%	8.9%	4.5%	4.1%	4.9%
Other	1.9%	1.0%	0.6%	1.1%	1.1%

Land is an important issue when considering housing. Large portions of the district still fall under tribal land ownership. Many claims have been lodged on these lands and these are expected to take years to process as the appropriate mechanisms for land tenure reform are still being formalized (Greater Sekhukhune District Municipality, 2005). This state of insecure land tenure has enormous implications in terms of development and investing in housing stock. Means of circumventing this issue are being

implemented, including the preparation of community resolutions that approve specific proposed developments, which are then to be signed by the Director General of Land Affairs.

2.9 Health

There are a number of hospitals and clinics spread around the district but resources at these health centers and accessibility to them remain poor. According to the latest review of the Sekhukhune IDP (Greater Sekhukhune District Municipality, 2005) there are chronically low levels of professional availability (medical officers, pharmacists, professional and staff nurses) in both hospitals and clinics and they estimate the figures for accessibility of these centers to residents to be as follows in table 4.

Table 4: Accessibility of health centres to residents (Source: Greater Sekhukhune District Municipality, 2005)

Municipality	% within 20km radius of a hospital	% within 5km radius of a clinic
Fetakgomo	80%	51%
Greater Groblersdal	80%	64%
Makhuduthamaga	80%	48%
Greater Marble Hall	40%	47%
Greater Tubatse	78%	45%

Water and sanitation levels are variable but at many health centres they are classified as unacceptable (DWAF, 2005). According to an assessment conducted by the Department of Health in 2003 (DWAF, 2005), 28 out of the 58 clinics in the district did not have an acceptable level of water supply. Similarly, 13 clinics did not have sanitation at an acceptable level, many only having the use of pit latrines. In clinics where the water problem was particularly severe, clinics were required to bring in water in tankers.

The most common health problems in the district include hypertension, diabetes, tuberculosis and asthma (Zanner et al., 2004). HIV/AIDS is of great concern for the country as a whole and this area is no exception. According to a speech made by the Limpopo Premier at last year's World AIDS Day gathering in Sekhukhune, the Limpopo HIV prevalence rate is 19.3% and that of Sekhukhune is 13.4% (Office of Premier, Limpopo Provincial Government, 2005). He noted that there has been a marginal drop in this rate from 14.1% to 13.4% for the Sekhukhune district while all other districts had seen an increase. What this may be an indication of is questionable. Many government officials expect the prevalence rate to rise in Sekhukhune as new mining operations begin and large numbers of migrant workers move into the area. Currently the group worst hit by the virus is the young adult population, particularly between the ages of 20 and 30 years (Aird and Archer, 2004).

Illustration 1: An HIV/AIDS awareness campaign board in Sekhukhune (© Frank Thomalla, 2006)

2.10 Politics and institutional structures

Under the homeland system during the apartheid era, local government institutions built up around traditional chieftancy structures, resulting in much tribal tension (Aird and Archer, 2004). An attempt has been made by the post-1994 government to develop a democratic local government structure. Leaders of the new structure have had to work alongside and ultimately with the existing, traditional leaders (chiefs and headmen) whose positions have endured the political transition, and who retain much authority in many rural social structures (Aird and Archer, 2004). Tensions have developed out of the coexistence of these different styles of leadership. Local municipalities are sub-divided into a number of wards, which are represented by ward councilors. In the rural areas, each ward is likely to include a number of villages. Similarly, by the traditional system a chief presides over a cluster of neighbouring villages. These two groupings of villages, however, rarely correspond completely and both chiefs and ward councilors vary dramatically in terms of their effectiveness and fairness.

From this background it is clear that Sekhukhune is a district with high levels of poverty and unemployment and a lack of infrastructure, particularly in the rural areas. In addition to this there is high climate variability and water stress. The emergence of many new mines provide both opportunities and challenges. There is considerable government restructuring and attempts to plan development activities in an integrated manner but institutional difficulties plague such efforts.

4. METHODOLOGY

4.1 Site selection & characterisation

The aim of understanding multiple processes, involving both the interconnected pathways of stresses and the interactions between numerous stakeholders, led to the development of an integrated methodological approach, combining benefits of qualitative and quantitative research techniques. To test the new research methodology, a case study was conducted in the villages of Mohlotsi and Ga-Selala in the Greater Sekhukhune District. The selection of these two villages was based on recommendations made by an expert at the Human Sciences Research Council of South Africa, drawing on the analysis of data from the above mentioned FIVIMS research. Selection criteria included: villages having ten identifiable households which were surveyed as part of the FIVIMS study; level of access, how close the village was to a main road and large town; and the type of water infrastructure, whether supplied with

tapped reticulated water to each house (Mohlotsi) or with shared communal standpipes fed with pumped groundwater (Ga-Selala).

Map 1: Map showing Sekhukhune and the location of villages where research was conducted for P&V as well as the villages where previous FIVIMS surveys were undertaken.

Mohlotsi is located to the north east of Phokwana and access to the village is only through gravel roads (Map 1). The estimated population for 2005 was 573 people (DWAF, 2005). There is a level-1 hospital nearby, Matlala hospital, which is seen as an important source of employment. A mobile clinic visits the village once a week after visiting all other villages, and subsequently has often run out of certain medicines. There is piped reticulated water to each house.

Ga-Selala is located to the north-west of Steelpoort and Burgersfort. Situated on a main tarred road Ga-Selala has better accessibility to large towns than Mohlotsi. It had an estimated population of 2559 in 2005 (DWAF, 2005). A number of mining companies operate in the immediate area and many more mines are planned to open in the near future. The village has no piped water to the houses but is serviced by six community taps fed with groundwater stored in a small dam on the hillside. From direct observation, crops in Ga-Selala appear to grow better than in Mohlotsi, similar varieties appearing in greater numbers, taller and with greater productivity.

Table 5: Village profiles of Mohlotsi and Ga-Selala, February 2006

	Mohlotsi	**Ga-Selala**
Population (2005)	573	2559
Water access	Piped water to each house	6 community taps
Road access	On gravel road far from main road to Marble Hall	On main tarred road between Burgersfort and Driekop

Distance to closest town	~50 km (Marble Hall) on tar and dirt roads	~20 km (Burgersfort) on tar road
Healthcare	Matlata hospital, mobile clinic, lack of indoor examination facilities, frequent lack of medication	Mobile clinic, indoor examination facilities, frequent lack of medication
Housing	Most dwellings are concrete structures, high number of RDP houses	Most dwellings are concrete structures, several RDP houses under construction
Electricity	All houses	Most houses
Sanitation	Pit latrines for most households	Pit latrines for most households
Education	1 primary school in the village	1 primary and secondary school in the village, several other schools in the vicinity
Irrigation	None	None
Home garden	Some	Some
Crops	Mostly maize and sorghum	Maize, sorghum and vegetables including pumpkins, moroho, tomatoes, onions, beetroot and watermelons
Community projects	Brickmaking, poultry, community garden (failed)	Community gardening project (failed)
Mining	None	Close proximity to platinum mines

Illustration 2: Children collecting water from a communal tap in Ga-Selala (© Frank Thomalla, 2006)

One of the aims of this research is to contribute to methodological development in the field of adaptation and specifically to investigate means of bridging the divide that exists between qualitative and quantitative research. In this section we discuss the issues around using a mixed-method approach and provide some detail as to the different methods used, how they were applied and to what end.

4.2 Mixed-method research: strengths and weaknesses

There has been a longstanding debate about the suitability and superiority of quantitative and qualitative approaches in terms of poverty and vulnerability research. One of the outcomes of this controversy is a move to consider the benefits of each and how these might be integrated (Marsland et al., 2001; Parker and Kozel, 2004). An important advantage of a mixed-approach is the use of quantitative research to ensure reliability and representativeness, and the use of qualitative research to provide validity by establishing that questions being asked are appropriate to the conditions on the ground and that the interpretation of results is reasonable (Parker and Kozel, 2004). Similarly qualitative methods allow for unplanned follow up to further explore unexpected responses, giving the opportunity to gain totally new insight (Parker and Kozel, 2004).

A study by London et al. (2004) examining various policy impacts, found that full integration of the results of the qualitative and quantitative components of a study is often constrained by the lack of a formal linkage between different samples used. Despite the data being from the same setting and the same time period, the sampling methods are usually not consistent. London et al (2004) also conclude that by having the same people conducting both the qualitative and quantitative analyses there can be a useful cross-fertilization across the data sources that may yield new and different insights. The potential downside however is that collecting the necessary data is differentially time-consuming and the different methodological approaches are often better at answering slightly different types of questions.

Parker and Kozel (2004) undertook a study similar to the one being discussed in this report, to understand poverty and vulnerability in areas of India using a mixed-method approach which combined the use of household economic data and economic analysis with open-ended qualitative research

methods. In the Indian study, the initial plan was to pursue a "qual-quant" sequencing pattern, first undertaking qualitative work to inform the survey design and the quantitative portion of the research. It was found that the research agenda developed into one that pursued a "qual-quant-qual" sequencing pattern involving follow up interviews to clarify ambiguous points that emerged in the survey results. Parker and Kozel (2004) clearly conclude that qualitative and quantitative methodological approaches generate different types of information that are valuable in their own right and in combination and therefore should be treated as complements rather than substitutes. The qualitative and quantitative methods employed in this study are discussed below, including consideration of the advantages and disadvantages of each.

4.3 Participatory research techniques

Moving away from ideas of objective scientific research, participatory research focuses on building an equitable partnership between the researchers and the stakeholders, drawing on the knowledge and skills of both parties in all aspects of the research process, from problem definition and issue selection through to developing ways to address the problem. It can take a variety of forms, tending to focus on narratives and allowing stakeholders to guide the process, whether through semi-structured interviews or focus groups (Chambers, 1994). It is thus important to develop a relationship of trust during the research process, encouraging an open and honest exchange of thoughts and feelings during the collection of data. Participatory research can involve a variety of people, for example farmers in a village and government officials from the local and district municipalities. There may be similarities and differences in how these people respond to the same question, e.g. the problems associated with severe droughts. These differences can in certain instances be used as a means for cross-checking and verification, while in others can highlight important differences in perception.

Extensive participatory research can often be more time demanding than conventional survey techniques. Although a proper conventional survey also requires an iterative preparation process involving a series of pilot surveys, the iterative process of participatory research is more continuous and bilateral, presenting and discussing the findings with the group. Due to the nature of the research technique, it is important to be aware of bias while collecting and analysing data. Nonetheless, participatory research is particularly useful for gathering contextualised information. In this study participatory techniques were applied at a number of levels, including: institutional semi-structured interviews with government officials from local and district municipalities; semi-structured interviews with individuals in the two villages; key informant discussions; focus groups with different groups of people in the villages (men, women, and community project participants); and village meetings.

4.4 Stated preference questionnaire and discrete choice analysis

Discrete choice analysis (DCA) has been developed in the transport sector, but is becoming popular in the environmental sector as a part of the contingency evaluation method (Ben-Akiva and Lerman, 1985). There have been a number of DCA applications used in socio-environmental projects (e.g. Hope, 2006). For example: predicting demand for a new crop under alternative pricing strategies and climate conditions; and designing a policy plan for a new irrigation technology. To accomplish these tasks, discrete choice analysis provides powerful methodological tools. Based on the modelling of individual behaviour, it is used to model in detail the structure of a market and society, and to predict the impact of various scenarios.

Stated preference (SP) survey technique and discrete choice analysis work closely together. In an SP survey, people are asked to choose their reactions to a hypothetical situation (the strategies used for getting people to respond to hypothetical situations are discussed in the survey procedure section below). SP technique is considered more efficient than conventional questionnaires. Since multiple questions can be asked of one person, multiple samples are generated from a SP questionnaire. Also,

human behaviour in hypothetical situations, such as a two degree temperature rise due to climate change, can be tested with this technique. Years of use and debate in the economic literature has seen improvement in questionnaire construction so as to minimise errors and bias. For example, combining the outcome of a stated preference question with the real behaviour of participating individuals (revealed preference) will improve the quality of a result (Adamowicz, et. al. 2002).

4.5 Pros and cons of the two techniques

Both participatory research and stated preference survey techniques have advantages and disadvantages. Participatory research enables one to access in-depth and contextual information and therefore has the advantage of finding new and real problems and solutions, e.g. finding existing adaptation strategies for dealing with experienced and expected changes in the climate. On the other hand, the limitations of participatory research is that it is site specific, so not always easy to generalize the findings to a broader level; and it involves more subjective judgment, introducing bias into the findings.

In contrast, stated preference survey, as a quantitative research method, is less subjective and it is possible to generalize its results by extracting significant factors and components after some statistical analysis. This type of questionnaire survey however makes it difficult to identify real problems local people are facing. For example, a stated preference questionnaire detects which suggested adaptation strategies people choose, but does not discover any new adaptation strategies they are using.

As discussed above, these respective strengths and weaknesses indicate that participatory research and stated preference survey techniques can compliment each other. Participatory research enables one to identify real problems to inform the hypothetical situations and identify locally appropriate choice sets in a stated preference questionnaire. This process could substitute for several pilot surveys. Equally, the results of a stated preference questionnaire and consequently its discrete choice analysis can be used to verify and cross-check the results from participatory research.

4.6 Process for analysing the data

Participatory research

Participatory research was conducted in the two villages mentioned above and in the respective local and district municipalities. Nine government officials from a range of departments within the Greater Marble Hall and Great Tubatse Local Municipalities and Sekhukhune District Municipality were interviewed, covering issues such as their role in the area, the main challenges faced by the municipality and people in the villages, and activities to address these. In the two villages the ten households that had been interviewed during the FIVIMS project were selected for semi-structured interviews. Questions were aimed at establishing information on household characteristics, activities engaged in by the interviewee, sources of household income, primary expenses, social networks, key problems and challenges faced, coping and adaptation strategies, and desired support. In Mohlotsi eight of these ten households were successfully interviewed and in Ga-Selala nine were interviewed. Following the household interviews, focus group discussions were facilitated. In Mohlotsi a group identified by their engagement in various communal projects was convened, followed by separate men's and women's focus groups. In Ga-Selala because there were apparently no functioning community projects only men's and women's focus groups were held. More details of both the institutional and village-level participatory research are discussed in the respective analysis sections below.

Results of participatory research as inputs for stated preference survey

The results of the participatory research were discussed and the findings utilised in the development of the stated preference questionnaire. The two sets of useful findings were 1) stressful events and significant social characteristics as hypothetical variables and 2) existing adaptation and coping strategies as a potential choice set. The common significant hypothetical variables between the two villages were

the price of maize-meal, sickness periods of household members, and droughts. The research found that the price of maize-meal they purchased varied and they appeared to have a good memory about the price and weight of maize-meal they purchased, even in the previous year. Various health issues were mentioned ranging from feet pain to serious illnesses. It is too expensive (Mohlotsi) or restrictive (Ga-Selala) to use bulk water, intended for domestic purposes, for irrigation. Therefore home gardens in the two villages were highly dependent on the rain and subsequently sensitive to drought. There were other significant stresses but some of them were not common problems for both villages. For example, there is tapped water for every household in Mohlotsi, so drinking water is not a serious issue in the village. While in Ga-Selala all households have to fetch drinking water from one of six community taps. Although these uncommon stresses were not used as hypothetical variables, they were included as socio-economic characterisation questions.

From the individual interviews and the group discussions, five potential adaptation strategies were identified:

1) work elsewhere,
2) get involved in a village project,
3) contact the district for support,
4) attend a training course at your own cost,
5) try to access a grant, and
6) start/improve a home garden.

The interviews indicated that some of these adaptation strategies such as "go on a course" might not be feasible choices due to monetary constraints and risks. Nonetheless, since people mentioned education and skills frequently, the strategy was included as a potential choice in the stated preference questionnaire survey.

4.7 Development of the stated preference questionnaire

The significant factors and existing strategies identified during the participatory research were used in the stated preference questionnaire to find out how decisions were related to multiple stresses. In the lead up to the hypothetical questions, five open-ended questions related to the hypothetical situations were asked to encourage people to engage with the questionnaire. This included asking the price and weight of maize they (or their household members and friends in some cases) purchased last time. Thus the level of maize price and weight in the hypothetical questions was set individually based on the last knowledge or experience of maize prices, i.e. 40 Rand higher or lower than the price they paid last time. Following the hypothetical questions, people were asked to identify their real strategies (revealed question) undertaken to cope with or adapt to their real current situation, in order to improve the quality of hypothetical answers.

Hypothetical situations

The three variables used to form each hypothetical situation were 1) drought, 2) the sickness period of a household member, and 3) maize price. In the hypothetical situation other conditions, such as income and education, were considered to be the same as the respondent's current real situation. An attempt was made not to include any socio-economic variables as hypothetical variables, but during the participatory research stage sickness period was found to be a significant common variable, so it was included as a hypothetical variable. The survey variable number was reduced to three and the number of levels of the variable was also limited to three so as to reduce the survey time. This was undertaken according to a specialised survey process (i.e. orthogonal design) as explained below. Of the three factors, two of them have three levels and the third has only two levels, and does not consider interaction effects. The factors and levels used for the questions are stated in Table 6. The stated preference questionnaire requires nine questions according to an orthogonal design as shown in Table 7.

Table 6: Hypothetical factors and their levels

Factors	0 : low	1 : mid	2 : high
If the current price of maize meal is	R40 less than the last price you paid	The same as the last price you paid	R40 more than the last price you paid
If a household member is very sick for	A day	1 week	1 month
Drought	Currently drought	Currently NOT drought	

Table 7: Orthogonal design of three variable and three levels for main effect analysis

Factors	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
Maize price	0	0	0	1	1	1	2	2	2
Sickness period	0	1	2	0	1	2	0	1	2
Drought	1	1	0	0	1	1	1	0	1

Choices (Adaptation and coping strategies)

Respondents were asked if they engage in any of the coping and adaptive strategies listed in the stated preference questionnaire. The majority of these strategies were based on the results of the participatory research. However, some coping strategies observed in previous research undertaken as part of the UNRAVEL project, were also tested in the questionnaires. The UNRAVEL project aimed to understand coping and adaptation in response to food insecurity, HIV/AIDS and additional stress, identifying a number of household strategies (Ziervogel et al, 2006). A total of seven coping strategies and six adaptation strategies were listed in the questionnaire, as shown in Table 8.

Table 8: Set of coping/adaptation strategies

Coping strategies	Adaptation strategies
Eat less preferred food	Work elsewhere
Reduce number of meals a day	Engage in a village project
Limit portion size of meals	Contact district for support
Rely on piecework	Go on a training course at own cost
Borrow food	Try to access a grant
Eat elsewhere	Start/improve home garden

Purchase food on credit

The table shows only the names of the strategies. During the administration of the survey each strategy was identified and described to the participants using translators.

Socio-economic variables
Most socio-economic variables were determined using data from the previous FIVIMS research. In addition to these variables sickness period and social network type questions were asked. Sickness period was particularly important for the revealed preference question.

4.8 Survey procedure
Before the questionnaires were distributed, a local translator explained the nature of the hypothesis questionnaire. This explanation was further expanded on in the form of a short play acted out by two of the researchers. The play described both the best case scenario (no drought, not seriously sick, and maize price is cheap) and the worst case scenario (drought, seriously sick, and maize price is expensive) and explored some of the possible reactions to these situations.

Illustration 3: Short play describing possible scenarios and participants filling in questionnaires (© Takeshi Takama and Frank Thomalla, 2006)

Some people, especially the younger generation, completed the questionnaires without any problems; the majority however needed some guidance and assistance, mainly due to high levels of illiteracy. Consequently each question and each tick box option was completed by the respondents as the translator read out each of the sections. Researchers and some of the younger participants, who had completed their questionnaires, assisted other respondents in completing theirs. The survey process, including the acting interludes, took approximately one and a half hours. Refreshments were provided afterwards and it seemed as though people were starting to get tired. However, many were happy to stay on for a focus group afterwards.

4.9 Quantitative analysis
The analysis of the survey data was conducted using BIOGEME discrete choice analysis software package (http://roso.epfl.ch/biogeme). The data was collected without trial sessions; therefore, the quality of data is at a pilot survey level. As a consequence of this, the results should be considered as the result of a pilot survey, which will be improved during future research.

4. 10 Limitations of research methodology

The field research was conducted over a period of two weeks in February 2006. This represents a relatively short amount of time in which to organise and conduct the interviews and focus groups, although the team of 6 researchers allowed for parallel investigation to occur. The short time for research raises issues of trust between researchers and individuals, particularly in the study villages. As a result the possibility of bias resulting from a lack of trust between respondents and researchers should not be ruled out.

The stated preference survey was conducted in Ga-Selala, as pre-arranged with the chief's permission. Overall 100 people took part in the survey. The questionnaire was translated into the local language, sePedi. A survey was also to be undertaken in the second research village (Mohlotsi) but due to a misunderstanding an insufficient number of participants arrived for the meeting, i.e. 10 people. The survey procedure detailed above is therefore based only on activities in Ga-Selala. This means that caution is necessary in any attempt to generalise from this research for both the villages and district as a whole. Further research in more villages in the district could enable broader generalisations to be made.

There are some obvious limitations to the data. In the questionnaire, since there was only a 'yes' tick box, a 'no' answer and a non-response are not distinguishable. Also, some people seemed to respond to the questions without considering stated values or skipped questions all together. Therefore, a number of questionnaires were omitted in a systematic way before this choice analysis was undertaken. If zero strategies were ticked 'yes' in equal to or more than six questions (six being half of all the questions including the revealed preference question); if the number of strategies ticked in a question is the same as the previous question in equal to or more than six questions; or if the number of strategies ticked in a question is changed only once or twice in the set of questions, the questionnaire was omitted. As a result of this, 35 out of 100 questionnaires were omitted. There were ten questions including a revealed preference question, so that the sample number becomes 650, i.e. 65 ×10.

In terms of the qualitative data, the sample size for the individual interviews at both the village level (17) and municipal level (9) is relatively small. The focus groups however involved many more people from each village. The information gathered during the focus groups has been used to supplement and support the statements made during the individual interviews, so in some ways the limitations of the small sample size have been addressed. Interviews and focus groups were conducted within working hours on week days when most employed individuals would not be available. For these reasons, the results should not be interpreted as indicative of the district as a whole, rather they add to our understanding of the conditions for coping and adaptation in Sekhukhune. Similarly with the institutional interviews, the people interviewed responded in their own capacity and may not represent the views of all government stakeholders in Sekhukhune. An institutional analysis undertaken previously in Sekhukhune as part of the FIVIMS project, helped to triangulate the information we obtained (Zanner et al, 2004).

5. ANALYSIS

As described above, the qualitative research results were used to inform and then interpret the quantitative aspect. The results from both the institutional and village level participatory activities are presented first to frame the more quantitative outputs of the research discussed later.

5.1 Sekhukhune District: Institutional analysis of vulnerability to multiple stresses

Semi-structured interviews were undertaken with 9 government stakeholders. Representatives were drawn from the two municipalities in which the case study villages were based and from the

Sekhukhuneland district authorities. The government officials included those involved in Local Economic Development, Integrated Development Plans, Community Services, Primary Health Care, Water services and Environmental matters. The interview started with the interviewees defining their role, expressing the issues they thought were of most concern at the district, municipality and village level, what was being done to address these issues and what might be done in the future. Issues around climate, water and health were highlighted if appropriate and if they did not come up of their own accord.

Perceived stresses

There were a number of commonalities that came up when different stakeholders discussed issues of concern and what they perceived as key stresses. Much of what people told us during interview sessions confirms the background information discussed earlier, highlighting the lack of basic services, water scarcity, lack of skills and government resources, high levels of unemployment and general rural poverty as significant challenges facing the district. People see multiple feedbacks between these conditions and link them to limits in the range of adaptation options available.

Lack of basic services: This included water, sanitation, electricity and roads. Water came up a number of times and its importance in district development was emphasised, as discussed in the next section. Sanitation was mentioned as being inadequate, as a large proportion of villages still need improved sanitation, generating a health concern in some areas.

Lack of skills and capacity at both village and municipal level: At the village level, government recognises that people require the skills needed to undertake income-generating activities either within the village or in order to apply for jobs elsewhere. At the municipal level, local skilled people are required so that experts from outside the district do not need to be brought in. Ideally, there needs to be improved skills development within villages that could contribute to addressing municipal needs. At present, people in the villages do not seem to have the adequate skills for developing successful village level projects. Often they require outside support and expertise, which limits development.

Unemployment: Even if skills are developed, employment opportunities are limited. There is 69% unemployment in Sekhukhune district and 49% unemployment in Limpopo Province (Greater Sekhukhune District Municipality, 2005). The mines are therefore seen as a potential source of employment although they employ a large number of people from outside the district.

Poverty was mentioned as an overarching problem in the district, closely related to many of the other concerns. Poverty seems to be pervasive across the rural areas, with some areas being less vulnerable to certain stresses but more vulnerable to others. For example, in the one village, Mohlotsi, they do not have good access to the nearest town as there are gravel roads and limited transport, commonly referred to as poor accessibility (European Conference of Ministers of Transport, 2004). This means that even if they are able to find employment in the nearest town, Marble Hall, rather than migrating to Gauteng, they spend such a significant portion of their income on transport that the benefits are limited and often not worthwhile. Ga-Selala, on the other hand, is on a tar road with easy access to Burgersfort. Yet, they do not have adequate water supply and so there are restrictions on having a home garden and much time is spent collecting water. Even though they are close to the mines, preferential employment seems to occur and their village does not seem to be in favour with the mine employers. As a result of these limitations many households in both villages are reliant on various government grants including state pensions, child grants and disability grants.

Communication was mentioned as a barrier in some cases, both between the general public and government institutions as well as across government departments and different levels of government.

Communication and shared understanding of expectations seems to be lacking in many cases. In government there is frustration where local officials feel they are not given sufficient authority or information on certain issues while national officials expect more input from the local level. This is partly caused by the restructuring of institutions. The role of the District has recently been established, located between the municipal and the provincial administration, and has caused some confusion and frustration regarding roles and responsibilities. Lack of capacity (because of limited resources and/or skills) to undertake allocated responsibilities adds to these frustrations.

There is frustration among the public concerning communication with government. One of the IDP officers attributes this to the fact that,

> *People don't understand the structure. The spheres of government are not clear to the public.*

Local problems are taken straight to the district level instead of the local municipality were they should be dealt with. This is not helped by the fact the Wards are not functioning well, where local problems should be systematically tabled by Ward councillors. Apparently, the Ward counsellors are often unemployed so they can not afford to travel 3 hours to have problems heard, but they are trying to develop an allowances system.

At the same time, there is a mismatch in the expectations and priorities of local government officials and those of people in the villages. There is a perception at the village level that government should provide information on jobs, training and project opportunities; and that many requests being made to the government are not being responded to or met. While municipalities recognise the need to deliver services and are making an effort to improve skills development and support employment opportunities, they also expect people from the village to approach them for support as opposed to waiting for help to arrive. This mismatch could be addressed if municipalities were aware of what information villagers wanted and similarly, if villagers knew who to approach for the desired information.

The vision of the district and local municipalities also differs from that of the villagers. The municipalities focus more on development opportunities that are not village-based but rather district-wide, including priority focuses for future investment and activity. Villagers do not necessarily see how they fit into these broader development plans and would prefer to see opportunities that are local.

Response to stress

In response to the lack of skills and capacity and high levels of unemployment an extended Public Works Programme has been developed where training is given and people are matched to projects. This includes projects involving infrastructure, economic activities, environmental issues (e.g. clearing alien vegetation) and social issues (e.g. Home Based Care). This is a new programme and can only support a limited number of people. Further support is needed to address the unemployment problem.

In some of the interviews government representatives expressed the need for more industry and value-added activities as this would increase employment opportunities at the same time as bringing more money to the district. This is the idea behind supporting growth points as key economic hubs that grow markets.

The existing and planned mines are seen as an important source of employment. It has been recognised that many local people do not have the necessary skills to work in the mines. As an IDP representative stated,

> *The level of education in Sekhukhune is not good so mines bring their own people from outside. But they are developing mining academies to develop local skills and employ local people.*

Although mandatory training within mines is being established, training is often basic and therefore limits the range of employment opportunities. However, there are still jobs created which is important for local development; the more local people can be involved in the mines, the more money goes into circulation locally; and fewer migrant labourers are needed, who are often associated with an increase in HIV/AIDS and escalating levels of crime (Williams et al., 2002; IOM, 2003).

Another exploratory focus for job creation in the district is tourism. Sekhukhune has a number of potential tourist features and places that could be developed. As mentioned in previous sections, there is high plant endemism and historically it is very rich. However, it was mentioned that land claims are slow and restrict development.

> *We are exploring tourism but it is in its infancy because of land issues. We are struggling to get land from traditional leaders for tourism.*

There are local economic development programmes that support farmers, assisting with the purchase of machinery and building support for co-operatives. Yet, market access is not necessarily improved and this limits agricultural development. Similarly, garden projects have been supported yet these are often constrained by market access and water limitations. The products are often low quality and are not value-added goods, limiting their value and demand.

Illustration 4: Man in Ga-Selala selling hand carved wooden spoons and mixers (©F. Thomalla, 2006)

Small scale project activities are seen as a means of addressing pervasive poverty issues. Projects such as brick making, poultry, bread making and car washing are fairly common in the district. Seed money is given to support projects in the early stages but they are expected to become self-sustaining. Some of these projects succeed but many fail due to the lack of continued support, both financial and otherwise (equipment, maintenance, management, etc.). Food parcels are distributed to eligible households at certain times by Social Services. Many households rely on government grants, namely pensions, child grants and disability grants (accessible in some areas to HIV+ people who have CD4 counts below a certain threshold).

Many people in the villages expressed the fact that their main source of stress was lack of income. In order to address this people migrate to find work. As one executive said,

> *The fact that people have to migrate means that the real issues have not been addressed.*

It is clear that the lack of development underlies the lack of jobs, which results in people migrating, in turn reinforcing the lack of development within the district.

Increased vulnerability to disasters has been better addressed in recent years through disaster management plans. It appears that there are now more rigorous procedures in place both to mitigate and respond to disasters. Disaster management plans have been developed and an advisory forum established that provides guidance and information on reducing disaster occurrence. The type of disasters of relevance to the area include fires around farms and within villages (increased electricity use has reduced household fires but many still use paraffin at the end of the month when there is insufficient money to pay for electricity), wind and rain destruction and disease outbreaks, for example diarrhoea (mainly linked to e-coli levels in domestic water supply) and measles. Communication is important in this regard, as some of the disaster management functions are more closely linked to the province than the municipality.

Although much is being done to address issues of poverty, one officer summed up her reservations regarding the current approach,

> *Have you seen projects that help village people? There don't seem to be projects that really help people. The majority have negative impacts. The purpose of the project is not met and when handed over they are not sustained. People are not consulted first.*

This comment really highlights the need for stakeholder participation in decision-making processes involving local activities aimed at achieving sustainable development.

Focusing on vulnerability to water, climate and health

Water

It is clear that much development relies on water. Pursuing water-intensive development such as irrigated agriculture and certain types of mining is likely to increase local vulnerability as it increases exposure to water stress. It would seem beneficial to explore alternative options that do not rely on large volumes of water and are therefore less sensitive to climate variability. This is supported by an LED officer who stated,

> *Projects are collapsing because of the challenge of water scarcity but people have to survive.*

It was mentioned by the Environmental Officer for Marble Hall that decreased water availability affects the economy because of the strain it places on agriculture. However, he stated that there are no solutions to this problem at present. One of the options is to scale down commercial agricultural operations and instead of allowing the Department of Agriculture to allocate agricultural water give DWAF control over agricultural as well as domestic water allocation. Another officer linked the decline of agriculture to the increase in water scarcity.

Groundwater was mentioned as a potential water source in a number of cases. In some areas the groundwater quality is poor. The possibility was suggested of agriculture reverting to groundwater use rather than using the supply from Loskop Dam, presently managed by the Department of Agriculture,

but there are limitations. The Flag Boshielo Dam in western Sekhukhune is primarily for the supply of potable water but is also used to supply water for agriculture. As an IDP officer explained,

> *Flag Boshielo dam is an anchor project that addresses water provision, local economic development and agriculture. It is envisaged that it will also create employment in agriculture and support subsistence farmers.*

The flagship project aims to create employment through ecotourism, agriculture and other activities at the same time as supplying water, some of which has been used to develop some small-scale irrigation projects. The dam wall is presently being raised 5m in order to increase its capacity.

At the village level, adequate access to potable water to houses is still limited. The Technical Water Services manager stated that there is a backlog of 77% to get water in the Sekhukhune villages to RDP (Reconstruction and Development Programme) level, where people have access to potable water at a distance less than 200m from their home. It is estimated that R1.6 billion is needed to address this backlog and one of the goals set out in the district strategy is that everyone should have water to RDP standard by 2008. An alarming indication of the lack of water infrastructure and availability in the area is that there are currently a number of health facilities in all of the municipalities within Sekhukhune that have tankered water brought in.

Climate

The climate is highly variable in terms of rainfall intensity, duration and frequency. Although this may seem like an important stress, it seemed that people viewed this primarily through the limited amount of water available rather than directly specifying climate as a key stressor. Rainfall variability impacts on rainfed crops. Although people grow rainfed crops, irrigated crops seem to be preferred. Yet, the lack of water availability limits irrigation. Irrigation is also limited by infrastructure and finance. One manager said that profiting from agriculture depends on the price for crops rather than climate, although these are often linked.

Drought was mentioned as a stress. Government has provided drought relief in the form of financial support for sinking boreholes, however it is uncertain how this might impact on the water table. In Greater Tubatse they have had to implement an emergency water scheme at the municipality level to address water shortages. This is a key concern, particularly if water availability changes with climate change. Addressing the water resource limits requires an adaptive management strategy, addressing supply and demand management as well as equity. Unfortunately it seems as though some people see the development of the proposed De Hoop dam as *the* solution. When asked about the limited water resources, an official replied that,

> *De Hoop dam will solve all our problems.*

Health

Health was mentioned as a concern in a number of instances, both in terms of the quality of health services and the prevalence of disease. The lack of health infrastructure is being addressed and a number of new clinics are planned, however staff retention is a problem as medical and management staff are often not willing to remain in rural areas long term.

HIV/AIDS was mentioned as a stress by many stakeholders at the municipal level, although many of them said that the full impacts were not yet being seen but they were worried about future implications. Many related the increase in HIV/AIDS to the increase in mining operations which directly impacts the health of both those working on the mines and those living in surrounding areas. One stakeholder linked increasing HIV/AIDS rates to the commercial farm trucking industry:

> *Trucks come into the area to collect fruit and produce from commercial farms and they bring in HIV/AIDS. Young women are selling their bodies and get greater 'rewards' (payment) for not using a condom.*

Interestingly, HIV/AIDS was not mentioned much at the village level. This could be due to issues of trust, where people did not want to speak about it. Responses to questions around health tended to focus on the elderly and the links between poor nutrition and poor health.

Home-based Care is operational in many villages through the Department of Health, NGOs and local organisations. In some areas carers receive remuneration but this is not standardized. Concern has been raised regarding many households being reliant on grants and this discouraging HIV+ people from getting better because of not wanting to lose their disability grant once their CD4 levels are raised. A Public Health Manager however mentioned that some disability grantees are encouraged to improve their health status by undertaking a course of anti-retrovirals (ARVs) so that they can work as home-based carers and get paid more than they would receive through a grant. Group projects have also been established to provide income generating activities for people living with HIV/AIDS. The proportion of HIV positive people receiving ARVs is however still relatively low as there are concerns around adherence to administering the full course and achieving the necessary nutritional requirements to make the drugs effective. It was mentioned that the mines and other organisations are involved in an on-going process of HIV education and awareness-raising and there are peer to peer campaigns funded by the municipalities.

5.2 Village level analysis of vulnerability to multiple stresses

At the village level, a total of seventeen individual interviews were conducted, eight in Mohlotsi and nine in Ga-Selala. A large proportion (14 out of 17) of the interviewees were women; some were household heads (9 of the 14) while others had husbands who were working outside the village. In addition to the individual interviews, gender specific focus groups were conducted with men and women in both villages. In the case of Mohlotsi these focus groups were supplemented by a mixed focus group discussion. The results of the focus group discussions have been used to provide additional supporting material for the qualitative analysis.

The analysis process consists of five steps:

1. Initial impressions and assessment of limitations and assumptions
   These were developed through the initial transcription and discussion of the interviews
2. Focus/key questions
   The key questions were generated from the aims of the research as a whole but were adapted to provide a sharper focus for the village level analysis
3. Coding to identify themes and patterns/categorisation
   Post-coding was used to allow key themes and patterns to emerge from the data, although the interests of the research project were also borne in mind during the coding process
4. Identification of patterns and connections
   The key themes were examined to look for links and pathways between them
5. Interpretation
   The data resulting from the coding and pattern identification were used to explain and understand the conditions of coping and adaptation in the study villages

There are two key questions that have driven the analysis of the qualitative interviews and focus groups at the village level. They are;

1. What are the important stresses that people are exposed to and how do they interact?
2. How do people respond to these stresses and what helps or hinders their ability to respond?

A summary of the key findings from these two questions is presented first. This summary helps to frame the issues that are then expanded on in more detail below.

What are the important stresses that people are exposed to and how do they interact?
A conceptual model of stress pathways relative to food security, as experienced by households in Mohlotsi and Ga-Selala is presented in Figure 2, based on the interviews and focus groups. It shows the complexity of the system that villagers are operating in and the multitude of stresses that people are coping with and attempting to adapt to. The majority of respondents emphasised the lack of money and jobs as the dominant stresses experienced by households. However, as the conceptual model shows, (un)employment is influenced by a number of factors or other stresses. Government investment is particularly influential through the provision of community projects, education and training. Stresses at the regional and national scales hinder investment locally so that there are few opportunities available to create local jobs. Employment stress can thus be seen as influenced and driven by stresses beyond the scope of the village and so beyond the ability of the village to solve alone.

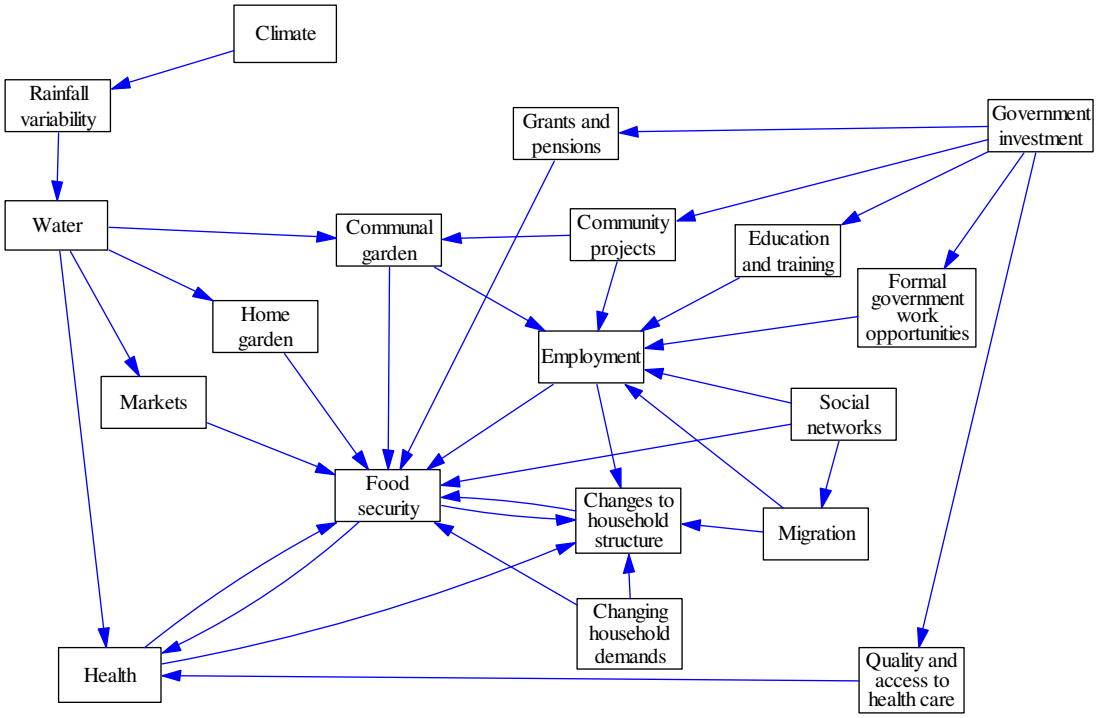

Figure 2: A conceptual model of stresses pathways relative to food security, as experienced by households in Mohlotsi and Ga-Selala.

Social networks are also a key factor in employment stress. Being part of strong social networks greatly increases the accessibility of job opportunities. These social networks not only operate locally but can extend over larger spatial scales to allow people to access work elsewhere. Good social networks are recognised by most as important but they seem to be very much based on kinship.

Water is probably the primary environmental stress and the avenue through which climate change is most directly experienced. Limited water availability has serious implications for agriculture in Mohlotsi and Ga-Selala, as well as directly impacting domestic water supplies in Ga-Selala. Limited water availability can impact on food security in a number of ways; by limiting the crops grown in communal gardens or home gardens; by causing harvest failure and in turn causing an increase in food prices; and through effects on nutrition and disease, impacting health.

How do people respond to these stresses and what helps or hinders their ability to respond?
Responses to stress are usually negotiated at the household scale resulting in a household strategy. The strategy usually consists of a range of actions, such as adjusting the household budget and migration, which are then undertaken by individuals within the household. Diversification of activities at the household level can serve to reduce vulnerability by spreading the risks (Ellis, 1998; Ellis 2000). In one example of an individual diversifying their activities in response to stress, the individual was the only adult in the household so she took on home-based care work, joined community projects, and restricted the household spending in response to a lack of employment and money. In most cases different actions are undertaken by different members of the household in order to contribute to a household strategy.

Although the lack of jobs and money are identified as the key household stresses, there are few strategies available for people to respond to these stresses directly and those that are available tend to be short term coping strategies rather than long term adaptation. Table 9 summarizes a range of coping and adaptation strategies that were mentioned during the interviews and focus group sessions. These are categorised according to whether they are long term or short term in nature, how much investment they involve and how risky they are as a response strategy, based on what people told us affects their decision-making in responding to stresses. It is interesting to note that many of the responses are aimed at increasing household income, but this is not surprising as most people mentioned lack of money as their biggest concern.

Table 9: Table showing the nature of coping and adaptation responses to various stresses

Stress	**Response/action**	**Short term (S)/ long term (L)**	**Adaptation (A) /coping (C)**	**High (H)/ Medium (M)/ Low (L) investment**	**High (H)/ medium (M)/ low (L) risk**
Money	Setup small business	L	A	H	M
	Home-based care - incentives	L	A	L	L
	Take children out of school	L/S	C	L	H
	Make handicrafts and try to sell	L/S	A	L	M
	Access grants	L	A	L	L
	Get work outside the village	L	A	H	L
	Piecework	S	C	L	L
	Casual labour	S	C	L	L
	Look for job outside village	L	A	H	H
	Sell your body	L/S	C	H	L
	Beg for food/money	S	C	L	M
Food/ Money	Buy only basic food	S	C	L	L
	Alter expenditure on food	S	C	L	L

	Buy different kinds of food	S	C	L	L
	Buy food on credit	L/S	C	M	H
	Steal	S	C	L	H
	Send children to live with other households	L	A	L	M
Food	Supplement food through home garden	L	A	M	L
	Borrow/exchange food	S	C	L	L
Water	Use borehole water for animals	L	A	L	L
	Not water garden/plot	S	C	L	L
	Collect rainwater	L/S	A	M	L
	Terrace land	L	A	M	L
	Use seeds as food	S	C	L	L
Health	Buy medicine (spend less on food)	S (L)	C	M	M
Climate	Strengthen houses	L	A	M	L
Other	Ask family member for help	S	C	L	L
	Seek district support	L	A	M	L
	Save for training/education	L	A	H	L
	Get information on training	?	?	?	L
	Undertake training	S	A	H	L
	Involvment in village project	L	A	H/L	H/L
	Initiate village project	L	A	H/M	H/L
	Volunteer for HBC	L	A/C	M	H/L
	Join catering club	L	A	M	L
	Join burial society	L	A	M	L
	Drink alcohol	S/L	C	M	H

Households will most often spend less money on food, eat less and rely on social networks during difficult times. These could be considered reasonable strategies when stresses are temporary and infrequent (Thomas et al, 2005), but these responses can lead to depletion of assets and increased vulnerability if they become a regular part of a household's livelihood strategy. Currently, the long term adaptation strategy available to limited local employment opportunities is migration. The success and sustainability of this strategy is variable and there are risks involved. Some people relocate but fail to find work, while for others the high cost of living in urban areas limits the amount of money that can be sent back to the household. However, the use of social networks can limit some of the risks by providing a place to stay, and support for the person who migrates. In general, migration is a process by which rural and urban risks become interconnected. Opportunistic movement to urban areas tends to result in the generation of urban risk, including the growth of informal settlements on marginal land, increased fire and flood risk, health concerns, eroded social networks, higher levels of unemployment and additional strain on meeting basic services. Rural adaptation strategies are therefore potentially generating enormous vulnerability elsewhere. This possibility needs to form the basis for further research.

Although responses at present are at the household level there is a strong desire for responses to be co-ordinated at the village level through community projects. These have the potential to benefit from the combined efforts of multiple actors and improved access to social, financial and material capital. Community projects also allow the risks of adopting a novel strategy to be shared, reducing the burden for individual households, potentially facilitating a transition from coping to adapting by providing more

long term strategies for dealing with stresses. There is the perception among villagers that government investment is much more likely in village level activities than those taking place at the household level. This raises the issue of dependency. Many households are dependent on government aid through grants and pensions and so government investment in community projects would not reduce the burden on the state in the short term. However, with few other sources of investment there is little option but to look for government intervention, although private investment could become more widespread. With the right investment and training, community projects at least hold the potential of becoming self sustaining in the longer term.

Impact of key stresses

Food Security

The increased dependence on local markets for food is reflected in the proportion of monthly income that is used to buy food. Of the households interviewed, many spend over half their monthly income on food and one or two use over three quarters. This means that there is very little leeway to adapt to changing prices or changing household demands. In some cases when there is not enough money people change what they buy to spend less. Many villagers do not buy meat, vegetables or fruit during hard times and rely on maize meal and flour. When only buying the basics then the quantity purchased is reduced to minimize expenditure. For some households fresh food is too expensive at most times and they rarely eat vegetables or fruit. This has serious implications for health and the link between nutrition and health was highlighted in both villages. Some people mentioned that the lack of a varied diet and reliance on processed foods is resulting in more illnesses. The perception is that in the past when people grew their own food they were healthier.

> *People ate homemade food made from sorghum and ingredients collected from the mountain so they were healthier and there was less disease around. Now people are eating sugar, beef and maize meal with chemicals added.*
>
> Sangoma from Ga-Selala

> *Food makes people sick now because it contains chemical whereas before the grandmothers used to make food.*
>
> Comment during focus group in Mohlotsi

This might also provide evidence for the desire to develop communal gardens and the persistence of some to keep their home gardens in the face of regular failure.

Social networks are important to food security in both villages. Both villages have food societies where people get together to provide help, money and food for big celebrations such as weddings and funerals. These food societies are important to a household's ability to cope during periods of greater stress. In addition family support is extremely important. Families can provide food and/or money in times of need and this network of support can extend beyond the boundaries of the village. For example, women can still turn to their families for support even if they have moved to their husband's village. Food is also borrowed and traded between neighbours and sometimes people will eat at each other's houses during difficult times with the understanding that they will reciprocate when their circumstances change.

In the recent 2006 FIVIMS survey analysis, respondents were asked who they rely on mostly in difficult times. Kinship networks appear most important as 63.1% relied on relatives in difficult times. Neighbours are approached 27.8% of the time and relatives outside the area approached 3.4% of the time. The Church is relied on by 4.5% of people and other groups including the police, businesses, social worker and the Chiefs kraal provide support at times. In terms of the type of support, money (46.4%) and the provision of food (41.6%) were the most common forms of support.

Impacts of rainfall variability on agriculture

Both villages are located in an area of high intra- and inter-annual rainfall variability, as discussed in the background section above. This means that in both villages there is uncertainty as to when and if the rains will come, the intensity of the rains and their duration. This variability in rainfall has implications for communal agriculture, home gardens and domestic water supply in both villages.

Illustration 5: Ga-Selala woman preparing morogo grown in her home garden (©Frank Thomalla, 2006)

In Mohlotsi, villagers are in the process of trying to set up a communal garden. The project developed from discussions at village committee meetings and the village headman provided land to be developed into a community garden. The land was cleared and in November 2005 a request was made to the municipality for a Caterpillar to clear the land of tree stumps, but the village is still on the waiting list. The aim of the project is to grow vegetables for sale at the market in Marble Hall and to the local hospital so as to provide an income for project members. There is the belief that with government investment a communal garden could provide an income for local people. However, there is recognition by some that rainfall variability acts as a barrier to the success of these communal gardens.

> *A (communal) vegetable garden would be good but water would be a problem*
>
> Villager from Mohlotsi

It is also recognised that climatic conditions have changed over the years and people have adapted by moving out of agriculture.

> *There used to be more people farming in the past when rainfall was better*
>
> Villager from Mohlotsi

It therefore seems unusual for people in Mohlotsi to view communal gardens as a route to a better life. However, there are two possible reasons for the positive view of communal gardens. Firstly, farming is a traditional livelihood strategy and therefore a natural choice. Secondly, there are few other opportunities for income generation in Mohlotsi and so agriculture still represents a possible option in the face of few other choices. This however could make people more vulnerable to rainfall variability and climate change with serious implications for the sustainability of their livelihoods.

In Ga-Selala there has been a communal garden scheme in the past. The scheme started in the early 2000s and finished around 2003. They received initial support from the government through the provision of a borehole, training and fencing. The project focused on the chronically poor who had previously received food parcels. The intention was that these people would be able to provide food for

themselves and reduce the need for government food parcels. The project ended because of a lack of water from the borehole and difficulties using the hand pump.

This project failure seems to provide evidence that one of the main barriers for communal garden schemes in Sekhukhune is a lack of adequate water for irrigation. Even though the project collapsed, there is still a desire in the village to restart the communal garden scheme to grow fruits and vegetables for home consumption and sale. As in Mohlotsi, this may be driven by tradition and a lack of other opportunities that overrides the failures of the past and the possibility of greater vulnerability to climate. With limited water supply, rainfall variability is also key to the success of home gardens in both villages. These water limitations lead to regular crop failure and the inability to grow enough food to feed the household even in good years, home gardens providing only a small portion of household food needs.

> *It [the plot] only yields a small amount of food and then only when it rains. This is the first year for a while that the rains have been good.*
>
> Villager from Ga-Selala

While some people try to adapt by avoiding water-demanding plants like green vegetables and growing sorghum rather than maize[1], home gardens represent a risky strategy because of the investments of time and money needed with few guarantees of a return. Both the lack of communal gardens and the high failure rate of home gardens mean that villagers are increasingly dependent on local markets for food and spend a larger proportion of their household income on food.

> *More money is available when it rains, because we get produce from our home garden and save on water bills*
>
> Villager from Mohlotsi

> *We used to grow some food but now we buy everything*
>
> Villager from Mohlotsi

This increased dependence on local markets for food means that villagers are more vulnerable not only to local drivers of price fluctuation but also to drivers at the national and international scales.

Health

While food security has implications for the health of households, illnesses or deaths in a family can have consequences for household income and expenditure and so food security. Illnesses cause extra expense in treatments and medicines which can be difficult to meet when household budgets are already stretched because of food demands.

> *My son has epilepsy and medicines are an extra expense that causes problems.*
>
> Villager from Mohlotsi

> *It would be difficult to get help or treatment if me or my children got sick.*
>
> Villager from Ga-Selala

It can be particularly difficult if the ill or deceased person is the major income earner or grantee in the family. If a source of income is lost in this way the rest of the household becomes more vulnerable, having less money to buy food. Changes to household structure are a response to the impact of changing health status, as sometimes children are sent to elderly relatives to help with household chores while others may take on the role of household head when a parent dies.

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[1] in Ga-Selala, in Mohlotsi sorghum was identified as more vulnerable to predation by birds

Another determinant of health status is the access to and quality of health care. Both villages are visited by a mobile clinic once a week, which provides treatment for a wide range of illnesses. However, in both villages the availability of medicines was an issue.

> *The mobile clinic visits us last so it doesn't always have medicines left.*
>
> Villager from Mohlotsi

> *The mobile clinic comes on a Friday, but sometimes doesn't have the right medicines. We then we have to go by taxi to the 'special' doctor in Burgersfort.*
>
> Villager from Ga-Selala

In Mohlotsi this problem is exacerbated by the lack of an indoor space for examinations. This means that when it rains ill children are not brought to see the doctor and the provision of family planning services are severely limited.

Employment

As with food security, social networks are important for accessing employment opportunities. Many of the people who participated in this study raised the issue of a lack of local jobs. Most would like to work but there are few opportunities for employment locally and getting the few jobs that are available is hindered by not knowing the right people.

> *It is difficult to get a job because you need to know someone to introduce you.*
>
> Villager from Mohlotsi

> *It is difficult for people to get work in local mines because the recruiter is from another village and so he discriminates against us.*
>
> Villager from Ga-Selala

In Ga-Selala the local mines provide an opportunity for work. The number of employment opportunities is expected to increase with the opening of planned mines. Currently, the majority of people in Ga-Selala who work on the mines seem to be from the older generation, many having migrated to Gauteng and send money home every few months.

Social networks are not just important locally. They also affect people going further afield to look for work. Social networks provide a system of support with family members and friends supplying accommodation and food while people search for work. However, the reliance on these networks means that people are restricted in where they can go to look for work. It may be that people are unable to look for work in areas where there are more opportunities because of the lack of an existing social network.

Migration is an adaptation strategy to the lack of job opportunities in the local area. Both men and, to a lesser extent, women migrate for work. Many households interviewed rely on the income of someone working elsewhere. Often this is the male household head, but there was also mention of sons and daughters migrating in order to look for work. A lack of money can however act as a barrier to poorer members of the community from accessing this strategy. Without money it is not possible to travel to places in search of work, even if there is a network to provide accommodation and food on arrival.

Some people are undertaking voluntary work. Women in both villages provide Home-based Care. Although there is some provision of incentives this is erratic at best and at worst non-existent. Despite this, women continue to provide the service. It is possible that volunteering gives women a sense of

purpose that goes someway to overcome the lack of payment, or that it gives hope that they might one day get paid for the work or the experience will lead to other paid employment. Some men are critical of volunteering, feeling that people should be paid for their time and effort.

> *We used to get hired for temporary jobs like cleaning, cutting trees and fixing roads but now we are expected to volunteer.*
>
> Comment during focus group in Mohlotsi

Community projects can be viewed as a potential adaptation strategy to the lack of local job opportunities. In both Mohlotsi and Ga-Selala the demand for community projects may well be the result of the inability of most people to get formal employment. Community projects provide alternatives whereby government investment allows local people to create their own opportunities. However, there are problems that come with community projects. In both villages communal gardens are hampered by the lack of rainfall, and investment in irrigation infrastructure by local government remains low. For both the communal garden projects and other community projects there is a self-identified lack of skills and knowledge in how to set up and manage a project so that it is sustainable, even in the short term. There is also a lack of information about where to go for help and financial assistance.

External support

External support comes from a number of sources. As previously discussed, remittances from family members who have migrated for work purposes are important to some households in Mohlotsi and Ga-Selala. In the majority of cases these remittances come from the male household heads who work outside the village, particularly in mines in the case of Ga-Selala. Based on the small sample interviewed, regular remittances from other family members are rare. Occasional remittances can come when a family is facing a particular hardship. Such as in the case with one family in Ga-Selala where a sister sent money to help out in the short term.

> *We have four sons who work in Pretoria but they all have their own families so they are not able to support us.*
>
> Villager from Ga-Selala

> *Occasionally they give us money when they come back to visit, which is about once every five months.*
>
> Villager from Ga-Selala

Government grants in the form of pensions, child and disability grants represent an important source of income for many households. Sometimes these grants are the only household income. For example, in one household in Ga-Selala eight people depend on one old age pension. In another household in Mohlotsi child grants are the main source of income. Both of these examples demonstrate how important government grants are for households, and highlight the vulnerability associated with reliance on them as the only source of income. In both cases, the households face serious hardship should the person receiving the pension die, or when the children pass the upper age limit for child grants.

There has also been considerable investment by government in both villages through the provision of pit latrines, electricity, communal water taps in Ga-Selala, water supply to each stand in Mohlotsi, and RDP housing in Ga-Selala[2]. However, there is a feeling among many people who took part in this study that there is not enough investment in development programmes that provide job opportunities. Only one respondent in Ga-Selala mentioned the opportunities for temporary work provided by these government interventions.

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[2] In Mohlotsi foundations for RDP housing have been laid but the houses have yet to be built

> *These projects [toilets and RDP housing] can bring job opportunities for the people in the village but not for me. The choice is made randomly by pulling names out of a hat in order to make it fair and I haven't been lucky.*
>
> Villager from Ga-Selala

Both villages demonstrated a willingness to be involved in community projects. Mohlotsi is particularly organised, having established committees for three community projects. However, none of their community projects are functioning because of a lack of money for start-up costs and a lack of business and management skills. In Ga-Selala there are currently no government-supported community projects or plans to set any up but many mentioned community projects as a way in which government should invest in the village to improve employment opportunities.

Education and Training

Education and training are valued in both communities. Parents place a high value on education for their children and almost all children in both villages seem to be at school.

> *I'm planning to save my pension money for my children's education.*
>
> Villager from Mohlotsi

> *It is necessary for children to get a better education in order to get better jobs.*
>
> Villager from Ga-Selala

Although education is recognised as important for future employability, many school leavers in both villages are unemployed and feel they have few prospects. It seems likely that if this situation continues the value of education may decrease.

The current situation suggests failure in three areas, namely:

1. There is a failure in the employment system, which means that there are too few jobs in rural areas and too few opportunities for young people to access employment elsewhere.
2. There is the question of whether the education system is providing young people with the skills they need, particularly in business and management, which they could use to overcome these constraints through entrepreneurship.
3. There is a failure of employment opportunity information transfer. Young people feel that they do not know where and in which sectors they should be looking for work or who to get in contact with in this regard.

Illustration 6: Two young men in Mohlotsi with the donkey cart they operate as a small business (©Frank Thomalla, 2006)

For those who have left school there is still the perception that skills are lacking, especially in the business and management skills necessary for community projects. Few people have the money to develop these skills and there are limited opportunities to access training. This links back to the desire for greater government investment. Many respondents want the government to provide opportunities to develop the skills they need. There was one dissenting voice in Mohlotsi who argued that people need to do much more for themselves.

> *They need to work together to get things happening and make the situation better for themselves. They need to organise things and then get the government, municipality or chief to help. The problem is that they might talk together but then everyone goes back to their own place and nothing gets done.*
>
> Comment during focus group in Mohlotsi

Changes improving conditions and worsening stresses

Respondents in both villages are aware of changes in the climate. In both Mohlotsi and Ga-Selala many feel that the climate is changing in a way that makes life more difficult, with less rain and hotter temperatures.

> *It has become hotter and there is less rain.*
>
> Villager from Mohlotsi

> *The main changes since I was young are that there are now hotter temperatures and more scarce rainfall. Seasonal variation is increasing and the timing of the rainfall is changing.*
>
> Villager from Ga-Selala

Others did not identify the change so much as highlight that current conditions are not good, particularly for agriculture. This is probably a reflection of the different timescales at which people think about the climate. Being aware of these changes or the limitations of current conditions does not necessarily mean that villagers change their livelihood strategies to cope or adapt. The recognition of poor conditions for water-intensive agriculture would suggest that people might want to move away

from reliance on such activities. That certainly seems to be the case for many young people who attended the focus group meetings in Mohlotsi. At the same time there are people who want to move into agriculture through community garden projects and larger commercial ventures. It may be that a lack of jobs and money are such pressing concerns that changing activities to adapt to climate change is low down on the agenda. It may also be a matter of not having access to information on the extent of the need for change and how best to do it.

In Ga-Selala there is the perception among some villagers that general health has become worse. As discussed previously, the deterioration in health has been linked to poorer diets and a reliance on processed food stuffs. Others do not identify nutrition as a cause of ill health but are aware of more young people dying, although they were unable, or unwilling, to identify the causes. It is possible that HIV/AIDS may be playing a part in these deaths but without the time to build trust with villagers it is not possible at this stage to determine the possible causes.

Although many feel that health and climate conditions have deteriorated, in general people feel that many things have improved. The provision of basic services such as piped water and electricity was widely mentioned as having improved standards of living.

5.3 Results from the stated preference questionnaire and the discrete choice analysis

This section presents and discusses the results of the survey undertaken in Ga-Selala. Details of the methodology and survey process are presented in the previous Methodology section. Basic statistics of socio-economic characteristics are presented in the first section followed by the results of the discrete choice analysis.

A total of 100 people in Ga-Selala village responded to the questionnaire. Not all questions were filled in adequately in every questionnaire, so the number of actual responses is mentioned in each section where necessary. The numbers that appear in brackets show the number of respondents in each particular category, e.g. home-based care (22), communal garden (16), etc.

Basic statistics: potential work, education, and support

Work outside of the village: Of the 96 people that responded to the question about trying to get work outside the village, 63 people mentioned that they would choose to seek work in the mining sector, of which 12 mentioned a specific mining company for which they would like to work, e.g. Marula Platinum Mine (3), Johannesburg Platinum Mine (1), etc. From information gained in the group interviews, people tend to look for a job where their friends and relatives are already working so these location specific answers may be an indication that they have already identified potential work due to their social networks. Some responses included a particular geographical location, the most common being Limpopo (21) including Burgersfort (5), followed by Johannesburg (6). This indicates that many people still prefer to work within the province as opposed to moving to the Greater Johannesburg area, often thought to be the preferred place to migrate to, due to perceived employment opportunities.

Work in the village on a communal project: 92 people responded to the question about getting involved in a potential new communal project within the village. The most popular project was Home-based Care (22), followed by poultry farming (17), communal garden (16), plumbing / water (14), and sewing (6). The results largely mirror the information gained during interviews. However, it was

surprising that only two people mentioned contract projects (e.g. brick making) and no one mentioned pottery projects, one of which is already being undertaken in Ga-Selala.

Education at ones' own cost: 89 people responded to the question about potential education obtained at ones' own cost. Sewing (13), computer (12) and technician/ engineering/ mining (12) are the most popular skills they would choose to gain at their own cost. These are followed by business and finance (8), farming (7), and policing (5). Many of these desired skills match the responses to questions about employment and being involved in a communal project. Mechanical skills are useful for getting a job with a mining company, while sewing and farming skills will be useful for establishing a successful village project. However, some responses regarding education do not match with jobs mentioned above. For example, Home-based Care was the most popular of the communal projects; however, only three people mentioned a desire to gain related skills such as nursing and being a care worker. Similarly, skills related to computing, business and finance may seem not directly relevant to some of the stated activities such as mining, but perhaps these people are identifying business, management and administrative opportunities in mines and elsewhere. For example, of the eight people who wish to learn business skills, seven people mentioned that they would like to work for a mining company. However, in some instances, people may not find employment opportunities using skills they have gained. This might be a reason why the previous FIVIMS research found that people in the rural areas of Sekhukhune have begun to place less importance on education, which is supported by the qualitative evidence as well. Further research could explore the role of education further, and what opportunities it does support versus the cost.

Contact person for district support: 85 people responded to the question about a potential/actual person they would contact to request support. If an answer was a specific name, the response was omitted since the position of the person was not clear. The level of organization/institution they would contact to ask for support is summarised in Table 10. While 50 people responded with someone at the district level, more than a third of people said they would contact people at other levels, such as village leaders and local municipality officials. The specific people most frequently mentioned were the district mayor (28) and the local counsellor (15). The village chief (3) was not as popular as expected.

Table 10: Organisational/institutional level they would contact to ask for support

Level	no. response	e.g.
Higher	8	president, home affairs
District	50	district municipality, mayor
Municipality	20	counsellor, local government
Village level	3	Chief Salala, village chief

Basic statistics: current socio-economic characteristics

Maize prices: 98 people responded to the question about the maize price and the size of the package they purchased last time. Nine out of 98 could not remember the price of the maize package they had purchased, or chose not to answer that part of the question. The majority of respondents bought either a 50kg (24) or 80kg (70) sack of maize and the distribution of maize prices varied around a mean of R140.40 and R229.50, respectively (Figure 3) (7 South African Rands ~$1).

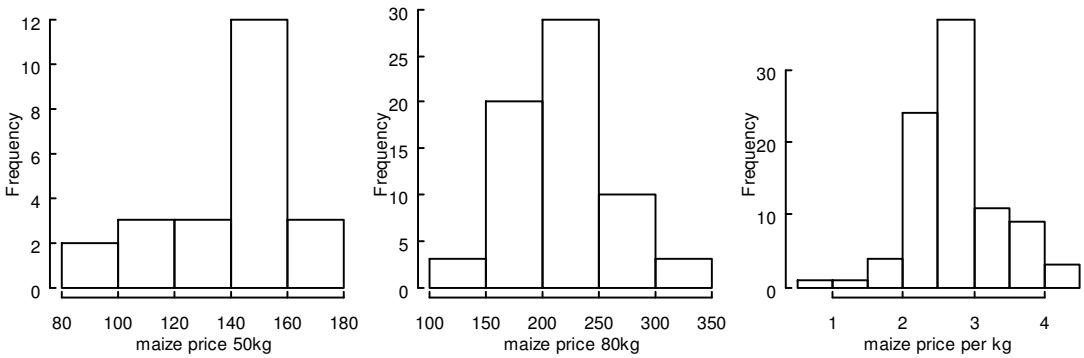

Figure 3: Histograms of maize price (ZA Rand)

The variance / mean ratios for the price of these packages are 4.53 and 9.87, which means the variances are more than 4 and 9 times wider than their mean values. Considering there are not many shops around the village, the variability is large. Village people may not remember the prices of maize as accurately as we expected from the interviews. Otherwise, the variation may be real since some people preferred to, or were only able to, buy maize from the vans, which brought maize from the larger towns to sell at higher prices in the village. Multiple data are required to confirm the price variation.

Distance from a communal tap: There are six communal taps in Ga-Selala and respondents were asked the distance to one of the communal taps in terms of walking minutes. 45 people responded to the question. Five people live within the 1-minute-walking distance from a tap, 32 people live within a ten-minute-walking distance, only four people live outside of the 30-minute-walking range (Figure 4). During the field work, we met a person who lives a long distance from a tap water; therefore, 30-minutes walking range is still realistic. However, it is not necessarily the case that these people use the communal taps. The aforementioned person said that she used a well instead of a communal tap since the communal tap was located too far from her home.

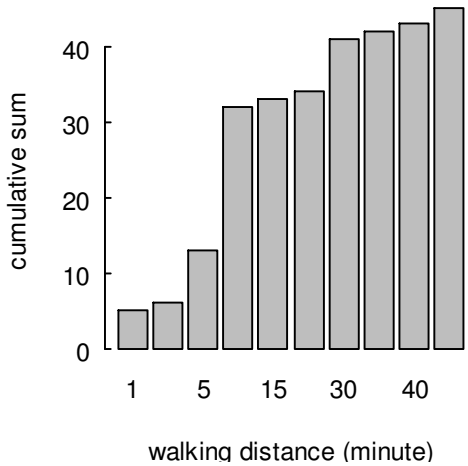

Figure 4: Cumulative sum of the number of respondents who fall within a certain walking range (measured in minutes) from a communal tap

Income: 58 out of 66 respondents answered that they do not have any household income. Initially, this might appear to imply that only eight respondents' households receive income from employment, remittances or grants, which is a low proportion. What is more likely is that respondents considered income and grants separately. Moreover, the low employment rate may confirm that the survey was potentially biased toward unemployed people as workers would not have been able to attend the survey meeting because of the timing (weekday morning).

Societies: The most popular social group is a burial society (35), which is followed by church (22), savings club (16), home-based care (14), agricultural group (13), and craft activity group (9). This trend was expected from the interviews, i.e. burial society, church, and savings club were repeatedly mentioned. It is unclear what kind of agricultural groups these 13 respondents belong to since no communal garden or poultry projects were to our knowledge currently in existence in the village, but they could be involved in agriculture outside the village.

Communication methods: 27 people either did not respond to the question about communication methods or do not use any method. Mobile phones (44) and public phones (42) are equally popular communication methods compared to post (24) and land phones (12). Moreover, a public phone is more popular than a mobile phone for unemployed people. Out of 58 unemployed respondents, 28 use and 30 do not use a public phone. In contrast, 23 use and 35 do not use a mobile phone. 43 respondents use only one communication method while 14, 9, and 6 respondents used two, three and all communication methods, respectively. Moreover, there are significant trends between the types and the number of communication methods used. For example, 55% and 38% of people, who use a mobile phone and a public phone respectively, use these as their only methods of communication. In contrast, only 8% of people who use post and land phones do not use any other methods. This means that post and land phones are more likely to be the secondary communication method in the village. These features are statistically proved by Fisher Exact Tests. The test compares two communication methods with regards to the number of communication methods they possess, i.e. only one method or more than one method. A p-value of 0.13 shows that the effect of having an alternative communication tool is the same between mobile phone users and public phone users. In contrast, a p-value of below 0.01 shows that the effect of having an alternative communication tool is not the same between mobile phone users and post service users. The trend is the same between mobile phone users and land phone users.

Home garden: 69 people responded to the question of whether they possess a home garden or not. 41 respondents answered that they had a home garden and 28 said they did not. The result shows that a respondent with a garden is more likely to participate in an agricultural group (seven out of 28), compared with one without a garden (two out of 41). A Fisher Exact Test supports this trend rendering a p-value of 0.03. Based on Fisher Exact Tests, no connection is found between the possession of a home garden, the distance to a communal tap and the plan for a communal garden. The lack of relationship between the existence of a home garden and the distance to a communal tap might be explained by comments heard in the women's focus group that a decision had been taken by the community that due to the scarcity of water in the village people would not use tap water to water their plants.

Choice analysis on adaptation strategies

Originally, three hypothetical factors namely drought, maize price, and sickness period were designed to be included in the analysis. However, no two factors together got any significant result simultaneously at the 5% level, i.e. no multiple stressing factors. Sickness period on its own was not significant in any strategy. Neither did any socio-economic factor, such as distance to a communal tap, get a significant result. Drought and maize price were statistically significant in some strategies. Therefore, each utility

function has only one slope coefficient. For example, the observed utility functions for each strategy against a drought are:

$$\text{Use a strategy: } V^1_i = \beta^D(\text{Drought}) \quad (1)$$

$$\text{Not use a strategy: } V^0_i = \alpha^0 \quad (2)$$

The drought is a categorical factor so that if there is currently drought, the value is 1; otherwise it is 0. The observed utility functions with maize price are similar to the ones above, but the maize price is a continuous factor. The α parameter is the Alternative Specific Constant (ASC). A positive α means that respondents prefer not to use a strategy if the other factor null, i.e. they prefer to avoid using the strategy. Ultimately, the probability of a strategy choice is calculated with the utility functions:

$$P(\text{Use a strategy}) = \exp(U^1_i) / \exp(U^1_i) + \exp(U^0_i) \quad (3)$$

U^1_i is unobserved utility including an error term, i.e. $U_i = V_i + \varepsilon_i$. Moreover, the absolute values of the utilities do not have any meaning. The utility of a function has a meaning only when it is compared with another utility.

Drought

The results of a logit model showed significant results in the strategies: 'borrow food', 'contact district', and 'try to access a grant' against the current occurrence of drought (Table 11).

Table 11: Binary logit model for the strategy choice with drought

Strategy	Not drought (α)			Drought (β)		
	Est.	Robust Std. Error	Robust t-value	Est.	Robust Std. Error	Robust t-value
Borrow food	0.31	0.13	2.47	0.59	0.16	3.64
Contact district	-0.44	0.13	-3.45	0.65	0.17	3.79
Try to access grant	-0.70	0.13	-5.35	0.67	0.18	3.65

Number of observations = 650

Robust t-values show the statistical significance of all six parameters. The actual values do not have much meaning since it does not represent units of money or time. However, the positive values in β show that respondents are more likely to use these strategies during drought. The signs of α show that respondents generally feel negative or find it difficult to borrow food, but they feel positive about contacting district or trying to access grant. The probability of the use of these three strategies was calculated based on equation (3). Amongst the three strategies, 'try to access to a grant' is most popular (Figure 5). Regardless of drought, more than 67% of people try to access a grant, but the probability increases to 80% during a drought. 'Contact district' and 'borrow food' are generally less popular than 'try to access to a grant'; however, the change in the probabilities of usage from 'not drought' to 'drought' increases by similar magnitude, i.e. 0.13, 0.14, 0.15, from left to right in Figure 5.

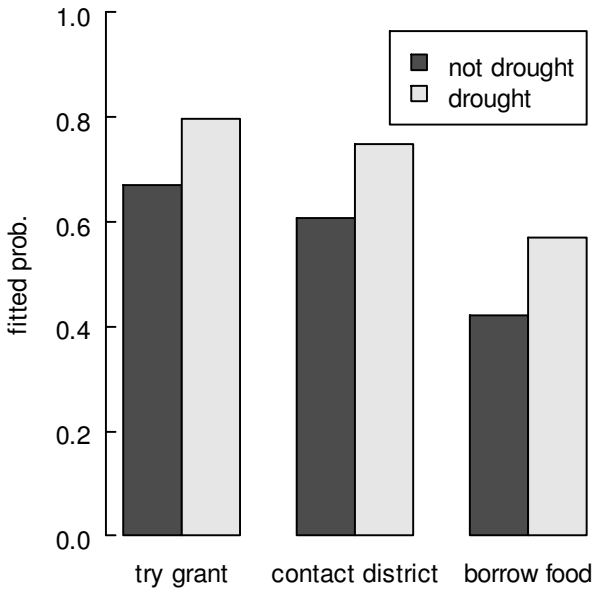

Figure 5: Probability of three strategies used when experiencing a drought

Maize price

The strategy 'eating elsewhere' is significantly affected by the maize price (Table 12). The change in the maize price is calculated based on the maize price and the size of package they purchased last time. The positive β means that respondents are more likely to eat elsewhere when maize price increases. Also, the positive α means that they generally feel negative or find it difficult to eat elsewhere.

Table 12: Binary logit model for the strategy choice with maize price

Strategy	Not adopt the strategy (α)			Maize price / package (β)		
	Est.	Robust Std. Error	Robust t-value	Est.	Robust Std. Error	Robust t-value
Eat elsewhere	1.89	0.34	5.61	0.003	0.001	2.29

Number of observations = 600

After converting the maize price to the price per kg based on the last package they purchased, the strategy of eating less preferred food got a significant value (Table 13). The positive β means that respondents are more likely to eat less preferred food when maize price increases. Also, the positive α means that they feel generally negative or find it difficult to eat less preferred food. Moreover, the price change per kg is a more logical unit to compare prices, but people may consider only the price change per package, so it is important to investigate this issue in any future research.

Table 13: Binary logit model for the strategy choice with maize price per Kg

Strategy	Not (α)	Maize price / kg (β)

	Est.	Robust Std. Error	Robust t-value	Est.	Robust Std. Error	Robust t-value
Eat less preferred food	1.03	0.33	3.09	0.28	0.11	2.53

Number of observations = 600

Probabilities of these two strategies being used against the change in a maize price are presented in Figure 6. The range of maize price for 'eat elsewhere' is the same as the range in the stated preference questions since the maize price is per package, i.e. -40:40. The price range for 'eat less preferred food' is divided by the mid point of popular maize packages such as 50 and 80kg, i.e. (-40:40) / 65.

The probabilities of use of the two strategies increases as the price of maize increases. 'Eat less preferred food' is more popular than 'eat elsewhere' since the probabilities of the usages are 26% and 13% at the current price respectively ('0' point in Figure 6). Also, 'eat less preferred food' is more sensitive to the maize price. When maize price per package is increased by R40, only 1.5% more people choose to 'eat elsewhere'. In contrast, 2.48% (80kg package) or 4.6% (50kg package) more people choose to 'eat less preferred food' in the same scenario. Overall, the maize price is less sensitive than drought according to the change in the probabilities.

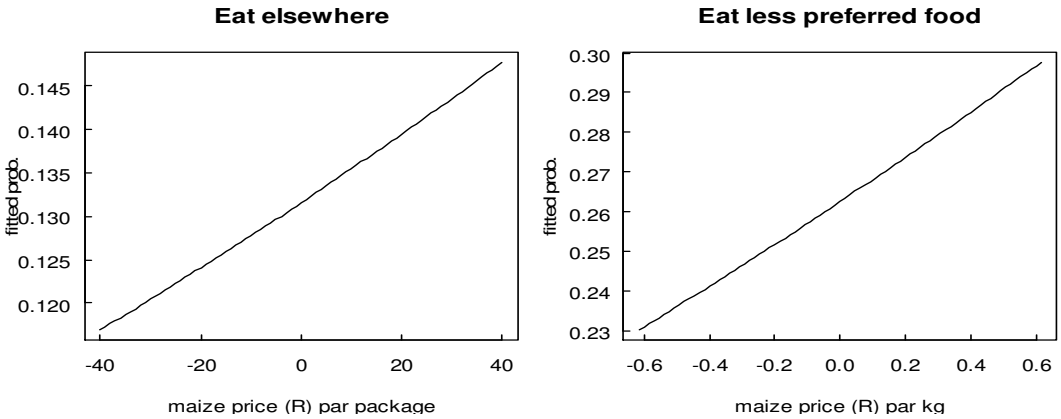

Figure 6: Probability of two strategies used with maize price

Key findings and suggestions regarding future survey and analysis

The descriptive statistics show that many people are keen to work in the mining sector and if possible they prefer to work within their home district. Engagement in a communal garden project is not as popular as expected. The preference of education fits well with employment choices within and outside the village; however, there are also some matching trends that do not correspond. Maize prices seem to vary considerably regardless of package size and 50kg and 80kg sacks are the most popular. The membership of societies/social groups matches the impression gained from village interviews. Mobile and public phones were more popular than post and land phone and the former two were considered as the primary communication method. Almost 2/3 of respondents had a home garden and those people were more likely to participate in an agricultural group.

The discrete choice analysis demonstrates that drought and maize price could be factors in choosing some adaptation and coping strategies. Generally, drought has a stronger effect and affects long term strategies such as 'try to access a grant' and 'contact district'. Maize prices affect more short term or

food related strategies, such as 'eat elsewhere' and 'eat less preferred food'. These findings have implications for addressing food security responses and climate adaptation support.

Utility of choice analysis approach

Although this research found some significant results it was at a pilot survey level, therefore one has to be careful when drawing conclusions from this study without further research. The complex research situation affects the quality of data and consequently the results of the analysis. The summary of the socio-economic characteristics largely supports the findings of qualitative interviews, but there is some conflict between the two sets of results. For example, the seemingly strong desire to establish a communal garden as investigated during the intensive individual interviews and focus groups did not emerge as a strongly favoured activity in the quantitative results.

Some of the problems associated with this survey are due to the high levels of illiteracy, the format and the length of the questionnaire, and could be eliminated if repeated. The question about the location of work should be sub-divided into a geographical location and type of job. It would also be useful for there to be strategy ID numbers labelling questions and responses that would make it easier for a translator to refer to when engaging with the respondents. The list of strategies and some socio-economic characteristics such as gender and age were presented as a table and this format may have been too complicated for many people. More importantly, the questionnaire did not have 'no' tick boxes, which meant in some cases, it was difficult to distinguish a 'no' answer from a non-response. This problem possibly created extra 'no' answers, which may be the reason why most strategies did not get any significant results, i.e. extra 'no' responses may increase the region of false negatives or a Beta error.

Some respondents mentioned that the questionnaire was too long. Ten out of 100 respondents seemed to stop answering stated preference questions before completing half of the questions. The total number of strategies could have been too many for some people. With the results of this pilot survey and the qualitative analysis, future research should be focused on only a few strategies to reduce the length of the questionnaire.

Lastly, due to the high illiteracy rate, it may be better to give up a pen-and-paper approach to data collection. A small play was conducted before this survey and this attracted a lot of attention. If the length of the questionnaire was shortened, it may be possible to conduct this kind of play for all the questions and then get people to raise their hand for different strategies they would employ, and a researcher could record these responses instead of asking people to tick a box on a questionnaire. This could however lead to group pressure affecting responses. Despite the challenges of doing the quantitative survey, it could be improved on and is valuable to use in gathering quantitative data from a large number of people quickly. This should then be followed up with further individual and focus group qualitative discussions.

6. IMPLICATIONS FOR ADAPTATION TO MULTIPLE STRESSES

An overview of both the village-based qualitative and quantitative data and the district level data enables us to draw certain lessons on adaptation to multiple stresses in Sekhukhune.

Adaptation to climate variability and change

Although we were interested in adaptation to climate variability and change, current climate variability did not appear as a key stress immediately. However, the impact of water stress emerged as one of the most significant stresses at all levels (village, local municipality and district). Water resources are directly impacted by current climate variability and it is expected that climate change could impact resources

significantly (Arnell, 1999; Schulze and Tyson, 1997; Schulze, 2005; de Wit and Stankiewicz, 2006). Therefore, focusing on water resource management options would be a priority for addressing adaptation to climate change. This is supported by the Premier of Limpopo, Mr. Moloto, who was recently quoted as saying,

> *Climatic change is not something we can stop. Limpopo is a province of extremes, swinging between drought and flood. But this new drier future is a whole new thing. ..We cannot just sit and wait for it to arrive. The government is proactively and aggressively driving new policies to stretch every drop of water we have as far as possible.* (Mail and Guardian, 2006)

In Sekhukhune it is clear that adaptation to climate change could be best supported by focusing on adaptation in the water sector. What also emerged, is that focusing on small projects at the village level, might not be the best approach to supporting adaptation if it is expected that climate change will be widespread and therefore impact large areas covering multiple villages where once-off projects to cope with climate change will not be enough. Approaches to supporting adaptation to climate change could therefore benefit from engaging with institutions at the municipal and district level. This research highlighted the need for an improved understanding of issues related to governance and institutions, such as the relations between traditional and elected leaders and the need for participation in government decisions of direct consequence to local people. This lesson can be applied more broadly, as much research on adaptation to climate change has tended to focus on local projects or national priorities. Yet, as this research shows, much implementation of policy and support for vulnerable groups happens at the district level. Understanding local governance issues is therefore necessary to facilitate adaptation action and success. This is an area that requires increased research in order to better understand how climate change adaptation might be supported; increasing local government capacity to plan with climate variability and change in mind.

Although this research did not focus on agriculture as employment, although it did explore the role of community gardens, there are large scale commercial farming operations, agricultural schemes, smallholder farmers and livestock husbandry in Sekhukhune. These could benefit from exploring ways of better adapting to current climate variability and future change. Much of this change would be related to water saving but additional actions, such as changing varieties, irrigation scheduling and alternative management and marketing options could be further explored.

6.1 Adaptation in the water sector at the district and provincial scale

Given that water limitations restrict district development and impact on the livelihoods and vulnerability of many people, adaptation within this sector should be a priority. The first type of adaptation in response to increased water stress is to reduce current demands. South Africa is a water-stressed country which has resulted in exploration of ways to reduce water demand and measures have been taken at a national level to support this, with a move to supply-driven approaches. Activities that help conserve water at the local level including gutters, rainwater harvesting tanks, stricter planning regulations and a drive to help industry develop new appropriate technologies that are more water efficient, are being explored in Limpopo (Mail and Guardian, 2006). Yet, these ideas were not put forward by local people and so perhaps this emphasises the need to improve communication and skills on these issues so that there can be adaptation by local people as well as at the policy level. At the broader district and provincial level decisions are being made between the prioritisation of mining and agriculture. An understanding of current climate variability and future climate change might help inform these decisions.

The second type of adaptation could be to pursue activities that are not water intensive. Government stakeholders mentioned that tourism is being pursued as an important sector to contribute to the economic development of Sekhukhune. Although luxury tourism has water demands, these may be

small compared to current activities. If natural vegetation is encouraged to regenerate, then natural climate variability is not an extreme threat; although, if game is introduced, the impact of drought will be felt on rangeland quality and environmental and animal health. While developing the tourism industry might bring increased revenue, the actual jobs created might be limited.

Commercial agriculture, including cotton, citrus, grapes and other crops, exists in the south west of the district and is highly dependent on water and rainfall availability. Therefore adaptation within the agriculture sector needs to explore ways of adapting to potential change in rainfall and water availability. This industry brings money into the district but is highly water intensive. Most of the farms remain under the ownership of previously privileged white farmers, although there are a growing number owned and managed by black farmers. The large farms provide seasonal employment for many. However, as mentioned by a respondent in Mohlotsi, this seasonal work is erratic as the number of workers needed fluctuates intra- and inter-annually, and those given work varies indiscriminately because few skills are needed. One of the officials involved in water resource management mentioned that, as a district, they were considering reducing the amount of water allocated to commercial agriculture and diverting it for domestic use so that more villages can receive reticulated water, in places where there are currently standpipes but not piped water to peoples' houses.

Mining, an important sector in Sekhukhune, is expected to grow in the future and with it water demand. Mining has the potential to generate large amounts of money and potential employment opportunities. It is critical to assess how this profit is distributed and used and who gets access to jobs. If the province invests the profits back into the local economy, long term benefits can be established such as improving schooling and health systems. If the money is not reinvested then locals perhaps stand to benefit in the short-term but not in the long term. Although mining brings jobs, through our interviews it became apparent that these jobs do not always go to local applicants. Many go to those with previous mining experience, often those that have been employed by the mining company in mines elsewhere in the country. Local politics are an additional challenge. Ga-Selala members stated that their chief was not favoured by the mining employers, limiting their access to jobs. In addition, the mines are likely to result in higher HIV prevalence rates which have significant social and economic costs. It is therefore important that water allocation employs the precautionary principle to protect the rural poor from adverse effects of (the expansion of) the mining industry, as has been suggested in relation to the sugar industry in the adjacent Inkomati basin (MXA, 2006). At the same time, domestic water demands need to be carefully balanced with other development needs.

6.2 Adaptation in the water sector at the household scale

Small-scale agriculture is not viable in many parts of Sekhukhune where it is relatively dry. In parts of Sekhukhune though, households have plots of rain-fed crops and there are a number of government funded irrigation-schemes across the district. In many instances, irrigation projects have failed. Yet, in both villages where we conducted in-depth research, there was the desire to establish new irrigation schemes and farming projects, although the stated preference questionnaire in Ga-Selala indicated that the actual number of people who were interested was relatively low (poultry farming, 17 and communal garden, 16 out of 92). Constraints were mentioned by villagers about infrastructure and access to water. They also mentioned access to relevant knowledge about farming and marketing as a constraint. The possibility exists of adopting water-saving technologies and continuing to pursue agricultural activities although the impact on and constraints from regional water supply need to be considered. It is likely that these decisions will not be driven by the local level, but rather provincial level. What is clear is that reduced agricultural activities should be supported by alternative livelihood options.

Home gardens are another interesting phenomenon. Many of the households we visited for interviews, had a small patch where they appeared to be growing some produce. In Mohlotsi, where houses have

piped water, people mentioned that water was too expensive to use for agriculture. Yet some of these households had gardens where some produce was growing, fed primarily by the rain. In Ga-Selala, where conditions were drier than Mohlotsi, there appeared to be many small fenced garden sections adjacent to the houses. The people here said that they were not able to water their home gardens as there was already high stress on the standpipes for domestic water and the added use of this water source for home gardens resulted in the water running dry too frequently. Home gardens are supported as a means to address food security in the Integrated Food and Nutrition Security Programme (Department of Agriculture, 2002), therefore they need to be carefully examined in terms of their vulnerability to climate variability and change.

It is clear that there are different scales and actions involved in responding to changing water stress. Adaptation to climate change in Sekhukhune will therefore be best addressed through an integrated approach that focuses on adapting to increasing water stress. Although it has been recognised that climate change is impacting water resources and associated development, adaptation planning has not been undertaken with explicit recognition of the nature of climate change. This is an urgent priority and climate adaptation policy is needed to support this goal.

6.3 Difference in perceived stresses at different scales

One of the objectives of this study was to ascertain how different groups perceive stresses and the optimal response to these stresses. Perspectives from the village and municipal levels are compared here as a start to this assessment. It is recognised that a number of factors have to be taken into account when comparing these perspectives as people fill a number of different roles and variations in perspective are not simply due to issues of scale. The similarities and the differences in the identification of key stresses are summarised in table 14 and discussed below.

Table 14: Stakeholder-identified key challenges, current coping strategies and potential solutions at village, municipal and district level

	Village						Municipal and district government		
	Mohlotsi			Ga-Selala					
	Key challenges	Current coping strategies	Potential future solutions	Challenges	Current coping strategies	Potential future solutions	Challenges	Current coping strategies	Potential future solutions
Lack of basic services									
				poor road quality constraints goods transport			lack of water, sanitation, electricity, roads	provision of RDP housing, electricity, pit latrines and water	
Poverty and food insecurity									
	Lack of money & food	See Table 9 for household coping & adaptation strategies		Lack of money & food	See Table 9 for household coping & adaptation strategies			state pensions, child grants and disability grants	
Lack of employment opportunities									
	Lack of employment opportunities in the village and surrounding areas	creation of community projects: brickmaking, poultry, and community garden (failed)	generation of employment within the village, encouragement of business enterprise support for development initiatives, coordination of skills, training and opportunities	lack of contacts to access employment opportunities in the surrounding mines, lack of employment opportunities in the village	creation of community projects: community garden (failed)	improved regulation of recruitment procedures in the mining sector to ensure equal opportunities,	high unemployment, limited, employment opportunities,	limited support for community projects, investment in regional economic development nodes	expansion of mining activities and related secondary industries and services, support of the growth of secondary industries: processing of raw materials and manufacturing, investment in tourism activities
Challenging climatic conditions									
	high rainfall variability, increasing drought, increasing temperatures,		installation of irrigation systems, use of drought resistant crop varieties,	high rainfall variability, increasing drought, increasing temperatures,		transition to less agriculturally based livelihoods			

Water scarcity									
				irrigation not feasible due to limited groundwater availability, temporary drinking water shortages					Increase dam capacity to capture more water
Lack of skills									
	Lack of management, business and farming skills	support children to complete primary education, save money for further education and training	skills training for community garden and poultry scheme, skills training on how to start up and manage a business (e.g. how to apply for bank accounts, loans, etc.)	lack of opportunities for further education in electronics, welding, construction, hair dressing and general business management skills	support children to complete primary education, save money for further education and training	provision of education and skills training that matches regional development goals, use of existing colleges in the area to provide the necessary training, provision of financial support to villagers for further education	lack of skills to undertake income-generating activities or to engage in regional employment opportunities, high reliance on outside support and expertise, lack of skills within municipal govt. requires recruitment from outside the district		capacity building within communities to participate in and benefit from regional growth
Lack of knowledge									
	unawareness of potential sources of support and advice for community projects, the nature of support available, and the appropriate contact points		better information about the roles and responsibilities for community projects and services of villagers, the village head and the municipal and district authorities, better information about support, realistic and feasible technical support and business and financial advice				lack of communication between the public and government, poor coordination across different of government levels and departments, mismatch between village and government of vision, priorities and expectations, local officials not given sufficient authority and info., national officials expect more input from local level	restructuring of institutions, redefinition of the role of the district,	deliver better services, improve skills development support income-generating opportunities, better information to villagers how to proactively seek support from government

At the village level (through individual interviews, focus groups and questionnaires), it emerged that lack of jobs were the greatest concern. This was directly related to lack of income. Many associated the stress of lack of jobs and income with limited food supply. This is supported by the FIVIMS-ZA livelihood survey, where most households (over 90%) spent the largest proportion of money on food, averaging around 40% of their total household income (Drimie and Ziervogel, 2006). People relied heavily on purchased food, as production was limited by lack of access to land, agricultural inputs and other assets. Consequently, purchased food left people exposed to inflation and price shocks. As was evident in our stated preference questionnaire, an increase in maize price directly affected people's coping strategies, such as an increase in 'eating elsewhere' for example. This is important to recognise when monitoring and addressing food insecurity.

The link between food and health emerged as important. Many stated that poor food diversity could be linked to the prevalence of poor health. There was specific reference to how diets have changed since their 'grandmothers' day, the diversity and wholesomeness of food having reduced, leading to poor health. In the two villages where intensive fieldwork was undertaken, HIV/AIDS was not mentioned as one of the more important stresses, despite being recognised as an enormous concern at the district level. As mentioned before, this may be attributable to issues of trust between village respondents and researchers, and concerns around HIV stigma.

Water stress was prioritised in both Mohlotsi and Ga-Selala. In Ga-Selala, where there are standpipes, water stress applies to both domestic use and agriculture. In Mohlotsi, where households receive reticulated water, water is still a stress as it limits agricultural production and other economic activities, such as brickmaking.

Environmental concerns were mentioned in relation to land quality and rainfall. Erosion was a concern in Mohlotsi, especially after heavy rainfall and this degradation was seen to impact on soil quality.

Income received from family members working locally or further a field as well as various grants were mentioned as important means for alleviating stress. Villagers highlighted their desire for increasing their skills and training, but expressed that they were not aware of many opportunities. They expect public rather than private support for economic and agricultural initiatives and rely on the government to provide more opportunities for employment, training, basic services and village-level support.

In contrast, municipal stakeholders recognise the need to reduce unemployment, addressing this through public works programmes and changes in IDP activities to include local training opportunities. This does not reach all villagers and it is therefore not surprising that villagers feel this need is not being adequately addressed. They also highlighted water stress in terms of bulk domestic supply and provision of water for agriculture. Small weak markets are recognised as a limitation to development within the district. Projects require alternative support to simply providing start up capital, if they are to be sustainable. Associated with unemployment, there is recognition of high levels of poverty in Sekhukhune. Other poverty reduction challenges identified by municipal authorities include limited access to land, poor communication between different government stakeholders, and increasing HIV/AIDS rates in the district. Health services are currently stressed and nutrition standards often not high enough. An increase in HIV/AIDS impacts is likely to worsen the situation.

The lack of skills and capacity is not just a problem at the village level but also affects government functioning. Limited skills in the district mean that people often have to be brought in from elsewhere. Living in Sekhukhune is not considered desirable by some and consequently there is a high staff turnover within government institutions. This has a negative effect on the efficiency and sustainability of government activities and coordination.

Figure 7, below, is a graphical representation of what aspects of stress, and factors affecting stress, are identified at different spatial scales, indicating the pathways through which they are manifested. It highlights that climate, both directly and indirectly, impacts multiple processes through various different pathways, so that understanding local adaptation to climate needs to identify responses to a variety of stresses occurring in a highly politicised socio-economic environment.

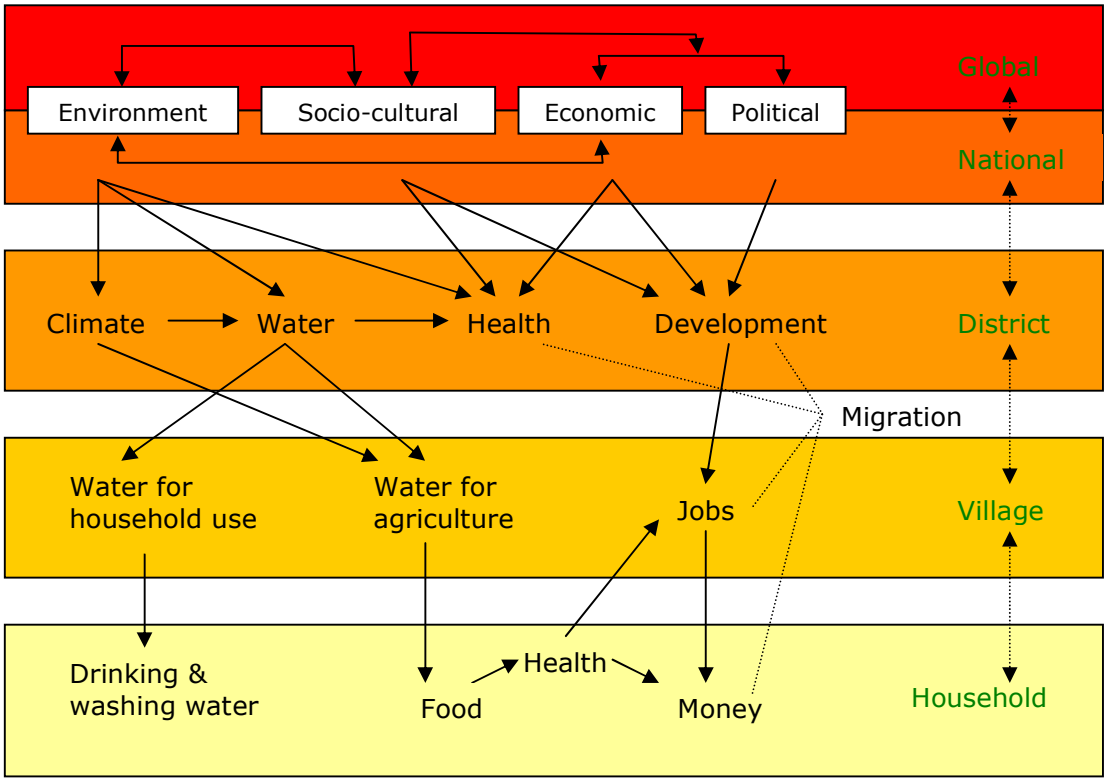

Figure 7: Interactions between different spatial scales indicating stress pathways and various levels of response and intervention.

6.4 Methodology

This study shows that there is indeed enormous strength in using complementary qualitative and quantitative methodological approaches. The qualitative research techniques were useful to operationalise the stated preference survey and the quantitative analysis was in turn useful to validate the narrative-based qualitative analysis in this complex situation involving multiple factors and scales. For example, qualitative analysis was useful to select potential stress factors to be used in the stated preference questions, such as maize price and sickness period, and the quantitative analysis helped to validate that the price of food (specifically maize) is indeed an important factor in choosing certain strategies, as indicated in the discrete choice analysis. There were some difficulties and shortcomings associated with both methods, but these were partly negated through the complementarity of the methods. Much of the qualitative, interview-based work requires a certain amount of trust when it comes to sensitive issues, is subjective, largely site specific and difficult to generalize; while the quantitative, survey-based work is less subjective, accesses information from a greater number of people and is more directed, but requires alternative methods to further explore survey responses. It was noted that certain targeted follow up interviews would have been useful to clarify unresolved issues and inconsistencies. This is in agreement with the developments in Parker and Kozel's (2004) mixed-method research, where they found the need to extend their qual-quant approach to adopt a qual-quant-qual sequencing. The use of village, local municipality and district level interviews proved essential to

capturing some of the scale issues associated with vulnerability and facilitating adaptation, and highlighted some of the challenges and current shortcomings in developing an integrated and sustainable response to climate, water and health stresses. It also provided the necessary range of data to communicate the findings to those interested in both narratives and statistics and encourages triangulation.

6.5 Poverty reduction and sustainable development

The findings of this research in terms of poverty reduction and sustainable development seem to support local economic development that aims to combat unemployment. The focus of this would have to be on increasing employment opportunities that are accessible to people in the local villages. This would in turn need to be supported by appropriate skills development. Given the current environmental stress, it is important that local economic development is sensitive to local resource availability. More specifically, water intensive activities should be carefully evaluated in terms of their local economic benefit, environmental impact and potential impact of future water availability.

Other key components of development plans should be levels of sustainability and local empowerment, facilitated through community ownership. There is a high expectation among those in the villages that government should provide jobs and services. This dependency is not sustainable and solutions should increase local capacity so that villagers are actively supported to pursue their own development. In order to do this, villagers recognize that additional skills are needed. Unfortunately, these skills are not necessarily the same skills that the government perceives to be important.

The area is rich in mineral resources. As a result, there has been enormous interest by the private sector to capitalise on these resources though mining activities. Government is choosing to support this inevitable activity but recognises the need for increased local employment, and consequently have made it a requirement for mining companies to provide training to potential and new employees. However, employment opportunities for local people appear to remain limited because people from outside the district with experience are brought in. This links to increased incidence of HIV/AIDS, associated with migrant labour. The expansion of the mining sector takes place in the context of large-scale existing water stress in the basin. Consequently, pressing decisions need to be made about water allocation and how mining can contribute to sustainable development in the district that benefits local people.

7. CONCLUSION

From the analysis there are a number of key issues that emerge, including the lack of infrastructure, services and basic resources (money, food, water). A number of important institutional matters become evident, such as the need for better communication between stakeholder groups and a more cross-sectoral view in policy-making. These are drawn together below.

The **provision of basic services** is a government priority and is to a large extent being addressed, but considerable backlogs remain to-date in many rural as well as urban areas. Significant improvements have been made during the last few years to provide rural villages with electricity, potable water, improved sanitation and housing. Water services provision has varied between villages. Some have been supplied with tapped water to every house, while in other villages additional communal stand pipes have been installed. This has greatly reduced the time and effort people have to spend on water collection, thereby increasing the security of domestic water supply.

Poverty and food insecurity remain wide-spread throughout the district and are the key challenges that urgently need to be addressed. Integral to these challenges is the need to address high levels of unemployment. Income generation is severely limited by the lack of formal employment opportunities available in the villages and the district at large, and the variable nature of non-irrigated agricultural production as a result of increasingly variable and extreme climatic conditions. Distance to larger urban

centres and high transport costs are barriers to looking for employment outside the villages. Low incomes result in small amounts of money circulating in the local economy, further limiting growth.

The government is currently addressing poverty and food insecurity through the **provision of grants,** including state pensions, child grants and disability grants, and food parcels. The high dependency of households on this support is seen as a major challenge by the municipal and district governments as it inhibits self-sufficiency, places a significant financial burden on the social system and is thought to discourage proactive behaviour.

Many households have developed a wide range of **coping and adaptation strategies** in response to changing conditions that affect their livelihoods and well-being (see Table x). Most of these are in direct response to a lack of money and/or food. Even though the climate is highly variable and droughts occur frequently, most people do not perceive it as a direct stressor. Rather, it is the limited amount of available water, affected both by climate and human management, they respond to. This finding supports the assertion that adaptation to climate change is not simply an isolated response to the impacts of climate variability and extremes but rather a complex set of responses to a range of interacting and dynamic stresses, of which climate is one (e.g. Adger et al., 2005).

The lack of employment opportunities in rural villages has in the past led to investment into a number of **community projects** including brick-making, poultry schemes, and community gardens. Some of these received initial support from government. Despite this, most projects have failed because of a lack of maintained financial support and expertise, a lack of appropriate skills, materials, tools and equipment, including irrigation infrastructure, and the lack of a strong market for the sale of products.

Expectations on how to reduce unemployment and poverty differ greatly between the interviewed villagers and the government officials. Whilst most people in the villages would like to see more income-generating opportunities within their village through the encouragement of business enterprise and support for community-based development initiatives, the government's vision is to invest in regional economic development nodes based on the expansion of mining and related secondary industries and tourism.

Both strategies would require **significant investment in capacity building** but would involve very different sets of skills. Community projects require, apart from the skills of the particular trade, knowledge on how to start and run a business. If rural communities are to participate in and benefit from the regional development goals envisioned by the government, the provision of education and skills training has to match the requirements of the mining sector and the related secondary manufacturing and services industries.

The **mismatch in the perception of how best to cope with and adapt to** the changing environmental and socio-economic conditions arises to a large extent from a lack of communication and common vision between the villages and the municipal and district government. People in the villages are largely unaware both of the nature of support and advice available for community projects, as well as the government's broader district and provincial development plans.

The **effectiveness of the government** to respond to the current development challenges is constrained due to limited financial resources, poor coordination and information transfer across different levels and departments, ongoing restructuring and redefinition of roles and responsibilities, insufficient authority and tensions with traditional leaders.

To-date there has been **no formal assessment** of the potential impacts of climate change on water resource availability in Sekhukhune, and hence there is no consideration of climate change in key strategic planning documents such as the Integrated Development Plan (IDP).

Current responses to water scarcity seem to be driven by provincial stakeholders and focus on supply management through increasing the capacity of existing dams (e.g. Flag Boshielo Dam) and the construction of new dams (e.g. De Hoop Dam). The development of plans that integrate across multiple sectors and strengthen the development role of the district government has only recently been initiated. Recognition of the the need to address food security in an integrated manner is evident through the establishment of a food security focus in the South African Social Cluster. This mechanism provides an opportunity through which an **integrated policy response** to vulnerabilities associated with climate, water and health could be supported. Much work will be needed to ensure that these integrated policy responses have positive impacts at the municipal level, at which vulnerable groups operate.

Despite increasingly scarce water resources and high uncertainties of potential climate change impacts, future regional development relies to a large extent on irrigated agriculture and mining, both of which are highly water-intensive. The rationale behind this strategy needs to be questioned because it is likely to **increase future vulnerability to water stress**. There is therefore a need to explore alternative development options that are less water-intensive and less sensitive to climate variability. There are also important health concerns associated with the two dominant growth sectors of mining and agriculture. The influx of migrant workers attracted by the opening of new mines and the increasing number of truck drivers passing through the area to transport agricultural produce is expected to greatly increase levels of HIV infection in Sekhukhune. This in turn generates a number of health, social and economic stressors, likely to further increase local vulnerability. Mechanisms for combating these negative impacts will need to be developed and implemented, including continued public health education and forms of social and economic empowerment, especially for women.

Another consideration is the relatively long time-scale required for the establishment of regional development nodes. Current levels of poverty in rural communities are high and **shorter-term solutions** need to be found that address unemployment and food insecurity without increasing the financial burden to the state and without increasing future vulnerabilities. Because of the complexity of factors contributing to unemployment (Figure 2) and the fact that many of these cannot be controlled by the villages themselves, a government-led integrated strategy that includes regional commercial development as well as community-level investment in further education and skills training will be required.

Focusing on water, climate, health and food security this project has investigated how vulnerability is configured and what decisions people make regarding adaptation strategies in response to a multitude of stresses, which interact in complex and dynamic ways. The findings indicate that water scarcity and limited economic opportunities are two major constraints to development at both the village and district scale that undermine adaptive capacity. People, to a large extent, relate both climate stress and food insecurity back to these two dominant stressors. This perspective highlights the need for integrated responses to support local adaptation that departs from sectoral approaches. It also requires improved and increased communication between government and local communities to facilitate the integration of strategies being implemented at different scales and better align expectations. Municipal government needs to carefully assess the likely environmental, social and economic impacts of investing in different sectors, incorporating a view on climate change and prioritizing water saving and wealth distributing options with the aim of minimizing future vulnerability.

This study has shown the benefits associated with combining qualitative and quantitative methods in adaptation research, enabling people to identify their key stresses and respective responses in an unconstrained manner and allowing researchers a fuller understanding of the context in which these stresses are experienced and acted upon, and then using this information to initiate a more formalized process of investigating decision-making processes involved in adaptation. In addition, value and insight has been gained by linking this work with other ongoing research programmes in the area and extending

research activities to include individuals at the village level as well as local and district government officials, thereby addressing important scale issues associated with vulnerability and adaptation. There is a long-term commitment to continue building these links through the future activities of the Poverty and Vulnerability Programme.

The concepts and analysis developed in this paper have been used to support development of Agent-based models and their application to issues identified in the CAVES project. Further fieldwork was organised around model validation and also utilised the models to support investigation and policy analysis in Sekhukhune District. Application and analysis of these models is part of an ongoing collaboration with Manchester Metropolitan University and other members of the CAVES project. The Agent-based modelling work is fully discussed in CAVES deliverables 8, 10 and 11.

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