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MASTERS RESEARCH PROJECT

Feast or Famine

Harvest Yields, Sustainable Livelihoods and Climate Variability in Vhembe District, Limpopo, South Africa

BY:

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ABSTRACT

The objective of the thesis was to determine the relationship between climate variability and rural livelihoods in the Vhembe District Municipality situated in the extreme north of South Africa. These relationships ranged between food and nutritional security, land tenure, financial security, domestic politics and their impacts on human well-being in terms of the Sustainable Livelihoods Framework. The thesis uses a multi-discipline approach to assess the socio-economic outcomes of poor support to rural households that are struggling to attain an acceptable standard of living in the face of increasing challenges brought about by climate change. It also looked to investigate the capacity of rural households to adapt to the challenges of living in such an area. Results were obtained through questionnaires and basic interviews conducted among the residents of three selected areas in the Vhembe District of South Africa.

The results demonstrate that residents of Vhembe go through daily suffering as a result of poor support and assistance in adapting to the challenges of climate change in the area and its impact on their livelihoods. The on-going academic literature suggests that integrated livelihood resilience is essential to adaptation to climate variability and that this can reduce the vulnerability of these areas. It also calls for the development and maintenance of effective local institutions supported by public private partnerships. Gaps identified in the literature suggested that more knowledge on land use change caused by seasonal variability as a result of the El Niño Southern Oscillation was needed as well as the prevalence of indigenous knowledge systems in adapting to these changes. It was found that local knowledge and effective local institutions were not as prevalent as expected in achieving livelihood adaptation. Some key findings were that 59% of households did not have access to arable land with 49% of respondents stating that they did not plant crops in the recent season due to the poor rains experienced. Furthermore, the reliance on social grants was notably high with 32% of respondents relying on these. Some residents who cannot pay to have access to electricity are forced to collect or buy firewood for everyday use. Furthermore, only 9% of respondents stated that they had access to flush toilets. These issues are shown to have environmental and other social consequences in the target communities. The thesis concludes that management of natural resources in Vhembe needs to be improved, as these are potential safety nets for the rural poor. It also suggests that there will need to be more support by

government and business to set up beneficial agricultural projects to sustainably grow inclusive prosperity for rural residents of the Vhembe District.

Key Words: Climate Variability, Sustainable Livelihood Framework, Adaptive Capacity

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Acronyms and abbreviations

AIDS	Acquired Immune Deficiency Syndrome
ASGISA	Accelerated and shared growth initiative for South Africa
CC	Climate Change
CO2	Carbon Dioxide
CV	Climate variability
ENSO	El Niño Southern Oscillation
ESTA	Extension of security of Tenure Act
FBS	Free basic services
FET	Further education and training colleges
GEAR	Growth employment and redistribution
HDI	Human development index
HH	Household
HIV	Human immunodeficiency virus
IDP	Integrated development plan
IFC	International Finance Corporation
IK	Indigenous knowledge
IKS	Indigenous knowledge systems
IPCC	Intergovernmental Panel on Climate Change
LED	Local economic development
LM	Local municipality
MKLM	Makhado Local Municipality
MTLM	Mutale Local Municipality
NDP	National Development Plan
NGOs	Nongovernmental organisation
OECD	Organisation for Economic Cooperation
OPDs	Optimized planting dates
PES	Payments for ecosystem services
RCM	Regional climate models
RDP	Reconstruction and Development Programme
SD	Sustainable development
SDF	Spatial development plan
SLF	Sustainable livelihood framework
StatsSA	Statistics South Africa
TA	Traditional Authority
TLM	Thulamela Local Municipality
UNDP	United Nations Development Programme
USA	United States of America
USD	United States Dollar
VDM	Vhembe District Municipality

CHAPTER ONE
FRAMES OF REFERENCE

1.1 *Background to the study*

The continent of Africa is at risk of becoming the epicentre of a major global food crisis if climate change (CC) issues remain unaddressed (Desanker & Justice 2001). As it stands, African communities' vulnerability to CC is exacerbated by high poverty levels and an existing climate that tends towards high temperatures and subsequently, low precipitation (IPCC 2012). The effects of gradual CC and extreme weather have recently been undermining progress in poverty alleviation and food security in Africa. Adding to this are the negative effects on development efforts as micro economic sectors that depend on weather conditions such as farming, pastoralists, fisheries and forestry practices are both directly and indirectly affected. Thus the livelihoods attained from these are directly sensitive to climate variability (CV) and changes (Southworth et al. 2000).

According to Gulati et al. (2013) forty percent of the land in Africa is considered to be dryland, thus water resources are already under severe pressure and meeting the demand for this will pose a daunting challenge in the future (Olmstead 2010). The cumulative impact that scarce water resources have on agriculture is also a challenge. Farmers may be able to adapt to long term changes in climate but inter annual climatic variability makes it very difficult to adapt while preserving certain livelihoods (Fussel 2007). Adding to the physical challenges, are the socioeconomic and cultural aspects of humans that need to be factored in as a response to climate change. Meteorological impacts often interact with anthropogenic impacts, therefore, the frequency of dry or wet years depends on both social and agricultural factors which are strongly related to hydrological processes, vegetation cover and land capability (Wang et al. 2012).

Considering that temperature and precipitation changes occur differently in certain areas, it is important to note that crop growth processes are affected differently by these changes (Fussel 2007). A seasonal increase in temperature can increase the rate of crop development. Increased levels of Carbon Dioxide (CO_2) coupled with increased precipitation in drier areas may allow an increase in the photosynthetic rate resulting in higher yields (Southworth et al. 2000). With this in mind, it is likely that not all poor households are affected negatively by

CV. Therefore, the proposed study will seek to uncover impacts as well as opportunities arising from a variable climate in developing countries.

Globally CC has and is having an observable effect on the environment. Glaciers have shrunk, winter ice and permafrost are thawing earlier, habitat ranges are shifting and trees are flowering sooner (Miller 2007). There is high confidence amongst the scientific community that global temperatures will continue to increase decades into the future. The Intergovernmental Panel on Climate Change (IPCC) predicts that increases in global average temperatures will produce beneficial impacts in some regions and harmful ones in others. Coupled with rapid population growth CC will increase net annual costs significantly, thereby impacting on the global economy (IPCC 2012).

According to the United Nations Development Programme (UNDP) , developing countries suffer 99% of the casualties attributable to CC (Corbera et al. 2007). Many of these developing countries are located in Africa, which stated by Hulme et al. (2001) is likely to experience most of the negative effects of CC due to its geographic position and the influence of the El Niño Southern Oscillation (ENSO) induced variability to temperature and precipitation. Many households in Africa are situated in rural communities where agriculture plays a large role in their livelihood strategies (Scoons 2009). Therefore, changes to precipitation patterns could affect the productivity of agriculture and could impact negatively on food security (Gulati et al. 2013). A further issue is that rural, isolated communities do not exhibit sufficient financial and technical capacities to manage the risks associated with CC and experience this when exposed to shocks such as flooding caused by ENSO induced CV (Fussel 2007).

In Southern Africa, the impacts are likely to be severe as poverty and inequality are endemic in Southern Africa and CC is likely to impact negatively on the poor as there are many institutions that the poor do not have access to such as formal financial protection of their assets through insurance (Stringer et al. 2009). The vulnerability and adaptation study for South Africa predicted that CC impacts include changes to terrestrial and marine ecosystems, which is likely to have a profound impact on agriculture, forestry, rangelands, fisheries and biodiversity. Furthermore, these changes can increase the suitability of habitats for water borne disease. The physical changes attributed to CC will affect the production throughout the primary sector, these will likely influence the value added to national income as well as

the livelihoods of those who work in this sector. These impacts at the primary sector are likely to resonate through the entire economy (Turpie et al. 2002).

In the Limpopo Province located in northern South Africa, agriculture is an important economic sector along with mining and tourism. Previous events of CV in the province have resulted in challenges for agriculture, these are in the form of increasing frequency of droughts and flooding that occurs with mounting severity (Critchley, Versveld and Mollel 1998). The same holds true for the Vhembe District Municipality (located in the northern area of Limpopo) and what is of concern here is the quality of arable soils, which tend to diminish with more frequent extreme climate events as the capacity to manage the soils through these challenges is not adequate. Severe droughts have occurred here in the: 1980s, 1970s, 1990s, 2005, 2012 and most recently in 2015. There are further challenges in the district which constrain livelihoods and these are: HIV/AIDs, poverty and unemployment. These socio-economic challenges tend to have far reaching impacts across all sectors of society. It is this socio-economic nexus that has led the researcher to focus on the Vhembe District Municipality (VDM), further socio economic information on the area can be found in section 8.1.

1.2 *Research statement*

This study seeks to understand how CV is affecting livelihoods in Limpopo. South Africa is dependent on rain fed agriculture and is therefore susceptible to different climatic conditions. The most recent summary for policy makers published by the IPCC in 2012 suggests that there is confidence that atmospheric warming will result in prolonged droughts, more intense and concentrated storms coupled with the average reduction of rainy days resulting in a decrease in average precipitation in Southern Africa. This suggests that when precipitation occurs it is with increasing severity and its resulting impact on the more vulnerable members of society is increased (Desanker & Justice 2001). It has been noted that South Africa will experience this variability by means of drought and floods (IPCC 2012).

In Southern Africa those that will be most affected by CV are the rural poor because their adaptation capacity in terms of their asset base and livelihood strategies are limited. With this in mind the study proposes to understand how the poor are affected by CV and also how the poor make use of differing livelihood strategies to cope with CV (Fussel 2007).

There are also a number of challenges that are faced by rural populations in the sense that their access to assets and capital is limited. Currently in South Africa, their institutions do not provide adequate safety nets for the poor to cope with these challenges (North 1991). These institutions could be either formal such as affordable insurance or access to credit facilities, alternatively they could be informal such as those that regulate open access to ecosystem commons such as arable land, water or firewood. An example of such an institution was described in a conflict resolution mechanism used by Olmstead (2013) to demonstrate that low cost mechanisms to resolve conflicts among users of a commons are an option to formulating greater resilience. It is the lack of the abovementioned formal institutions which lend to a state whereby the rural poor need to forge their own informal institutions that appropriately understand the impacts of CV and how they effectively adapt in order to maintain productivity with what is available (Fussel 2007).

With the abovementioned statements, the research intended to determine the vulnerability that communities in Limpopo experience with regards to CV. This was calculated based on the suit of livelihood activities that these communities are engaged. It determines the proportion of livelihood sources that are based directly or indirectly on specifically subsistence agriculture in the area. Furthermore, it looks at their dependence on purchased food produce that is susceptible to price variations in accordance with CV. It is this that is being impacted by CV. In order to gauge the adaptive capacity, it is necessary to establish what other livelihood assets are being used as mechanisms to cope with these changes.

1.3 *Research questions*

In view of the above-mentioned observations, the following questions guided the research process.

- What is the relationship between CV and rural livelihoods?
- What institutional framework is utilised where households are adapting?
- In what ways do poor households adapt to CV?
- How can the findings be applied to the Sustainable livelihood framework (SLF) to promote the most appropriate livelihood strategies?

1.4 *Aims and objectives*

The current problem being experienced in the VDM of the Limpopo Province is that CC is making it difficult for the rural poor to sustain their livelihoods (Scoons 2009). For many

lower income households, their prime source of livelihood is subsistence agriculture and as explored by Critchley et al. (1998) this is becoming more difficult as a result of greater frequency of climatic events that impact agriculture. Furthermore, if households use social grants or income to purchase food, the diminished crop production in times that make it more difficult to produce leads to an increase in the price of food which diminishes the disposable incomes of these households (John 2016). The aim of this project was to understand the relationship between CV and Livelihood options available to the rural population in the Vhembe district. It specifically aimed to investigate the relationship between CV and livelihood diversification amongst the poor in the VDM, as well as understanding how the poor adapt to change so as to attain a sustainable livelihood.

In view of the aim above, the objectives were to:

- Establish the impacts of CV on food and nutrition of the poor in the VDM; creating an inventory of CV impacts on rural livelihoods;
- Identify capital and assets that play a key role in building adaptive capacity against CV; and
- Identify challenges that make adaptation difficult to achieve.

1.5 *Ethical clearance*

Before the research commenced, it was necessary to receive ethical clearance from Wits University. This served to verify that due course was considered in terms of voluntary informed consent. To achieve this, stringent consultation with community members and officials was necessary, so as to ensure that all research participants were informed of the purpose of the project and therefore ensured that they were willing participants in the project. Arrangements were also made to ensure that results were effectively communicated to both community participants as well as the relevant authorities.

1.6 *Research structure*

The structure of this research report will consist of the following chapters:

1. Frames of reference in which the stated problem will be discussed;
2. Discussion of the literature review in which the most prominent knowledge gaps will be identified;

3. Discussion on methodological issues;
4. Empirical data of the study;
5. Analysis of the data and further discussion; and
6. Conclusions and recommendations.

CHAPTER TWO
THEORETICAL CONSIDERATIONS AND LITERATURE REVIEW

2.1 *Introduction*

This chapter covers the literature that was consulted in formulating the research aims and objectives. The chapter begins by exploring the sustainable livelihood framework which can be used as a tool to increase resilience in vulnerable communities and in doing so reduce the impact of CV on their livelihoods. The second part of the chapter addresses developments in livelihood resilience. A large focus of this is on food and nutritional security and draws a lot from the economic perspectives of nutritional availability. It also brings into frame the interrelated aspects of a system that needs to be fully understood when applying certain adaptation strategies. The third theme addressed is that of the impacts of CV on certain parts of the SLF. The section begins with a broad overview and then brings attention to these impacts on a global scale. The section gradually becomes more focused down to literature that is closely related to the selected study area. The third section addresses the importance o institutions in supporting each of the arms of the SLF. It also uses an approach that narrows the literature down from a global perspective to the Southern African perspective. It stresses the importance of vulnerable communities as essential actors in their socio-ecological systems.

2.2 *Integrated resilience as an adaptive strategy towards climate variability*

Currently, CC and its predicted impacts have become a key focus area around the world. So far the literature suggests that impacts are largely to be experienced in Africa because large areas of Africa already experience considerable variability on a year-to-year basis and subsequently, land use systems have evolved to accommodate this variability (Desanker & Justice 2001). It is also important to note that there exist opportunities such as indigenous knowledge systems (IKS). Indigenous people offer alternative knowledge on CC based on their own developed methods of resource use (Leonard et al. 2013).

Access to land as a means of production is very difficult amongst lower income groups in Southern Africa thus, there has been a development of inappropriate farming systems in

communal areas of the homeland[1] states due to apartheid land tenure system which resulted in soil erosion, declining soil fertility, depletion of organic matter, destruction of soil health, bush encroachment, overgrazing, alien invasion and declining water quality (Critchley, Versveld and Mollel 1998). It is these persistent land degradation issues which need to be addressed to ensure sustainability of rural communities, thus, the development of the SLF has been introduced to communities in Vhembe.

Previous livelihoods research and subsequent remedial programs that have taken shape in the VDM have focused on replicable models for sustainable food production, rainwater harvesting, appropriate technologies, and on promoting ways to enhance, restore and utilize IKS. The programs initiated draw a lot from the SLF model for guidance. Some of these programs include: a demonstration medicinal garden, a model home nursery, a permaculture homestead food garden supporting a wide diversity of crop species as its name suggests, and various types of appropriate technology. Also demonstrated were ways to incorporate hands-on environmental education into school curriculums (Critchley, Versveld and Mollel 1998). Successful implementation of the SLF through effective participation has resulted in some success of the abovementioned projects. These are examples where lower income groups in the face of population growth and land degradation can engage in sustainable land management (Stringer et al. 2012). Perhaps other areas with similar income levels, population and land issues to the VDM in Southern Africa can apply similar strategies to assist in achieving sustainable development of rural areas. For more information on the conditions experienced in the VDM refer to section 8.1 to get an idea of population, income and access to land.

A key knowledge gap identified in section 2.4 is the application of a vulnerability and resilience analysis to better interpret current and potential impacts of climate change on rural households. Adaptation weakness can be identified using these analyses in order to formulate policy support that will assist in building resilience. The five capitals model or the sustainable livelihood framework was identified as the best way to quantify vulnerability, resilience and adaptive capacity in rural households (Donohue & Biggs 2015).

[1] Apartheid South Africa had designated areas where Africans were moved to in 1913. These areas were formally known as Bantustans and were considered separate states from South Africa. They had no support from South Africa with the intention of forcing their inhabitants to provide low cost labour which was exploited during the years of Apartheid especially in the mining industry. In this report, these areas are referred to as homeland areas.

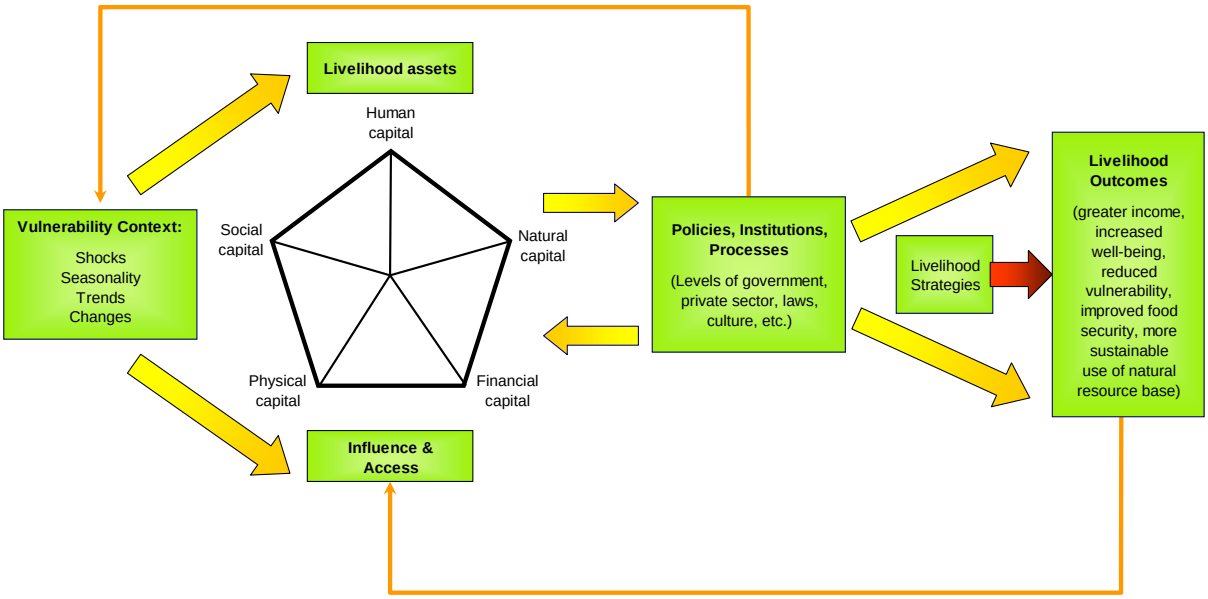


Figure 2-1: Sustainable livelihood framework

Source: (Donohue & Biggs 2015) (Shackelton 2007) (Ferrol-Schulte et al. 2013).

The main elements in this framework are:

- ***Context*** (the external environment, which may be responsible for many of the hardships faced by poor people). These may include:
    - ***Shocks*** (e.g. floods, droughts, deaths in the family, violence or civil unrest);
    - ***Seasonality*** (e.g. regular significant changes in temperature or rainfall); and
    - ***Trends*** or ***changes*** (e.g. population growth, environmental change, technological development, changes in markets and trade, or globalisation);

- ***Livelihood assets*** (the resources poor people possess or have access to and use to gain a livelihood). These comprise:
    - ***Human capital*** (health, nutrition, education, knowledge and skills, capacity to work and capacity to adapt);
    - ***Natural capital*** (land and produce, water, trees and forest resources, biodiversity, wildlife and environmental services);

- ***Social capital*** (networks and connections, norms of reciprocity, participation in decision-making, leadership, common rules and sanctions);
- ***Physical capital*** (infrastructure for transport, water supply, sanitation, energy and communications; shelter and buildings; tools and technology for production, and agricultural materials); and
- ***Financial capital*** (savings, access to credit, remittances, pensions and wages).

- ***Policies, institutions and processes*** (the institutions, organisations, policies and legislation that determine access to assets and choice of livelihood strategies);
- ***Livelihood strategies*** (the ways in which poor people deploy their assets and capabilities to improve their livelihoods – e.g. consumption, production, processing, exchange and income-generating activities); and
- ***Outcomes*** (the results of successful livelihood strategies, which could include improved income and more economically sustainable livelihoods, increased well-being, reduced vulnerability and more sustainable use of the natural resource base) (Donohue & Biggs 2015) (Ferrol-Schulte et al. 2013)..

In the context of the study, the SLF mentioned above is useful to determine community resilience in a holistic way. The external environment can have detrimental effects on vulnerable communities if they are not sufficiently proposed by various groups of livelihood assets. External shocks, seasonality and other external trends for example: an economic downturn or an environmental event such as drought can create sudden changes to the livelihoods of communities. The five types of capital described under livelihood assets are necessary in creating safety nets that can assist to ride out sudden changes caused by external changes or events. Institutions, policies and government support can assist in preserving these various forms of livelihood capital. Through these structures a sustainable and resilient livelihood strategy can be applied at HH level. These livelihood strategies can result in higher incomes, better management of natural resources and increased food security for vulnerable communities. The distribution and underlying dynamics of poverty in the study area were analysed in terms of the Sustainable Livelihoods Approach, and the results of this analysis are summarised at the end of section 5.

2.3 *Progression towards integrated resilience to climate variability*

Some key hazards and risks identified in the literature on CV relate to: Drought and floods, agricultural performance, water quality, land use, livelihoods, shared resources and hazards from dam control in shared river basins (Desanker & Justice 2001). The countries of Southern Africa's vulnerability to CV is comparatively more pronounced because of persistent poverty and inequitable distribution of land resources, among other things (Krishnamurthy et al. 2014) (Dube & Phiri 2013). Considering that for one example, negative impacts of land degradation on communities are exacerbated due to the lack of resilience provided by the natural landscape and by traditional land-use systems, it is necessary to investigate the relationships between CV risks and resilience (Dube & Pickup 2001).

It is understood that CV is encountered in the form of weather extremes such as for example, flooding and its effects are felt as the resultant impacts of such events on rural livelihoods. Many control measures that act as a buffer against the impacts of CV are beyond the capacity of developing countries. This is a problem that can lead to humanitarian suffering when the occurrence of flooding becomes increasingly frequent and the abilities of communities to absorb such events is eroded on each occasion. Low adaptive capacity and resilience is associated with low levels of human, financial and natural capital as well as weak institutional capacity and poor governance (Motsholapheko et al. 2011). Similar issues reoccur when considering the other extreme being drought. In the United States of America (USA) a study found that future CV will be detrimental to future agricultural production (Southworth et al. 2000). It was found that the responses of crops to changing environmental conditions are spatially varied. This has created the stance that further adaptations to farming require increased tolerance of maximum temperatures in the existing crop varieties or a change in the varieties of maize grown (Southworth et al. 2000).

In Africa, the attention is turning to adaptive capacity to manage smaller facets of CC. For example, under increased frequency of extreme drought, the management of soil moisture becomes a focal point, this requires improved soil infiltration and water holding capacity (Southworth et al. 2000). This kind of soil management creates a need to identify farming practices that yield those benefits through soil tillage and cropping systems. Local adaptations such as the building of stone terraces and better preservation of runoff water was found to be extremely beneficial for agricultural production in arid areas (Bruins 2012). Other

kinds of adaptation have been identified in African communities which have shown the ability to overcome difficult periods as a result of CV, for example after events such as droughts trees have been planted to protect the soil from drying out (Miller 2007). Such strategies were adopted in Namibia and Kenya in order to try mitigate against negative economic impacts of CC (Brown 2009) (Miller 2007). They also diversified their agricultural products as one of their strategies to cope with CV. In some cases, forest ecosystems deliver food and shelter during extreme events (droughts and floods). This makes forests and woodlands key assets for increasing the resilience of poor communities. In some areas of Southern Africa, rural capability to adapt depends on the access to natural resources. Therefore, policy challenges lie in maintaining high access to natural capital in the face of growing population, land use changes and need for resource conservation (Motsholapheko et al. 2011).

From the economic perspective, CV creates greater challenges for the African continent than elsewhere. There is evidence that shows that extreme CV can set back economic growth and development prospects in the poorest countries. If climatic shocks become more intense before these countries are able to reduce their vulnerability then the potential for long term growth is reduced (Peters 2006). Another issue is that increased CV (such as periods of intense rain to prolonged dry periods) can result in adverse growth shocks and cause higher risks of conflict as work opportunities are reduced, making recruitment into rebel groups much easier (Peters 2006). Adding to this, conflict arises as a result competition for resources. Some have suggested that water resources or lack thereof are the undertone driving conflict in the Middle East. In light of these suggestions of the literature, reducing the vulnerability of poor people to CV and CC should be the starting point for adaptation efforts in developing countries.

The multifaceted issue within our environmental and socio-economic systems such as the water, food, energy nexus, suggest that the abovementioned resources relate to the issue of food security. According to Miller (2007) food security refers to a society or community where everybody in that area has access to enough food to sustain themselves. This view is supported by the theory presented in Van Wyke (2014) but goes further to suggest that it should encompass the ability to access gainful nutrition in order to live healthy and active lives. It should include both physical and economic stability with regard to accessing food in line with dietary requirements (Miller 2007) (van Wijk et al. 2014). Stifled economic ability

to access this nutrition can have drastic effects on lower income groups and can lead to significant cases of social instability. Currently one in six people in developing countries cannot afford to buy enough or grow enough food to achieve the abovementioned access to nutrition and the FAO (2006) begins to agree that food security is multifaceted and requires the integration of our social and environmental systems stating that it depends on reducing harmful environmental effects, such as soil erosion and aquifer depletion, but should go further to state that our socio-economic institutions should adapt in order to reduce the abovementioned harmful effects.

A consequence of not having access to their required nutrition is a state under-nutrition meaning that an individual is not receiving enough daily calories to execute the day's tasks effectively. The other is malnutrition, meaning an individual is not ingesting the required vitamins to achieve an acceptable level of health (Miller 2007). Supporters of this view expand on this concept by suggesting that CC and its induced variability exposes these already vulnerable groups to further risks by creating more food insecure populations highlighting the causal relationship between CC and food security (Krishnamurthy et al. 2014). A further aspect of this nutrition relates to protein intake, protein is usually associated with foods that tend to be more expensive thus lower income groups struggle to access this protein. Consequently, many people don't get enough protein in their diets and are more likely to rely on staples such as wheat, rice and maize while meat is not affordable leading to protein deficiencies. This exposes many children to risks of death as a result of measles or diarrhoea which would not kill as many children in developed countries. Another challenge that relates to developing countries is acute food shortages which often occur due to shocks such as war, drought or flood (Miller 2007). Although Miller (2007) states that the unaffordability of meat can lead to protein deficiencies, there are available protein substitutes such as beans, legumes, quinoa or soy. While more quinoa and soy could be introduced to food production in the VDM, there is availability of beans and legumes at affordable prices and these are often eaten by households in the VDM (Fuss et al. 2015).

The importance of nutrition and protein deficiency cannot be understated, but to focus entirely on this is to fall short by non-recognition of the economic reasons for inaccessibility, as well as potential institutional adaptation identified by Rurinda et al (2014) which shows that societies faced with nutritional issues identified more hardy indigenous crops to cope with CV. Rurinda (2014) assessed the performance of grains as well as maize under variable

rainfall and soil conditions to evaluate crop germination and yield performance of maize, finger millet, and sorghum for different planting dates and fertilization rates. The analysis of nutrient and water abstraction efficiency for the three crop types was used to determine economic benefits and nutritional value of the three crop types under smallholder management conditions (Dawson et al. 2014).

The points above bring to light the need to investigate different species for planting in sub Saharan Africa. Shedding light on these Laurie et al. (2015) recommend that policies be adjusted to incorporate specific crops such as the orange flesh sweet potato in government development programs with the goal of increasing nutrition by addressing vitamin A deficiencies. They also suggest that public private partnerships will be crucial for up scaling the positive impact of orange fleshed sweet potatoes on food and nutrition security (Laurie et al. 2015). Assessing the integrated nature of food security indicate the merits of applying both primary and secondary data collection methods to achieve institutional adaptation (Rurinda et al. 2014). This highlights the ability of a society to adapt to an external stressor as well as its ability to implement institutional capacity to ensure the adaptation ensues as is necessary (Rurinda et al. 2014).

Returning to the theme of crop suitability, empirical findings from literature around this showed that maize tends to yield more than millet and sorghum regardless of time and seasonal rainfall patterns. Traore (2013) agreed reporting that maize out yielded sorghum and millet under different rainfall conditions in the Sahel region of Africa. The studies suggest that recommendations to substitute small grains for maize will not be a good option for adaptation to a changing climate nor will it attract farmers (Rurinda et al. 2014). However, sorghum and millet have proved their hardiness to drought over many generations of agriculture in Africa and in some cases sorghum is cultivated in arid areas in Australia giving credence to its potential uses in Africa and around the world.

Perhaps more light shed on the matter by Waongo et al. (2015) showing maize production would out-perform small grains three out of four years while small grains would out-compete maize only once in every four years. Thus, if based on total rainfall only, sorghum and millet could play a role in complementing maize in order to stabilize household food self-sufficiency. Especially when considering that the region is projected to become increasingly drier due to CV. Although one drawback is that these crops are prone to bird damage. For this

reason, planting sorghum that is not prone to bird damage as well as marketing the structure of the crop might attract farmers to integrate the use of sorghum into maize based farming systems. Another consideration is that these crop performances, even under fertilised conditions showed that soils are so poor in fertility that fertility management of these soils will prove to be very beneficial (Waongo et al. 2015).

Results obtained by Van Wijk (2014) and Krishnamurthy et al. (2014) show that negative impacts of CC and CV go well beyond crop yields in isolation but identify threats to entire livelihood frameworks as a result of these variabilities. However, Vermuelen (2012) found that many promising practices are grounded in local knowledge such as community managed irrigation, pooling finance and concrete policy options. Therefore, due to the assessment that increased CV is expected to intensify the cycles of poverty, food security is not isolated from other aspects of the SLF. These findings give support for assessing CC impact on households through the lenses of the SLF (Vermeulen et al. 2012)(van Wijk et al. 2014)(Rurinda et al. 2014) .

Long term climate change (temperature and shift in rainfall regimes) presents challenges to agricultural and food security systems in policy and science and the great challenge would be to accelerate adaptation without threatening sensitive livelihoods. (Vermeulen et al. 2012)(van Wijk et al. 2014)(Krishnamurthy et al. 2014). Risks presented at country level can also help narrow the severity of these impacts (Krishnamurthy et al. 2014). At this point we are drawn attention to IKS and highlighted by both Vermuelen et al (2012) and Rurinda (2014) stating that crop breeding improvements to cope with changing climates need to understand where abiotic stresses are dominant, then match crops to future climates in a way that accounts for uncertainties. In support of this, proponents of local knowledge suggest crop identification of, for example, sorghum and millet or sweet potato as well as combining rotational pastoralist knowledge accommodates for the shortfalls in addressing the challenges mentioned above (Laurie et al. 2015) (Rurinda et al. 2014) (Brown 2009). These major points bring to light the need to investigate different species for planting in Sub-Saharan Africa shedding light on Laurie et al. (2015) who recommend that policies be adjusted to incorporate orange flesh sweet potato in government development programmes with the goal of reducing vitamin A deficiencies. They also suggest that public private partnerships will be crucial for up scaling the positive impact of orange fleshed sweet potatoes on food and nutrition security (Laurie et al. 2015).

In concluding, it is clear that food systems faced with CC need urgent remedial action in spite of various uncertainties. Policy makers need to apply strategic approaches that focus on key dependencies and processes within a holistic system. Downscaling models and impacts to regional level and decadal timeframes of uncertainty in CV is a disincentive for investment in improved agricultural technology and results in CC driving price fluctuations which lead to acute food insecurity. If improperly managed rural rangelands will become too fragmented. Such a situation could be a driver of future urbanization that is not fuelled by the desire to gain prosperity but rather an urbanization that is driven by survival. The key challenge to addressing food insecurity is to produce more crops on less land while recognizing that improved investment into agriculture could increase degradation if not managed carefully (Vermeulen et al. 2012)(van Wijk et al. 2014). To assist with this management, Krishnamurthy et al. (2014) Provides insight into methods for analysing food security and vulnerability to CV that is replicable at different scales to create robust planning tools for policy makers. This is achieved primarily by examining plausible impacts of CC by constructing scenarios that fall into the vulnerability model (Krishnamurthy et al. 2014). Based on current and future scenarios of social and environmental conditions, it should be possible to determine an outright status of climate vulnerability by assorting empirical research into an integrated vulnerability index that highlights the resilience and adaptive capacity of an area to with regards to CV.

2.4 *Impacts of climate variability on vulnerable livelihoods*

The literature suggests that CV has an adverse impact on rural households and supporters of this on a broad scale suggests that CV becomes an economic problem by creating severe price shocks that negatively affect the livelihoods of people globally. In line with this is the notion that CC and CV negatively affect development and pose challenges to meeting the sustainable development goals. Key to this assumption is that variability in weather patterns carries with it the most severe impacts on the poorest households in developing countries. This, as discussed in section 2.3 above, is largely because shocks brought about by climate anomalies sharply reduce food supply and this has alarmingly detrimental effects on poorer households as they usually cannot adapt their livelihood practices in time to cope. (Brown & Kshirsagar 2015)(Dube & Phiri 2013)

Furthermore, the implications of CV on HHs is discussed in research that was conducted in Asia, it suggests that drought has severe impacts on water supply, crop production, unskilled rural employment and financial status of HHs in drought prone areas of Asia. The research is in support of Dube & Phiri (2013) who state that adaptation to water scarcity and crop production is primarily a developmental issue that severely retard financial and economic improvements to livelihoods for those trying to exit the cycle of poverty (Udmale et al. 2015). With this in mind, the importance of reducing vulnerability was explored by Shackelton & Shakelton (2008) who state that surrounding ecosystems can provide safety nets when households experience shocks as mentioned above. However, this should be taken in context suggested by Dube and Phiri (2013) who point out that the altered physical geography as a result of CC often leads to disappearance in flora and fauna an especially at latitudes near each of the tropics, this will leave vulnerable HHs unable to access their surrounding ecosystem services as safety nets (Dube & Phiri 2013).

Other commentators such as Brown & Kshirsagar (2015), Dube & Phiri (2013) and Udmale (2015), state that CV becomes a challenge to economic development. Brown & Kshirsagar (2015) note that for example, impacts of CV have had an affect on various commodity markets across 51 countries. The study idicates that prices of food comodities increased while prices for industrial comodities decreased as the increase in food prices resulted in a trade off favoring industrial activity. The empirical results obtained by Udmale (2015) showed largely negative impacts of CV which stated that during drought access to domestic water supply was cumbersome, and time spent on water collection activities doubled compared with normal rainfall years. There was also a loss of 86% in major crops, reduction in farm employment opportunities and an increase in unskilled labour in off farm activities (Udmale et al. 2015). As much as 69% had to get loans and 79% delayed payments on loans due to drought (Udmale et al. 2015). Although the economic damage tended to vary according to HH size, income, landholding size, farming system and drought intensity (Udmale et al. 2015). Dube & Phiri (2013) found that their participants identified significant restraints on water and food supply which was severely retarding developmental prospects. A shortened summary of the above issues is provided by Brown & Kshirsagar (2015) who established that local food markets are affected most by international weather changes and reduces economic activity through domestic weather anomalies prompting the discourse to consider food markets as part of an increasingly complex system (Dube & Phiri 2013) (Brown & Kshirsagar 2015).

The literature on global CV highlights the need to improve the understanding of the magnitude and relative importance of weather disturbances and how to mitigate adverse impacts of weather disturbances (Brown & Kshirsagar 2015). Furthermore, there are notable occurrences of declining precipitation and rising temperatures making farming difficult and aggravating food insecurity in arid and semiarid areas of the globe. In designing these vulnerability reducing programs, special attention should be given to increase livelihood resilience when designing drought management strategies (Udmale et al. 2015). Drought stricken areas suffer a resultant loss of human, natural and financial capital during these climate shocks. Increases in debt and subsequent defaults also display negative impacts on financial systems as the ability of borrowers to pay back debt influences financial liquidity of these institutions (Porrit 2009). When referring to the SLF the literature on global climate change indicates there is a general reduction in resilience and increased vulnerability as a result of uncertainties regarding climate.

Research on CC and CV impacts that focus on sub Saharan Africa indicate that there is the need to track alterations in livelihood discourse over periods of time to reflect CC as well as ENSO induced variability in relation to household adaptation strategies. Suggestions have been made to spatially monitor both social and environmental change. The results of this monitoring can then be used to group HH Livelihood strategies so as to fall within certain eco-livelihood zones such as in mid latitude zones in Sub-Saharan Africa. These data can be integrated with observed changes in for example farming practices in order to measure impacts of CC and induce vulnerability on sub-Saharan African communities and populations (Donohue & Biggs 2015)(Jankowska et al. 2012)(Seo 2014).

Both Jankowska et al. (2012) and Donahue & Biggs (2015) have explored the benefit of using asset based inventories to, on the one hand display household resilience, and on the other, to highlight the relationships between temperature, precipitation and the SLF (Jankowska et al. 2012)(Donohue & Biggs 2015). Others such as Seo (2014) focus, more specifically, on relationships between human and natural capital in varying agricultural ecological zones (AEZs) as a method for understanding agriculture and measuring the impacts on it as a result of CC. These could entail, *inter alia*, farmers' decisions on the length of growing periods to assist future predictions of farming practices relative to CV. These can be determined by observing behaviour involving such choices as crop type net revenue,

livestock species distribution, and grain yield (Seo 2014). Additionally, Seo (2014) found that it won't be appropriate to include activities such as natural resource collection, as risk management with these activities are difficult to capture and found that trying to apply AEZs to measure impacts of future CC while including this was difficult. Although Shackleton & Shackleton (2004) as well as (Twine et al. 2003) have managed to do so by including natural resources into various CC scenarios. Donahue & Biggs (2015) went further and identified considerable spatial variability in ecosystem use which highlights effective methods for monitoring change in socio-ecological systems.

The suit of results obtained from the research that is focused on Sub-Saharan Africa present potential locations alongside their appropriate livelihood strategies. This aims to target livelihood capitals appropriately to facilitate SD for the future. These developments are based on the assumption that no one capital in the SLF can use up in perpetuity any of the other livelihood capitals (Donohue & Biggs 2015). However, it is worthwhile to note that the intersection of CC and macro-demographics may shift the vulnerability experienced by HHs. Identification of the risks associated with human capital are prominent findings at macro level suggesting that millions of people in Sub-Saharan Africa are at heightened risk of malnutrition from CC and its induced livelihood changes resulting in stunting effects on hundreds of thousands of children. This would indicate vulnerability hotspots that need urgent adaptation interventions (Jankowska et al. 2012). Another challenging aspect of climate agricultural research is that shifts in agricultural behaviours are hard to measure. This should promote the need for future research to improve classification of agro eco-systems and develop improved integrated analysis of environmental systems and economics (Seo 2014). The majority of literature suggests that urgent CC programs and policies are needed to prevent livelihood catastrophe in semi-arid regions of sub Saharan Africa and further suggests that interdisciplinary studies to identify CV adaptation would be most practical and effective (Dube & Phiri 2013).

Research on vulnerable groups conducted by Mubuya (2012) forms the basis to narrow down literature on CV influences on vulnerable communities. This is done by highlighting the extent to which CV in Southern Africa is set to increase. It suggests that Southern Africa will likely get drier and experience more variable weather conditions which indicate that Southern Africa is going to experience more droughts and floods in the future. Amplifying these are indications that risks don't exist in isolation and are compounded by a multiplicity of

stressors. The threats of these risks indicate the need to understand, at a local level, farmer perceptions with regards to climate risks within complex systems. Mubuya et al. (2012) applied both qualitative and quantitative methods to investigate perceptions regarding threats to livelihoods in southern Zambia and found that farmers reported changes in local climatic conditions consistent with documented CV. However, it was also stipulated that it is still problematic to assign contributions of CV and other factors to negative impacts on the agricultural and socio-economic systems as there may be other forces at play (Mubaya et al. 2012). Literature on vulnerable populations indicate that CV remains the most critical issue facing the rural poor and its role in exacerbating livelihood insecurity for those societies with higher levels of vulnerability to these stressors.

2.5 *Reducing vulnerability and increasing adaptive capacity through institutions*

At the global level of addressing climate adaptive capacity, supporters of this such as Butler et al (2014) interpret CC adaptation as something to be considered alongside other human development metrics and has argued in favour of a decision-making framework that supports the development of capacity to adapt to CV. Wang (2013) agrees with these sentiments, by studying areas on the Mongolian plateau in Asia he explored these possibilities in greater depth. The studies focused on a principle that adaptation to CV is an integral aspect of achieving SD by accounting for the dynamics of complex systems such as mentioned in section 2.4 above. Both studies consider the merits of applying an analytical framework that focuses institutions in studying of adaptation to CV. The key assumptions underlining these are that HHs whose livelihoods are under stress will find adaptation or coping measures as a survival means and through these adaptive strategies begin to formulate institutions that support the development of resilience for the future. The key theoretical consideration is that it is through the understanding of complex systems and resilience thereof that is the key for CC adaptation policies (Butler et al. 2014)(Wang et al. 2013).

Fuss et al (2015) elaborates on the concern about food security issues that CC raises and the need to adapt rather than focus on studies quantifying CC impacts at HH level focusing specifically on crop yield. The key to this study is that it is the changes in yield variability that may be of more importance to food security. Thus, current remedial aid in this space could result in decision making that is reactive and not robust across varying scenarios (Fuss

et al. 2015). Karfakis (2012) indicate that CC is indeed creating vulnerability to food security as large scale analyses are based on differing scenarios. The study also calls for the application of a framework for assessing the impacts of CC and weather shocks at HH level. This framework can be used to outline key policy messages for successful adaptation to CV. (Karfakis & Smulders 2012)

Further studies abroad such as Petzold & Ratter (2015), Koontz et al. (2015) and Qureshi & Whitten (2013) address vulnerability in the context of adaptive capacity. Petzold & Ratter (2015) focused on communities of small oceanic islands which highlighted the vulnerability of these communities to CC. However, there are some encouraging factors that have been drawn from this study such as the observation that these communities display a high degree of resilience through dense social capital. Their application of IKS towards economic development, political capital and dense social networks highlight the importance of social capital within the SLF (Petzold & Ratter 2015). Furthermore, adaptive governance depends on adaptive institutions and the many variables affecting adaptive institutions. This leads to the suggestion that research should be targeted towards institutional change with the goal to nurture social capital and by doing this improve adaptive capacity (Koontz et al. 2015). Other insights into institutions show that CV impacts differently on natural resource users depending on resource availability, quality and climate. Adding to this is that policy affects resource allocations and efficiency technologies while responding via changes to resource use at HH level (Qureshi & Whitten 2013). These institutions will play key roles in increasing the understanding around adaptive capacity in vulnerable communities.

There have been many ways that researchers have tried to understand adaptive capacity for example, Butler et al (2014) used interviews with provincial leaders to show causes of community vulnerability (Butler et al. 2014). While Wang et al (2013) used a HH survey designed and implemented across three broad vegetation types (Wang et al. 2013). Others decided to integrate agriculture, bio-energy and forestry to examine food security under crop yield variability (Fuss et al. 2015), while in addition, research was done by identifying differing types of rural HHs as well as different statistical assessments on SLF adaptations after HH shocks (Karfakis & Smulders 2012). Petzold & Ratter (2015) applied an analytical framework based on empirical studies conducted and with a step by step approach which helped analyse the potential of social capital in adaptation frameworks (Petzold & Ratter 2015). Further studies looked at two decades of literature to guide research into institutional

change (Koontz et al. 2015) and another study used positive mathematical programming to check impact of two incremental adaptations (Qureshi & Whitten 2013).

Some of the results obtained through uses of the methodologies provided above are explored in the paragraphs that follow. Butler et al (2014) found that community vulnerability is dynamic and highly complex with 20 different interacting drivers (Butler et al. 2014). Wang's study in Mongolia found that in China and Inner Mongolia, Local institutions played a large role in shaping livelihood adaptation strategies. Some strategies are: Storage, livelihood diversification and market exchange as the three key categories of adaptation strategies shaped by market institutions and local government in inner Mongolia. These local institutions had both enhancing and undermining effects on adaptive capacity at times. Furthermore findings also suggested that sedentary grazing increased livelihood vulnerability of herders to CV while the storage of forage had become an important strategy of herders to adapt to a highly variable climate (Wang et al. 2013).

As elaborated on in section 2.3, food security requires overproduction to meet minimum food demands. This, *inter alia* leads to higher prices and large cropped areas which increases GHGs and pressure on biodiversity (Fuss et al. 2015). There is also evidence of the loss of welfare measured by increases in poverty, food insecurity or health related impacts as found in further studies (Karfakis & Smulders 2012). Other results show the importance of social capital and the need for holistic livelihood frameworks to achieve effective adaptations to CV (Petzold & Ratter 2015). There are still however, many confusing factors that can be traced back to local institutions regarding federalism, polycentricism, networks and the diffusion of knowledge to name a few (Koontz et al. 2015). These are found to be prominent impacts of CV while the effectiveness of adaptation options vary across regions (Qureshi & Whitten 2013)

From the global perspective Butler et al. (2014) Suggested that the use of livelihood innovation is achievable through multi-scale systems scenario planning and adaptive co-management. It is also beneficial to pre-empt rapid social change to build capacity for imminent impacts brought about through CC (Butler et al. 2014). Whereas Wang et al (2013) show that behaviours in the purchasing of forage, for example, depend on: strategies of livestock management, financial capital management, environmental variability and finally the status of pasture degradation. Such behaviour suggests that there are many factors that

determine effective adaptation strategies (Wang et al. 2013). Other studies point to further positive developments such as trade liberalisation and enhanced irrigation that have shown to be promising adaptation channels to stabilise food supply (Fuss et al. 2015). In addition to these findings, there are certain policy priorities for farmers that are unable to adapt to changing conditions. These policy priorities should support production, supply and consumption patterns. If policies are not effective in delivering adaptation strategies, then in all likeliness an exit from the agricultural industry is expected.

A potential buffer against threats brought about by CC to livelihoods are adequate safety nets which are important to both urban and rural poor who are spending a significant share of income on food (Karfakis & Smulders 2012). It is also important to understand that social features like family networks and collective action are integrated into local decision making and planning to provide these safety nets. Collective memory for adaptation can in addition, be used by building on lessons learnt by civil society and adapted to assist with acceptance of adaptation measures and in doing so, improve community resilience (Petzold & Ratter 2015).

Key aspects of institutional adaptation will be better understood through future research determined to identify the potential negative effects of key variables such as polycentricism and, income inequality. This understanding extends to include heterogeneous networks that increase coordination costs and results in a hindrance to the establishment of adaptive institutions. Thus, future research needs to identify factors that foster adaptability in different societal contexts. This could be done by trying to understand regional differences in strategy for adjusting to CV (Qureshi & Whitten 2013) (Koontz et al. 2015).

Narrowing the discussion slightly, the focus moves onto Sub-Saharan Africa. Here there is an increasing amount of research stating that robust institutions are needed to affectively adapt to future challenges brought about by CV. In African communities, informal associations are becoming increasingly important in shaping and mediating adaptation practices, this suggests that social innovation for analysing climate adaptation can take place in multi-staged institutional environments with complex vulnerability. Furthermore, local institutions have the ability to facilitate collective experimentation and risk management which contribute to livelihood resilience (Rodima-Taylor 2012). Smucker et al. (2015) agrees institutions should play a role in CC adaptation. In their study conducted in Tanzania local institutions are

examined and their role amongst differing rural populations with regards to CC adaptation was assessed. In the research it was also suggested that corruption of institutions represented a threat to adaptation developments by failing to address governance and social equity (Smucker et al. 2015). Olmstead (2013) further supports the value of institutions by suggesting that the influences of CV on resource supply, demand and adaptation, had led to negative economic impacts such as unemployment and inequality. This was evident in the institutions that manage river basins. These institutions show the ability of communities to apply adaptation strategies to mitigate negative economic impacts by managing their natural capital. Furthermore, Olmstead theorises that the formal implementation of beneficial adaptive responses will need to be implemented by regional and national water management institutions (Olmstead 2013).

Theories around socio-ecological systems in Africa suggest that adaptation to CV is complex and dynamic in the sense that they can be unequal. The theories suggest that the communities who suffer most from CV are those whose financial livelihoods are more challenging than other communities. The research indicates that a new concept of divergent adaptation should be adopted. This is when one user's or group's adaptation causes a subsequent reduction in another group's adaptive capacity. This brings the issue of inequality into the debate about climate adaptation. The study in question focused on the example of pastoral groups in Niger which showed that divergent adaptation converts to adaptive capacity usually when communities are engaged in conflict over access to resources (Snorek et al. 2014). Additional Sub-Saharan research goes further by addressing adaptation through changing the land degradation lens and accommodating sustainable land management systems. It is suggested that these strategies should link the SLF with the preservation of ecosystem services as the primary structure to assist in managing rangelands. It further suggests that there is a need for new mechanisms of tackling land degradation based on retaining critical levels of natural capital while basing livelihoods on a wider range of ecosystem services. For example, suggested measures for reducing bush encroachment [2] can be achieved through use of payment for ecosystem services schemes that aim to incentives the reduction of bush encroachment. These would be designed to enhance the flow of ecosystem services that support livelihoods in rangeland systems (Reed et al. 2015).

[2] Bush encroachment refers to the suppression of palatable grasses and herbs by encroaching woody species which are often unpalatable to domestic livestock (Miller 2007).

To bring the discussion down to small scale agricultural households, Waongo et al (2015) states that high intra seasonal rainfall variability and lack of adaptive capacity are major limiting factors for agricultural production in smallholder farming systems. Adaptation of crop planting dates would be a low cost agricultural management strategy that would aim to alleviate water stress from farming and contribute to enhanced agricultural decision making. These suggestions are based on the premise that water requirements throughout the crop growing cycle can be determined by cropping models in conjunction with IKS. Subsequently planting dates for future decades can be based on the potential maize yield simulations driven by CC projections that feed into models to determine optimised maize planting dates (OPDs) (Waongo et al. 2015).

During the literature review the researcher identified a number of different methodologies that have been applied to climate studies in Africa. At HH level ethnographic studies along with participant observation were identified as useful tools for adaptation recording (Smucker et al. 2015). Additionally, reviewing responses given by resource users to variables such as resource prices can be useful. Snorek (2014) used livelihood surveys in recording adaptations but also backed findings up with HH interviews that were conducted along a rainfall gradient (Snorek et al. 2014). Other methods propose better use of case study analysis such as Reed et al. (2015) who focused on Kalahari rangelands in southwest Botswana (Reed et al. 2015). There is also scope for comparative studies of OPDs to well established planting dates for West Africa, which can be evaluated to identify potential adaptation strategies for CC in a number of different studies (Waongo et al. 2015). Other researchers have developed methods that limit factors across farming systems through the exploration into livelihood benefits of IK assessed (Niles et al. 2015). While finally in Southern Africa economic impacts of shocks were understood in the form of direct use values, focus groups and surveys etc. for HHs in dry-land areas (Shackleton et al. 2008)

Unfortunately there is still a large research and policy implementation gap that makes it difficult to design effective adaptation institution (Smucker et al. 2015). There are however increasing possibilities to incorporate adaptive responses into integrated assessment models (Olmstead 2013). These varying institutional forms facilitate resource management of difference under diverse ranges of income categories (Rodima-Taylor 2012). Results relating to socio-ecological rangeland systems show that negative aspects such as bush encroachment limitation is a key form of rangeland degradation and would need adequate policy support to

introduce payments for ecosystem services (PES) schemes (Reed et al. 2015). Furthermore, rangeland farming practices should account for expansion of farmland and loss of pastoral space as restricting pastoral adaptation. Further results pertaining to divergent adaptation on livelihoods include for example, practices of cultivating near pastoral wells. This practice is shown to potentially limit the mobility of pastoralists that if managed appropriately wouldn't necessarily increase overgrazing degradation. Other results on institutions show that lack of adaptive capacity is compounded by conflicting governmental views, low accountability and corruption (Snorek et al. 2014). This being said, it was also found that OPDs institutions can achieve approximately 15% higher potential maize yield regardless of the regional climate model. However, the combined impact of OPDs approach showed on average that mean maize yield deviation of -23% and 34% in comparison to 1989-2008 baseline period (Waongo et al. 2015). It is these kinds of complex impacts of CV that are imperative to gauge, with the intention to understand its threat.

Results obtained in studies in sub Saharan Africa show that adaptation challenges identified by communities in Mwanga district of Tanzania show complex local institutions and resource tenure questions that are not addressed in national climate policy but require attention if CC adaptation is to be achieved (Smucker et al. 2015). Other results show there is a need for further research on resource management institutions in the creation of effective adaptation strategies to CC (Olmstead 2013). Further research establishes that connections need to be made across various scales and create the potential to enhance the adaptive capacity and possible challenges to sustainable climate adaptation (Rodima-Taylor 2012). Once such area of adaptation is through economic mechanisms that could potentially help incentivize the restoration of degraded rangelands as well as assist in the creation of more sustainable land management practices (Reed et al. 2015). The importance of these institutions are illustrated further in a case study showing the need to enhance adaptive capacity of multiple user groups to reduce conflict, increase human security and to promote resilience (Snorek et al. 2014). While others have stated that yield deviation depends on the regional climate models (RCMs) and its locations. Waongo's (2015) RCM shows that the average yields for 2011-2050 maximums show a decrease of 8% from the baseline conditions. These findings highlight the potential of OPDs as a crop management strategy but on the other hand it is also apparent that farmers need to combine the OPDs with other suitable farming practices used to adequately respond to CC (Waongo et al. 2015).

Further research on the subject goes on to say that agriculture in Southern Africa is vulnerable to CC and therefore adaptation responses are necessary to minimize CC impacts on the sector. The current diversity and unpredictability of impacts along with differing capacities for change make understanding behaviours for adaptation challenging to implement. Limiting factors in the farm system such as precipitation and temperature influence the adoption of adaptation practices. Furthermore these limiting factors vary across regions and farm systems (Niles et al. 2015).

Research in Southern African adaptation to extremes is showed in the inquiry into Molapo farming methods, which is a form of IK used by low income subsistence farmers to adapt to flooding of land. whether or not current land use policy supports or stifles the practice and IK, Molapo farms are owned by women and is an important livelihood for marginalized groups (Motsumi et al. 2012). Shakelton et al (2008) also focus their research on Southern African drylands and suggest that HHs respond to shocks by use of dryland forest products. The angle of their study was focused on shocks brought about by HIV and not climate related shocks. The theoretical framework determined that HHs that experience shocks will rely on the natural environment as a safety net. Their study acknowledges the role ecosystem services provide to numerous communities but state that the role of forests in contributing to the SLF is widely debated in equatorial regions. While there is much research on this based in humid areas, it does not have much focusing on dry savannahs and woodlands (Shackleton et al. 2008).

In Southern Africa it was found that factors varied across farm systems and regions based on historical climate, agro-ecological context, infrastructure and adaptation capacity (Niles et al. 2015). Therefore the potential threat to ecological functions of fertilisers and pesticides needs to be fully understood (Motsumi et al. 2012). Finally, with regard to adapting to shocks it was found that large proportions of populations in Limpopo make use of forest products and resources from them. They form a vital component for the livelihoods of local people and prevent them from falling deeper into poverty (Shackleton et al. 2008)

Finally at the level of Southern Africa, it has been shown that farmers perceive and respond to CC in accordance to their personal experiences with CC and the limiting factors within their system (Niles et al. 2015).One such example of this constrained adaptation is possible through practices such as making use of floodplains which would minimise the need for

fertilisers and pesticides. Still there is no policy that can be implemented to use IKS on such matters (Motsumi et al. 2012). Another example of resourcefulness and adaptation are informal and formal forest activates that result in being able to move out of poverty as well as coping with external stresses. The limitations of dry areas combined with high unemployment restrict the extent of alternative locally based livelihood options. The literature goes on to point out that HIV AIDS has exacerbated people's dependence on forest products and this could be the same for stresses brought about by CV but importantly these forest products will also be impacted by CV leading indirectly to increasing household burdens if they have experienced a significant shock through unemployment, sickness or loss of life (Shackleton et al. 2008).

A Final observation of the literature suggest that communities affected by the shocks associated with climate variability tend to navigate around food security and ecosystem services through the implementation of effective institutions (Przeworski 2004). This suggests that communities are not passive actors in the ecosystem but instead are integral to sustaining the resilience of the system. Building the adaptive resilience of Limpopo will require the enhancement of effective institutions as well as the eradication of those that are not so effective (Parlee et al. 2005).

2.6 *Context of study within the relevant literature*

Although much research is being targeted towards the impacts of CV, there still remain gaps in the literature, for example, a change in the climate variance has a larger effect on agriculture than a change in the mean, and thus the effects of possible changes brought about by this variability remain uncertain. This highlights the need to understand phenomena contributing to this variance such as the (ENSO). While these are important, it is further necessary to determine the cumulative impact that future CC will impose, considering the original and additional strains on natural and managed resources over and above CV phenomena (Hulme et al. 2001). For example, land cover/atmosphere interactions as well as dust and biomass aerosols have not been factored into climate models, it has been noted that increasing aerosols has the effect of increasing heat reflection where it was once predicted to absorb. Such considerations can help improve our predictions and quantifications of uncertainties presented as a result of CV (Desanker & Justice 2001).

More research on the sensitivity of Africa to CC is needed and these should be focused on elaborating on short term seasonal timescales. These can be a reconstruction of observed CV in the last century or new regional seasonal forecasts. Steps to reducing vulnerability to adverse climate events look at increased capacity to adapt to short term and seasonal weather conditions. Adding to this would be the likeliness of added social and economic benefits from this adaptation by building capacity to cope with longer term changes (Hulme et al. 2001). Therefore, studies that capture the social dimensions of CC are needed. These should identify climate hazards that will be experienced by rural, urban and indigenous groups such as droughts, floods and CV (Desanker & Justice 2001). Identifying these climate hazards can greatly assist in guiding adaptation.

IKS are seldom used appropriately in scientific research although the potential to do so is there. IKS such as the awareness of different soil potential under variable rainfall or anthropogenic inputs support the existence of flexible and responsive management strategies which could be better at coping with increasing variability in African systems than what is suggested by orthodox agricultural science (Osbahr & Allan 2003). In Southern Africa, extreme events caused by CV need not be a major threat to household livelihoods if there is proper planning and preservation of knowledge transfer. Knowledge transfer can be promoted through building of databases to support planning and policy, while at the household level this can be inscribed in oral traditions. various studies contribute to the former and the methods used in the estimation of household access to capital and adaptive capacity can be copied or modified to develop better and universally applicable tools (Motsholapheko et al. 2011).

This review showed that most studies of outcomes of institutional and livelihood adaptation in the face of CV have focused on Central and South Asia and some areas of the Sahel region of Africa, in particular, India and West Africa. There are few evaluations on Southern Africa and these suggest early signs of success of the SLF in terms of poverty alleviation as well as climate institution adaptation when compared to the West African and Asian cases. The programs that have been successful in Southern Africa appear to have been helped by IKS, local institutions and necessity induced strategy changes. The researcher expects these conditions to hold in Limpopo Province as well. In this paper the literature guides the researcher to examine the effects of CV on livelihood strategies in Limpopo by using the SLF to guide the provisioning of safety nets in the face of external shocks (Rodima-Taylor 2012).

From the literature, it was evident that climate research should pay particular attention to local institutions, livelihood strategies and IKS.

CHAPTER THREE
METHODOLGICAL CONSIDERATIONS

3.1 *Introduction*

Methodology has been defined as the gathering, arranging and analysing of data as part of the theoretical framework and system of activities applied to field study (Barry and Proops 1999). It includes: research design, study location, sampling techniques, limitations of the study as well as methods used for data collection, analysis and reporting. The study has intended to collect both quantitative and qualitative information; this has been used to establish demographics, skills, livelihoods, assets and land use. Household surveys were used to gather quantitative information, while focus groups and key informant interviews were used to extract necessary qualitative information. The intended research employed data triangulation which optimally combined *quantitative* and *qualitative* data. *Quantitative* research involves generating data into a quantifiable form which can be subjected to rigorous analysis in a formal and rigid fashion. The *qualitative* research approach is concerned with a subjective assessment of attitudes opinions and behaviours and this data is in a form that is not subjected to rigorous analysis (Hox and Boeije 2005).

Data was sourced using two kinds of data:

- **Primary data** extracted through means of a site visit, during which surveys and interviews was conducted with the purpose of determining livelihood strategies in response to CC.
- **Secondary data** was sourced via desktop review of relevant literature, 2011 national census, information gathered while conducting impact assessments in the area as well as pertinent information located in the local municipalities (LMs) and district municipality (DMs).

The methodology described in this chapter seeks to achieve the aims of understanding the impacts of CV on integral aspects of rural livelihoods such as food security. It also intends to indicate which of the five capitals of the SLF are playing key roles in building resilience and adaptive capacity, as well as identifying the challenges that are hindering the adaptation of these rural communities.

3.2 *Research positionality*

This thesis is embedded within the theoretical framework of vulnerability to CV and resilience as well as the appropriate adaptation strategies towards CV in the global and Southern African Context.

3.3 *Research design*

The design of the proposed project is represented in the subsections that follow below. It stipulates the plan that was executed during fieldwork.

3.3.1 Study location

The study area and target populations are shown by the yellow circles in Figure 3-1 and in Figure 3-2. The VDM delineation is represented by the red outline shown in the North East of the Limpopo Province. The majority of the population in the area are Venda and Tsonga. Socio-economic conditions of these areas are described in section 3.3.2.



Figure 3-1: Location of VDM

The study areas are shown in greater detail in Figure 3-2 below, there are three main study areas that have been identified, situated in different local municipalities to represent a more decentralised governmental authority. The study areas are situated in the Makhado Local

Municipality (MKLM), the Thulamela Local Municipality (TLM), and the Mutale Local Municipality (MTLM). Both the MTLM and the TLM are situated in areas that were part of the former Venda homeland while the MKLM is not. These study areas represent different climatic, environmental, geopolitical and socio-economic circumstances and was assumed that this diversity will create a set of realities that will assist in achieving the aims and objectives of this study.

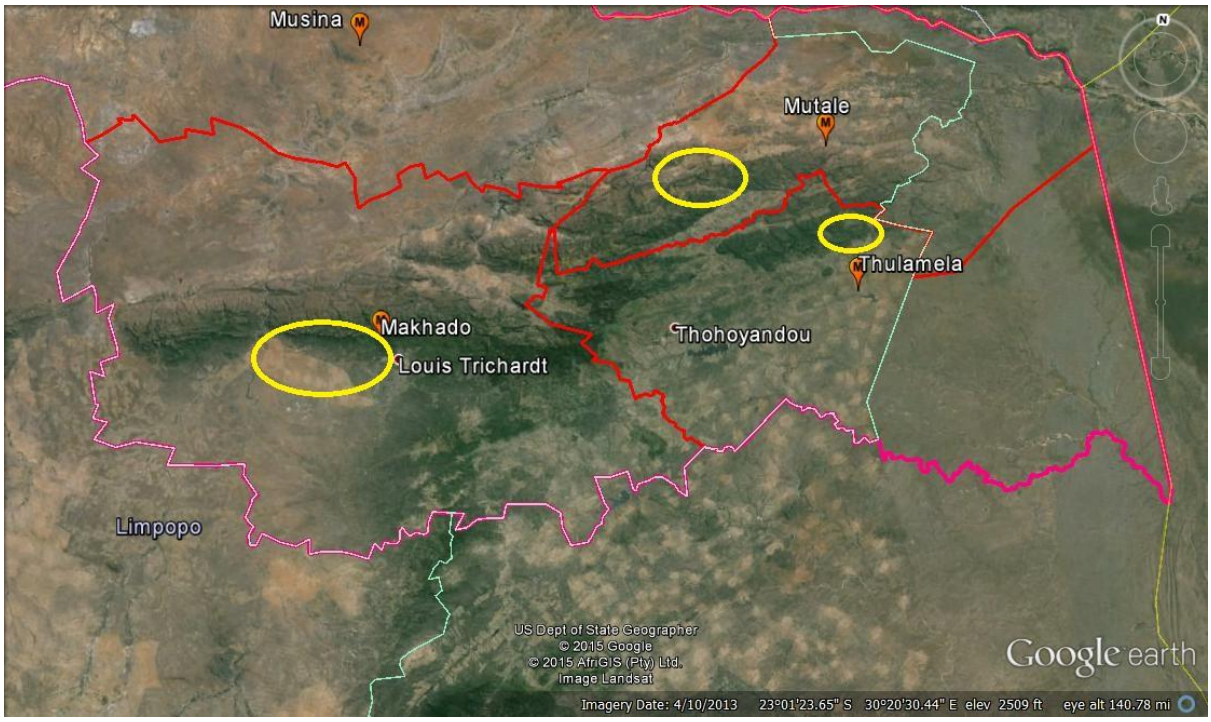


Figure 3-2: Location of study areas relative to the LMs of the VDM

3.3.2 Overview of study area

The VDM where the study area is located is one of five district municipalities in the Limpopo Province. It is situated in the far North of South Africa and borders Zimbabwe by the Limpopo River. The study areas are situated in the Thulamela, Makhado and Mutale Local Municipalities of this district. The climate of the Limpopo Basin is spatially varied in that it is arid in the west, semiarid in the east and largely temperate in the central areas. This is a result of the Soutpansberg as the key geographic feature in the area (Nel and Nel 2009). This mountain acts as a rain shadow which concentrates higher relief rainfall to the south eastern parts for the district. This often leaves the north western areas as significantly drier. The mean annual rainfall in the central and eastern parts is between 755 and 955 mm annually and in the northern and western areas can range between 560 and 750mm annually. The highest

temperatures are in January with a mean of 27.4°C, a maximum of 43.5°C and minimum of 13°C. The coldest temperatures are in winter with a mean of 15.9°C, a maximum of 32.4°C and a minimum of -3.6°C (Nel and Nel 2009). Occasionally during exceptionally wet years, the area is influenced by tropical cyclones brought in from the Indian Ocean. It is also affected by the Inter-Tropical Convergence Zone which can extend as far south to influence the rainfall in the northern parts of the district. Temperatures are at their highest in the summer months and lowest in the winter. Severe droughts in the early 1990's as well as 2015 and exceptional floods in the year 2000 illustrate the extreme rainfall and runoff in the area (Nel and Nel 2009).

Originally inhabited by Khoisan people this area was the last area to be claimed by the Boer Republic as the local Venda people of Bantu dissent were displaced in order to establish the Boer areas in the north. During Apartheid the Venda homeland was established as one of the Bantustans in South Africa which were used for the relocation of people once they had been displaced (Giannecchini et al. 2007). This area was later reintegrated in to the greater South Africa. Its history as a borne homeland has resulted in a relatively dense population that is to some extents prominent in subsistence agriculture, although other industries appear to be developing here. Its climate and history make lower income areas in some parts of the VDM particularly vulnerable to CC and CV and it is necessary for intense planning into the future in order to support vulnerable populations here in order for further sustainable economic development to thrive (van Marrewijk 2013).

3.3.2.1 Demographics and human capital

The total population of the regional study area is 761 935 (StatsSA, 2013). This population reside in 315 234 households with an average of 3.8 people per household. The areas comprising the regional study area experienced a lower than national average population growth rate during the last decade (1.3%) according to available census data. The population of the regional study area grew at 0.69% between 2001 and 2011. The MTLM had the highest growth rate at 1.03%. The TLM has had a population growth of 0.62% between 2001 and 2011, whilst population growth of the MKLM was 0.43% (StatsSA 2013). This suggests that these populations are relatively stable and that development around the central economic nodes has not attracted an influx of migrants. Currently rates of population growth are attributing to general expanding populations however, it is apparent that people then move out of the VDM for both employment and educational opportunities. This is also highlighted

in Figure 8-1 through to Figure 8-3 in section 8.1 by the large proportion of people in the 0 – 19 age brackets (StatsSA 2011).

Population density indicates the potential pressure that human occupation might exert on natural resources and public services. The population density of the regional study area was 64 people per km^2 in 2011, with the TLM having the highest (106 people/km^2) and the MTLM the lowest (24 people/km^2). It is worth noting that the national population density is 42 people per km^2 (StatsSA 2011). This indicates that there is a greater than average population density in the VDM which is as a result of history with it encompassing the former Venda homeland area. The MTLM indicates that it is more of a rural LM than the other two.

The dependency ratio shows the amount of older and younger dependants on those of working age i.e., those aged 64 and older as well as those aged 15 and younger. In regional terms, there are 74 people that are dependent on 100 people of the working-age population. The national dependency ratio is 52 which is substantially lower than the study areas. MTLM has the highest and the TLM has the lowest, a high dependency ratio indicates increased burden on state welfare systems as working people will not have to rely on these (StatsSA 2011).

Table 3-1: Demographic summary

	Makhado	Thulamela	Mutale	Regional
Population	51603	618462	91870	761935
No. of HHs	134889	156594	23751	315234
Density Persons /Km^2	62	106	24	64
HH size	3.7	3.9	3.8	3.8
Pop. growth (%)	0.43	0.62	1.03	0.69
No of Agri. HHs	50625	71812	12751	135188
F headed HHs (%)	52.1	54.4	54.8	53.76667
Dependency	72	70.1	79.9	74

Source: (StatsSA 2011)

Gender and age are important variables, as they indicate the labour-sending capacity of an area. Figure 8-1 to Figure 8-3 presents the gender ratio for the region is 83.1 males to 100 females. In the MKLM it is 84.8%, in the TLM it is 82% and in the MTLM this is 82.6% which shows more females than males in all areas suggesting these areas are mostly labour sending areas that will rely on migrant labour of male workers employed in other parts of the

country. The age distribution shows that the majority of the local study area's population falls within the 0-19 year bracket, while there are still many people that are younger than 14 years (StatsSA 2011). This indicates a large propensity of people tend to move out of these areas who are above the ages of 15, most likely for education and employment opportunities.

Racially, the regional population comprises mostly African (81%), followed by White (11%). The most prominent language spoken in the regional study area is Tshivenda, followed by Xitsonga then Afrikaans (StatsSA 2013).

The level of education among the regional population is low, with between 7% and 8% having completed Grade 12 and between 43% and 46% not completing primary school (StatsSA 2013). Relatively low education levels usually have negative implications for the employment potential of the population and also for the feasibility of local economic development (LED) initiatives (UNDP 2014).

Table 3-2: Education levels for those over 20 years of age

	Makhado	Thulamela	Mutale	Regional
No schooling	19%	17%	19%	18%
Less than matric	50%	49%	55%	51%
Matric	22%	22%	19%	21%
Higher	9%	11%	8%	9%

Source: (StatsSA 2011)

3.3.2.2 Services and physical capital

The Constitution of the Republic of South Africa (Act 108 of 1996) provides all South African's with basic human rights, which includes the rights to access basic infrastructure and services. Free Basic Municipal Services (FBS) such as electricity, water and solid waste management provision are provided by the municipality to households who cannot afford basic municipal services.

Figure 8-5 below shows household assets, used as a representation of physical capital. These can assist with livelihoods shocks through reciprocal trading with neighbours and relatives as well as providing a better quality of life. The figure shows that cell phone ownership was very high indicating the importance of communication among social networks. Vehicle

ownership was notably low indicating lack of access to financial capital as well as a dependence on public transport.

Those who do have access to housing mostly reside in formal dwellings. Of these, as much as 61% of houses in the regional study area have been paid off. This may indicate that there is an ability to pay back debt and also indicates a low willingness to get into debt for housing purposes (StatsSA 2013). This is encouraging for LED prospects, as a low debt level will likely encourage spending in the area, which will have a positive effect on consumer expenditure.

Table 3-3: Housing tenure

Tenure status	Makhado	Thulamela	Mutale
Rented	8%	5%	4%
Owned and fully paid off	58%	66%	58%
Owned but not yet paid off	4%	4%	6%
Occupied rent free	29%	25%	31%
Other	2%	1%	1%

Source: (StatsSA 2011)

The Vhembe District Municipality is a water service authority and its local municipalities are the service providers. The District municipality purchases clean bulk water from the Department of Water Affairs. They are responsible for processing and cleaning the water before local reticulation. It is the goal of the Vhembe Municipality to supply every household with a reliable and adequate supply of potable water. According to the District Commissioned Study, 128 372 households have access to water in the District. The water is however, not up to The Reconstruction and Development Programme (RDP) standard, which has created a backlog in service upgrading. The Vhembe district has 11 dams although ground water is an important resource in the District with a total of 1358 boreholes being used. Of the 1358 boreholes in the district, only 861 are operational. Those that do not work are as a result of drought, vandalism and saline intrusion[3] (Vhembe District Municipality 2012).

Just over 66% of households in the regional study area are supplied with water by regional water schemes. The water supply infrastructure has deteriorated as a result of ageing

[3] Saline intrusion refers to groundwater that has been overused, once the fresh water is used up, the surrounding salt water will take the place of the freshwater leaving a groundwater resource useless to humans and the surrounding ecosystem (Miller 2007).

infrastructure and corrosive effects (TLM). The result is that water supply infrastructure is prone to bursts and leaks, resulting in water losses. Table 8-3 shows where most of the population gets its water from. Groundwater (made up of boreholes and springs) are used by 15% of the population in the region. This could be as a result of there being non-operational boreholes in the area. Surface water (consisting of dams, lakes, rivers, streams) is more prominent in the MTLM which is concurrent with its more rural status than the other two LMs. There is a noticeable lack of rain water tanks being used in the area and represents an opportunity for potential Corporate Social Investment or focused governmental LED operations (StatsSA 2011).

Approximately 9% of households in the region have access to flush toilet facilities and the remainder mostly rely on pit latrines. This figure is lower than expected because it is substantially less than the national average of 60%. In the MTLM this is as low as 4%. (StatsSA 2011).

With regard to the energy usage most households in the regional study area (80%) rely on electricity for lighting, with 73% and 61% using it for cooking and heating respectively (StatsSA, 2013). Many households, however, still rely on alternate energy sources (e.g. wood, candles and paraffin) for heating and cooking purposes (StatsSA, 2013).

A legacy of poor refuse removal in South Africa still requires a large effort to overcome. This is noticeable in the large proportion of the population that still do not have access to formal refuse removal in the region. As highlighted in Table 8-4, there are still many people who are forced to make use of their own rubbish dumps. This also points to a propensity towards pollution and environmental degradation that needs to be addressed in order to preserve the integrity of their surrounding environments (StatsSA 2011).

3.3.2.3 Economy and financial capital

South Africa experiences serious challenges in terms of poverty, inequality and unemployment. With regards to poverty, it is useful to understand what level of income is required in order to escape poverty through compound investment savings. According to the World Bank, this threshold is approximately USD2 000 per person per year, or approximately

R30 400[4] or R2 533 per month, for an average household size of 3.8 people, this translates to an annual household income of R115 520 or R9 626 per month (UNDP 2014).

Approximately 89% of the households earn less than R76 400 per year indicating high levels of poverty, with the largest proportion situated in the MTLM (90%) and the smallest in the MKLM (88%). StatsSA (2013) showed that as much as 13% of the regional population earns no income whatsoever. These issues point to the second challenge, being inequality. Affluent South Africans in 2010 experienced a Human Development Index[5] (HDI) score of 0.86, which placed them in the category of very high HDI and amongst the 25 best performing countries in the world for this index (it rated higher than the United Kingdom and equal to Spain). The HDI of those South Africans who are caught in the poverty trap live in scores as low as 0.47, which is on par with some of the lower performing countries in the world (lower than Kenya and equal to Bangladesh) (UNDP 2014).

Table 3-4: Annual household income

Income	Makhado	Thulamela	Mutale
None	12%	11.9%	13.2%
R1-R4 800	7%	8.9%	8.9%
R4 801-R9 600	13%	16.4%	17.5%
R9 601-R19 600	25%	23.9%	24.0%
19 601-R38 200	22%	19.8%	19.1%
R38 201-R76 400	9%	7.6%	7.4%
R76 401-R153 800	5%	5.3%	4.9%
R153 801-R307 600	4%	3.8%	3.3%
R307 601-R614 400	2%	1.8%	1.3%
R614 001 -R1 228 800	0%	0.3%	0.3%
R1 228 801 -R2 457 600	0%	0.1%	0.1%
R2 457 601 or more	0%	0.1%	0.2%

Source: (StatsSA 2011)

This leads to the third challenge of unemployment: in the regional study area unemployment levels are at 23%, this shows slightly better employment than the national average (25.2%) however, this expands to 52% when including discouraged work seekers. This regional

[4] Taken at exchange rate of 15.25 R to the $ on 22/3/2015
[5] The HDI is developed by combining three primary indicators, these are: life expectancy at birth, mean years of schooling for those aged 25 and gross national income at purchasing power parity. The top performing countries on this index in 2014 were Norway, Australia and Switzerland.

employment profile represents too many people of working age who are without work. (StatsSA 2013).

Employment rates within an area are linked to the size of the economy, as well as to personal income, education levels and skills. An important consequence of high unemployment and low income levels is that a considerable proportion of households cannot pay for basic services, which places severe pressure on municipal resources as well as natural resources due to higher demands for services among poverty stricken populations.

Figure 3-5: Employment status

Employment status	Makhado	Mutale	Thulamela
Employed	53%	38%	45%
Unemployed	31%	36%	35%
Discouraged work seeker	16%	26%	20%

Table 3-6: Expanded employment status

Employment status	Makhado	Mutale	Thulamela
Employed	53%	38%	45%
Unemployed	47%	62%	55%

Source: (StatsSA 2011)

3.3.2.4 Agricultural activity and natural capital

StatsSA indicate that agricultural in the VDM is relatively diverse with livestock farming, vegetable production as well as staple crops being cultivated in each of the municipalities in the study area (Figure 8-6). In terms of income generation, it would appear as though there are little incentives to get involved in the agricultural industry in VDM with the majority of farms generating between R4 801 R 38 400 a month. As much as 36% of farms generate no income and are mostly subsistence. This is clearly in the more rural areas as this was the case for the MTLM (Figure 8-7).

3.3.3 Sample

The research participants were: Ward councillors, traditional authorities, farming co-ops, and individual households. It was required that these groups be consulted because they have the best knowledge of local institutions, climatic conditions and agricultural practices. Where

possible male, female and youth community members were consulted with separately, so as to ensure that there was no external pressure resulting in inaccurate data.

3.3.4 System

Through consultation with local councillors as well as the traditional authorities, appropriate communities in which to conduct the study were selected. 25 surveys per community were carried out with the use of random interval sampling technique to identify households. After one household was surveyed, an interval of five houses was used then the household on the opposite side of the road was selected. This kind of sampling is also known as chance sampling, where each individual household has an equal chance of being sampled and each one has the same probability of being selected. 75 Households were selected and these were the households included in the study.

In addition to the 25 surveys, one interview was carried out per community. These interviews were conducted with tradition al authorities and ward councillors present. The responses to the interviews were transcribed by the researcher. The schedule of interviewees is listed in Table 3-7 below.

Table 3-7: Stakeholders present for key informant interviews

Study area	Present at interview
Gundani	Gundani TA and ward councillor
Mahagala	Mahagala TA and ward councillor
Tshikuwi	Tshikuwi TA and ward councillor

3.4 *Data collection tools*

Data collection happened in two ways, the first was to review via desktop existing literature such as books, documents and previous studies conducted in South Africa and other countries. Any required biophysical data was as much as possible sourced from previous environmental assessments or studies carried out in the general area. The abovementioned methods made up secondary data collection techniques while primary data was sourced using surveys, focus groups and key informant interviews, these interviews were semi structured so

as not to appear as pushing any certain agenda. All primary data was collected by means of a site visit and while on sight, observations were used to correlate data collected.

3.4.1 Secondary data literature review

A literature review can be applied as a means of collecting necessary information for the completion of the report. These sources are books, national, provincial and local legislations and policies, previous studies conducted in South Africa and other countries, theses and internet sites (Hox and Boeije 2005). Secondary data was reviewed initially through the university library using a range of information sources such as the OPAC system, academic and commercial abstracts, bibliographic databases, and Internet search engines (Williams 2007). The collection began with background reading which provided a guideline as to where and from whom the researcher could access the required information (Bless and Higinson-Smith 2000). The primary tool for this part of the research was the researcher.

3.4.2 Primary data collection and sampling

Where gaps were identified in the secondary data it was necessary to extract primary information pertaining to these by means of household surveys, participant observation, semi structured interviews and focus groups. Wheeldon and Faubert (2009) described data collection as the process of gathering and quantifying information on variables of interest in a systematic way that empowers the researcher when answering a stated research question and the evaluation of hypothesis and outcomes.

3.4.3 Household questionnaires

HH questionnaires were used to establish an index that indicates the vulnerability and sensitivity of communities in the area to risks associated with CV in the VDM. The index was created by combining three main themes for the household surveys, these were: a Socio-economic survey, individual and community asset inventory and a livelihood survey all combined into one large survey. The purpose of these was to establish the level of access to five kinds of capital and the adaptation strategies associated with these, these are: Human capital, financial capital, environmental capital, natural capital and physical capital.

3.4.3.1 Socio economic survey

Once the fieldwork plan had been constituted, a socio-economic survey was undertaken to establish the location and characteristics of each household (e.g. the number of household

members, their Extension of Security of Tenure Act (ESTA) rights in terms of length of occupancy, employment status, livelihoods, access to capital, vulnerability to the possible negative socio-economic impacts of CV, etc.).

3.4.3.2 Asset survey and inventory

An asset inventory was conducted simultaneously to reflect the land use and adaptive resilience of the communities. Data collected during the asset inventory, as well as by the socio-economic survey discussed in the previous sub-section, was captured in an electronic, database. The database was subject to rigorous quality control mechanisms – e.g. spot checks of captured data and verification of internal consistency of data for each household. This combined data served the following functions:

- It provided a baseline for subsequent monitoring and evaluation activities; and
- It provided quantitative data for the planning of CV risks and subsequent adaptation logistics.

The owner of the asset was present during the exercise and required to countersign the inventory sheets, as proof that he/she agrees to the assets that have been recorded. The various components of the asset inventory are outlined below.

3.4.3.3 Structures

Information was collected on all residential structures belonging to each household, including, its use, construction materials and condition. Similar information will be collected on secondary structures (such as livestock pens, poultry shelters, etc.).

3.4.3.4 Fields/food gardens

In the event that a household relied on the cultivation of arable land or economic trees, a survey of the cultivated areas was undertaken; this comprised the following activities:

- The recording of all agricultural fields;
- The primary use and distances of these fields; and
- The number, ages and types of economic trees were recorded.

3.4.3.5 Communal assets and ecosystem services

Photographic records and relevant information was also collected on communal assets and resources that are important for the community, and the local institutions that monitor the

harvesting of these resources. These were correlated against information gathered for section 3.4.3.4 so as to establish the importance of land tenure in CV resilience. Examples of such communal assets and resources include water sources, recreational facilities, grazing areas, areas used for harvesting natural resources (e.g. firewood), etc.

3.4.3.6 Livelihood survey

Livelihoods encompass systems of accommodation and settlement, income generation and resource use, as well as systems of social interaction, cooperation and mutual support. This survey was cross referenced with sources of income indicated in the socio-economic survey.

The objective was to determine that affected people's livelihoods and living standards are maintained or improved to a sufficient degree or not at all after external shocks brought on by CV, when all is taken into account, they are better-off than they were prior to their disruption indicating the resilience. The identification of affected people (defined as those who in any way are deprived of assets or access) as project beneficiaries:

- The participation of affected people as the architects of their own adaptation or adaptive management; and
- The inclusion of host communities in livelihood restoration as a way of negating any impacts they may experience because of the introduction of the adaptive management in the area.

Potential livelihood adaptation and development options that were investigated in consultation with communities included the capacity to develop:

- ***Smart Agricultural projects.*** The form of adaptation with development of small-scale smart agricultural projects was determined by the availability of suitable institutions, agricultural and other resources, as well as production options that were assessed by the researcher in consultation with the affected households; and
- ***Non-agricultural or wage-based income generation opportunities.*** To prepare vulnerable homesteads for livelihoods that are wage-based or enterprise-based (where adequate agricultural land is not available).



Figure 3-3: The researcher and participants during the qualitative and quantitative data collection

3.4.4 Interviews

Qualitative data can be used to confirm or verify results found during the collection of quantitative information. This data can be sourced through the use of key informant interviews, participant observation and focus groups, these are useful because they shed light on individual and community beliefs, values and perceptions (Wheeldon and Faubert 2009). Collecting these data can be done in several ways, for example, face-to-face interviews, interviewing by telephone and interviewing using a web based forum, although participant observation requires the researcher to be on site (Bless and Higinson-Smith 2000).

The series of interviews ranged from open-ended to semi-structured, depending on the nature of data required, for both individuals and groups. Open-ended questions are the most appropriate discourse towards gaining an authentic understanding of people's experiences on the ground (Neuman 2000). The study used face to face interviews, which was planned well in advance by the researcher. The possibility of a snowball technique was followed in this study. This was useful as it looked to build research themes further as a result of information gathered in preliminary interviews and focus groups.

With the help of traditional authorities, the researcher made an appointment with the research participants at a time which suited them. The participants were reminded of the interview agreement date before an interview and also given background of what the interview was about so as to achieve voluntary informed consent.

3.5 *Data analysis*

Analysis of the quantitative data was conducted in Microsoft Excel, the coded answers recorded in the surveys were captured onto spread sheets. Using formulas on Excel these were decoded to reflect the written answer that correlated to the code. From these data an array of charts and tables were constructed. In many cases the count was reflected in the data as well as the percentage. The percentage values made it easier to gauge the proportions of HHs that indicated the use of particular assets. Qualitative data was recorded in a notebook and the pertinent information was provided in such a way that it adds support to certain quantitative information that is presented.

The data was used to determine the capacity of individuals and communities for adaptive management of livelihoods in the VDM. The analysis critically analysed the livelihood strategies, adaptive capacity, institutions and policy implementation related to the risks of CV and land management in the VDM. This was done by summarising key results into the SLF that is provided in section 2.2.

3.6 *Methodological reflections*

Participating in research such as this appears near impossible from the start, the severe complexity of the situation that requires unpacking can present itself as a daunting mountain to climb. Through systematically moving towards the goal with the assistance of experienced academics, the true nature of the project begins to unfold. There are many challenges in the process, from preparation of an acceptable proposal to gaining the ethical clearance that is required to pursue the research can take a significant amount of time and it is advisable to plan for this accordingly by discussion with other academics as well as students. One of the more rewarding aspects of the fieldwork process is working in such a scenic environment which is a perk of conducting such research. Most satisfying is the opportunity to meet a diverse range of people who are accommodating, interesting and welcoming to such research taking place in their areas. Once the fieldwork is captured the results begin to unfold and can be extremely rewarding in that these results were obtain through one's own questioning and

research design. Extracting useful information that can potentially benefit the areas of research is the crux of why researchers such as me enjoy this kind of work.

3.7 *Conclusion*

To conclude this section, it is important that the reader appreciate the extent of information that is attainable from the previously mentioned data collection tools. They are designed in such a way as to focus the interviewee on minor details that are brought together to shed light on the full suite of livelihood strategies employed by some of the HHs in these communities. Furthermore, the research is merely a sample and with only 75 HHs interviewed these data represents a small portion of these communities. Due to these limitations, a broad baseline for each LM was sourced via StatSA (2013) and summarised in section 3.3.2.

CHAPTER FOUR
EMPIRICAL FINDINGS

4.1 *Demographics, Age and gender distribution*

During the interviews respondents stated that the populations of the various study sites were 2000 people residing in Gundani, 2500 in Mahagala and 2300 in Tshikuwi. The average size of HHs was reported to be six in Gundani and five for both Mahagala and Tshikuwi. All areas stated that females outnumbered males and this sentiment was reflected in the survey data collected as indicated in Figure 4-1 discussed below.

The distribution of various age groups in a population can be graphically represented in a population pyramid. These are viewed in statistics as a very effective way to graphically depict the age and gender distribution of a population and they can reveal a great deal of socio-economic information for a particular area. It can also shed light on how many people of each age range live in an area. Usually females have a longer life expectancy than males and thus there tends to be more females in the older age groups (UNDP 2014). These statistics can also be used to determine the proportion of economic dependants defined as children who are in full-time education and unable to work as well as those over 65 who are often retired (UNDP 2014). It is important for governmental bodies to plan local economies in such a way that working populations can support these dependants.

Figure 4-1 below shows the overall age distribution for men and women across all study areas. The shape depicted in the figure deviates slightly from the typical pyramidal shape found for a growing population, in that there are a relatively large number of elderly people, i.e. over 65 years of age. The LM population pyramids differ slightly to what was found in the study area, this is largely as a result of the relatively small sample size of the survey in comparison to the populations of each of the LMs. There is also a large gender disparity showing that of the 314 people, 185 are female and 129 are male. This suggests that the area is mostly a labour sending area as males tend to have the higher education and will often seek employment in more urban areas (Vhembe District Municipality 2015).

The survey results also show that 18% of the population is under the age of 15, while as much as 9% is older than 65. This is dissimilar to the age distribution for VDM as a whole,

where 24% of the population is under 15 and 3% is over 64, but reflects an older population than other provinces, where 33% of the population is under 15 (Vhembe District Municipality 2015).

The relatively high amount of people in the study area between the ages 15 and 25 is explained by the following factors:

- A high national unemployment rate rendering too many young people out of work and forced to reside with family members in rural areas until they can find employment; and
- The fact that many people are not completing secondary education resulting in them being unable to find work.

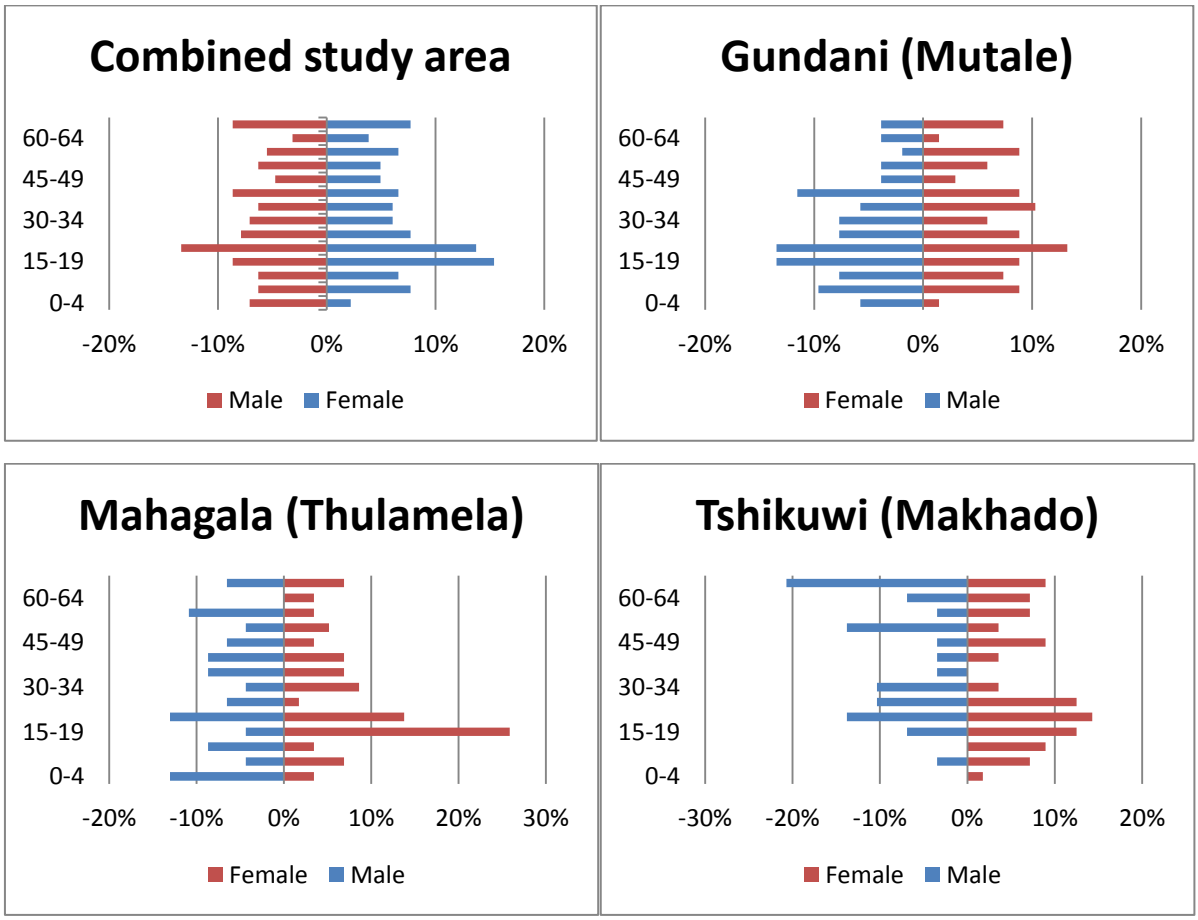


Figure 4-1: Population pyramids for study areas

4.2 *Employment levels*

Respondents from the focus groups indicated that an important source of livelihoods are salaries, indicating that there are some kind of employment opportunities, but they were

stated as not sufficient to absorb growing numbers of younger people. Most respondents stated that the majority of work opportunities are in government, various educational posts and running small businesses. These sentiments are supported in the quantitative data collected. They also draw attention to unemployment being undesirably high and not providing enough opportunities to the youth. These views are supported by the data collected which is summarised in Table 4-1 below. These employment statistics show those of working age that are able to find occupational employment in the areas, as well as those who cannot, which make up the unemployment rates of the area. High unemployment rates are usually an indicator of poor economic growth.

Table 8-5 shows what proportion of the total population is employed. The figures show that in the Mahagala site more people were enrolled in education programs than the other three sites. In the Tshikuwi site, many people were reported to be pensioners, as much as 18% correlating to its gender population pyramid in section 4.1 above. The demographics of the study areas along with the interviews do not suggest that there is a significantly large gender discrepancy in employment but there is a high rate of unemployed economically active people in the study areas. This is evident in Table 8-5 (see Appendix A section 8.2).

The most unfortunate aspect of Table 4-1 and Figure 4-2 is that 55% of the population in Gundani is unemployed and looking for work, this is a seriously high unemployment rate and this can lead to other social issues in the area. The average unemployment rate in all of the study areas is 34% which is similar to that of the national average, highlighting the issue of unemployment in South Africa.

In terms of occupation, the most common forms of employment were through the education sector (10%) and the Government sector (7%) although in Gundani this was not evident with many people working as security guards or elsewhere. A large array of varying occupations were grouped together in the other category, these were made up of such occupation as caretakers, tellers, printing clerks and undisclosed occupations (see Table 4-1 and Figure 4-2).

Table 4-1: Employment

Row Labels	Grand Total	Mahagala	Tshikuwi	Gundani
Unemployed but looking for work	36	8	4	24
Other	19	5	6	8
Works in education	10	6	4	-
Works in government	7	2	5	-
Owning small business	5	2	2	1
Works in security	4	-	-	4
Part time employment	4	3	-	1
Artisanal work	3	1	1	1
Employed in mining	3	-	1	2
Works in manufacturing	2	-	2	-
Farming with own crops	1	-	-	1
Mechanic	1	-	1	-
Nursing	1	-	1	-
Working on a farm	1	1	-	-
Works in administration	1	-	1	-
Works in banking	1	1	-	-
Works in construction	1	-	-	1
Works in finance	1	-	1	-
Works in IT	1	1	-	-
Works in management	1	1	-	-
Works in property	1	-	1	-
Works in transport	1	-	-	1
Grand Total	**105**	**31**	**30**	**44**

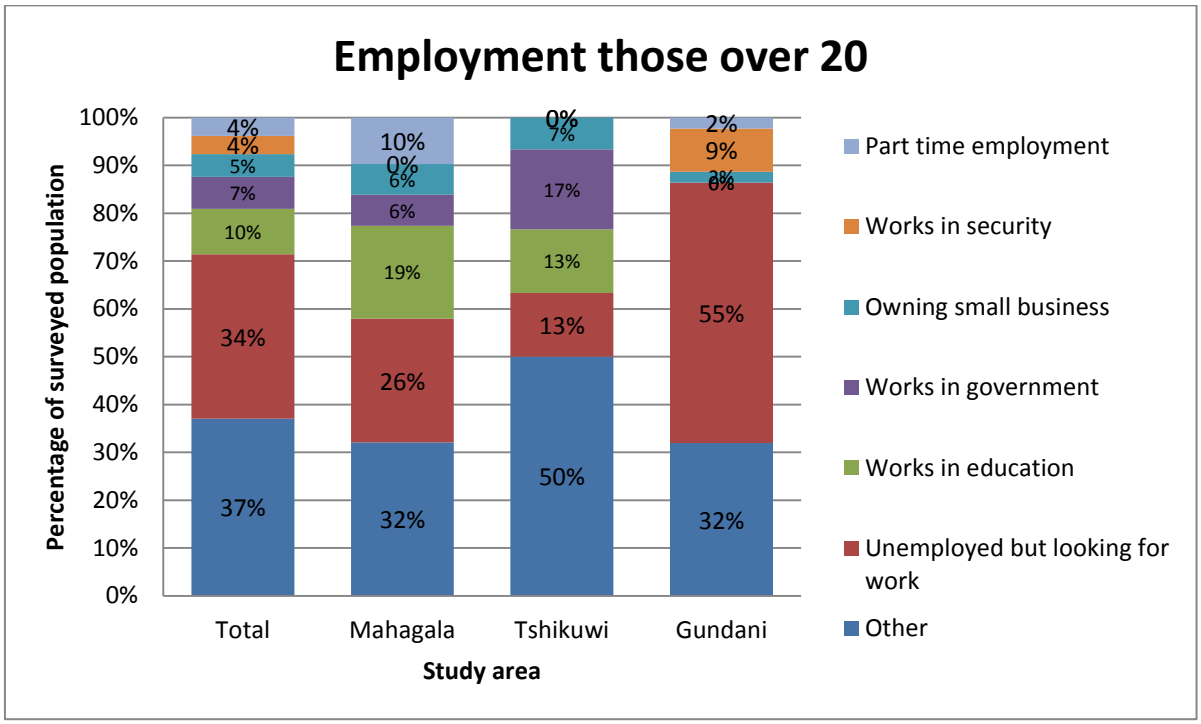


Figure 4-2: Employment people over 20

4.3 *Education and training*

One aspect of the research was to understand through the respondents, their livelihood assets through the five capitals model explained in section 2.2. Their resilience in situations of CV can be quantified by the robustness of their five capitals. One of these capitals is human capital. Education and skills make up an integral part of human capital and for this reason a population's average level of education is commonly used as an indicator of human capital and is measured by the percentage distribution of the population older than 20 and the highest level of schooling they completed.

It was evident in the interviews that respondents understood that their institutional framework for adapting to CV can be derived from the appropriateness of training in the area. Respondents in Tshikuwi were far more optimistic about HH access to education while in Gundani they were despondent. One respondent stated, "The walk to school for the children is unbearably far and the transport is often unreliable". Another respondent laments the learning conditions, "I often hear my children complain that their desks and chairs are broken or that it is too hot to learn in the summer". Another respondent questioned the

appropriateness of the curricula, “I am not sure that what they are learning is required because there are still no jobs for the educated”.

These comments are more relevant when combined with the quantitative state of education levels among the population in the local study area. This is presented in Table 4-2 and Figure 4-3 below, which indicates more than half of individuals have attained some secondary schooling, irrespective of their gender grouping. Education levels among females are lower than among males. Interestingly, a higher than expected proportion of the population were engaged in some kind of tertiary study and in Tshikuwi, as much as 51% of the population there had completed secondary school which is a great deal higher than the case for the national population.

Table 4-2: Count of highest level of education

Row Labels	Gundani	Mahagala	Tshikuwi	Grand Total
Some secondary school	40	30	20	90
Completed secondary school	26	24	19	69
Higher education	10	18	23	51
Some primary school	27	17	6	50
Completed primary school	8	7	9	24
None	6	3	8	17
Grand Total	**117**	**99**	**85**	**301**

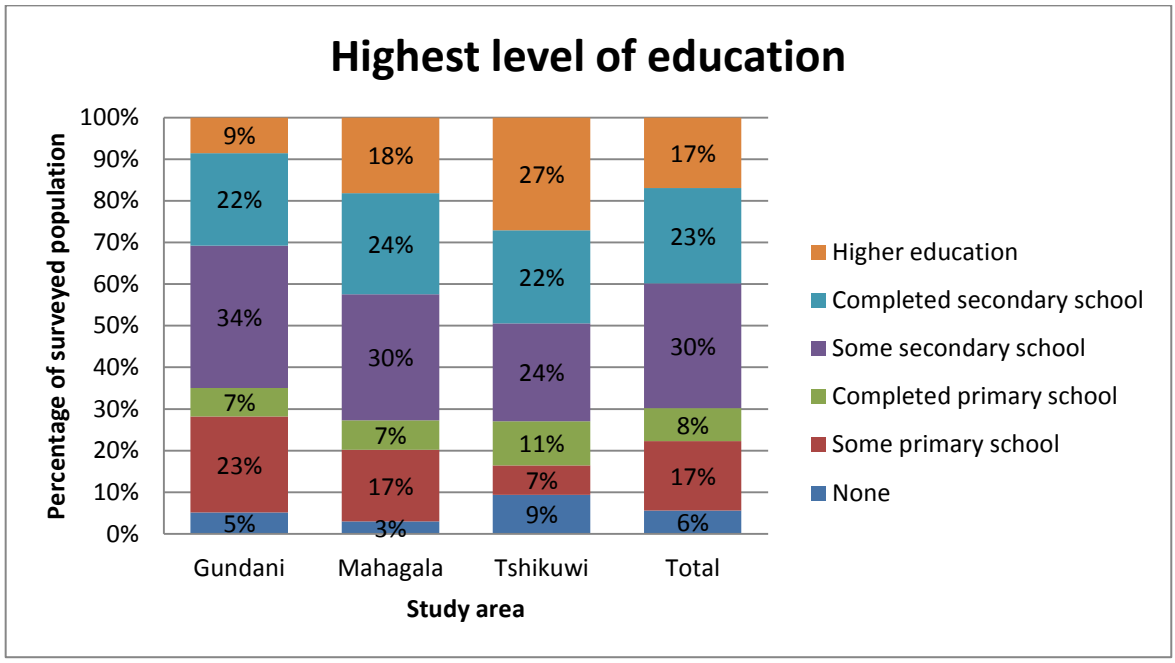


Figure 4-3: Highest level of education in percentage

4.4 *Access to basic services*

Access to basic services is a right to the people of South Africa and this access can assist in reducing the vulnerability of communities to CV through the strengthening of the SLF. As a result, the provisions of water and electricity are important government provided services.

Safe drinking water and adequate sanitation is necessary for attaining good health, as households without safe water and adequate sanitation systems are more vulnerable to waterborne diseases. From the information gathered from respondents, it is clear that the drought has made the access to water difficult, with some stating that people in Vhembe had to walk long distances to fill tanks of water from mountainous springs and other streams. Others complained that the services were erratic and this could often lead to service delivery protests in the area. The survey results show that government water schemes provide most households within the local municipalities. On average 9% of the respondents made use of groundwater in the form of boreholes or springs. There is more use of groundwater around the Tshikuwi area as it was reported that there are relatively reliable aquifers in the area. Few households (4%) make use of surface water and rainwater tanks although this is higher in Gundani suggesting that their risk to erratic water supply is higher in that area than the other three (StatsSA, 2013).

Table 4-3: Count of source of water

Row Labels	Gundani	Mahagala	Tshikuwi	Grand Total
Community standpipe	14	9	-	23
Piped water in house	-	7	12	19
Multiple sources	1	6	3	10
Groundwater	1	1	5	7
Purchase	-	-	4	4
River/dam	3	1	-	4
Rainwater tank	3	-	-	3
Unreliable tap	2	1	-	3
Borrow	1	-	1	2
Grand Total	**25**	**25**	**25**	**75**

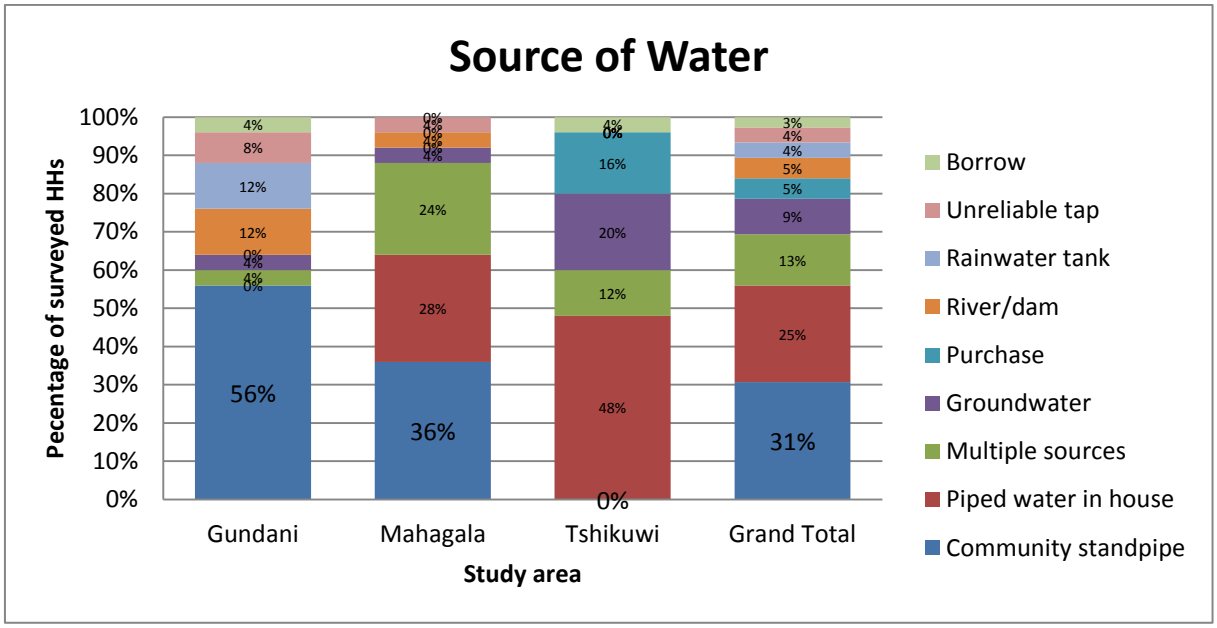


Figure 4-4: Source of water in percentage

In terms of sanitation, the majority of households within the local study area don't have access to flush toilets (80%), followed by a relatively small number of households (9%) that make use of pit toilets with ventilation (see Table 8-8). The proportion of those who have flush toilets is low compared to national average and indicates poor development prospects.

The majority of households within the local study area have access to electricity for lighting purposes (Table 8-9). With regard to cooking and heating, there seems to be a greater reliance on alternative energy sources, especially wood and charcoal.

4.5 *Land tenure*

Only two households reported they had tenants on their property while one household interviewed reported that they were paying rent to a landlord. Most people who arrive in the area are required to present a vetting letter to the traditional authority, once their eligibility to settle there is confirmed they may choose a stand in the area. They are usually required to pay an amount of R 1 500 in order to gain access to a stand. Once the stand is determined, the traditional authority will assess it and advise if it is: a flood prone area or generally unsuitable for subsistence agriculture. It is important to note that the stand occupier is rarely the owner of the land.



Figure 4-5: A typical household and plot in the study areas (Source Author)

4.6 *Migratory patterns*

Table 8-10 shows the variation between households in terms of the number of years they have been living on the property they were occupying. Many of the households have been in the area for a long time; most of them have been living there for more than 30 years. The first households settled in these areas between 1915 and 1920 indicating long term residence in the area.

4.7 *Health status*

An interesting feature of the health status – which has been confirmed by several similar surveys elsewhere in South Africa and on the African continent – is that affliction by witchcraft, is widely regarded as a legitimate disease category. The number of HIV/AIDS cases and AIDS-related diseases (such as tuberculosis) are most likely under-reported because of the stigma attached to this disease (McSweeney 2005).

4.8 *Livelihoods baseline*

The data presented in this section is related to the livelihoods of the respondents. Through the five capitals model the data can assist in understanding community resilience and vulnerability in the face of adverse circumstances focusing on CV.

4.8.1 Shocks

Shocks can occur at community or individual/household level: a community-level shock would be an event or incident that affects large numbers of people, while an individual/household level shock would be a more private tragedy (although the distinction is not watertight; community-level shocks would also affect individuals and families).

Examples of community-level shocks that have occurred in the study area in the last few years include relatively frequent climatic events, for example it was reported that in the year 2000 there were severe floods while 2015 experienced widespread drought. One TA had reported that he had noticed a steady reduction in rainfall since the year 2010. These incidents show that socio-economic stressors and risks associated with CV are present and these risks adversely affect the livelihoods of many households.

Of individual - or household - level shocks, the death of a family member is arguably one of the most severe. Figure 4-6 shows the number of households included in the 2016 household survey who lost a household member during the last year. As the table indicates, a total of 8 households (amounting to about 11% of the surveyed households) reported having lost a member during the last year. In many cases the cause was simply indicated as “illness” (suggesting that these deaths might be HIV/AIDS-related – see Section 4.7 above); other frequent causes of death were accidental.

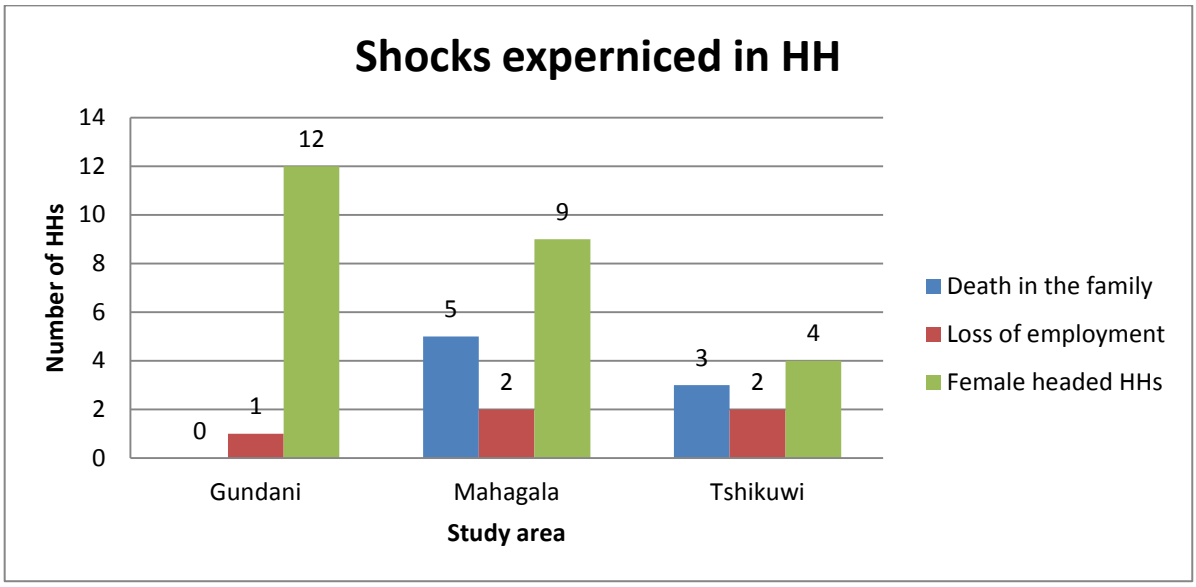


Figure 4-6: Household shocks experienced

The prevalence of household trauma can also be inferred from the numbers of households in the study area that are headed by women. Figure 4-6 shows the amount of female-headed households included in the 2016 survey, this amounts to approximately 28% of households with the most being in the Gundani area. It should be noted that a female-headed household does not necessarily imply the death of a male partner. As pointed out above, there is evidence suggesting that many men have left their households in the study area to search for work elsewhere. However, for many women, the experience of being entrusted with the responsibility of heading a household (especially in a cultural context where traditional patriarchal values are still prevalent) may itself be an undesirable experience, regardless of whether it is as a result of death or economically-motivated departure of their partner (World Initiative for Sustainable Pastoralism 2010).

4.8.2 Seasonality

There is both quantitative and qualitative evidence suggesting that climate related shocks in seasonality are becoming more severe. The year 2015 saw a very large ENSO anomaly drastically affecting economic growth in South Africa through drought as well as causing large stress on lower income households (National Oceanic and Atmospheric Administration 2016). Negative effects of such an event ranged from water scarcity in the community, reduced grazing land, reduction in indigenous trees and the drying up of rivers and aquifers. Many community residents stated that the increasing frequency and severity of such events

leaves them in a state of pessimism regarding their future and the future of generations to follow.

4.8.3 Livelihood assets

Livelihood assets refer to the resources that the poor utilise in order to gain a livelihood. As mentioned earlier, the SLF comprises five capital resource bases: human capital, natural capital, social capital, physical capital and financial capital. While a shortage in one resource base can to some extent be compensated for by a surplus of resources in another category, people typically require all five resource bases in order to secure an adequate livelihood. For instance, while money (financial capital) can be used to buy assets (physical capital), it does not always succeed in buying friends and social support systems that are necessary for emotional and psychological well-being. In the following sections, communities in the study area are assessed in terms of their share in each of these five asset bases (Donohue & Biggs 2015).



Figure 4-7: A view of a typical household yard in the study area (Source Author)

4.8.4 Natural capital

One of the research questions for this study was to explore the relationship between CV and livelihoods. For those HHs that don't have sufficient salaries or grants as a form of

livelihood, many make use of natural capital as explored in section 2.5 and as indicated in section 2.4 CV has negative impacts on natural capital and therefore on livelihoods. The data in this section discussed the role of CV through its effect on natural capital and its impacts on the livelihoods of the people who use this natural capital.

Natural capital refers to people's access to and utilisation of productive land, water, trees and forest resources, biodiversity, wildlife and environmental services (Forum for the Future 2007). The use of ***arable land for productive purposes*** appears to be relatively common in the district although this was not always the case in all of the study areas. Some HH responses to the interviews showed a higher than expected proportion of HHs that earn income from employment and for this reason did not engage in any meaningful agriculture as the income is used to purchase goods at supermarkets. This data is supported in Figure 4-8 which shows the percentage and count of households included in the 2016 survey who indicated that they have access to arable land that they use, or have used in the past, for cultivation. As is evident from this table, the majority of households in the study areas have access to land around their homesteads, but don't necessarily rely on farming.

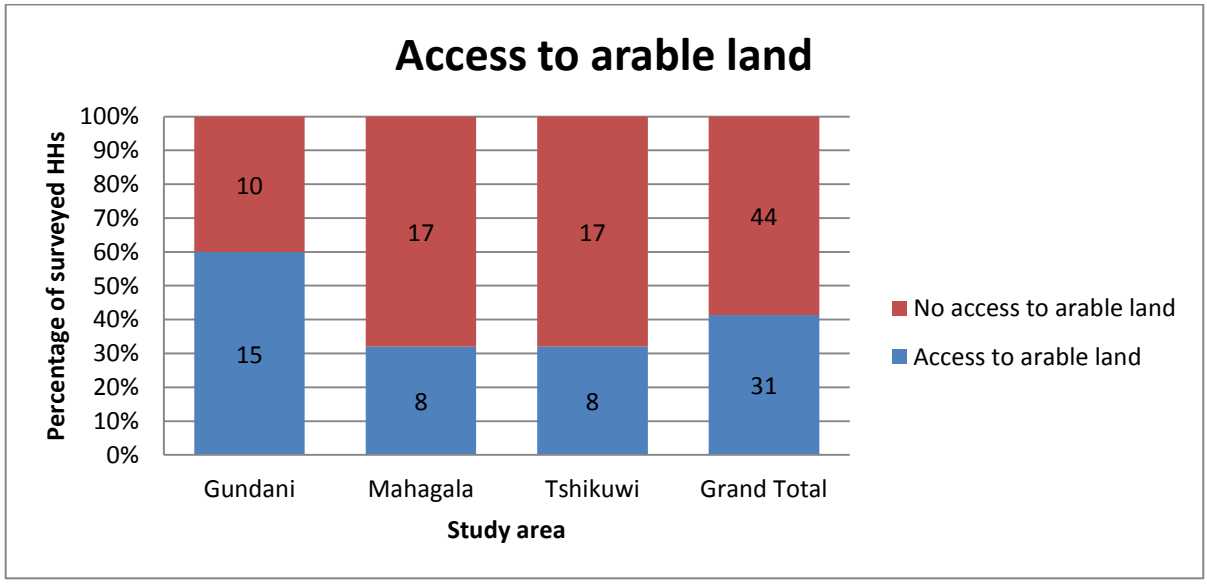


Figure 4-8: Access to arable land

Another indicator of access to arable land is the distance from HH to cultivated areas and during the focus groups and interviews many people stated that they do not own land that is considered to be their own farm. The survey results provide further evidence for this and

from the results one can say that it was relatively rare for HHs to have their own farms (24% of the respondents). Instead the majority of households made use of their yards for cultivating maize, peanuts and other crops on a small scale while fruit trees were commonly grown on these plots as well. Most notable was the abundance of mango trees which were extremely prevalent in the area.

As indicated in the literature review, impacts of CV tend to affect the productivity of arable land. This was backed up in the focus groups and key informant interviews where people stated that their arable land was severely affected during the floods of the year 2000 and the drought of 2015. This is elaborated on in Figure 4-9 below which shows the extent of negative impact of the current drought. Although in Mahagala approximately 12% of households were unable to farm, this could be as a result of its geographic location being on the lower areas of the eastern sides of the mountain range, and it tends to get more relief or orographic rainfall than the other areas. The Impact of the drought is clearly seen in the Tshikuwi and Gundani areas where 62% of the arable land was rendered unproductive and was not cultivated at all.

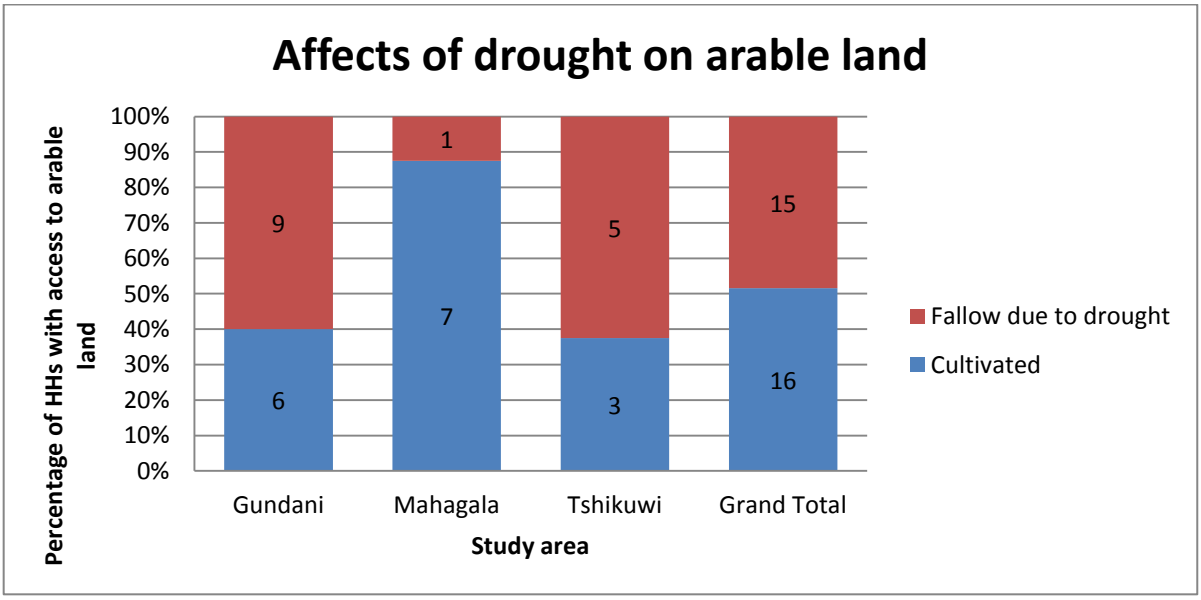


Figure 4-9: Number of fields cultivated in 2015

Table 8-12 in Appendix A shows the most preferred trees and crops grown on their land. Mango was by far the most common with as many as 45 households having reported that

mango trees were their preferred choice of cultivation. Maize was second with 26 households while citrus and avocado were also notable cultivation choices.

Some households report to have access to more than one field and for this reason Figure 4-10 is used to show the number of mangos planted as well as the number of fields. This is intended to show the prevalence of mango trees. The Mahagala area showed the most mango cultivation with as much as four fields having more than ten mango trees on them while five having between five and ten mango trees. In Tshikuwi, three fields had more than ten trees and six fields have between five and ten. In Gundani eight fields had between five and ten mango trees on them.

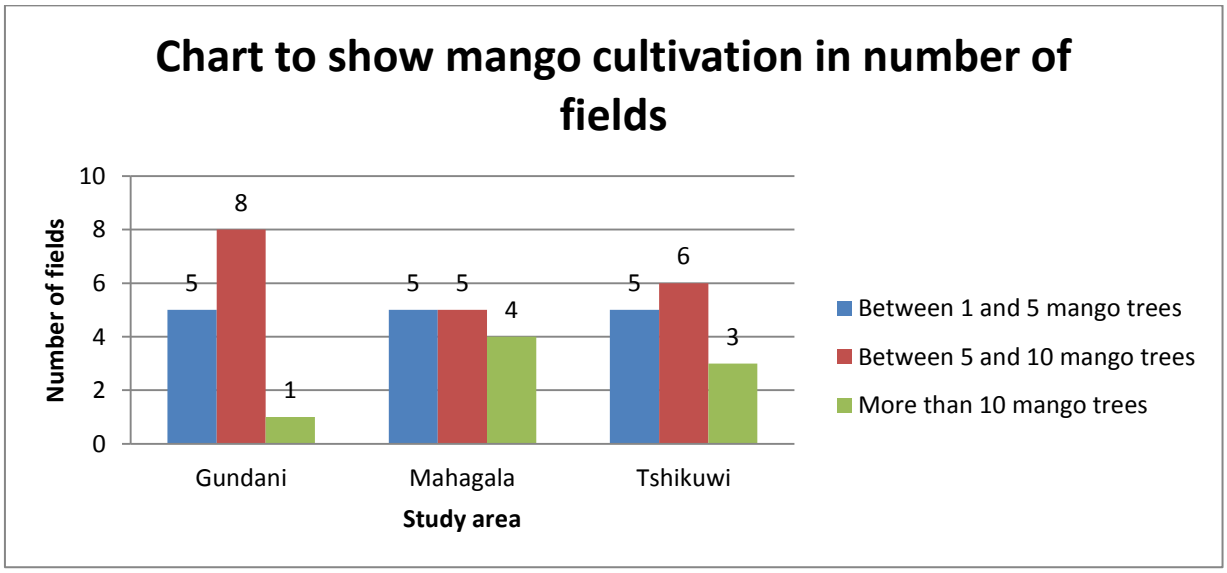


Figure 4-10: Extent of mango cultivation

Table 8-13 shows the most common secondary crops/trees growing as well as the number of trees. As mentioned before citrus such as oranges and lemons as well as avocados are notable mentions as a secondary tree cultivated.

Dependence on the harvesting of natural resources is relatively common in the area, particularly the more rural areas such as Gundani. The Tshikuwi area however, did not collect a large amount owing to the relatively high levels of household income in the areas. The resource most frequently harvested is firewood, and this practice is most frequent among HHs, a trend related to the fact that access to electricity is possible, but most are unable to afford the electricity prices resulting in more use of firewood (see Figure 8-8 - 12).

In Gundani 24 HHs out of 25 receive more than R2000 a year in ecosystem services from firewood sales collection and as much as 9 HHs receive more than R 16000 in Gundani annually. This was also indicated in qualitative data collected as an important safety net for HHs. One respondent said, "If we are denied access to the collection of firewood we would not be able to afford schooling or even some kinds of food". Such a statement underlines the importance of natural resources in their livelihood endeavours. Another notable natural resource collected is mopani worms, although not as lucrative as firewood, some HHs can receive more than R 1000 a year in ecosystem services from these. Fruit and vegetables were also reported to be harvested from the surrounding ecosystems. Direct use values of natural resources in the Mahagala area also show that firewood is an important resource. As many as 8 HHs indicated that they benefit to the value between R4001and R8000 annually from firewood collection. Only one HH in Tshikuwi uses firewood, but collects more than R16000 worth annually.

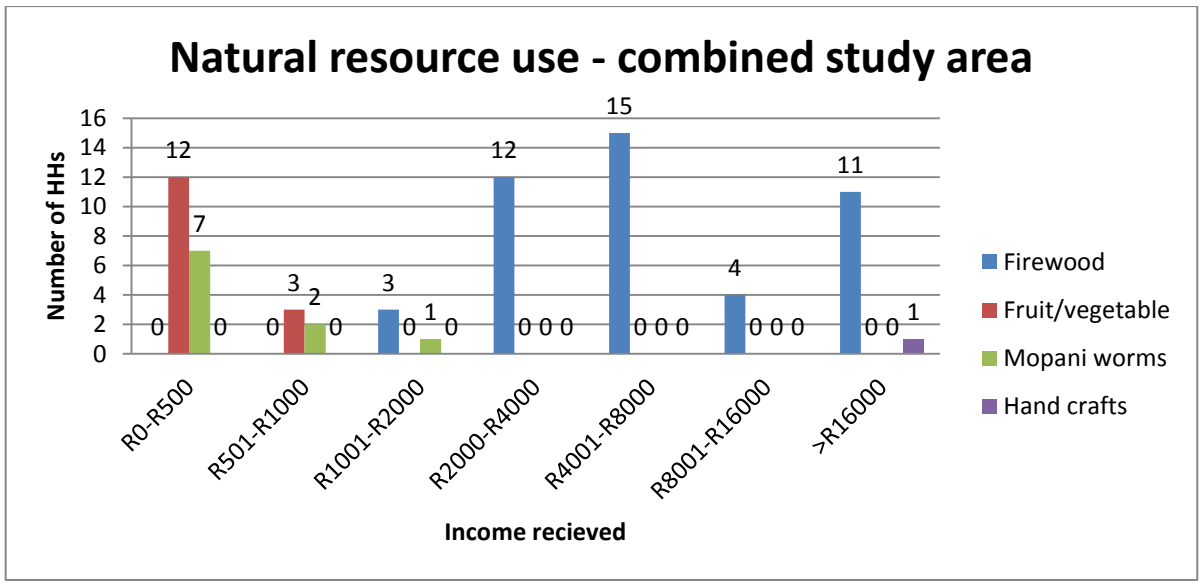


Figure 4-11: Natural resource use

Of all the HHs in all study areas who collect firewood, a total of R 388 950 was attained through firewood from the surrounding ecosystems. The most efficient firewood harvesting HH collected R 36 500 and the least efficient collected R1 600 worth of firewood annually. The average value collected was R8 643 with a standard deviation of R 7 376.

Table 4-4: Direct use value statistical summary of natural resources by resource type in Rands

	Firewood	Wild fruit	Mopani worms	Combined
Mean	8 643	256	528	9 657
Stan dev	7 376	272	625	8 940
Min	1 600	18	30	1 600
Max	36 500	900	2 000	41 800
Sum	388 950	3 836	5 280	434 566
Count	45	15	10	45
Monthly mean	720	21	44	805
Monthly sum	32 413	320	440	36 214

Table 4-5: Direct use value statistical summary of natural resources by area in Rands

	Gundani	Mahagala	Tshikuwi	Combined
Mean	11 487	7 031	18 250	9 657
Stan dev	8 507	9 061	-	8 940
Min	2 600	1 600	18 250	1 600
Max	36 500	41 800	18 250	41 800
Sum	275 698	140 618	18 250	434 566
Count	24	20	1	45
Monthly mean	957	586	1 521	805
Monthly sum	22 975	11 718	1 521	36 214

In terms of natural resource management, the communities do have some institutions in place to try and regulate these. It is clear that firewood is regularly harvested and used to supplement the livelihoods of some lower income households. The function of this ecosystem service indicates that it is an important resource to be managed. The community has realized this and there are some practices to help manage this use. For example, the requirements are to collect dry wood instead of cutting down trees and this is enforced by local police in collaboration with the TAs. There is also a permit that must be obtained at a small cost to ensure that the woodland is not open access to all. According to the TAs interviewed, regular check-ups on the state of these areas are conducted to ensure that no one particular area is overharvested.



Figure 4-12: Wild herbs gathered from the woodland to be used in cooking (Source Author)

4.8.5 Human capital

Human capital refers to people's endowment in terms of health, nutrition, education, knowledge and skills, capacity to work and capacity to adapt. In terms of ***health***, one of the greatest threats to the well-being of communities in the study area is the HIV/AIDS pandemic. As indicated in Section 4.7, available data suggests that HIV prevalence rates in the study area may be in the order of 2.9%. Alcohol and drug abuse – both problems among several communities in the study area – are also likely to take their toll on health. Access to health services is also an important aspect of this capital. There is one large hospital that services a number of communities as well as smaller clinics. This still indicates that there is a shortage of health services available in the VDM.

Another effect of CV on livelihoods is to push up prices of foods as explored in section 2.4 reducing the access of some HHs to their required nutrition. Some stated in the focus groups that the increase in food prices often meant the forfeiture of more nutritious food as they had to supplement their food choices with less nutritional, but more affordable types of food. For example it was stated that more maize was purchased in the place of meat. In terms of ***nutrition***, the results of the 2016 household survey indicate that food shortages do not occur in the majority of HHs, but are not uncommon in the study area. As can be seen from Figure 4-13, HHs who have experienced recent food shortages (defined as indicating a food shortage

at any time in a year before the survey) are mostly concentrated in Gundani. Figure 4-13 shows that June, August, September, October and December were the more prominent months for food shortages. Three HHs reported that they are being impacted by food shortages during the months stated above. The reasons given for them were: seasonal changes, drought, and having to spend large amount of income on school fees during December.

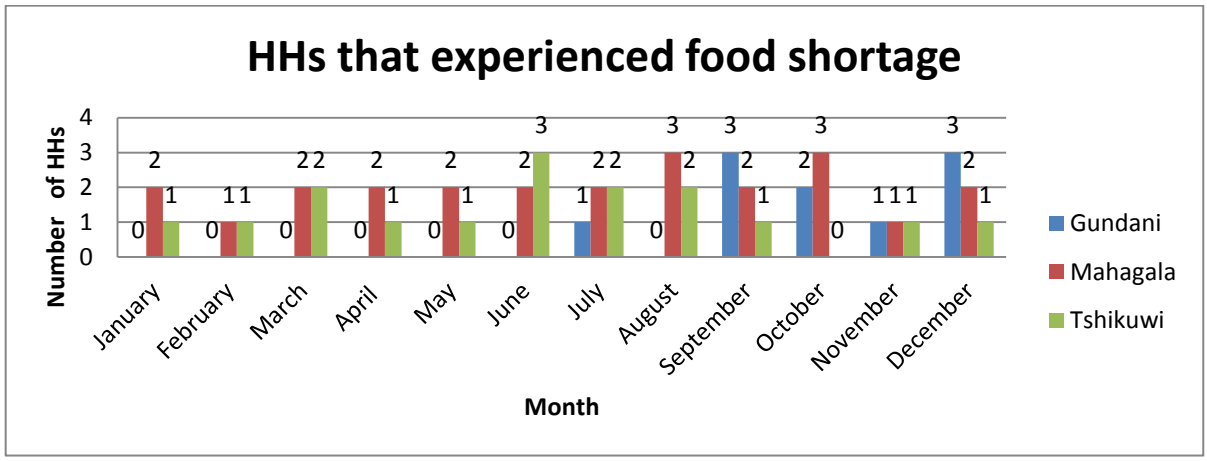


Figure 4-13: Food shortages reported in the last year

In terms of ***education***, it was pointed out in Section 4.3 that education levels among adults living in the study area are mixed. In Tshikuwi it is relatively high but in Gundani it is low. However, with a high reported amount of children attending school, there is a favourable education trend appearing and, is likely to continue into the future. In terms of ***skills***, participants in the household survey undertaken as part of this assignment were asked to identify skills that they have acquired (either through work experience or training) that potentially enable them to benefit from agricultural and other developments in the area. As can be seen from Table 4-6, the most common skills are: driving, agriculture, IT related, construction and building. The "other" category represents a diverse range of skills such as: arts and crafts, nursing, managerial and even fire fighting skills.

Table 4-6: Prevalence of available skills

Type of skill	Gundani	Mahagala	Tshikuwi	All
Driving	7	6	9	22
Computer skills	3	6	6	15
Agricultural skills	6	1	4	11
Construction	7	1	4	12
Electrical skills	2	2	5	9
Education	1	4	3	8
Multiple skills	-	5	3	8
Administrative skills	1	3	2	6
Mechanical skills	1	1	2	4
Security	1	2	-	3
Artisanal	1	-	1	2
Other	2	7	6	15
Total	**32**	**38**	**45**	**115**

4.8.6 Social capital

Social capital refers to the networks and connections that people use to support or execute their livelihood strategies, prevalent norms of reciprocity within communities, participation in decision-making, leadership, and the common rules and sanctions that characterise communities. The first place to look for social capital is ***within households***. Table 8-15 in Appendix A shows the relationship of household members included in the 2016 survey to the household head. The table shows that relatively few household heads have their spouses living with them. This is consistent with the fact, pointed out above, that 28% of households are headed by (single) women. The table also shows the relative scarcity of households housing extended family members: grandchildren of household heads constitute only 6% of the total surveyed population, and parents of household heads only 1%.

Another aspect of social capital is for HHs experiencing tough times, they are able to gain assistance from neighbours, family and friends. Many respondents stated that they feel there is a good feeling of social cohesion in all the communities surveyed. Other more affluent HHs also indicated their willingness to lend money out to friends or neighbours at no interest. The quantitative data also collected is also indicative of good social networks. As seen in Figure 4-14 social networks were most commonly used for taking care of sick family members with 54 (72%) HHs using social networks for this activity. Next were 49 (66%) HHs using their networks to exchange goods, which, most likely, supports food security

during tough times. It was also common for HHs to use their networks to assist when they need to borrow equipment. As many of 41 (56%) HHs found that this was the best way to gain quick access to physical capital if needed.

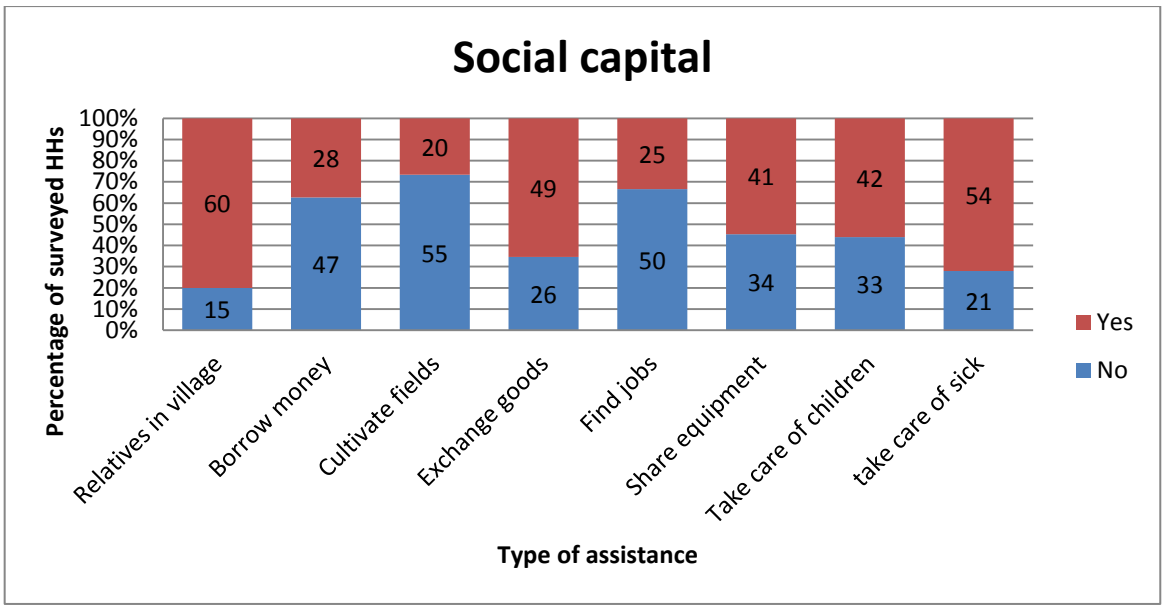


Figure 4-14: Household use of social capital

In terms of civic participation, membership of social organisations among persons included in the 2010 survey also appears to be relatively rare. As can be seen from Figure 8-11 in appendix A is traditional councils and ward councils. The Mahagala area appears to be the more diverse area in terms of membership of social organisations but in general most people are not members of any organisations.

4.8.7 Physical capital

Physical capital refers to: shelter and buildings; infrastructure for transport, water supply, sanitation, energy and communications; access to public services such as health and education facilities; tools and technology for production; and agricultural materials (Forum for the Future 2007). Physical capital can be affected by CV which in turn impacts on livelihoods. Some of the effects are the damaging of equipment by a storm or the loss of livestock during times of lean rainfall. In general, housing types vary according to settlement type and the TAs confirmed this during the focus group discussions. There are, for example, a higher proportion of informal houses in rural areas, while formal houses are predominantly a feature of the urban environment. The majority of households within the study area reside in

formal dwellings, followed by a combination of formal and informal housing. Traditional structures were not common (see Figure 4-15).

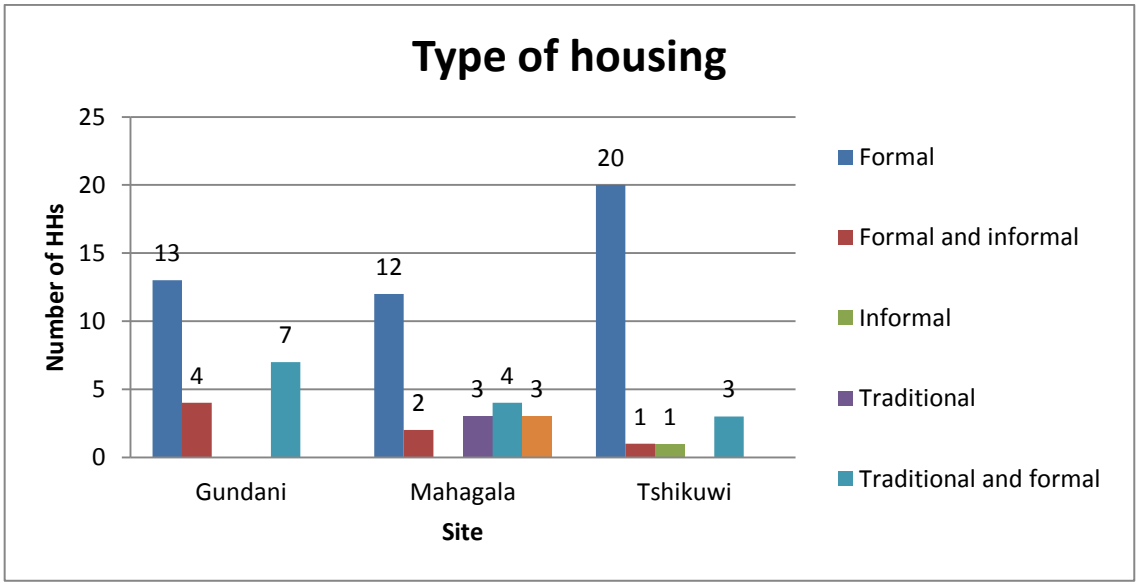


Figure 4-15: Housing

Other indications of physical capital are HH goods and purchased assets owned. These can assist with HH resilience by improving quality of life by making tasks easier and can be let out when needed. These goods can also be fronted for collateral when applying for a personal or business loan. The summary of household possessions is indicated in Figure 8-12 in Appendix A.



Figure 4-16: Formal structures built in the study area showing physical capital in the area (Source Author)

In terms of ***transport infrastructure***, it was evident the roads were in good condition and their ease of access was frequently pointed out by respondents during the 2016 household survey as a factor that impacts positively on their livelihoods and well-being.

Access to ***water, sanitation and electricity*** was discussed in Section 3.3.2.2 above. It was pointed out that about three-quarters of households included in the 2016 survey have access to piped water in their house or yard. Sanitation lags somewhat behind in that 91% of households surveyed lacked flush toilets. As much as 99% of households have access to electricity.

In terms of ***communications technology***, trends in the study area reflect those elsewhere in South Africa (and many other parts of Africa), in that there is a ubiquitous reliance on cell phones; the 2016 household survey results indicate that on average households have 3 cell phones. Access to other forms of communications technology (e.g. the Internet) remains limited. Very few households have a computer, while these are almost entirely absent among poorer households.

In terms of ***access to public services***, available data indicates that the study area is fairly well supplied with health services. The number of people that were provided with the clinic services in the district has increased from the 2008/9 financial year to the 2009/10 financial year.

Table 4-7: Personal asset ownership

Asset	Average	Count	Max
Bed	3	228	8
Bicycle	0	12	3
Car	1	51	3
Cell phone	3	215	12
Chair	7	469	26
Charcoal stove	0	2	1
Cupboard	1	105	8
Donkey cart	0	2	2
Electric stove	1	55	3
Generator	0	10	2
Machete	1	91	5
Mill	0	22	4
Mosquito net	0	24	3
Plough	2	147	6
Radio	1	69	4
Sewing machine	0	5	2
Table	2	125	15
TV	1	75	3
Wheel barrow	1	74	3

Livestock ownership in South Africa and the rest of Africa serves many functions and is an important asset in the sense that it is used to build HH resilience. Livestock is often used for consumption of meat as well as animal products and alternatively, these products can be sold to others in the community. Another aspect is their use as an investment, cattle is often used in this way as well as an informal insurance policy. In times of drought and poor access to food, livestock can be slaughtered to compensate for this although this is by far a less than ideal option for a HH. These strategies were communicated to the researcher from the respondents in the interviews conducted.

Figure 4-18 shows the count and percentage of those who own livestock. Gundani had the highest percentage, with 14 HHs (56%) stating that they owned livestock. In Tshikuwi, only 24% owned livestock, which also lends to their larger reliance on financial capital than natural and physical.

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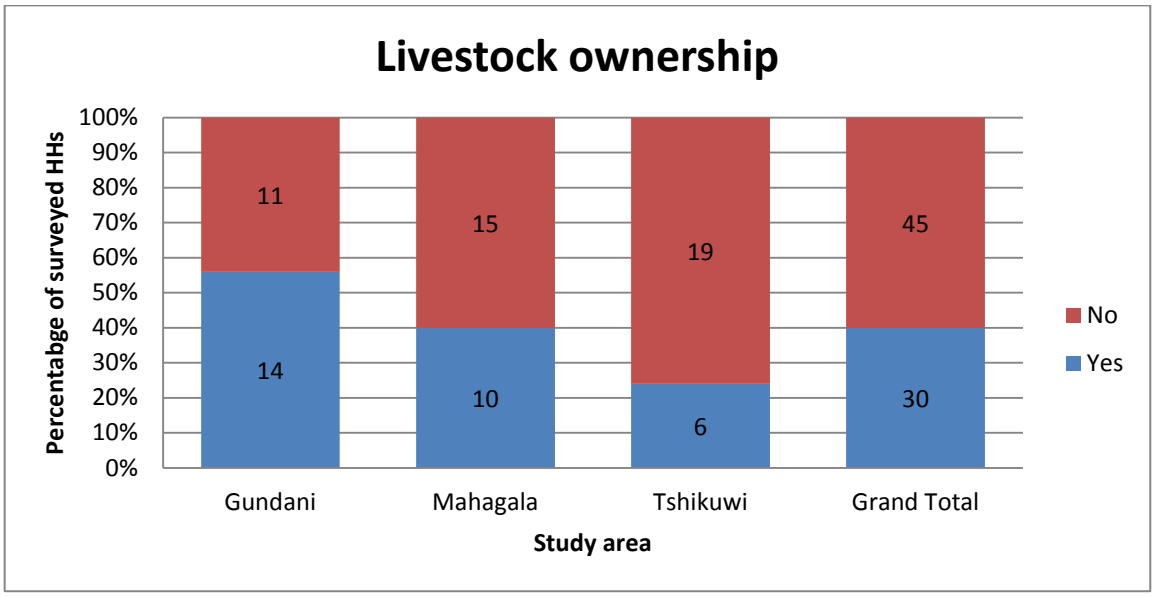


Figure 4-17: Households that own livestock

In total, the most common domestic animals were chickens and cattle, with as much as 6 HHs owning between 8 and 16 cattle and 4 HHs owing more than 16 chickens. Some unexpected domesticated animals include pigeons, dogs and cats. Dogs and cats are not used for consumption but rather for security and pets. Surprisingly only one HH owned donkeys (they are used as a beast of burden), so it was expected that more HHs would have owned at least one of these animals.

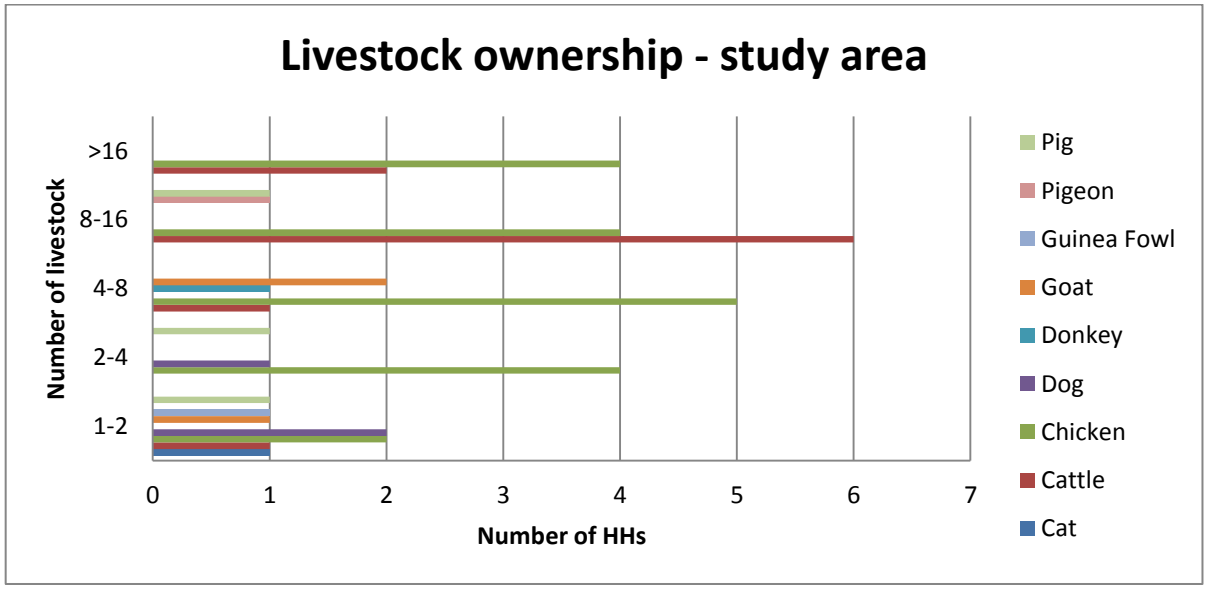


Figure 4-18: Livestock ownership

As mentioned earlier, livestock have a number of uses, the lack of use for sales of animals was notable, only 1 HH in Gundani used chickens for sales and another HH sold pigs. In Tshikuwi 2 HHs sold pigs. The most common use for chickens was for meat, with 3 HH in Mahagala and Tshikuwi and 10 in Gundani using chickens for meat. All HHs that owned cattle said that they used this for investment purposes, with 4 HHs in Gundani, 5 in Mahagala and 1 in Tshikuwi using their cattle for investment and informal insurance. Access to grazing for livestock could also be seen as an aspect of natural capital, most HHs (71%) grazed their livestock around their homestead and 24% made use of communal grazing areas.

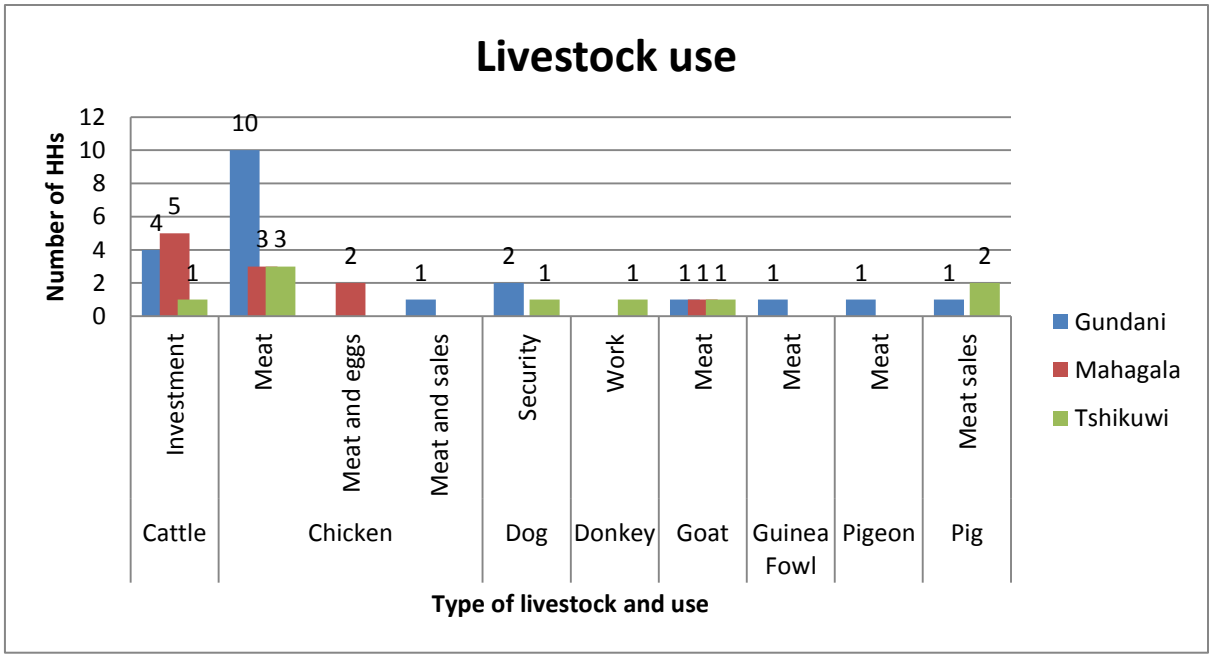


Figure 4-19: Livestock use

4.8.8 Financial capital

Financial capital refers to people's access to and use of various monetary resources, such as salaries or wages, remittances, social grants, savings and credit facilities (Forum for the Future 2007). Figure 4-20 below shows the degree to which households included in the 2016 survey are dependent on ***various types of income***.

As can be seen from this table, most households rely on salaries and social grants as their main form of income, although in Tshikuwi more people had decent salaries and therefore had much less people receiving grants. Government grants (pensions, child grants and disability grants) constitute an important source of income, particularly in Gundani and

Mahagala. Dependence on migrant remittances is low in all areas except for Gundani; this is surprising as in most rural areas, they are labour sending areas and would usually be recipients of migrant remittances.

Table 4-8: Count of most important source of livelihood

Row Labels	Gundani	Mahagala	Tshikuwi	Grand Total
Salaries	5	8	15	28
Social grants	9	10	5	24
Natural resources	5	-	-	5
Pension	-	3	2	5
Part time	1	1	2	4
Self-employment	3	-	1	4
Remittances	2	-	-	2
Farming	-	2	-	2
Rent	-	1	-	1
Grand Total	**25**	**25**	**25**	**75**

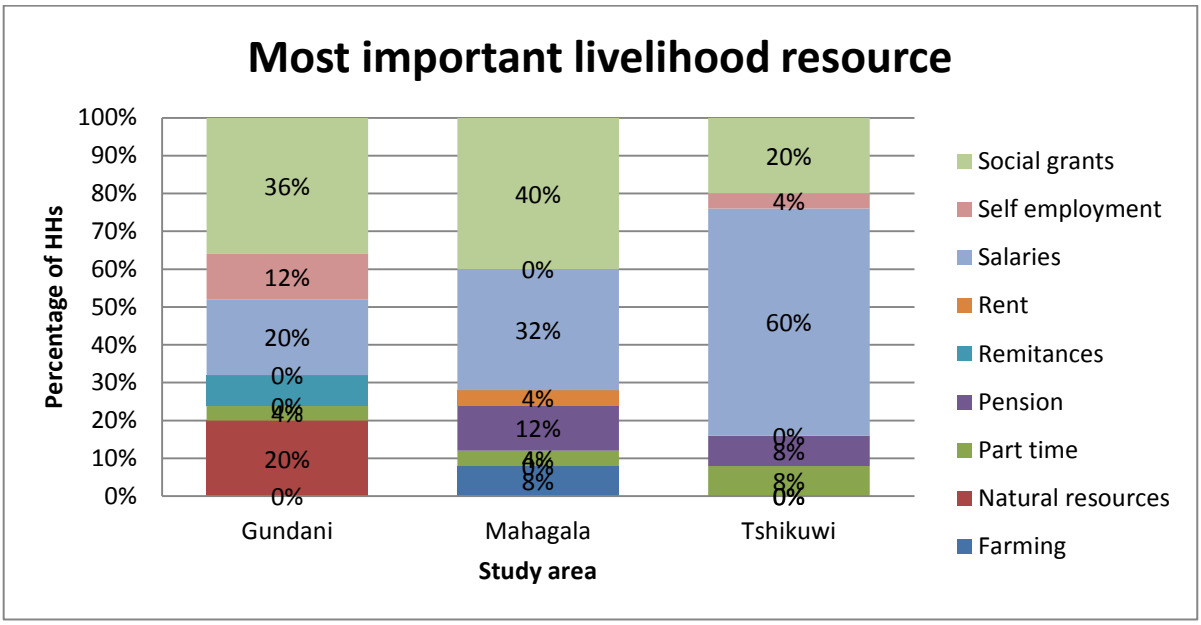


Figure 4-20: Source of income for households in percentage

In terms of ***savings***, *stokvels (communal savings schemes)* was not as popular as one would expect in the study area. The use of formal banking facilities also remains relatively low.

In terms of ***access to credit,*** in total 1 person applied for a business loan but it was not approved, this individual was a resident of Gundani. With regard to personal loans, 2 people in Gundani applied for one, but only one was approved. In Mahagala 5 households applied for a personal loan and three were successful. In Tshikuwi 4 people applied for personal loans

and three were successful. One individual in Tshikuwi was not willing to disclose this information. It is evident that the utilisation of credit facilities is very rare.

4.8.9 Poverty and vulnerability

People or groups can be classified as vulnerable for a number of reasons. Often they are classified according to demographic or social profiles. As adapted from the International Finance Corporation (IFC) definition, vulnerable groups are people who by virtue of gender, ethnicity, age, physical or mental disability, economic disadvantage, or social status may be more adversely affected by climate impacts (or shocks in general) than others and who may be limited in their ability to claim or take advantage of adaptation related benefits (Motsholapheko et al. 2011)

The most common groups identified as vulnerable are children, the elderly, child and female headed households, the poor and the disabled. Other socio-economic aspects also make certain people and groups more vulnerable, such as low levels of education and high levels of unemployment. The low average monthly income combined with the high dependency ratio, unemployment rates and a relatively low (although increasing) level of education implies the persistence of poverty and vulnerability among households in the more rural areas within these study areas (see section 4.8.8).

4.8.10 Livelihood strategies

Livelihood strategies refer to the ways in which poor people deploy their assets and capabilities – whether through consumption, production, processing, exchange or income-generation – so as to improve their livelihoods. As emphasised by the Sustainable Livelihoods Model, the choice and execution of livelihood strategies depend on the availability of assets or capital (human, natural, social, physical and financial), this dependence being mediated by institutional structures and processes and by contextual influences (Donohue & Biggs 2015).

It was pointed out in Section 4.8.8 above that, for the great majority of households in the study area, their main livelihood strategy comprises salaried employment and social grants. The first sub-section below therefore explores the types of ***occupations*** held by employed persons. The second sub-section provides details on the levels of ***income*** that people derive from these occupations. Recognising that wage-earners constitute a relatively small portion

of the study area's population, the final two sub-sections respectively discuss ***intra-household economic dependencies*** and ***alternative livelihood strategies*** employed by those who do not earn wages, or whose wages are insufficient to secure their livelihoods especially when confronted with the significant challenges of CV.

4.8.10.1 Occupations

The lack of formal education can usually be mitigated by acquiring skills. Figure 4-21 shows the occupation categories in which the population older than 20 years were skilled in 2011 (StatsSA 2011). The largest proportion of the population was engaged in elementary occupations, indicative of a relative lack of education (StatsSA 2011). The largest difference between the VDM and the TLM is the difference between occupations unspecified and not yet classified. In the VDM this was represented by 17% of the population but in the TLM, this only came to 11% of the population. Crafts and related trade workers are pursued by 11% in the VDM and 12% in the TLM, shop and market sales workers are shown by 12% in the TLM and 11% in the VDM. These figures all suggest relative lack of formal education, when one notes that only 10% of the population attended tertiary education, it is not surprising that most of the workforce engage in occupations that do not require higher training (StatsSA 2011). The occupations found in the survey are highlighted in section 4.2 in Table 4-1.

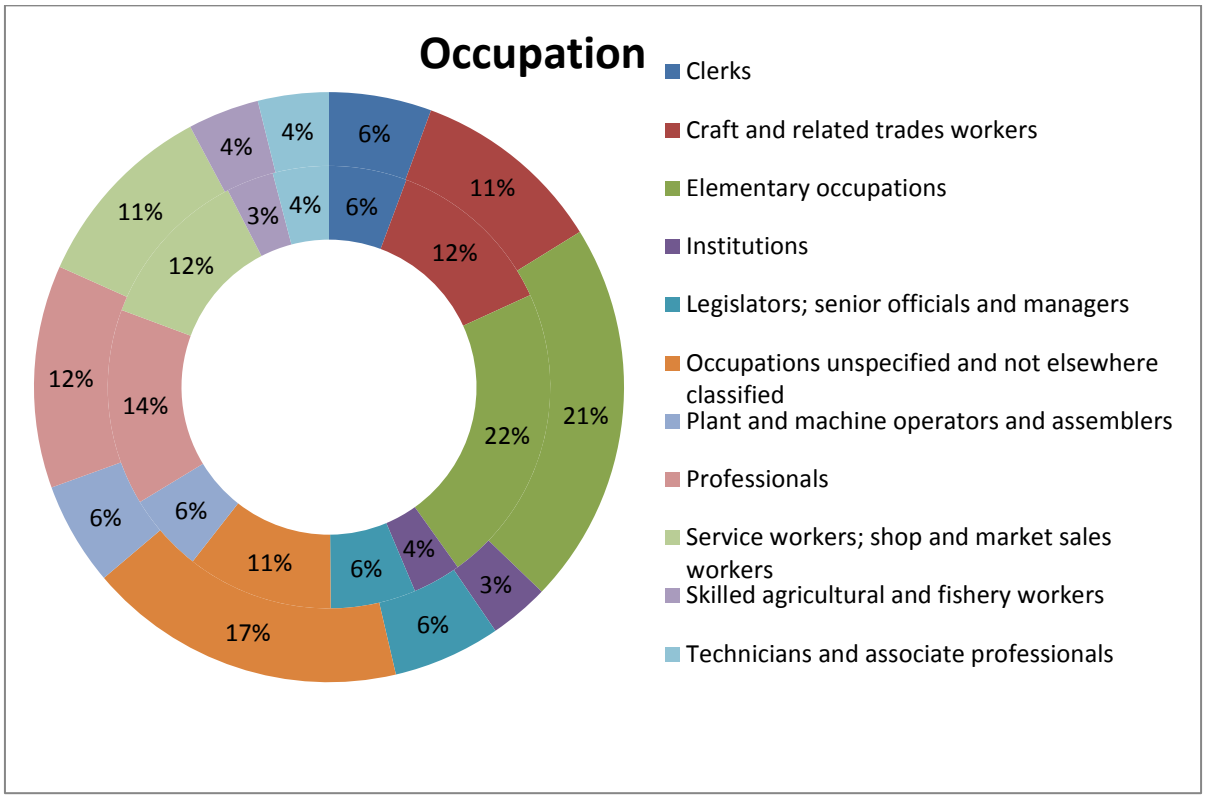


Figure 4-21: Occupation Chart TLM (inside) & VDM (outside) (Source: StatsSA, 2011)

4.8.11 Income

Table 4-9 shows the individual monthly income statistical distribution for the combined study population as well. Generally income levels within the local study area are extremely low, with the average monthly income being R 5 193 which at first glance appears sufficient, but the fact that the standard deviation is higher than average indicates that the statistical anomalies are extremely high in comparison to the other HHs. This is supported by the indication that the highest HH income was as much as R38 000 per month. Almost 79% of people are earning less than R 2 533[6] a month. There is a large number of people who rely on social grants, while 6 HHs (8%) earn over R 16 000 per month (Figure 8-16). This, in accordance to the standard deviation of HH income is indicative of a high Gini-coefficient[7] (measure of inequality). It also states that the count in the study area only went up to 74 as one HH was not comfortable with disclosing their monthly income.

[6] As mentioned in Section 3.3.2.3 a monthly income of at least R2 533 or R9 626 (6 333 at R10/$) per HH is considered a threshold by which an individual begins to move out of poverty.

[7] The Gini-coefficient is a mathematical measure of income inequality. Its theoretical maximum value is 1 – which would imply that a single person receives 100% of the total income and the remaining people receive none – and its theoretical minimum value is 0 – in which case everyone receives exactly the same income.

Table 4-9: Statistical summary of income received in previous month in Rands

	Gundani	Mahagala	Tshikuwi	Combined
Mean	3 016	6 375	6 228	5 193
Stan dev	3 779	8 248	7 607	6 910
Min	330	320	600	320
Max	15 000	30 000	38 000	38 000
Sum	75 395	159 380	149 480	384 255
Count	25	25	24	74
Annual mean	36 190	76 502	74 740	62 312
Annual sum	904 740	1 912 560	1 793 760	4 611 060

Approximately 59 households of the 75 (79%) surveyed, were below the poverty threshold, although if the rand dollar exchange rate were to improve to R10/USD then approximately 6 more HH (8%) would be deemed above the necessary income to escape poverty. Additionally, the figure also shows the high reliability on social grants with as many as 33 HHs (44%) receiving between R 0 and R 2000 a month in social grants and as many as 8 HHs (11%) received between R 2000 and R 8 000, if they did not receive these then it is likely that these HHs would not have any income whatsoever. The higher incomes were received from salaries and wages with one HH reporting that they had a successful business and 3 others stating that they received substantial remittances from family member working further afield. Crops and firewood sales were shown to yield low amounts of income of between R 0 and R 1000 a month.

CHAPTER FIVE
DISCUSSION AND ANALYSIS

5.1 *Climate change impact report*

As discussed in sections 3.3.2.1 and 4, the municipal areas as well as Gundani and Mahagala show expanding populations. This was also depicted in the qualitative data where respondents stated there were large average HH sizes. The relationship between HH size and rural livelihoods is significant. Taking care of a large HH presents financial obstacles for their providers, especially if the HH income is relatively low. Demographic studies have suggested that expanding populations are an indicator of relatively high infant mortality rates. High infant mortality rates lead to population growth as families try to ensure their survival into the next generation by having more offspring (Peters 2006). The role of CV in this nexus cannot be ignored, as it may cause shocks which can for example increase the price of food or lead to contamination of water sources (Miller 2007). Such events can reduce infant survival rates. Furthermore, the quantitative data suggests these populations are indeed expanding. This is indicative of a youth bulge. Some commentators think this is problematic and hypothesise that for an example, an excess in especially young males can lead to social unrest (National Planning Commission 2012). These commentators elaborate that the third or fourth sons cannot achieve a prestigious position in their society and will seek further impetus to compete by religious or political ideology (Roemischer 2005).

Others have gone further and show that periods of unrest that are independent of external triggers (climate changes, or environmental catastrophes) like genocides, terrorism and on-going conflicts are a result of these large youth bulges. It is likely that this acting in unison with climatic and environmental constraints on food security and economic performance, could lead to significant social unrest in the VDM. It was this combination of factors that resulted in the 2011 Arab Spring social unrest (Krishnamurthy et al. 2014). It could even result in poor economic growth and recession, as large portions of adolescents entering the labour force and electorate puts a strain on an economy designed for a smaller population (Porrit 2009). This sentiment is supported in the qualitative data collected when community leaders stated that the large propensity of youth rebelling against their tradition were resulting in anger by the ancestors and in their reaction to this, the ancestors have reduced rainfall in the area resulting in water and food shortages. An effective institutional adaptation for this

problem would be to drastically reduce infant mortality through better infant healthcare. This would be especially needed during shocks that are brought about by CV.

There is debate whether unemployment can be negated through market mechanisms arguing that unionisation and minimum wage laws are regulations that discourage the hiring of workers. Although the Keynesian school recommends that government intervention in an economy reduces unemployment during external recurrent shocks, such as what is brought about through climate variability (Frayne et al. 2009).

Gender discrepancy in education indicates a need to educate more women in both the local and regional study areas. Empowering woman through education can have a positive effect on family planning, thus reducing population growth and subsequent pressure on services (UNDP 2014) (StatsSA 2013). Additionally, opportunities exist to develop skills for those who do not complete secondary school.

Section 4.3 indicates a relatively high degree of human capital in Tshikuwi, low human capital in Gundani and in Mahagala education lies in the middle of the two. This is supported by their relatively higher standard of living achieved in Tshikuwi. For this reason, they are not as affected by shocks such as drought as other areas, although it was still raised as a significant concern for most of the community members there (StatsSA 2011). In terms of possible job creation in the area, smart agricultural projects[8] can, on the one hand take advantage of sufficient education levels in Tshikuwi as well as using these projects as a target towards which educational investments can be geared. Perhaps encouraging more agricultural training in the area can improve the human capital and economies of these rural areas (Yacob et al. 2012).

Free basic services relate mostly to, electricity, water provision and refuse removal. The legacy of Apartheid policies have left a distinct lack of these services especially in rural homeland areas such as Vhembe (Ferrol-Schulte et al. 2013). Although large improvements in these have taken place since 1994, there remains a great deal to improve on. As discussed in section 4.4 most people have various options for water collection. Most people rely on communal standpipes, but in the qualitative discussion it was indicated that these standpipes

[8] Climate smart agriculture is an initiative that guides transformation of agricultural systems to effectively support SD and ensure food security in a changing climate (UNDP 2014).

are often unreliable especially in times of drought and this will result in people having to travel large distances to access water from a borehole, or river.

Lack of flush toilets increases the likelihood of diseases and especially increases the risk of children getting sick. Globally many child deaths are as a result of dysentery caused through poor sanitation. During times of drought the proportion of faecal coliforms present in community drinking water increases. It is also possible for these bacteria to infiltrate into groundwater which can contaminate drinking wells with water borne diseases such as typhoid or cholera (United Nations Human Settlement programme 2011). Compounded with relative inaccessibility to appropriate healthcare systems, people, especially children are at risk of death caused by these water borne diseases that would otherwise be preventable. The consequences of a high rate of infant fatality in an area are directly related to life expectancy. Low life expectancy usually results in expanding populations as families do not engage in family planning, resulting in social pathologies mentioned as a result of the a youth bulge (Sustainable Development Solutions Network 2012).

During the site visits, observations were made that there is generally electricity available to most households in Vhembe. This was supported by most participants. However, their lack of employment and lower income earning results in most households being unable to afford to use the electricity. With the energy and electricity challenges that South Africa has recently experienced, it is likely that if people in areas such as Vhembe were able to afford electricity there would be insufficient supply to meet the demand. This would necessitate the construction of more power stations which are expensive and if are coal fired can have environmental consequences on the atmosphere (Business Enterprises 2011). Another consequence of this is that many households have to make use of the burning of fuel wood in the area. While this is undoubtedly an unsustainable practice as can be seen in some areas of Mahagala and Tshikuwi that appear to be devoid of large trees, it also poses an external threat to the atmosphere through the release of carbon as the wood is combusted.

Land tenure is an important parameter for socio-economic development: people are much more likely to invest in their environment (in terms of household improvements, use of available resources for productive purposes, etc.) if they own the property on which they live and have security of tenure. Many people in rural areas are subjected to the mechanisms of

traditional governance and in many cases land is not directly owned by the occupier, but usually granted to them through the local chief (Davenport et al. 2012).

Migratory patterns shown in section 4.6 is indicative of a low mobile population and also speaks to the notion that there are primarily labour sending areas where households will remain in one place while its younger members seek employment at other urban areas around the country.

5.2 *Livelihood sensitivity report*

The relatively low frequency to which people reported that they make use primarily of agriculture as an income source is slightly unusual for an area that is rural. However, there are urban areas within the VDM and there is a high prominence of employment in manufacturing and service industries. Although this would appear as if there is vulnerability to events affecting agriculture, this is smaller, however, because it is their relatively low income earning that still makes people more vulnerable to the economic implications of CV and its impacts on food purchases and disposable incomes (Maddison 2006).

Most household based agriculture was practiced within their homestead which is indicative of their use for supplementations of other purchased goods as opposed to being entirely subsistence based. In these yards maize, herbs and pumpkins were often grown in small vegetable patches but the most prominent were fruit trees such as citrus, banana and avocado. The most common trees by far were mangos with a large proportion of households having between 5 and 10 mango trees in their households, mango cultivation, at this frequency was more than expected, but not uncommon in a rural tropical area. Having said this, it also highlights the surprising dearth in the cultivation of the cassava crop in the area as this too is common among other African tropical rural areas (Rodima-Taylor 2012).

Another important aspect of natural capital is the area provided for the grazing of livestock. This leads to the importance of surrounding ecosystems to support rural households and displays the direct use values these households are able to attain from these ecosystems. According to the direct use values, the prominence of firewood as a source income is large. This combined with the fact that often the electricity available is still unaffordable and households will be required to buy or cut trees for firewood (De Coninck 2009). Other mentioned natural resources include: mopane worms, wild fruit and only one household used

it to make and sell handicrafts. Mopane worms are a common food source in the area and this is not surprising, but the frequency of handcraft production was lower than expected. This importance of the ecosystems as buffers against shocks renders their management in time of CV to be of great importance (Shackleton et al. 2008). This data indicates the importance of forest resources in supporting HHs and preventing them from sinking further into the poverty trap. Bearing in mind the drought could well reduce the density of these woodlands, careful management of these resources is required to ensure its sustainability especially considering the current impacts of the drought (Mapedza et al. 2003).

In terms of ***environmental management***, the VDM is faced with a number of complexly interrelated challenges, some of which have been alluded to earlier in this report. These include:

- Unfavourable and illegal land use, including uncontrolled growth of informal settlements;
- Current and future impacts of CV;
- Challenges related to development on unfertile land;
- Interference with river and groundwater flows;
- Potential imbalances between water demand and supply in parts of the study area; and
- Lingering sanitation service delivery backlogs and inadequate bulk sewerage infrastructure.

Since environmental sustainability cannot be divorced from social and economic sustainability, these challenges have the long-term potential to impact on the livelihoods and well-being of communities in the study area (Forum for the Future 2007).

HIV/AIDS has been and is an on-going social inhibiter as it often removes key bread wining family members in times of their prime income earning years. Health and nutrition remain relatively poor as a result of lower income, although nutrition is improving. These aspects of human capital are key to building resilience in communities and continually need to be assessed as a matter of great importance (Shackleton et al. 2007).

With the continued gender bias in school attendance, females remain at a disadvantage, this being an important issue which needs to be addressed. Moreover, almost all households who currently have children in primary school indicate that they intend to send them to secondary

school. Among the few households who indicated otherwise, the most common reasons stated for withdrawing children from school are that schooling is too expensive and that the secondary school is too far away. Having said this, there was a greater diversity of skills acquired with a relatively diverse range of occupations reported. This availability of skills is a good sign for potential development in the area and can be put to use in establishing infrastructure to help manage CV through the mitigation of floods and drought impacts.

There is a large amount of HHs that have family networks which is to be expected in a rural former homeland area. These networks appear to be supported by friends as well. It indicates that these communities experience a very high degree of social capital and it is likely that in times of difficulty the community pulls together through family and friend networks to adapt to these circumstances (see Table 8-16). Types of support that households provide to one another include sharing equipment, tools and transport etc.; taking care of one another's children; assisting one another with finding jobs; lending money and cultivating fields (see Figure 4-14). It is clear from these findings that there is a high degree of social capital that is often called upon to supplement or replace financial capital. Further evidence of this is the likeliness of households to assume membership of social organisations such as ward councils, youth or women's groups. This indicates willingness to accept and lend assistance in community issues (Forum for the Future 2007).

The area shows a large proportion of formal structures, a potential result of: long term residence, marginal government assistance and the availability of cheaper building materials in recent times. Road and electricity infrastructure are also impressive and reports that physical capital is not in low supply which will go a long way to building this resilience as it provides supportive infrastructure during water shortages or land degradation (Forum for the Future 2007).

The Tshikuwi area had a larger ownership of personal assets and the Gundani area was lower. The more rural characteristics of the Gundani area are supported here as they had more assets such as Wheelbarrows, Machetes and Ploughs. They also had a lot less households that possessed TVs, radios and electric stoves. Vehicle ownership in the area was low with the most HHs that owned a vehicle located in the Tshikuwi study area. Interestingly, bicycles were not a popular possession in either area indicating that public transport is manageable and perhaps that bicycles are susceptible to theft. Some HHs had managed to buy a generator

which was an interesting finding, while not many HHs possessed a sewing machine. Also notable was the popularity of cell phones, supporting the strength of social networks as well as the high degree of communication possible in the area (Portes 1998).

Livestock ownership was less prominent as originally expected with only 40% of respondents possessing domestic animals. Cattle was used for investment all of the time indicating, which is common amongst many rural areas in Africa, they are also used as in informal insurance policy for many rural HHs. The other more common animals were chickens which were most commonly used for meat and rarely used for eggs (Wang et al. 2013).

In terms of the more important sources of livelihoods, social grants and salaries represented the majority of livelihood activities. This was unexpected for a rural area usually associated with more agricultural activity. Also surprising was that migrant remittances were not as prominent as expected, these are common in the South African former homeland areas, this combined with the prominence of salaries indicates that there is a fairly diverse range of occupations available and a platform from which further economic growth can take place. Having said this it is still imperative to consider that the importance of social grants to many of the HHs cannot be underestimated. It is likely that without these grants many HHs could sink deeper into poverty and severely reduce other livelihood capitals rendering them especially vulnerable to reduced quality of life and even death in the face of a variable climate.

5.3 *Adaptive capacity*

Households without any income from salaries or social grants are forced to employ alternative livelihood strategies in order to survive. In rural areas across South Africa, many households depend on income from rooms (often informal extensions to the house, or loose-standing informal structures) that are rented out to ***tenants***. However, the results of the 2016 survey indicate that, only 2 of the households in the study area do have tenants, these are almost exclusively concentrated in wealthier, formal settlements. It therefore does *not* appear to be a livelihood strategy frequently employed by those without other forms of monetary income.

Other strategies for securing an income in the absence of employment include ***entrepreneurial activities***. For instance, it was found during the research that several people

have taken up the brewing of liquor to sell. Informal food stalls also represent a popular occupation. As shown in 4.2, self-employment constitutes a significant source of livelihood, representing the occupation of 5% of adults in the study area although in Gundani this was as much as 12%.

As was pointed out in Section 4.8.8, ***subsistence agriculture*** and ***the harvesting of natural resources*** are also limited in the study areas except in Mahagala where only 8% were making use of subsistence agriculture. In Gundani the use of natural resources was as much as 20%, although in the other two study areas, this was not stated as their most important livelihood. The initial hypothesis formulated by the researcher was that subsistence agriculture would be very prominent in the area. Instead, due to: limited availability of water (in some areas), land tenure inequality and lack of agricultural skills appeared to result in a reluctance to engage in subsistence agriculture as well as income generating agriculture. For the areas that appear to be well suited to agricultural development this is rather surprising. Importantly however, it is noted that towns such as Louis Trichardt, Thohoyandou and Mutale are able to sell mostly imported produce and the ability of people to access social grants and salaries has resulted in further popularity of the purchase of imported goods. It is worth mentioning that some communities on private farmland are often constrained in the types of livelihood strategies they can employ because of the conditions set by the landowner for them remaining on the farm. In many cases, farm owners do not allow residents to engage in agricultural activities on their land.

As also discussed in Section 4.8.8, dependence on the ***harvesting of natural resources*** is likewise limited. Nevertheless, the research and household survey did uncover some instances in which it can be considered a livelihood strategy. For instance, some households in Gundani and Mahagala reportedly collect goods sourced from the surrounding woodland, which they sell or consume. Firewood collection and sales are by a long way the most prominent kind of natural resource use and important to note the institutions governing the collection of firewood in the area are important to sustaining the wellbeing of the surrounding woodland. For the remainder, social grants are a very important livelihood support. For now it is necessary to assist those in poverty, but a gradual plan to wean people off of social grants is needed for the future as it is not a sustainable solutions. This can be done by establishing more support for agricultural skills and activities in the area.

5.4 *Outcomes*

This section assesses the degree to which the livelihood strategies described above have led to improved incomes, economically viable livelihoods, increased well-being, reduced vulnerability and/or increased overall economic, social and environmental sustainability.

The foregoing analysis shows that, for many communities in the study area, opportunities to secure sustainable livelihoods are meagre. Major constraining factors that limit such opportunities include:

- ***Contextual*** factors, such as:
  - Competition for jobs (arising from a substantial *population growth* and domestic job-seekers);
  - Limited and shrinking *job opportunities* (related, amongst other things, to sectorial shifts such as inadequate agricultural industries and high dependency on social grants);
  - An increasing *skills-bias in employment* (i.e. the fact that available jobs increasingly require higher skills levels);
- Factors related to ***human***, ***natural***, ***social***, ***physical*** and ***financial capital***, such as:
  - An *increasing degree of climate variability* affecting food security and rural livelihoods
  - Limited *skills*;
  - Semi - fragmented *social networks* (mainly due to the prominence of migrant labour);
  - Lack of access to and utilisation of *credit facilities*;
  - *Service delivery backlogs* (water, sanitation, etc.), which affect health and place time demands on household members;
  - Inadequate *transport infrastructure* (which limits access to livelihood opportunities);
- ***Institutional*** factors, such as:
  - Challenges with regard to *municipal service delivery*;
  - Reported *nepotism* and *corruption* at local government level;
  - *Competing land use pressures* (development vs. conservation).
  - *Unethical land tenure* as a result of traditional authorities control resulting in abuse for self-gain;
  - Low *quality and relevance of education* (which limits the acquisition of job-related skills);
- ***Factors related to the choice and implementation of livelihood strategies, such as:***
  - *Low income* from existing occupations;
  - High *dependency ratios*;
  - Limited opportunities for or willingness of unemployed persons to engage in *alternative livelihood strategies* (such as subsistence agriculture).

The combination of constraining factors listed above indicate that in terms of planning for the increased occurrences of CV does not appear to be high on the priority of local government. This indicates that if an intervention that increases the level of governmental support is to be implemented, it will have to revolve around creating large agricultural opportunities as well as opportunities in agro-processing. Most of these solutions will be explored in the next chapter as recommendations. These recommendations come as a result of the data presented from the survey. These will assist communities through effective support networks that will aim to achieve more sustainable livelihoods geared to overcome the challenges listed above. Not only will it aspire to mitigate some of these challenges it also seeks to identify opportunities that can arise from this increased support and aim to grow economic industries in disenfranchised areas. These kinds of reforms are necessary for South Africa to achieve better economic performance that is inclusive of a greater proportion of the South African population.

5.4.1 Land use

The fact that the study area is situated in the former homeland area, combined with its location in close proximity to some of South Africa's major conservation areas (mentioned in 5.4) poses some specific challenges in terms of land use planning. On the one hand, its history as a former homeland area implies certain restrictions on the distribution of land; most importantly its designation amongst TAs and their control of ownership of this land. The other being the expansion of the Kruger Park conservation area which has over the years displaced many into homeland areas where high population density exacerbates the unequal access to meaningful land tenure. These restrictions prohibit the establishment of new residential areas to house people who have recently moved into the area, while limiting the expansion of existing settlements. Even without these restrictions, however, development of the area would still be constrained by the fact that much of the area is mountainous and receives spatially varied rainfall which may be much higher in some areas as opposed to others (Vhembe District Municipality 2012).

A somewhat different situation prevails in the region of the study area outside of the former Venda homeland. In contrast with the latter, which is currently characterised by trends of large land ownership for the production of tropical crops, nuts and deciduous fruits, this outside area shows a greater level of human development and reinforce typical socio-

economic issues related with inequality. Continued pressure on these large land owners is likely to increase as their high degree of land ownership is evident and likely to cause significant animosity. These areas are indeed susceptible to criminal activity highlighting the need to create further agricultural industries in Vhembe in order to attempt to increase human development in those areas. If addressed inadequately, there is likely to be more security measures taken by farmers feeling under threat which could perpetuate an already complex issue (Critchley, Versveld and Mollel 1998).

5.4.2 Education

It was mentioned in Section 2.2 that skills are assuming ever-growing importance in terms of people's ability to secure sustainable livelihoods. There are indications that access to education has improved somewhat in the study area over the last 15 years– although participants in the research undertaken as part of this assignment stressed that there is a shortage of secondary education facilities in the area (Vhembe District Municipality 2015) (StatsSA 2013).

An issue of significant concern, however, is that the ***quality and relevance of education*** offered by South African schools and tertiary education institutions seem to be declining. For an example, even those who complete secondary school struggle to find gainful employment to further develop skills. While this may reflect employers' preference for more highly-skilled graduates, it may also indicate that a Matric certificate has lost its potency as a measure of quality education. Likewise, high unemployment rates among persons with diplomas and degrees suggest that the institutional environment designed to produce the country's semi-skilled and skilled workforce – namely universities, further education and training (FET) colleges, and universities of technology – is producing too many graduates who are not in demand by employers (Shackleton 2003).

5.4.3 Policies institutions and processes

Evidence suggested in the literature review states that impacts of CV on households is measurable by its impacts on welfare, food security, value of assets (mainly farm related), income, consumption or health (Vermeulen et al. 2012). Even though the impacts of these vary it is widely expected CV in the area will further undermine the welfare of poorer farmers as well as those who are considered net buyers of food in both rural and urban areas (Fuss et al. 2015). Even though many agricultural HHs exist in the areas, the survey shows many HHs

fall under the category of net buyers. Through effective vulnerability and resilience analyses a significant knowledge gap identified in the literature review can be addressed. Sustainable livelihood research has been used in this study to identify adaptation weakness and effectively identify policy support in building HH resilience. An aid to this is supporting institutional structures and processes, organisations, policies and legislation that determine households' access to assets and choice of livelihood strategies.

The following institutional and policy issues that are relevant to livelihoods of the poor in the study areas are as follows:

- Municipal, provincial, national and international planning frameworks and strategies;
- Capacity of LMs for the implementation of development plans;
- Spatial development through land use planning to accommodate changes in land use patterns as a result of CV focusing on increasing equitable access to land tenure;
- The quality and effectiveness of education and training systems focussing on developing a strong agricultural sector in the area. These should be focused on smart agricultural initiatives aimed at increasing efficiency while reducing resource use as well as quality crop selection.

5.5 *Contributions towards CV in Southern Africa*

As indicated in section 2.6 there were gaps identified in the literature on CV in the Southern Africa. As stated, impacts from CV were greater as a result of extreme variance rather than gradual increases in average temperatures. This statement is supported by this study as it showed the large impacts of the 2015 drought on farmers in the area with just less than half of the land owners stating they had left their fields fallow. Qualitative information collected also indicated that flooding experience in the year 2000 also left many fields damaged and were unable to cultivate that year. Better monitoring and analysis of trends in the ENSO cycle can assist in sufficient planning for such events. Evidence collected also indicates that other safety nets such as natural resource collection are also reduced in times of extreme weather. The cumulative effects are also being felt economically as indicated by the calculation that for a basic basket of food goods, the price has increased by 15% (John 2016). Goods which demand are not affected by its price such as maize increased by as much as 32% thus severely reducing disposable incomes of rural HHs (John 2016). The dependence of these communities on social grants leaves adaptation to such a change unattainable.

This research contributes to a need to elaborate on the sensitivity of Africa to CV by indicating that lack of support contributes to weak resilience of African communities. A reconstruction of ENSO cycles could be a potential tool to predicting the likeliness of flooding or drought (National Oceanic and Atmospheric Administration 2016). Capacity building of communities in relation to these trends can be achieved through the study of social dimensions and this research indicates these dimensions through use of the SLF. These, combined with the documented ENSO trends can identify potential future climate hazards and appropriately prepare them for these hazards.

Another aim set out in this research was to potentially bring to light IKS in rural agriculture that would potentially assist in CV adaptation. These did not appear as expected in the research as there were fewer HHs interviewed which engaged in agricultural activity than what was expected. The most promising indigenous knowledge was to identify farming areas that were in close proximity to ground water aquifers which would provide a buffer to some farmers during the drought. Another interesting practice was that of stone terracing on the hilly terrain which served to preserve soil productivity through the reduction of erosion caused by the increasing intensity and occurrences of thunderstorms. Although these were noticed during the research it was only practiced by at most 3 HHs out of the 75 interviewed, indicating a potential diminishing distribution of local knowledge.

This research also adds to the literature on CV adaptation in Southern Africa and builds on previous studies in these areas. In many of these studies the SLF was used to isolate the direct use values of natural resource collection yielding some interesting results which highlights the importance of local institution in protecting these resources. This research added a great deal more socio-economic information into the SLF for climate sensitive regions in South Africa. Some of the more important indications are that there is too large a dependence on social grants and too little access to other forms of financial capital such as credit. It indicates that a large amount of government support will be needed in order to build capacity and develop industries to reduce the reliance on social grants and in doing so, reduce the vulnerability of these communities to CV.

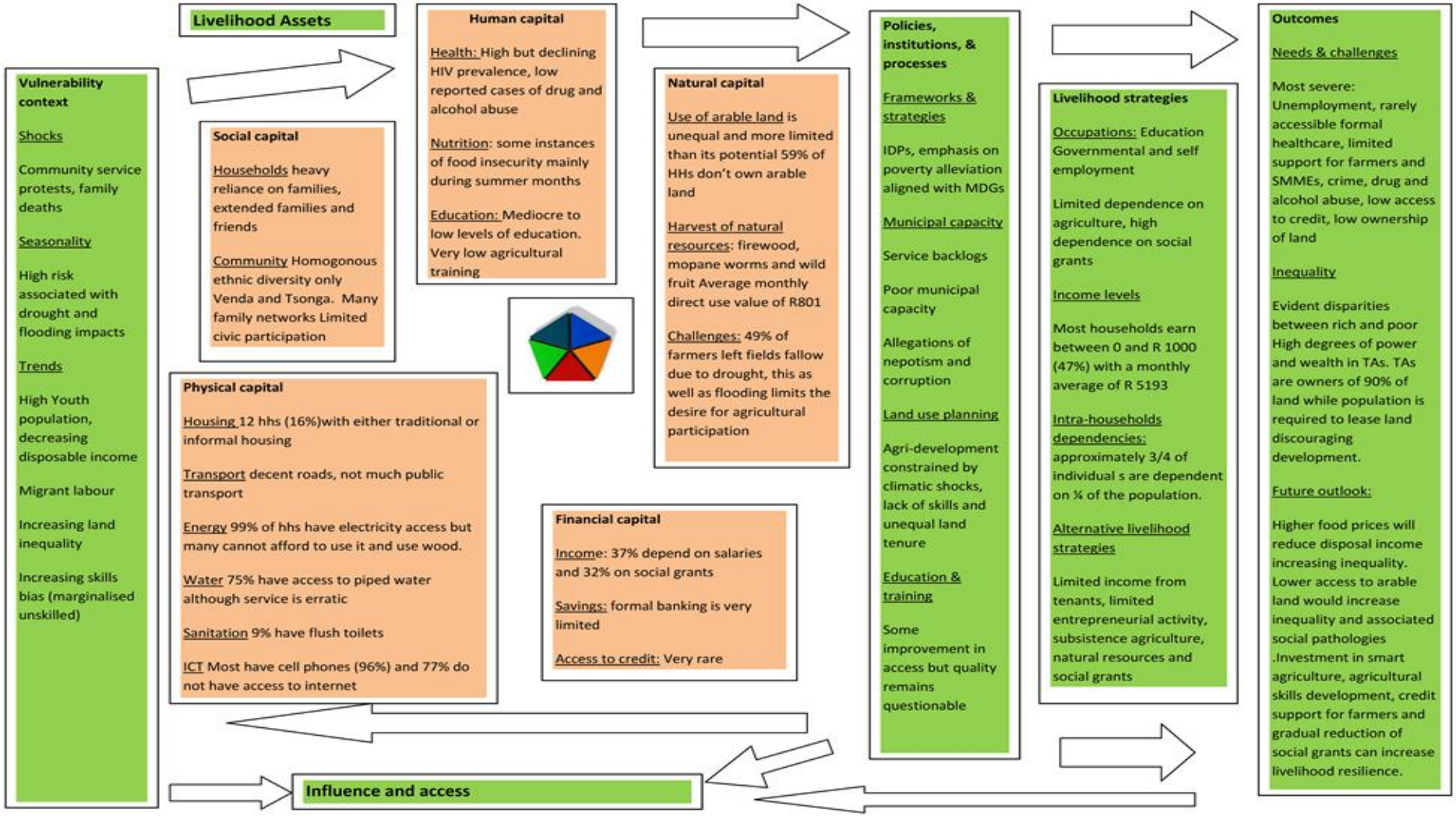


Figure 5-1: Summarised SLF for the combined study areas based on survey results

CHAPTER SIX
CONCLUSION AND RECOMMENDATIONS

Molestsi Mbeki has stated that there is a silent civil war happening in South Africa. He further suggests that there has always been a force driven against producers and workers in the South African economy. He has indicated that a good way to deal with this is to build more industries in both rural and urban areas, while there are plans to implement these industries in urban areas; rural areas are largely neglected suggesting the possibility of expanding agricultural productivity along with agricultural processing industries in the Vhembe district (Madibogo 2016).

In addressing the relationship between CV and rural livelihoods, it is clear that CV affects these through shocks causing a high risk to these livelihoods reducing access to arable land, increasing food prices and decreasing disposable income. These factors are likely to result in an increase in social pathologies such as service delivery protests, alcohol and drug abuse decreasing health and nutrition and general unhappiness (Gelb 2003). This is synonymous with the steady erosion in resilience according to the SLF that is being experienced in these areas (Giannecchini et al. 2007). In many cases resilience to these shocks are found in a high degree of social capital and to a certain degree in natural capital. These are through extensive family and social networks while natural capital is utilized in natural resource harvesting, and small amount of subsistence agriculture around the homestead (Shackleton 2003). Social grants have also emerged as a key source of livelihood in the area however, this will gradually need to be phased out in favour of other livelihood opportunities in order to ensure the social and environmental sustainability of the area.

6.1 *Key findings and main contribution of thesis*

It was found that local knowledge and effective local institutions were not as prevalent as expected in achieving livelihood adaptation in the research areas. Some key findings from the research were that 59% of households did not have access to arable land with 49% of respondents stating that they did not plant crops in the recent season due to the poor rains experienced. Furthermore, the reliance on social grants was notably high with 32% of respondents relying on these. Some residents who cannot pay to have access to electricity are

forced to collect or buy firewood for everyday use. Furthermore, only 9% of respondents stated that they had access to flush toilets. These issues are shown to have environmental and other social consequences in the target communities.

The main contributions of the thesis is to highlight through the SLF the sensitivity of African communities to CV. this is especially noticeable when considering the differing sensitivities depending on the cycles on the ENSO affected seasonal changes. The livelihood capitals indicate strengths in some of the capitals but a great deal of weakness in others as well as a weakness in the institutions necessary to support these capitals. The results provide comprehensive socio economic information in relation to the external environmental conditions and these findings can be put to good use if made available to policy makers. The thesis also provides information on areas where capacity for adaptation can be increased through the SLF. Some of these adaptations are elaborated on below in relation to land use and appropriate education among others. These socio economic data can be used to identify CV hazards that are likely to occur in rural Africa. Navigation around these hazards and risks can be used to formulate IDPs which can be used to guide adaptation. Based on these main contributions the conclusions and recommendations for the thesis follow in the sections below.

6.1 *Planning frameworks and strategies*

Planning frameworks that impact on the development of the study area include:

- The municipal Integrated Development Plan, or IDP (TLM,MKLM and MTLM, 2015) and their Spatial Development Framework (SDFs, 2015);
- The Limpopo Social Development Strategy (Vhembe District Municipality 2015); and
- National strategies such as Reconstruction and Development Plan (RDP), the Growth, Employment and Redistribution (GEAR) strategy, and the Accelerated and Shared Growth Initiative for South Africa (ASGISA) (which identifies tourism as one of its two immediate priority sectors for intervention and the implementation of initiatives) (National Planning Commission 2012).

These strategies and plans are commendable in a number of respects. First, their development typically entailed significant stakeholder involvement and consultation. Second, they are well aligned with international policy frameworks such as the Sustainable Development Goals (SDGs) – a set of measurable development goals that were developed on the basis of agreements reached at several global United Nations summits and conferences

held recently in 2014, and that are outlined in the Organisation for Economic Cooperation and Development (OECD) document *Shaping the 21st Century* (UNDP 2014).

The MDGs set the following targets for the year 2015:

- Eradicate extreme poverty and hunger;
- Achieve universal primary education;
- Promote gender equality and empower women;
- Reduce child mortality;
- Improve maternal health;
- Combat HIV/AIDS, Malaria and other diseases; and
- Ensure environmental sustainability.

A third positive attribute of the development plans listed above is that they all give priority to the upliftment of poor people, recognising that economic growth and equitable social development do not necessarily go hand in hand. Economic growth is desirable but there must be regulation to ensure that their growth and development is equitable so as not to widen the existing gap between rich and poor (UNDP 2014) (Vhembe District Municipality 2015).

6.2 *Land use planning*

As recommended, a drive to develop significant agricultural production and agro-processing industries in the VDM would find itself at loggerheads with significant development pressures – for instance through the establishment of new residential areas around Thohoyandou and Louis Trichardt, as well as through the need to support and provide infrastructure for the growing number of people (StatsSA 2013).

A negative consequence of increasing populations in the area is the fact that infrastructure does has not always keep pace with population growth and in the development of new communities, residents are often plagued by power outages, poor water quality and water cuts. This problem is compounded by the limited capacity of local authorities to respond to the crisis through improving and expanding service delivery. An equally serious problem is that no planning has been undertaken for housing for people residing in former homeland areas. There is a danger that this will lead to the proliferation of informal settlements and lower income urban areas in and around Thohoyandou (Unep 2012) (Vhembe District Municipality 2015).

Decisions related to land use planning in the study area therefore have to contend with numerous competing priorities. On the one hand, encroaching agro-development compounded with CV may exacerbate the effects of existing livelihood challenges in the area in terms of posing a threat to environmental integrity, as well as disturbing the ability of the areas to be productive in agricultural activity that make this an attractive development option in the first place (Nel and Nel 2009). On the other hand, the urgent need for job creation, housing and service delivery – as well as the need for people to live better lives into the future while dealing with challenges brought about by CV – cannot be denied.

6.3 *Education and training*

If it is true that the education system is ignorant of the needs of employers which suggests therefore, further opportunities exist for business to assist Nongovernmental organizations (NGOs) and government to train those who do not finish secondary school in, for example, agricultural associated artisanal skills as well as plumbing, carpentry and electrical apprentices etc. Another worthwhile investment would be to set up agricultural training colleges aimed at developing skills in smart agriculture as well as associated skills needed in agro-processing industries at a tertiary level (van Marrewijk 2013). This combined with investment and support for growing an agricultural industry in the area will result in more graduates finding work. There exists large opportunities for development in this regard as it would serve to both increase food security in the area as well as providing livelihoods for those engaged in the agricultural industry (Donohue & Biggs 2015). Large production output in line with the area potential can also increase exports and play a role in reducing the country's trade deficit. The current discourse will result in the continuation of the national trend that for many South Africans a lack of relevant and applicable skills is their single biggest impediment towards securing adequate and sustainable livelihoods (de Sherbinin et al. 2008).

6.4 *Sustainability*

Upon recommendation aligned with the national development plan, the re-emergence of strong economic growth in South Africa (which ideally is more inclusive than in the past) can be achieved by a large investment into efficient agricultural production. The most promising would be capacity building in smart agricultural projects in areas such as the Vhembe District. The following factors are to be considered in establishing the sustainability of these projects:

- ***Technical soundness*** (do achievements rely on sound technology using inputs efficiently and providing productivity gains).
- ***Policy and political sustainability*** (in terms of government commitment, a supportive legal/regulatory framework, etc.).
- ***Social sustainability*** (are community participation and beneficiary incentives adequate to maintain the flow of project benefits, and do the government and project beneficiaries "own" the project benefits with a special emphasis on the extent to which reduction of poverty or improvements in condition for women and vulnerable groups are likely to be durable).
- ***Economic sustainability*** (do the operations' achievements depend on appropriate macroeconomic and sector conditions or policies being in place, and are cost-effectiveness indicators or estimates of economic and financial criteria based on robust assumptions).
- ***Financial sustainability*** (are financial policies adequate, and can the projects be expected to generate adequate revenues or receive adequate budgetary funding in the future).
- ***Environmental sustainability*** (do the projects affect the environment and/or renewable and non-renewable resources, and were the projects' likely environmental impacts assessed prior to implementation and adequate mitigation measures identified).
- ***Resilience to exogenous factors*** (do the achievements depend on exogenous factors, such as the terms of trade, the world market prices or the political situation in neighbouring countries) (Forum for the Future 2007).

Assessment of the potential agro-development projects in terms of the technical, economic and financial dimensions of sustainability falls beyond the scope of this study. With regard to ***policy*** and ***political*** sustainability, plans exist in the IDPs in line with the NDP and the above recommendations could be incorporated into them, although this does not necessarily guarantee its effective enforcement (National Planning Commission 2012). With regard to ***social*** sustainability, the results presented above indicate that, although government commitment to the projects could be high, community buy-in and support is always difficult to come by and this may potentially pose a threat to its social sustainability. Poor service delivery by Local Government also tends to create general mistrust of government among stakeholders and communities (Marais 2013). With regard to ***environmental*** sustainability, the recommendations above will be impacted by climate change and therefore careful management of renewable or non-renewable resources is imperative along with close monitoring (Twine et al. 2003). It also highlights the need for smart land management in relation to these agricultural developments in order to increase adaptive capacity in the communities (Critchley, Versveld and Mollel 1998). Finally, the following ***exogenous factors*** have been identified that could potentially pose a threat to the Project's sustainability: Both local and national food markets represent the greatest source of potential revenue for the agricultural industry in the study area – although its potential has not yet been adequately

explored to date. Its long-term financial viability may be vulnerable to changes in the international market meaning that a significant amount of government support needs to be established to ensure resilience in the sector. Conditions that could pose an exogenous threat in this regard include economic crises (such as the recent recession) or major political events (Fuss et al. 2015).

In summary of the research conducted, it was not evident in either community assessed that there are sufficient local institutions that have been developed to mitigate impacts of CC and CV on these rural livelihoods, particularly the poorer households as what was theorised. It is evident that insufficient access to some of the five capitals stipulated in the SLF dramatically reduces the resilience of the communities and therefore inhibits their ability to adapt to CV in the area. As it is predicted that there will be increased CV in this area it is of great importance that meaningful intervention be established to assist in building resilience of these communities. One possible solution is that local Government in partnership with aid funding and businesses entities need to be involved in a wide range of areas to increase access to livelihood capitals in order for the rural poor societies to be in a position to build resilience to CV and without it they will be severely threatened.

6.5 *Opportunities for future research*

The areas for future research that could be explored would be to perform a similar study on the same communities in five years' time in order to gauge the severity of CV impacts on their livelihoods using the SLF. This can be statistically tested in order to determine the significance of the impacts on these households. Other areas of research would be to assess the viability of smart agricultural projects to assist in food security for these areas as well as to potentially grow the economy through agro-development. It would also be necessary to establish the best way that these projects can be rolled out to ensure their sustainability. Perhaps more research could also be used to establish the willingness of these affected communities to engage in these agro-developments to establish if there will be the necessary community buy in to create partnerships to develop these industries. Furthermore, it would also be beneficial to establish the willingness of the government, NGOs and businesses to understand what their requirements and expectations would be in establishing these partnerships. Determining the level of community expectations surrounding the potential for the partnerships to pursue these developments will also assist to manage any potential conflict or teething problems that projects of this sort may be hampered by. As serious as the

situation is getting for some of these HHs and communities there still remains opportunities in the areas mentioned above to improve livelihoods in the area as well as establish meaningful partnerships that can be used to establish a greater deal of resilience in times to come.

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APPENDIX A

CHARTS AND TABLES

8.1 *Municipal*

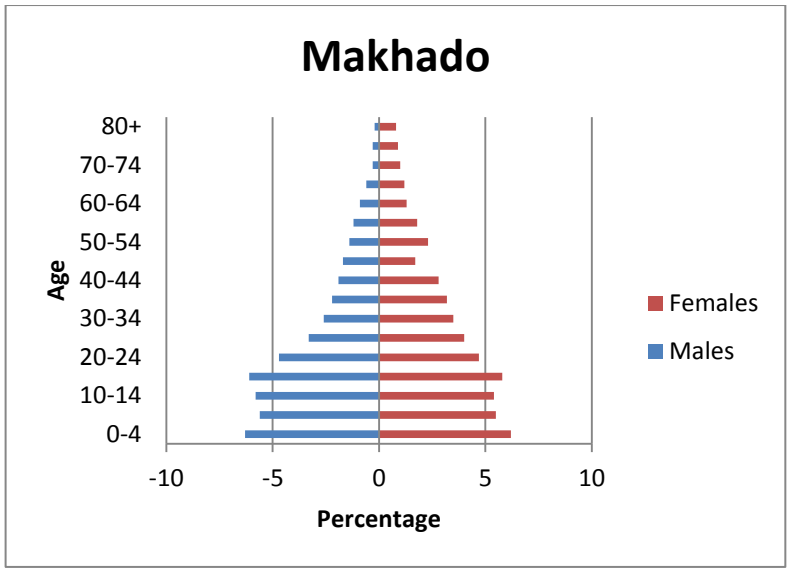


Figure 8-1: MKLM Population pyramid

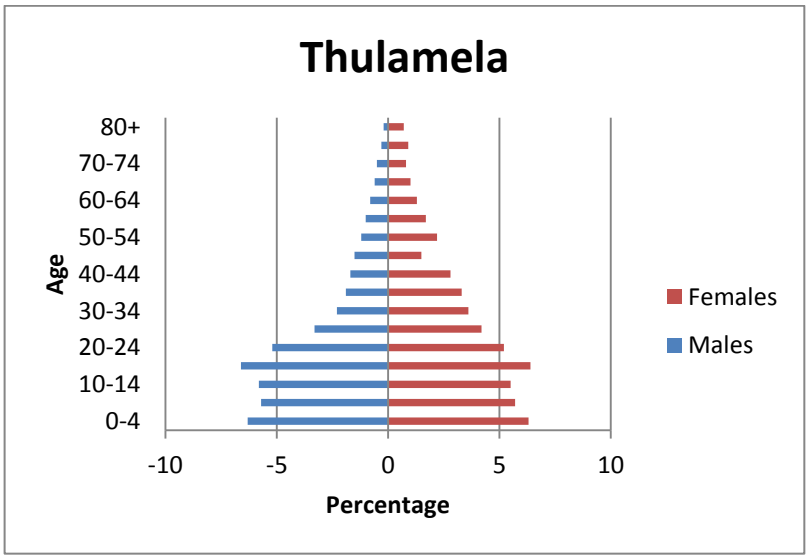


Figure 8-2: TLM Population pyramid

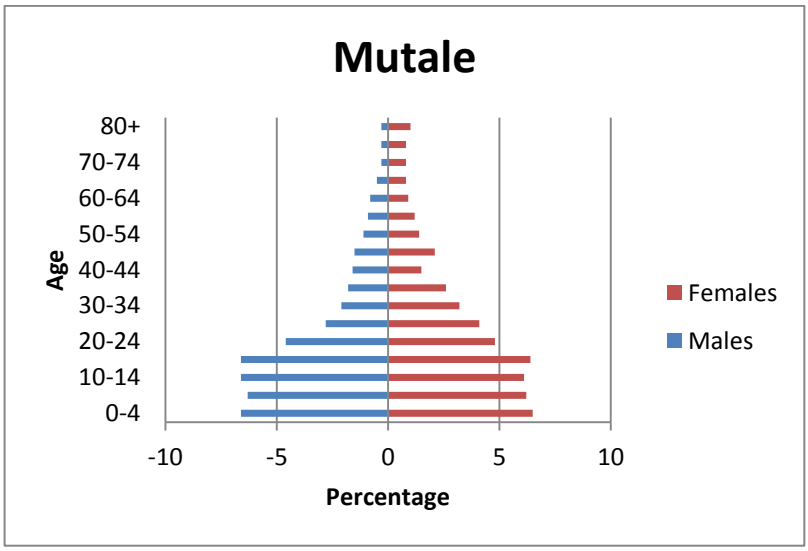


Figure 8-3: MTLM Population pyramid

Table 8-1: Language

Language	Makhado	Thulamela	Mutale
Tshivenda	67.3%	63.0%	96.0%
Xitsonga	21.9%	32.5%	0.8%
Afrikaans	2.2%	0.3%	0.6%
Sepedi	2.6%	0.3%	0.2%
English	1.2%	0.7%	0.3%
Sesotho	1.2%	0.1%	0.2%
IsiZulu	0.2%	0.1%	0.1%
Other	3.4%	3.0%	1.8%

Source: (StatsSA 2011)

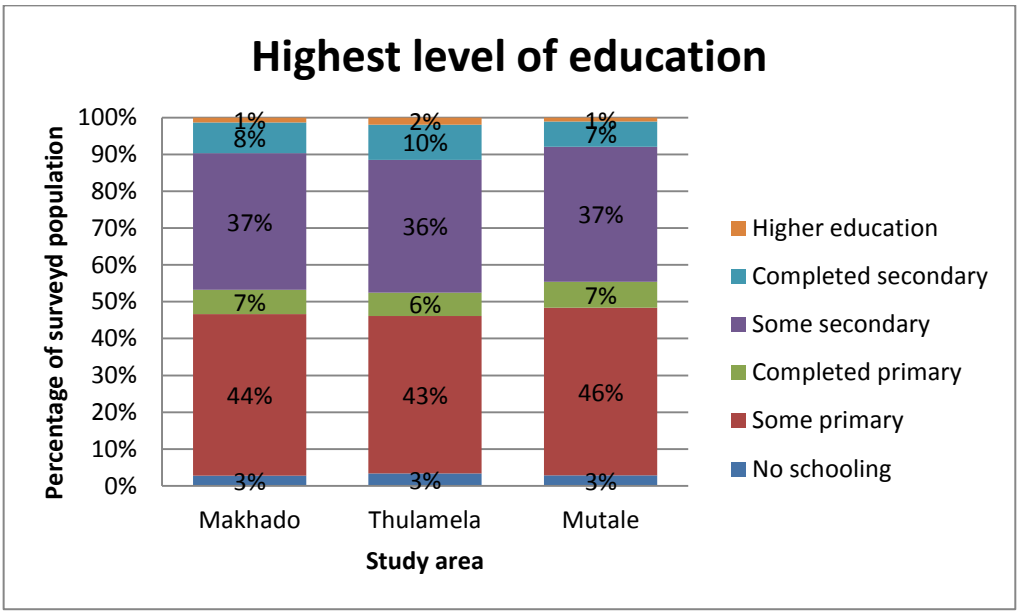


Figure 8-4: Highest level of education

Source: (StatsSA 2011)

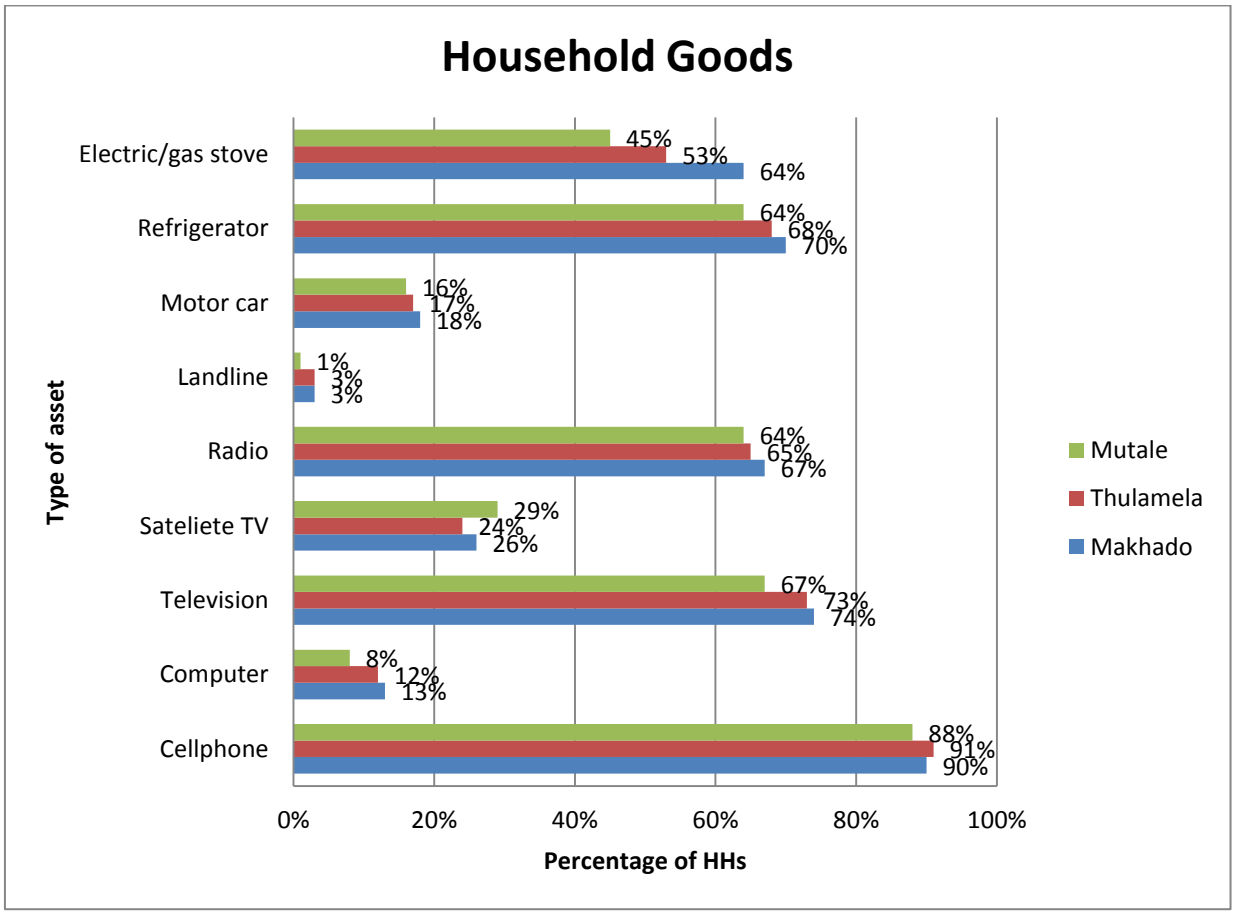


Figure 8-5: Household assets

Source: (StatsSA 2011)

Table 8-2: Internet access

Internet	Makhado	Thulamela	Mutale
From house	3%	2%	2%
From cell phone	14%	18%	17%
From work	2%	1%	1%
From elsewhere	4%	5%	2%
No access	78%	74%	79%

Source: (StatsSA 2011)

Table 8-3: Water provision

Source of water	Makhado	Thulamela	Mutale
Local water scheme	58.8%	76.9%	63.0%
Borehole	17.2%	5.0%	12.9%
Spring	2.7%	3.8%	4.9%
Rain water tank	0.4%	0.4%	0.3%
Dam/pool/stagnant water	6.4%	2.7%	6.8%
River/stream	3.0%	5.0%	9.4%
Water vendor	6.8%	1.6%	0.4%
Water tanker	2.0%	1.9%	1.8%
Other	2.7%	2.7%	0.5%

Source: (StatsSA 2011)

Table 8-4: Refuse removal

Refuse removal	Makhado	Thulamela	Mutale
Removed by local authority 1 a week	9.5%	12.5%	5.2%
Removed by local less than once a week	0.6%	0.4%	0.5%
Communal refuse dump	1.2%	0.8%	2.4%
Own refuse dump	78.4%	73.5%	78.9%
No rubbish disposal	9.3%	12.3%	12.8%
other	1.0%	0.5%	0.1%

Source: (StatsSA 2011)

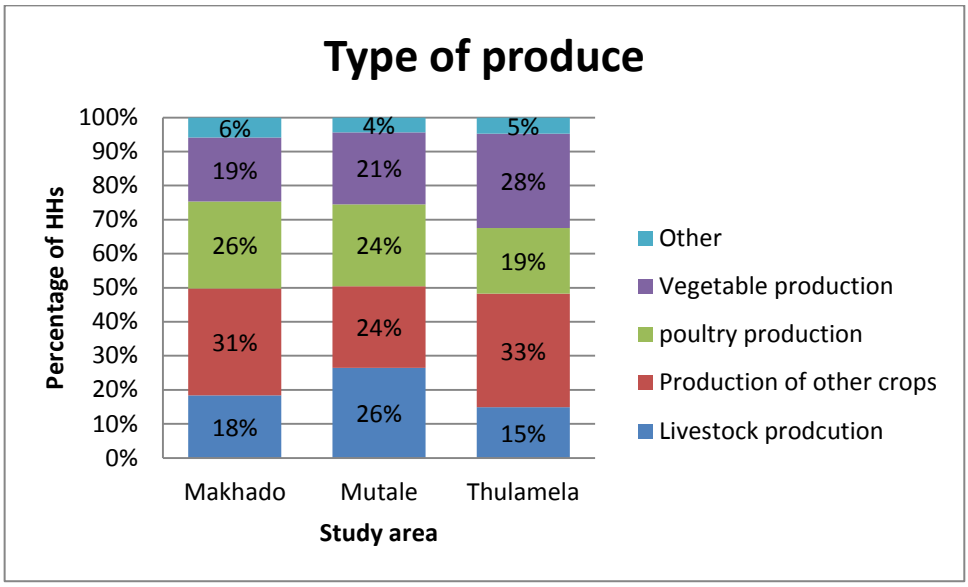


Figure 8-6: Produce generated on farms

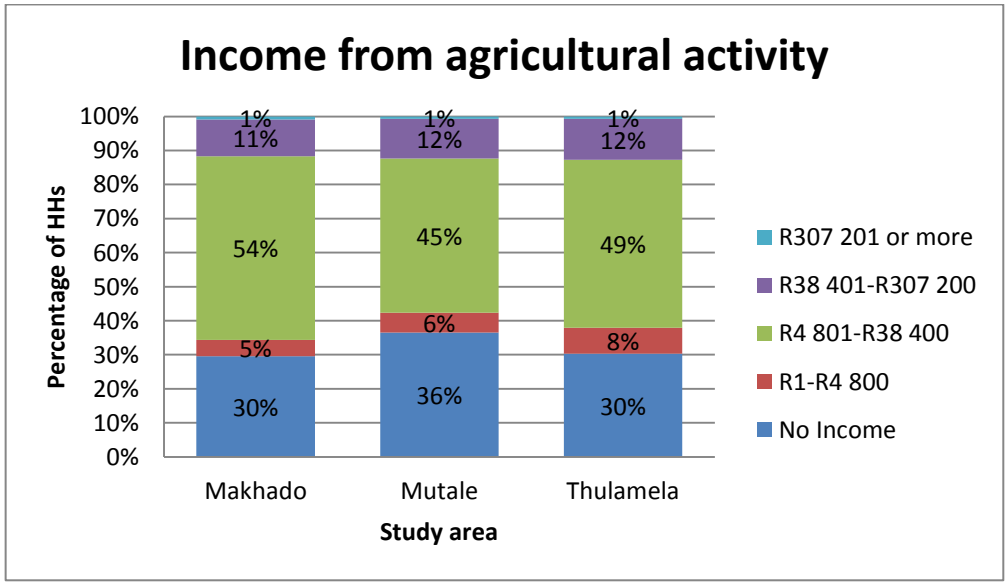


Figure 8-7: Monthly income generation of farms

8.2 *Site specific*

Table 8-5: Employment of total population

Employment	Gundani	Mahagala	Tshikuwi	Total
Still in school or studying	35%	41%	32%	36%
Staying home/not looking for work	26%	23%	15%	22%
Unemployed but looking for work	21%	8%	5%	12%
Employed	17%	23%	31%	23%
Pensioner	1%	4%	18%	7%

Table 8-6: Education and gender

Highest level of education	Female			Female Total	Male			Male Total
	Gundani	Mahagala	Tshikuwi		Gundani	Mahagala	Tshikuwi	
None	9%	5%	11%	8%	0%	0%	7%	2%
Some primary school	28%	16%	9%	18%	16%	19%	3%	14%
Completed primary school	6%	5%	13%	8%	8%	10%	7%	8%
Some secondary school	32%	40%	25%	33%	37%	17%	20%	26%
Completed secondary school	19%	21%	18%	19%	27%	29%	30%	28%
Higher education	6%	12%	24%	13%	12%	26%	33%	22%

Table 8-7: Source of water

Source of water	Gundani	Mahagala	Tshikuwi	Grand Total
Community standpipe	56%	36%	0%	31%
Piped water in house	0%	28%	48%	25%
Multiple sources	4%	24%	12%	13%
Groundwater	4%	4%	20%	9%
Purchase	0%	0%	16%	5%
River/dam	12%	4%	0%	5%
Rainwater tank	12%	0%	0%	4%
Unreliable tap	8%	4%	0%	4%
Borrow	4%	0%	4%	3%

Table 8-8: Sanitation

Sanitation	Gundani	Mahagala	Tshikuwi	Grand Total
Pit latrine	100%	80%	60%	80%
Flush toilet/pit latrine	0%	0%	28%	9%
Flush toilet	0%	12%	4%	5%
None	0%	8%	4%	4%
Other	0%	0%	4%	1%

Table 8-9: Sources of energy

Energy source for cooking	Gundani	Mahagala	Tshikuwi	Grand Total
Wood	84%	56%	44%	61%
Electricity	4%	16%	48%	23%
Electricity/wood	8%	28%	8%	15%
Charcoal	4%	0%	0%	1%

Energy source for lighting	Gundani	Mahagala	Tshikuwi	Grand Total
Candles	0%	0%	4%	1%
Electricity	100%	100%	96%	99%

Energy source for heating	Gundani	Mahagala	Tshikuwi	Grand Total
Wood	88%	88%	48%	74%
Electricity	4%	13%	52%	23%
Charcoal	4%	0%	0%	1%
Electricity/wood	4%	0%	0%	1%

Table 8-10: Migratory patterns

Years staying in residence	Gundani	Mahagala	Tshikuwi	Grand Total
Less than 5 years	8%	0%	0%	3%
Between 10 and 20 years	12%	13%	4%	10%
Between 20 and 30 years	8%	17%	63%	29%
Between 30 and 40 years	0%	8%	25%	11%
Between 40 and 50 years	16%	4%	0%	7%
Between 5 and 10 years	4%	13%	8%	8%
More than 50 years	52%	46%	0%	33%

Table 8-11: Distance of arable land from home

Distance form house	Gundani	Mahagala	Tshikuwi	Grand Total
At the house	75%	74%	79%	76%
Between 100m and 500m from house	17%	24%	15%	18%
Less than 100m from house	8%	0%	6%	5%
More than 500m from house	0%	3%	0%	1%

Table 8-12: Most prominent primary tree/crop cultivated

Type of crop or tree	Gundani	Mahagala	Tshikuwi	Grand Total
Mango	14	17	14	45
Maize	8	8	10	26
Citrus	3	2	8	13
Avocado	6		2	8
Guava	2	2	2	6
Grapes	1		4	5
Other	11	8	8	27

Table 8-13: Most common secondary crops

Type & Number of trees	Gundani	Mahagala	Tshikuwi	Grand Total
Citrus	**3**	**2**	**8**	**13**
Between 1 and 5	2	2	8	12
More than 5	1			1
Avocado	**6**		**2**	**8**
Between 1 and 5	5		2	7
More than 5	1			1
Guava	**2**	**2**	**2**	**6**
Between 1 and 5	2	2	2	6
Grapes	**1**		**4**	**5**
Between 1 and 5	1		4	5

Type of crop or tree	Gundani	Mahagala	Tshikuwi	Grand Total
Citrus	6	6	8	20
Avocado	8	1	4	13
Peanuts	2	3	3	8
Peach	3	0	4	7
Mango	3	1	3	7
Paw paw	4	1	1	6
Guava	1	3	1	5
Banana	1	2	1	4
Other	7	8	5	20

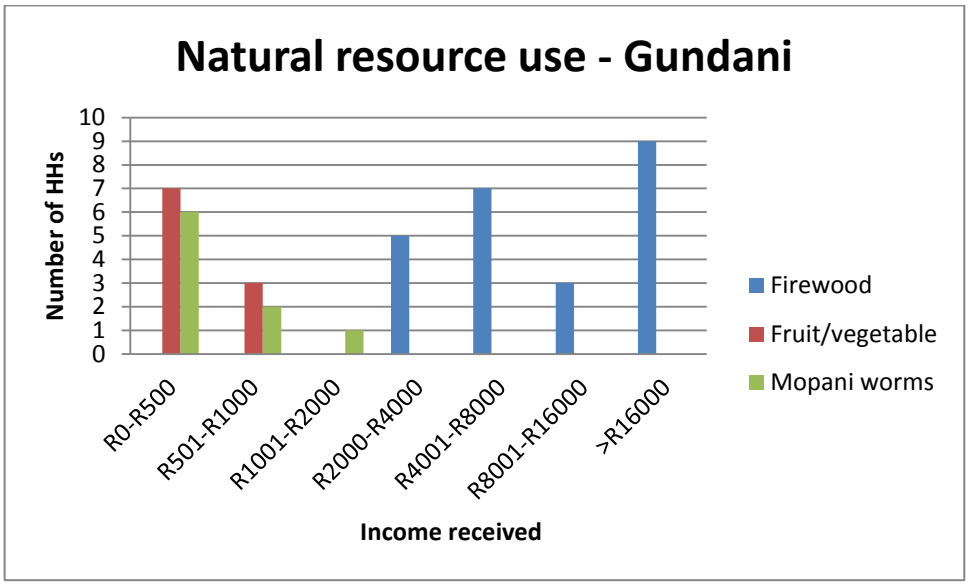


Figure 8-8: Natural resource use value

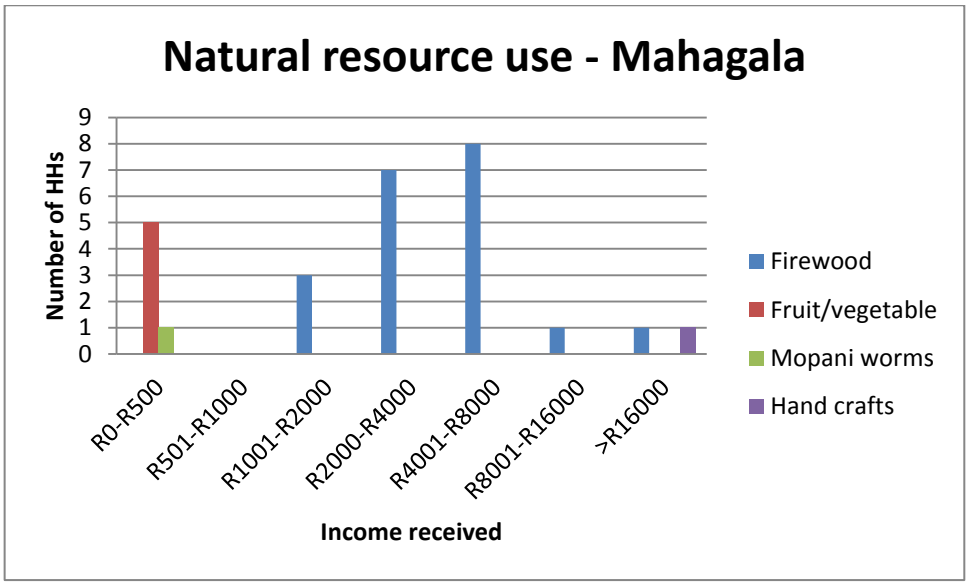


Figure 8-9: Natural resource use value

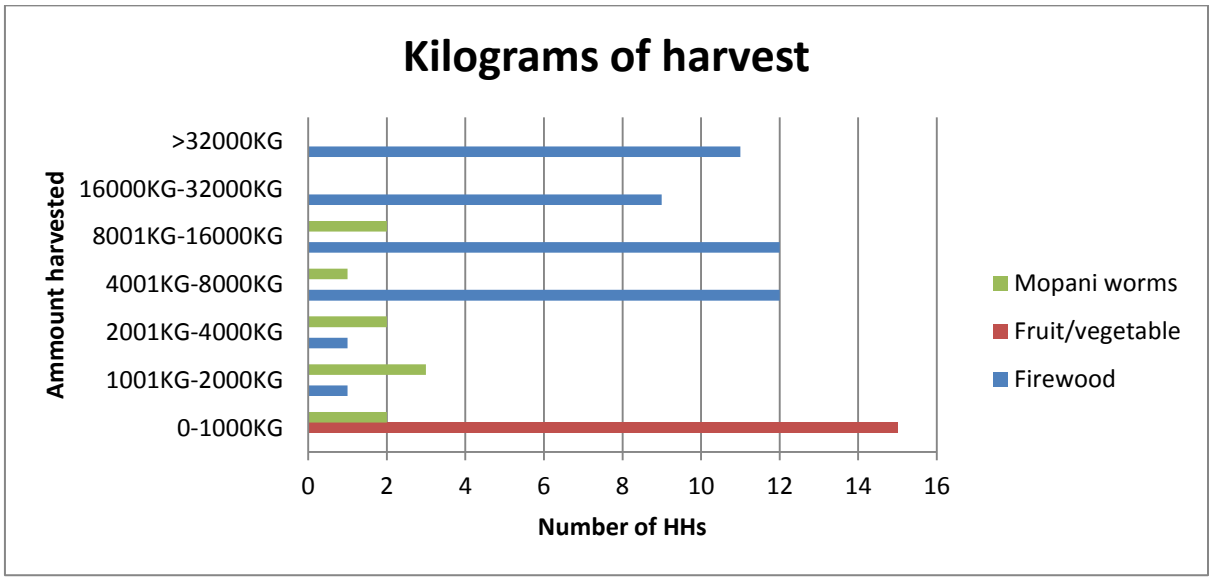


Figure 8-10: Number of kilograms harvested

Table 8-14: Food security

Shortage of food	Percentage of HHs
No	68%
Yes	32%

Table 8-15: Household relationships

Relation to household head	Gundani	Mahagala	Tshikuwi	Total
Household head	21%	25%	30%	25%
Spouse of household head	12%	10%	18%	13%
Son/daughter of household head	58%	48%	45%	51%
Grandchild of household head	2%	11%	6%	6%
Brother/sister of household head	3%	3%	1%	3%
Parent or parent-in-law of household head	3%	1%	0%	1%
Son-in-law/daughter-in-law of household head	1%	1%	0%	1%
Great grandchild of household head	0%	1%	0%	0%
Niece/nephew of household head	1%	0%	0%	0%

Table 8-16: Social networks

Gundani	No	Yes
Relatives in village	12%	88%
Borrow money	60%	40%
Cultivate fields	64%	36%
Exchange goods	32%	68%
Find jobs	64%	36%
Share equipment	56%	44%
Take care of children	44%	56%
Take care of sick	28%	72%
Mahagala		
Relatives in village	20%	80%
Borrow money	56%	44%
Cultivate fields	60%	40%
Exchange goods	40%	60%
Find jobs	68%	32%
Share equipment	52%	48%
Take care of children	56%	44%
Take care of sick	40%	60%
Tshikuwi		
Relatives in village	28%	72%
Borrow money	72%	28%
Cultivate fields	96%	4%
Exchange goods	32%	68%
Find jobs	68%	32%
Share equipment	28%	72%
Take care of children	32%	68%
Take care of sick	16%	84%

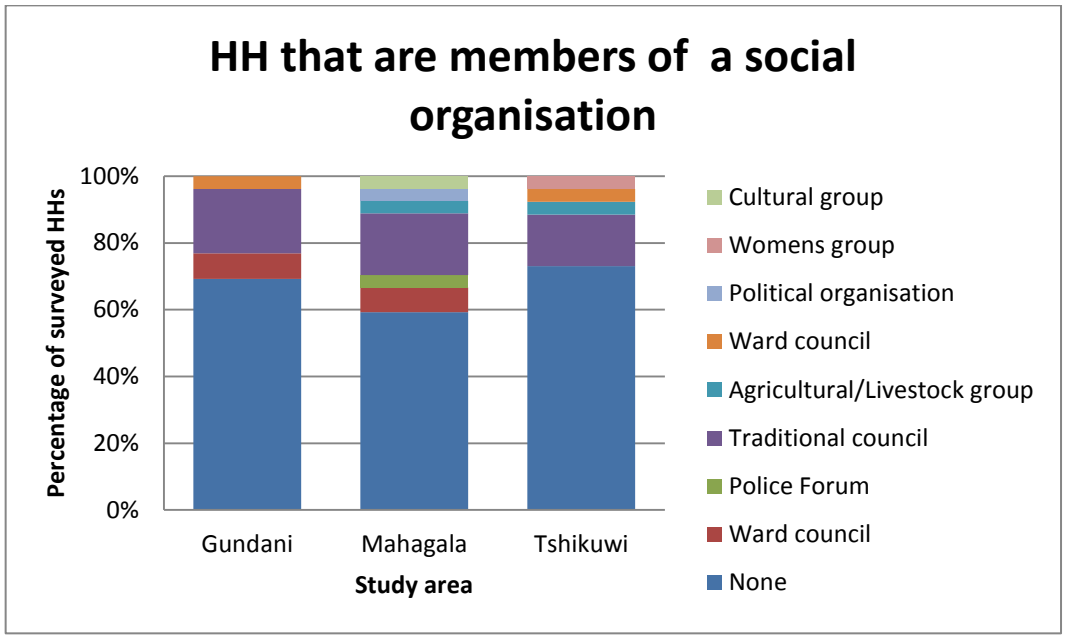


Figure 8-11 Social organisations

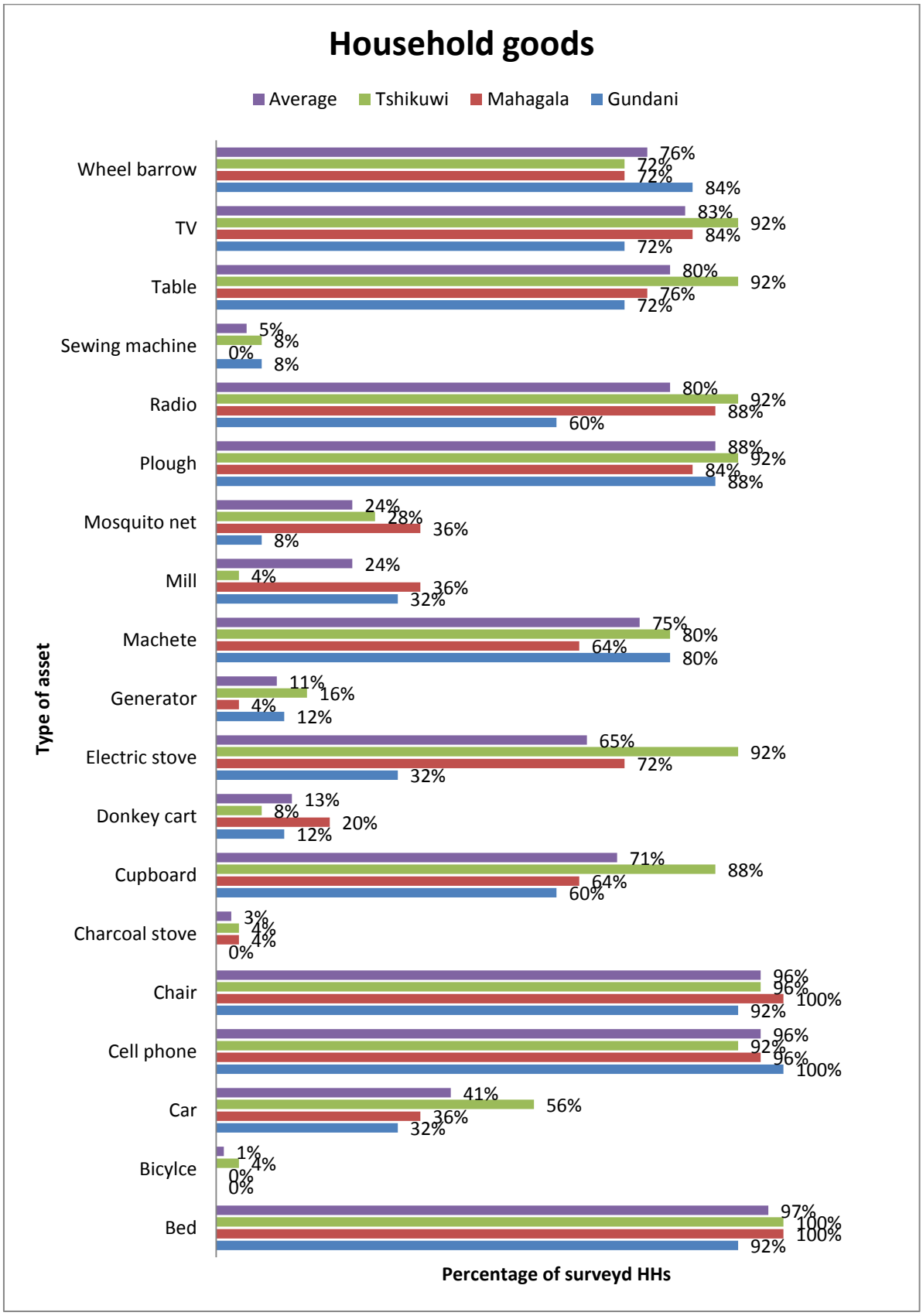


Figure 8-12: Household goods

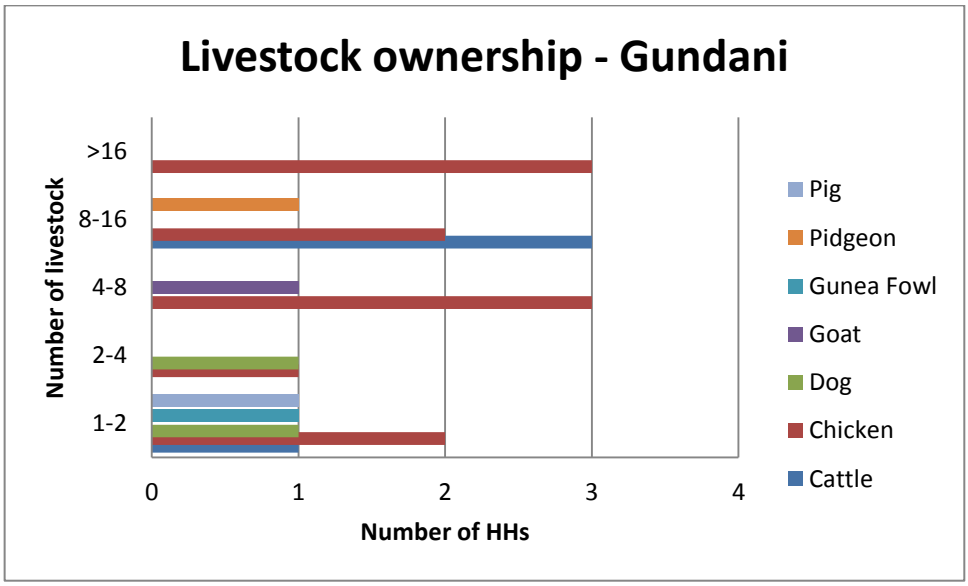


Figure 8-13: Gundani livestock

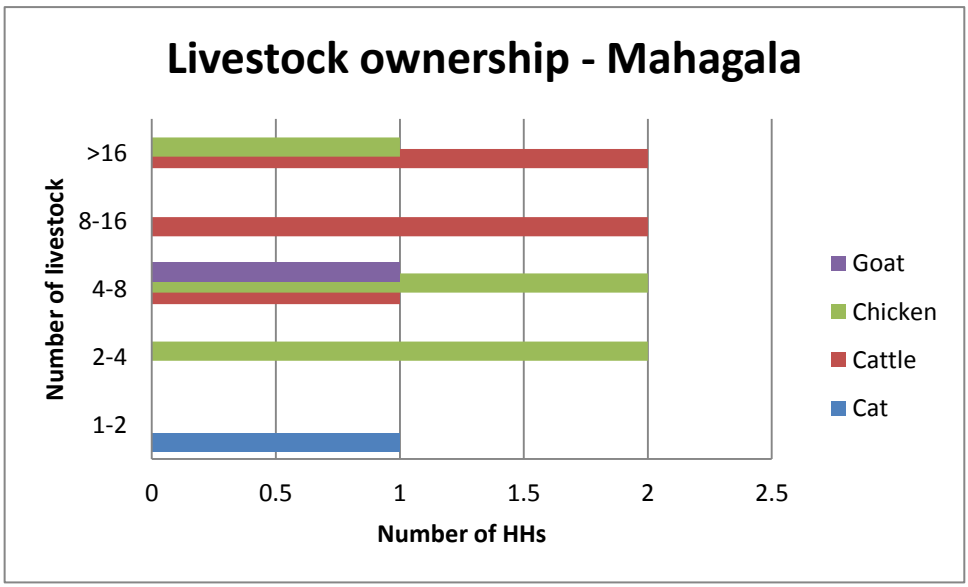


Figure 8-14: Mahagala livestock

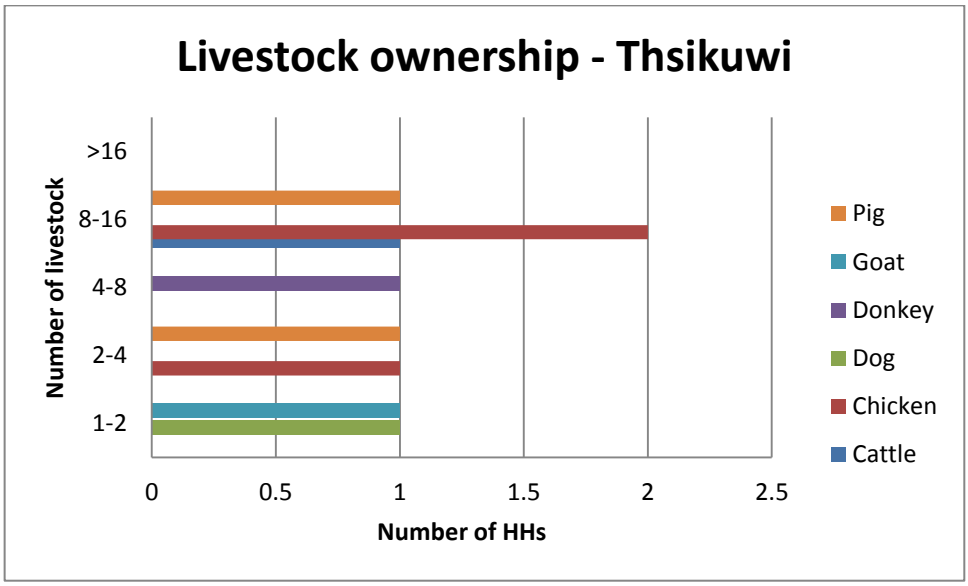


Figure 8-15: Tshikuwi livestock

Table 8-17: Access to grazing

Grazing area	Gundani	Mahagala	Tshikuwi	Grand Total
Communal grazing area	19%	45%	11%	24%
Homestead	76%	55%	78%	71%
Village	5%	0%	11%	5%

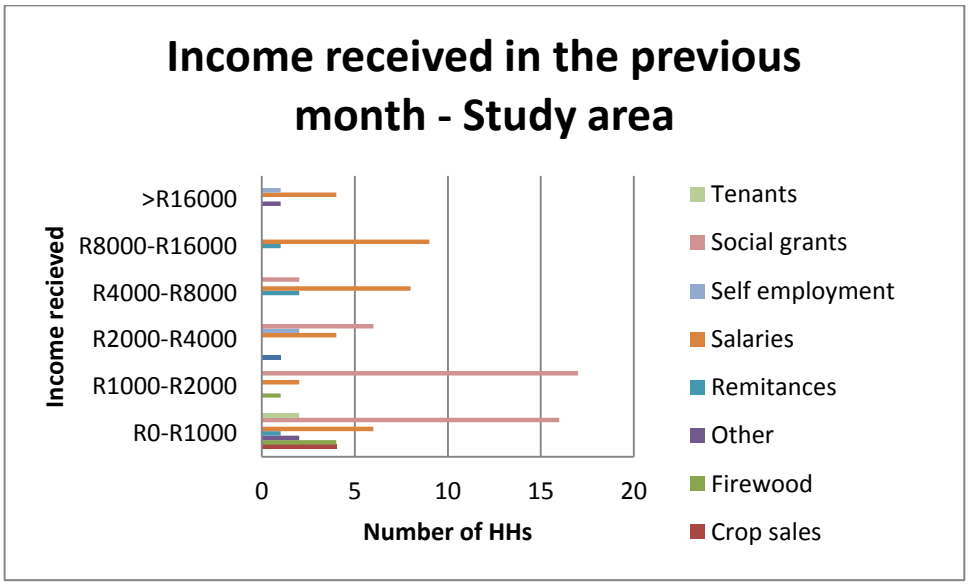


Figure 8-16: Monthly income by source

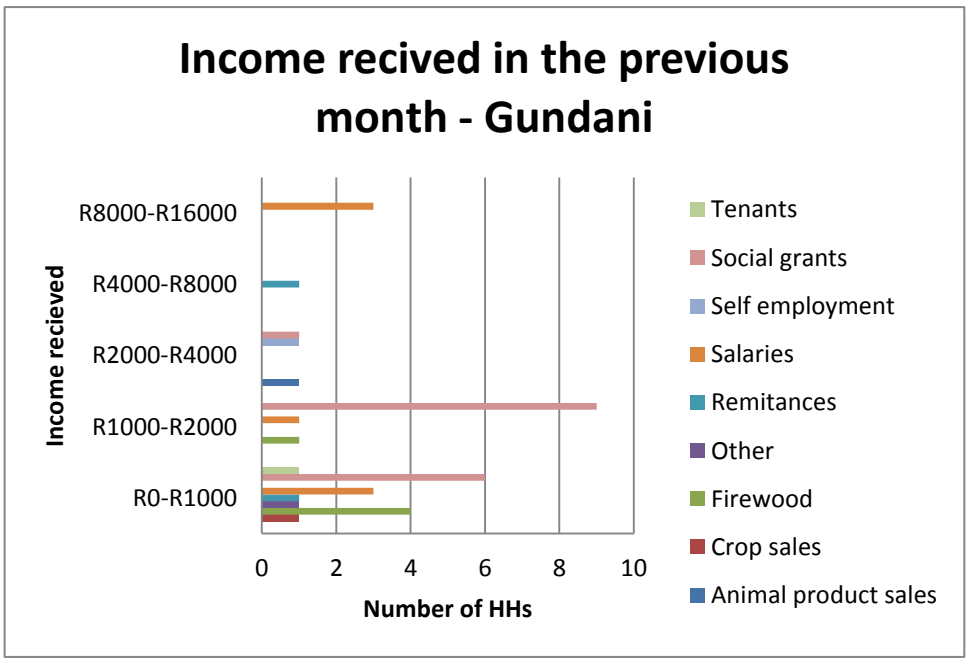


Figure 8-17: Monthly income by source - Gundani

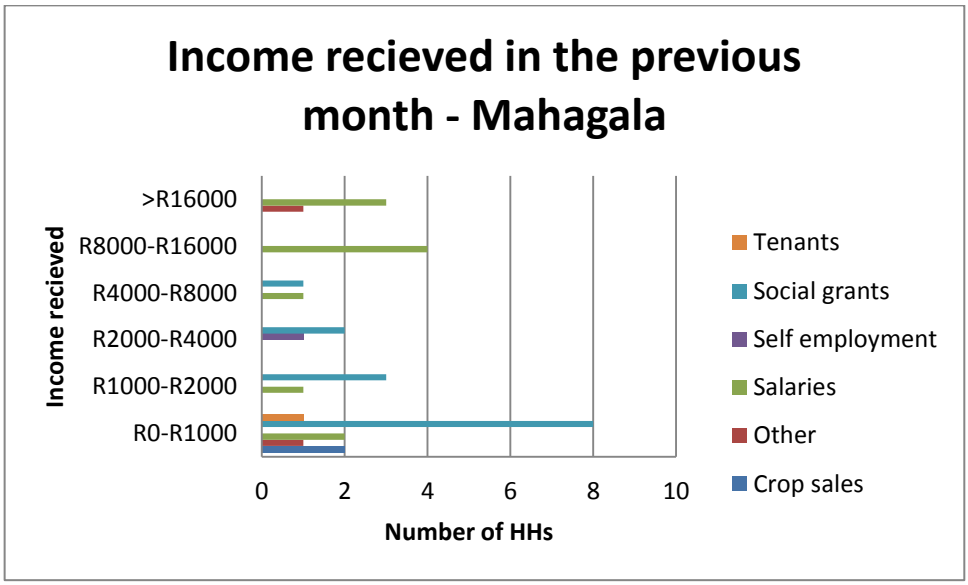


Figure 8-18: Monthly income by source - Mahagala

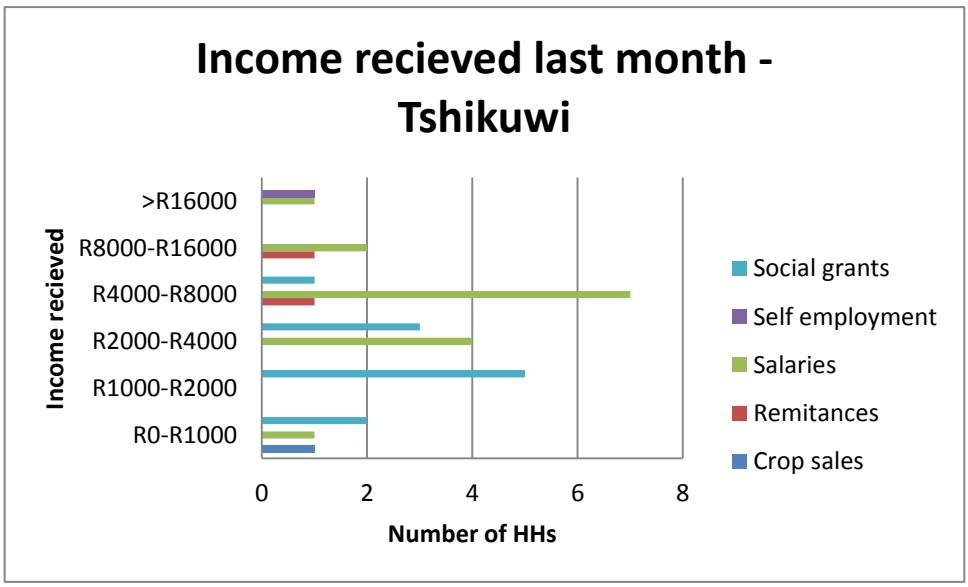


Figure 8-19: Monthly income by source - Tshikuwi

APPENDIX B

QUESTIONNAIRE AND INTERVIEW

UNIVERSTIY OF WITWATERSRAND – VHEMBE DISTRICT MUNICIPALITY:

SOCIO-ECONOMIC, ASSET INFRASTRUCTURE, COMMUNITY SURVEY

This survey is in partial fulfilment of the requirements for a Master's degree with the University of the Witwatersrand, South Africa. It aims to identifysocial and environmental relationships between climate variability and rural livelihoods in the Vhembe District of Limpopo and the factors accounting for institutional frameworks in the management and adaptation to impacts experienced from climate variability. I am interested to know in what ways rural households adapt to shocks experienced as a result of climate variability and the manner in which the rural authorities in Vhembe manage shocks and develop resilience and adaptive capacity in different socio-economic communities in Vhembe. The purpose of gaining an "on-the-ground" understanding of how people live and are affected by this variability through an integrated approach for a sustainable solution to ensure food security and sustainable livelihoods for residents of Vhembe

PART A: INFORMATION INTERVIEW AND HOUSHOLD

1. Name of interviewer _____
2. Date of Interview _____
3. Identification of Household _____
4. Gender of household head ___M / F___

PART B: HOMESTEAD DEMOGRAPHICS AND SOCIO-ECONOMIC INFORMATION

Complete the following table for all homestead members, **including persons temporarily absent but excluding tenants**

Person no.	5. Gender	6. Age (if younger than 1 indicate with < 1)	7. Year of birth (only if known and age is unknown)	8. Relation to HHH	9. Resident status	10. Highest level of education (only for persons 18 and over)	11. Employment status
1.	M / F			_____		_____	_____
2.	M / F			_____		_____	_____
3.	M / F			_____		_____	_____

Person no.	5. Gender	6. Age (if younger than 1 indicate with < 1)	7. Year of birth (only if known and age is unknown)	8. Relation to HHH	9. Resident status	10. Highest level of education (only for persons 18 and over)	11. Employment status
4.	M / F			_____		_____	_____
5.	M / F			_____		_____	_____
6.	M / F			_____		_____	_____
7						_____	_____

Person no.	5. Gender	6. Age (if younger than 1 indicate with < 1)	7. Year of birth (only if known and age is unknown)	8. Relation to HHH	9. Resident status	10. Highest level of education (only for persons 18 and over)	11. Employment status
8							
9							
10							
11							

Person no.	5. Gender	6. Age (if younger than 1 indicate with < 1)	7. Year of birth (only if known and age is unknown)	8. Relation to HHH	9. Resident status	10. Highest level of education (only for persons 18 and over)	11. Employment status
12							
13							
14							

12. Household language _____

13. Household ethnicity _____

PART C: WATER, SANITATION AND ENERGY

14. Where is water for domestic purposes obtained from? (Choose from code sheet) _____

15. What sanitation service does the household have including communal facilities? (Choose from code sheet) _____

16. Source of energy for cooking (Choose from code sheet) _____

17. Source of energy for lighting (Choose from code sheet)_____

18. Source of energy for heating (Choose from code sheet)_____

PART D: OWNERSHIP AND TENANTS

19. For how many years has the household been living in this house? _____

For those households who arrived in the ***last 5 years***:

20. Where did you move from? _____

21. Why did you move? _____

22. Does the homestead head have any other home? ___Y / N___

23. If YES, where is this other home (give name of city, town or Local Municipality) _____

24. Are there any tenants accommodated on the property? ___Y / N___

25. If YES, number of tenants currently accommodated and number of years each has been living there _____

LIVLIHOODS BASELINE

PART A: SHOCKS

26. Has the hh experienced any shocks such as the loss of income and what was the reason for this? _____

27. Were there any climatic shocks such as floods, droughts or fires experienced by the household in the last 5 to 10 years _____

PART B: HUMAN CAPITAL

Complete table for each person in household that ever worked, or acquired any skills (e.g. through training), in any of the following areas. Ensure that agriculture related skills are included as well.

28. Was there a shortage of food during the past year? Yes / No

29. If yes, indicate the months: Jan / Feb / March / April / May / June / July / Aug / Sept / Oct / Nov / Dec

30. Most important reason for food shortage (choose form code sheet)	
31. Second-most important reason for food shortage (choose form code sheet)	
32. Third-most important reason for food shortage (choose form code sheet)	

33. Has anyone in the household had an accident or been injured at work in the past year? Yes / No

34. If yes, was the person unable to work as a consequence of this accident/injury? Yes / No

*If there is a child **5 years or younger** in the household:*

35. Has your youngest child had any illness with a cough at any time in the last two weeks? Yes / No

36. . Has your youngest child had diarrhoea at any time in the last two weeks? Yes / No

37. 7. Where did you first seek treatment the last time your youngest child had fever? Health facility / pharmacy / shop / traditional healer / parents or friends / did not seek treatment / Other (specify)

38. If you did not go to a health facility, why not?

39. Have you ever consulted a traditional healer? Yes / No

	1. Name of person	2. Type of skill	3. Ever worked (W), Never worked, but acquired skills (S)
1			
2			
3			
4			

5			

PART C: NATURAL CAPITAL

59. Does your household currently have access to arable land that you use, or have used, for cultivating crops or grazing cattle? YES Go to Question 60 NO Go to Question 69

60. GPS number		61. Distance from house	62. What is the land used for	63. Main crop	64. % of land area covered by this crop (for trees, give the number of trees)	65. How much harvest sold?	66. Secondary crop	67. % of land area covered by this crop (for trees, give the number of trees)	68. How much harvest sold?
1									
2									
3									
4									
5									

Please complete the table below for any use of natural resources by household

69. Resource type	70. How often do you harvest it?	71. Units harvested per visit	72. Kg/ harvest unit	73. Market price per kg	74. For own use (O) or to sell (S)
Firewood	Daily / weekly / monthly / seasonally				O / S
Forest food products (excluding meat or insects) i.e. fruits and vegetables	Daily / weekly / monthly / seasonally				O / S
Bush meat	Daily / weekly / monthly / seasonally				O / S
Fish	Daily / weekly / monthly / seasonally				O / S
Insects	Daily / weekly / monthly / seasonally				O / S
Medicinal plants	Daily / weekly / monthly / seasonally				O / S
Building materials	Daily / weekly / monthly / seasonally				O / S
Other (Specify)	Daily / weekly / monthly / seasonally				O / S

Other (Specify)	Daily / weekly / monthly / seasonally				O / S

PART C: SOCIAL CAPITAL

75. 1. Do you have relatives in this village? Yes / No

Please indicate if social networks are used to assist in any of the activities listed in the table below

76. Activity	Dependence	Activity	Dependence
Share equipment / tools / transport / etc.		Find jobs	
Exchange goods / services		Borrow money	
Take care of children		Cultivate fields	
Take care of sick HH members			

77. Are you a member of any of the following social organizations? Town or ward council, Traditional Council, Agriculture/ livestock group. Water committee, Cultural group, Sports club, Women's group

PART D: FINACIAL CAPITAL

Please identify the key sources of livelihood for the household from the table below

78. What is the MOST important livelihood resource in this household?	
79. What is the SECOND most important livelihood resource in this household?	
80. What is the THIRD most important livelihood resource in this household?/	
81. Does the HH have a cash income?	Yes / No

82. Source of income	83. Amount during last month for entire HH	84. Regular (R) or occasional income (O)	82. Source of income	83. Amount during last month for entire HH	84. Regular (R) or occasional income (O)
Migrant remittances		R / O	Firewood		R / O
Artisanal mining		R / O	Logging		R / O
Self-employment		R / O	Bush meat		R / O
Salaries / wages		R / O	insects		
Tenants		R / O	Fish		R / O
Livestock sales		R / O	Medicinal plants		R / O
Animal product sales (eggs / milk / etc.)		R / O	Building materials		R / O
Crop sales		R / O	Other		R / O

85. Where do you sell the majority of your produce, crops or animals?
86. How long does it take you to transport your goods to where it is sold?
87. What is the principal mode of transportation used to take your goods to where they are sold?

At the homestead / market in the village you live / other village (specify name) / other (specify)

Less than 1hour / 1-3 hours / 3-6 hours / more than 6 hours

On foot / animal drawn cart / bicycle / motorbike / public transport / other (specify)

	88. Ever applied for business loan	89. Was the business loan successful?	90. Ever applied for a personal loan	91. Was the personal loan successful?

PART D: PHYSICAL CAPITAL

92. Please state the type of housing available? Traditional, Informal, Formal, Free standing
93. Please state the number of structures owned? _____
94. What is the most common building material uses?_____
95. What is the secondary building material _____
96. What is the tertiary building material _____

97. Asset	98. Does this household own at least one?	99. Number the household owns	97. Asset	98. Does this household own at least one?	99. Number the household owns
Bed	Yes / No		Cell phone	Yes / No	
Chair	Yes / No		Mosquito net	Yes / No	
Table	Yes / No		Radio	Yes / No	
Charcoal stove	Yes / No		Sewing machine	Yes / No	
Wood stove	Yes / No		Motorcar / van / pickup	Yes / No	
Cupboard	Yes / No		Motorbike	Yes / No	
Machete	Yes / No		Donkey cart	Yes / No	
Plough	Yes / No		Bicycle	Yes / No	
Wheelbarrow	Yes / No		Generator	Yes / No	
Maize/cassava mill	Yes / No		Solar panel	Yes / No	

100. Does the household own livestock? ___Y / N____
If yes complete the table below:

	101. Type of livestock	102. Number owned by Household	103. Main use	104. Where is the livestock grazed?
1				
2				
3				
4				

105. Service	106. Location (village name)	107. Minutes' walk	105. Service	106. Location (village name)	107. Minutes' walk
Church			Hospital		
Primary school			Shop		
Secondary school			Market		
Bus stop			Pension / pay point		
Clinic			Bank / credit facilities		

CODE SHEET

:Relation to HHH

Household head 1
Spouse of household head 2
Son/ daughter of household head 3
Son-in-law/ daughter-in-law of household head 4
Grandchild of household head 5
Parent or parent-in-law of household head 6
Brother/ sister of household head 7
Cousin of household head 8
Grandparent of household head 9
Adopted/ foster/ step child of household head 10
Other relative 11
Not related but dependent 12
Tenant 13
Other (specify) 14

Resident status

Lives here full time 1
Lives here part-time (more than 5 days per month) 2
Lives here irregularly (5 days per month or less) 3

Highest level of education (only for persons 18 and over)

None 1
Some primary 2
Completed primary 3
Some secondary 4
Completed secondary 5
Further or tertiary education 6

Employment status

Employed in mining (specify which mine) 1
Working on a farm 2
Owning small business (specify) 3
Farming with own crops or livestock for food/ to sell 4
Unemployed but looking for work 5
Staying home/ not looking for work 6
Still in school or studying 7
Other (specify) 8

Type of skill

Driving 1
Operation of heavy equipment 2
Mechanical skills 3
Electrical skills 4
Electronic skills 5
Plumbing 6
Masonry 7
Carpentry 8
Construction 9
Computer operating 10
Administrative/ clerical 11
Warehouse/ storekeeping 12

Household language

IsiZulu 1
IsiNdebele 2
Afrikaans 3
English 4
Sesotho 5
Siswati 6
Xitsonga 7
IsiXhosa 8
Setswana 9
Sepedi 10
Tshivenda 11
Other (specify) 12

Please state the type of housing available? Traditional, Informal, Formal, Free standing

Formal (bricks) 1
Informal 2
Traditional 3

Where is water for domestic purposes obtained?
Piped water in house / yard 1
Community standpipe 2
Well 3
River / dam 4
Rainwater tank.....5
Other (specify).....6

What sanitation services does the household have?
Flush toilet 1
Chemical toilet.....2
Pit latrine 3
Bucket latrine.....4
None.....5
Other (specify).....6

Source of energy
Electricity.....1
Paraffin.....2
Candle.....3
Battery.....4
Gas.....5
Wood.....6
Charcoal.....7
Other (specify).....8

Distance from house
At the house 1
Less than 100m from house 2
Between 100m and 500m from house 3
More than 500m from house.....4

What is the land used for
Cultivation/vegetable garden 1
Fallow/resting 2
Rented or lent to someone else 3
Not in use 4

Main crop
Amadumbe.....1
Potato.....2
Tomato 3
Maize.....4
Citrus.....5
Wheat.....6
Peanut.....7
Paw paw.....8
Mango 9
Pineapple 10
Other(specify) 11

How much harvest sold?
All of it.....1
3/4 2
1/2 3
1/4 4
None.....5

Type of livestock
Chicken 1
Goat.....2
Duck 3
Sheep 4
Dog/cat 5
Donkey 6
Pigeon 7
Cattle.....8
Other (specify) 9

Main use
Meat 1
Milk.....2
Eggs 3
Skin 4
Other (specify) 5

What is the most common building material uses?_____
Bricks.....1
Concrete.....2
Wood.....3
Corrugated iron.....4
Tiles.....5
Glass 6
Stone.....7
Thatch/grass.....8
Dung/earth.....9
Other (specify) 10

Reason for food shortage

Land is not of sufficient quality and size....1
Lack of water for crops/livestock....2
Lack of inputs such as fertilizer, tools, equipment....3
Not enough human resources in family....4
Lack of education/training....5
Sold food to raise cash....6
Lack of credit....7
Lack of markets....8
Poor health....9
Lack of employment....10
Bad luck/ witchcraft....11
Flood....12
Other (specify)....13

Reason – Health facility

Don't have access/transport....1
Don't like the health facility....2
Don't have money....3
Prefer to use traditional healers....4
Prefer to self-treat....5
Not necessary....6
Husband did not give permission....7
Other (specify)....8

Dependence

No....1
Yes, depends on relatives....2
Yes, depends on friends....3
Yes, depends on friends and relatives....4

Livelihoods

Farming....1
Livestock....2
Selling firewood....3
Selling building material....4
Artisanal mining....5
Formal employment....6
Operating a small business....7
Other (specify)....8

Interview schedule with community members

Population, demographics, influx,

Do you have an idea of the total population? If not, number of households/families in the community?

What is the average number of people per household/family?

Has the population grown in the last 2 years? When has the growth been the most? What is the reason for this growth? Is growth seen as a positive or negative thing to the community?

Are there primarily older or younger generation living here? Are there generally more males or females living in the area? What are possible reasons for this distribution?

Social organisation, structure, settlement and development

Is there a formal administrative organisation within your community? How is the organisation arranged between community members and the municipality?

What internal community leadership structures exist? Can you give me an example?

Are there separate social/community groups in the settlement (e.g. women's groups, youth groups, farming groups etc.)?

When did people first settle in your community? Do you know when the community was established?

Where do newcomers to the community generally come from? Are they from within the Province/Country?

Where do they generally settle within the community? How do new-comers apply for land?

How do floods and droughts affect development and growth within the local area? E.g. increase in use of forest resources? And how has this impacted on settlement food security in the past? What are you feelings for the future?

Is there regular movement of people in and out of the area or do people live in one area for many years?

Culture, ethnicity, language

What is the primary cultural/ethnic group people belong to?

Are there ever cultural tensions and conflicts within the community? If yes, what are the reasons for this tension?

Economic activities

What are the main forms of livelihood and income for people in the community? Can these be distinguished into different categories?

What are the main forms of employment?

Other than employment, what are the main forms of income production?

Is small scale business and trade a large contributor to the local economy within the community? Are there any small and large market places/trading centres and where are they located?

What impact do you think more frequent floods and droughts will have on economic activity in the area?

Resource availability

Is water for household use readily available within all of the community?

Is there sufficient water in the area for everyone throughout the year? Is the water clean and do people get sick because of the water?

Is there good availability of electricity in the community? Do people rely heavily on wood as alternative energy sources?

Does any member of the local or other community make use of plant and/or animal material available in the footprint area for, ritual, ceremonial, or spiritual purposes

What fuel do you use most often for cooking?

Does any member of the local or other community make use of plant and/or animal material available in the footprint area for, ritual, ceremonial, or spiritual purposes

Basic services and infrastructure

What are the main development needs within the local municipality? Is there anything specific to the area?

What is the primary mode of transport for people within the area? How do people travel to nearby towns?

What are the roads in the area like and is travel easy or difficult?

Where is the nearest primary school? And nearest high school? Are these schools able to accommodate all children in the area?

What percentages of children attend primary school and what percentage attend secondary school? Do they finish school (matric) and if no, why not?

How many people have attended university or college? Are they employed? What options do they have after completing their education?

How do children travel to school (what mode of transport is used)?

Where is the nearest health centre and where is the nearest hospital? Are these well-equipped?

Has the levels of health amongst the community increased or decreased in the last 2 years?

Do people consult traditional or modern medical practitioners or both and what is preferred?

Social Issues and Crime

Is crime a problem in the area? What are the main crimes faced on a daily basis? Is there violent crime?

Are there problems with drugs and alcohol abuse in the population?

How is crime controlled in the area? Is there collaboration between local police and community members?

Perceptions about the climate variability

Do you think the current drought has been is good or bad for the community? Why?

What are your thoughts on the extended frequency of floods and droughts? How will this influence the community?

Do you feel that floods or droughts will provide any benefits to people in the area (personally and for the wider community)?

APPENDIX C

CONSET FORMS AND ETHICS CLEARANCES

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Participants Information Sheet

My name is Lloyd McFarlane. I am a Masters student in the School of Geography, Archaeology and Environmental Studies at the University of the Witwatersrand, Johannesburg, South Africa. I would like to invite you to participate in my research study entitled: ***"Feast or Famine: Harvest Yields, Sustainable Livelihoods and Climate Variability".***

My research focuses on the effects of droughts and floods on people trying to make a rural living in the Vhembe District of Limpopo and the local measures taken to manage and adapt to impacts and challenges that come from living in areas affected by floods and droughts. I am interested to know in what ways rural households cope with sudden challenges caused by these floods and droughts as well as how governmental or traditional authorities in Vhembe manage these challenges and build strength against these challenges in three different communities in Vhembe. The purpose of gaining an "on-the-ground" understanding of how people live and are affected by these challenges to assist in creating or understanding sustainable solutions to ensure food security and sustainable livelihoods for the people of Vhembe

All answers and information given will be safely protected. By participating in this household survey, you agree to this project, under the jurisdiction of the university, and possibly published in an academic journal as well as presented at conferences, seminars and workshops. The results of the survey may be made available to researchers, policy makers and other interested parties, who may be working on similar projects. No names, places of work, religion or race, or any other personal information will be recorded or distributed, only generalized information will be recorded or published.

If you have any questions or concerns about the research, please feel free to contact my supervisor:

Dr. Danny Simatele (Cell: +27833836884; Email: danny.simatele@wits.ac.za

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CONSENT FORM

As a participant of the research project titled Feast or Famine: Sustainable Livelihoods and Climate Variability, I agree to the following:

1. Protection of privacy and personal information

- Consent to text transcripts, archiving and participation in the survey.
- An audio recording will be taken during my participation in this research project.

2. permission to use personal information and data collected during any and all discussions

- As the research participant, I confirm that I have been informed of the research and the project. .
- I am able to understand this document or, if not, I am able to hear and understand when the form is read or translated to me.
- I acknowledge that I am fully capable of understanding the nature of this research explained and, therefore, can be considered competent to give informed consent.

3. Resolve issues and disputes ethically

- If I do not consent, my interview will not be recorded. I may stop the recording at any time or erase any portion of my recording.
- My participation in this study should take a total of approximately 30 minutes and is voluntary. I will not be paid for my participation.

Statement of person obtaining informed consent and research authorization

❒ I agree to all of the above

Signature of person taking part in study	***Date***

Printed Name of person taking part in study:……

For further information regarding the research or the implication of your participation, please do not hesitate to contact me:

Lloyd McFarlane

Masters Student

School of Geography, Archaeology and Environmental Studies

University of the Witwatersrand

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Or my supervisor: Dr. Danny Simatele (Cell: +27833836884; Email: danny.simatele@wits.ac.za

ETHICS CLEARANCE

Research Office

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

CLEARANCE CERTIFICATE	**PROTOCOL NUMBER: H15/10/21**
PROJECT TITLE	Feast or famine: Harvest yields, sustainable livelihoods and climate variability
INVESTIGATOR(S)	Mr L McFarlane
SCHOOL/DEPARTMENT	APES/
DATE CONSIDERED	23 October 2015
DECISION OF THE COMMITTEE	Approved unconditionally
EXPIRY DATE	26 November 2018

DATE 27 November 2015 **CHAIRPERSON** J. Knight

(Professor J Knight)

cc: Supervisor : Dr D Simatele

DECLARATION OF INVESTIGATOR(S)

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

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

_____ _____/_____/_____

Signature **Date**

PLEASE QUOTE THE PROTOCOL NUMBER ON ALL ENQUIRIES