RURAL HOUSEHOLDS' PERCEPTION OF THE EFFECT OF CLIMATE CHANGE ON FOOD SECURITY IN uMZINYATHI DISTRICT MUNICIPALITY OF KWAZULU-NATAL, SOUTH AFRICA

B y

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PREFACE

The research contained in this thesis was completed by the candidate while based in the discipline of Food Security, School of Agricultural, Earth and Environmental Sciences of the College of Agriculture, Engineering and Science, University of KwaZulu-Natal, Pietermaritzburg Campus, South Africa. The research was supported by The University of KwaZulu-Natal for graduate scholarship and The Water Research Commission.

The content of this work has not been submitted in any form to any other university and except where the work of others is acknowledged in the text, the results reported are due to investigations by the candidate.

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Signed: Professor Paramu Mafongoya (FZAS)

Date:

DECLARATION

I, Stephen Odede Shisanya declare that:

i. The research reported in this thesis except where otherwise indicated or acknowledged is my original work;

ii. This thesis has not been submitted in full or in part for any degree for examination at any other university;

iii. This dissertation dos not contain other persons' data, pictures, graphs or other information unless specifically acknowledged as being sourced from other persons;

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v. Where I have used materials for which publications followed, I have indicated in detail my role in the work;

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Signed: Stephen Odede Shisanya

Date:

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Abstract

The study examined in specific terms the interaction between household food security and rural farming communities' perception of climate change in uMzinyathi District Municipality of KwaZulu-Natal, South Africa. A survey was conducted among 200 households randomly selected from five wards. Households were randomly selected from villages and only those household members at the age of at least 40 years and participating in agricultural activities were asked to volunteer to participate in the survey. Focus group discussions and key informant interviews were carried out to obtain qualitative data. Data was then analysed using the Statistical Package for the Social Sciences (SPSS). The results show that communities' perception of climate change matched the quantitative data of climate of the area. The study area is becoming hotter and drier. Over the period 1993 – 2010, average annual temperature had increased by 1.5^{o}C. Rainfall generally decreased over the period 1981 - 2010 with the years 2004, 2007 and 2010 recording the least rainfall amounts of 368mm, 296mm and 319mm respectively below annual average rainfall of 784mm. Households observed increased frequency (73.0%) of droughts while incidences of floods had decreased over time by 52.0%. Households were evenly distributed across the five vulnerability categories with extreme categories of 18% households being very highly vulnerable and 20% being less vulnerable. The results confirmed that indeed households were experiencing climate change and that they are reacting to this change by adopting differing agricultural and non-agricultural practices. A large proportion (83%) of households anticipate that they will alter their livelihoods systems to respond to climate change with 59% of households indicating that government grants will play an important role in their adaptation to climate change. Households assessed (97%) were found to be severely food insecure while 3% were moderately food insecure. Households were worried about the negative impacts of climate change which included droughts, floods and soil erosion. Households who were found to be vulnerable to climate change recorded high levels of food insecurity. Perceptions of communities to climate change should be considered by policy makers in advancing strategies to mitigate impacts of climate change. Households are not homogenous and experience vulnerability to climate change differently, recommending that blanket interventions for communities should not be used to mitigate climate change but household specific interventions should be considered. Households will effectively adapt to a changing climate by governments putting in place mechanisms that will help finance the adaptation interventions. Capacity of households should be built through extension services so that

households are well prepared to effectively undertake appropriate adaptation methods. Rural farmers should be assisted with packages that can help them undertake effective adaptation mechanisms to climate change. Information will play a critical role in ensuring farmers can do what is within their means to address household food security in a changing climate.

Key words: Climate change, vulnerability, adoptive capacity, food security, households

CHAPTER 1

INTRODUCTION

1.1 Rationale for the research

Everyone has the right to basic needs such as food, clothing, housing, medical care, among others (United Nations (UN) 2011). The South African *Bill of Rights* reaffirms article 25.1 of the Universal Declaration of Human Rights, by stating in Section 26 and 27 that, everyone has the right to adequate housing, health care services, sufficient food and water and social security. Considering food as a basic need, how are the stated rights correspond to individuals' food security for rural communities in KwaZulu-Natal, South Africa in a changing climate? At a global scale, the number of hungry people worldwide rose from 842 million in 1990-1992 to 873 million in 2004-2006 and to 1.02 billion people in 2009 as a result of reduced access to food (International Food Policy Research Institute (IFPRI) 2010). In 2009 it was estimated that food security was expected to deteriorate in Sub-Saharan Africa and the number of food-insecure people was to increase 5.5 percent in 2009 to 406 million with a food distribution gap projected to remain virtually unchanged at less than 15 million tons (United States Development Agency (USDA) 2009). Although the level of the undernourished dropped from 23.4% to 13.5% over the period 2012-2014 for developing countries, globally, 805 million people were estimated to be chronically undernourished over the same period (FAO, IFAD and WFP 2014).

Challenges towards achieving food security have included post-harvest loses, poor agricultural practices leading to low agricultural productivity, and lack of infrastructure for sustainable food availability (Altman et al. 2009). Low household incomes have also contributed to difficulties in households accessing food. Further, it is believed that climate change will exacerbate the above factors over time (Aggarwal and Singh (2010). Climate change will become critical for African economies that are very dependent on rain fed agriculture accounting for 30% of GDP with almost three quarters of the population of Africa living in rural areas and almost all of the rural labour force working in the agricultural sector (Trobe 2002).

It was estimated that 39% of the South African population was vulnerable to food insecurity with 22% of all children under the age of nine years stunted due to chronic malnutrition (Human Science Research Council (HSRC) 2004). Of the 9.9 million people in KwaZulu-Natal, it was estimated that in 2006, 35% of the population was food insecure (Shisanya and Hendriks 2010).This state of food insecurity is currently exacerbated by the escalating food prices and about 3.5 million people in KwaZulu-Natal are in need of an intervention to enhance their food security. A big proportion of the food insecurity was found in the rural areas since roughly 70% of the country's poorest households live in rural areas (HSRC 2004). (Altman et al. 2009) estimated that 85% of rural households in South Africa are unable to afford even the below average dietary energy cost (cost of a nutritionally adequate food basket per person).

The multiple factors that influence access to food are not well understood, and this impacts negatively on the ability to identify appropriate policies to improve household access to food (Altman et al. 2009). Food security is multidimensional and cannot be understood in isolation from other developmental elements such as social protection; sources of income; rural and urban development; changing household structures; health; access to land, water; retail markets; education; nutritional knowledge; government policies; conflict; globalisation as well as environmental issues (Bonti-Ankomah 2001 and Misselhorn, 2005). In an effort to meet the needs of the rapidly growing world's populations and economies, there is increasing demand for food, energy, fibre, water and land for housing. But efforts to meet these and other essential human needs are transforming the global environment and driving dangerous changes in the world's climate and hence the need to establish a comprehensive adaptation programmes to alleviate the possible adverse effects (Global Donor Platform for Rural Development (GDPRD) 2010). Many of these changes are in turn increasing the vulnerability of society—especially the poor—to disruption in climate, and are undermining the food and livelihood security of billions of people around the globe.

Vulnerability to climate change is the degree to which a system is susceptible to, or unable to cope with adverse effects of climate change including climate variability and extremes (Khan et al. 2009). Vulnerability to climate change is considered to be high in developing countries due to social, economic and environmental conditions that amplify susceptibility to the negative impacts (Leary and Kulkarni 2007). This results in low capacity to cope with and adapt to climate hazards, requiring the developing countries to understand the threats from

climate change, formulate policies that will lessen the risks and to take action (Leary and Kulkarni 2007, Trobe 2002, Leary et al. 2007). The challenge of reaching sustainable food security and delivering on it through 2050 is daunting with an awkward starting point, in 2010, a world with unacceptable levels of poverty and deprivation, as is clear from the 2010 report on the Millennium Development Goals (Nelson et.al. 2010). Climate change will affect all four dimensions of food security: food availability, food accessibility, food utilization and food systems stability with direct impact on human health, livelihood assets, food production and distribution channels, as well as changing purchasing power and market flows (Food and Agriculture Organization (FAO) 2008, Trobe 2002).

Farmers in developing countries are already seeing the effects of climate change daily with erratic weather patterns that directly affect food production (Trobe 2002). In 1991 and 1992, cereal production in the Southern African Development Community (SADC) region was almost halved as a result of drought, and around 20 million out of 85 million people suffered food shortages (United Nations Environmental Programme (UNEP) 1999). Rural households tend to rely heavily on climate-sensitive resources such as local water supplies and agricultural land; climate-sensitive activities such as arable farming and livestock husbandry; and natural resources such as fuel-wood and wild herbs. This implies that climate change can reduce the availability of these local natural resources, limiting the options for rural households that depend on natural resources for consumption or trade (Hunter 2011). Droughts and floods can also directly impact on health, where polluted water may be used for drinking and bathing, and this could spread infectious diseases such as typhoid, cholera and gastroenteritis Trobe 2002).

Presently, there is little awareness about climate change and its impacts, and climate change issues are given a low priority in the face of competing and urgent priorities. (Mitchell and Tanner 2006). Information about the impacts of climate change on important sectors and systems in developing countries such as agriculture, forestry, fisheries, water resources, human health, human settlements and ecological systems is inadequate for understanding key vulnerabilities and planning appropriate adaptive strategies (Leary and Kulkarni 2007). Adaptation will include learning about risks, evaluating response options, creating the conditions that enable adaptation, mobilizing resources, implementing adaptations, and revising choices with new learning (Leary et al. 2007). While climate change is seen as a relatively recent phenomenon, individuals and societies are used to adapting to a range of

environmental and socio-economic stresses. In many parts of the world, and especially in semi-arid lands, there is an accumulated experience with phenomenon such as drought and floods. As climate extremes are predicted to increase in frequency and intensity in future, it is important to understand and learn from relevant past adaptations and indigenous knowledge systems (Intergovernmental Panel on Climate Change (IPCC) 2007). However, changes in climate variability and mean values will bring additional complications to many, especially those dependent on food systems that are particularly vulnerable to these additional stresses (Guijit 2007).

There are several scientific uncertainties regarding the relationship between climate change and biological effects and between these effects and socioeconomic consequences (IPCC) 1990). Hart (2009) suggests that livelihood strategies that determine households' sensitivity and resilience to stressors and their ability to accumulate necessary assets (resources and services) to acquire food should be understood in terms of the system in which they are embedded. Tear Fund (2006) emphasizes that a risk-based approach to stressors of climate change adaptation should be adopted, informed by bottom-up experiences of vulnerability and existing responses. (Hendricks 2005; Hart 2009) suggests that understanding causes, nature and impacts of changing conditions and stressors requires local level and in-depth qualitative studies of households experiences under 'normal' conditions. Such in-depth studies will provide information that is required for a better understanding of the context in which larger quantitative studies such as national assessments of food and nutritional insecurity can be undertaken. Ellis (2003) stresses that local people carry out their own assessments and diversifies their livelihood patterns according to their perceptions of risk and in terms of available risk management strategies. Policy responses that mitigate some of these challenges may exacerbate others (Clark et.al. 2010). Managing the complexity of the real world interactions among agriculture, food security and climate will require complex, context-appropriate responses and an ability to address inevitable trade-offs (Clark et al. 2010).

There is a need to prioritise policies and investments in adaptation to promote resilient agriculture and food security. Policies should support farmers to diversify and build resilience under institutional and climate uncertainty. Adaptation policies must address gender, equity, capacity building and distributional issues and build on local knowledge and emerging research and technologies (Food, Agriculture and Natural Resources Policy Analysis

Network (FANPARN) 2010). Critical reflection in strategic alliances with unlikely partners, articulating theories of change, and the role of stories to clarify and convey the complexity of transformation is part of a new emerging discourse and practice (Guijit 2007).

Adaptation to climate change is a priority; disaster mitigation and preparedness (DMP) is a vital component of adaptation and must be undertaken at national and local levels (Trobe 2002). Climate-related disasters are expected to increase not only as a result of global warming but also as a result of human-induced environmental destruction (IPCC 2007). This will require national policies to take account of climate change as well as address other practices that destroy the environment such as illegal logging and unsustainable agricultural practices (Trobe 2002). Policies should ensure that farmers have access to affordable credit, which would give them greater flexibility to modify their production strategies in response to climate change and to increases farmers' resilience to climate change (Gbetibouo 2009).

1.2 Importance of the study

Climates around the world have been changing ever since the beginning of time, but the rate and intensity of the change we're experiencing now is beyond anything we know of in the past **(**Blignaut and van der Elst 2009). Food insecurity continues to threaten rural communities in KwaZulu-Natal (HSRC 2004). The social interaction of food insecurity and climate change among rural communities has not been comprehensively studied (Hendriks 2005). South Africa has a number of integrated policies, including an Integrated Sustainable Rural Development Strategy (ISRDS), an Integrated Nutrition Programme, and an Integrated Food Security Strategy (IFSS). This strategy sets out the aims of the World Food Summit Declaration and Plan of Action and the Millennium Development Goals to halve hunger by 2015. A desk review of the interaction between the current food security policies as a result of climate change adoption options for the rural communities revealed the existence of a huge gap between the two. There is very limited documentation on how climate change and adaptation options actually result in food insecurity. Yet without taking into account the socio-cultural environment in which the interactions between food insecurity and climate change take place, it becomes difficult to comprehend the issues and to design relevant policy and programmatic strategies.

1.3 Research objectives

The overall objective of the study is to investigate in specific terms the interaction between household food security and rural farming communities' perception of climate change in uMzinyathi District Municipality of KwaZulu-Natal, South Africa.

The specific objectives are:

1. To determine farmers' perceptions on climate change
2. To examine the vulnerabilities of the rural small scale farming communities to climate change
3. To evaluate the experiences and adaptation mechanisms to climate change among rural small scale farming communities.
4. To assess the responsiveness of existing food security strategies to climate change among rural small scale farming communities

1.4 Research questions

The key research questions for the study are:

1. What are the rainfall and temperature patterns in uMzinyathi District Municipality, KwaZulu-Natal over time as determined by recorded meteorological stations' data?
2. What are the perceptions of households in uMzinyathi District Municipality on climate change?
3. How vulnerable are the rural farming communities to climate change?
4. How are rural farming communities adapting to climate change?
5. What are the impacts of communities' vulnerability to climate change on household food security?

1.5 Organization of the thesis

Chapter one provides a background to the research problem and its setting. Chapter two provides a critique from literature of household vulnerability to climate change and the implications to food security. The theoretical and conceptual framework used in the study is

also outlined in this chapter. Chapter three expounds on the research methodology used in the study. The chapter three gives a background of the study area and characteristics of the community. Chapter four looks at the household perceptions to climate change. An assessment of household vulnerability to climate change is presented in chapter five. Further analysis of rural farmers' adaptation to climate change is presented in chapter six. The impact of climate change on household food security is presented in chapter seven. Conclusions and recommendations are outlined in chapter eight. The following chapter synthesises literature on vulnerability, climate change and food security and their implications for rural households.

CHAPTER 2

LITERATURE REVIEW

2.1 Vulnerability to climate change

Climate exerts a significant control on the day-to-day economic development of Africa, particularly for the agricultural and water-resources sectors, at regional, local and household scales (Gerald et al. 2010). Climate change is expected to have serious environmental, economic, and social impacts on South Africa particularly for rural farmers, whose livelihoods depend on the use of natural resources (Gbetibouo 2008; Abou-Hadid 2006). Vulnerability to climate change is considered to be high in developing countries due to social, economic and environmental conditions that amplify susceptibility to negative impacts and contribute to low capacity to cope with and adapt to climate hazards (Abou-Hadid 2006; IPCC 1990). There is need for the developing world to understand the threats from climate change, formulate policies that will lessen the risks and to take action (Leary and Kulkarni 2007; Trobe 2002; and Leary et al. 2007). The determinants of vulnerability do not operate in isolation, and usually interact in complex and 'messy' ways, frustrating attempts at appropriate interventions to increase resilience to change (Boko et.al. 2007).

Climate-sensitive resources such as local water supplies and agricultural land; climate-sensitive activities such as arable farming and livestock husbandry; and natural resources such as fuel-wood and wild herbs will be conspicuously impacted by climate change and variability. These impacts can reduce the availability of these local natural resources, limiting the options for rural households that depend on natural resources for consumption or trade (Hunter 2011). Climate change extremes such as drought, floods, heat waves, frosts and cyclones can also impact health as a result of water resources becoming scarcer and competition for water increasing, where polluted water may be used for drinking and bathing, and this spreads infectious diseases such as typhoid, cholera and gastroenteritis and on the other hand decreased availability of water for irrigation and food production heightens the risk of poor nutrition and increased susceptibility to diseases (IPCC 1997).

Presently, there is little awareness about climate change and its impacts, and climate change issues are given a low priority in the face of competing and urgent priorities, although awareness-raising remains an important first step in improving understanding of climate change and development of locally appropriate responses (Mitchell and Tanner 2006).

Information about the impacts of climate change on important sectors and systems in developing countries such as agriculture, forestry, fisheries, water resources, human health, human settlements and ecological systems is inadequate for understanding key vulnerabilities and planning appropriate adaptive strategies (Leary and Kulkarni 2007). IPCC (2008) points out that even under the most optimistic scenarios of coordinated global action to reduce further emissions of greenhouse gasses into the atmosphere, an era of rapid and accelerating climate change is inevitable and adaptations to climate change remain critical. Mitigating climate change is necessary and adapting to climate change is necessary too. The state and dynamics of these processes differ from place to place and generate conditions of vulnerability that differ in character and degree to an extent that populations that are exposed to similar climatic phenomenon are not impacted the same leading to vulnerabilities that differ for different sub-populations or groups inhabiting a region, and even from household to household within a group (Abou-Hadid 2006). In the following section, the concept of adaptation is first unpacked through a detailed exploration of what it can mean and consideration of the role it plays in international approaches and instruments for managing global environmental change. The projected climate change and desertification impacts for southern Africa are then examined, and finally, the extent to which local and policy adaptive strategies are working together is analysed alongside the challenges and research gaps that need to be overcome for successful adaptations to continue into the future.

2.2 Adaptation to climate change

The climate change community uses the term *adaptation* to refer to the process of designing, implementing, monitoring, and evaluating strategies, policies, and measures intended to reduce climate change–related impacts and to take advantage of opportunities (Smit et al. 2007). The IPCC (2001) further adds that adaptation as an adjustment in ecological, social or economic systems in response to observed or expected changes in climatic stimuli and their effects and impacts in order to alleviate adverse impacts of change or take advantage of new opportunities. This definition acknowledges that adaptation is a continuous sequence of activities, actions, decisions and attitudes that informs decisions about all aspects of life, and

that reflects existing social norms and processes (Chikozho 2010). Defining adaptation to climate change is complicated because agents adapt to a number of different pressures at the same time, not just to climate change. Defining successful adaptation is even more complicated because criteria for success are generally contested and context specific. Adaptation will include learning about risks, evaluating response options, creating the conditions that enable adaptation, mobilizing resources, implementing adaptations, and revising choices with new learning (Leary et al. 2007). Dinar et al. (2008:135) indicates that agricultural adaptation can be loosely be categorized into: farm production adjustments such as diversification and intensification of crop and animal production; market responses that may include crop and flood insurance schemes; institutional responses that require government responses including pricing policy adjustments and technological adaptation that may include development of new crop varieties. An example of different level adaptation and mitigation of droughts and floods focussing of food security are given in Table 2.1.

Table 2.1: Preparedness and mitigation to climate change, the case of floods and droughts

Local level/community in case of floods flood	**Local level/community in case of drought**	**National level in case of floods and droughts**
buildings are storm/flood proof	Enhancing agricultural production	Conducting regional vulnerability assessments
Constructing, or turning an existing building into, an emergency shelter	Establishing community grain banks	Establishing early warning systems
Establishing evacuation routes	Food preservation	Providing communities with 'safe' land for building
Protecting water supplies	Improved water resource and watershed management	Strengthening infrastructure (such as roads and bridges)
Preparing emergency supplies of food	Deep wells	Large-scale reforestation
First aid training	Drought-resistant crops	Protecting watersheds
Reforestation	Adapting planting schedules	Good urban planning
	Soil preservation	

Source: **Adopted from Trobe (2002)**

Adaptation to climate change risks will need to take place at the individual, family, community, and government levels (Kristie and Semenza 2008). Adger et al. (2005) argues that individual adaptation actions are not autonomous because they are often constrained by

institutional processes such as formal regulatory structures, property rights and social norms associated with rules in use.Elements of effectiveness, efficiency, equity and legitimacy are important in judging successful adaptation. Research carried out by IFPRI has revealed that one of the most important obstacles to adaptation in Africa is lack of access to credit, information on climate, as well as limited options for adaptation (IFPRI 2006). Some of the literature on climate change argues that with adaptation, farmers' vulnerability can be significantly reduced (Kurukulasuriya and Rosenthal, 2003; Odekunle et al., 2007; Gbetibouo, 2009). However, the available information on vulnerability of specific communities to climate change and potential adaptation measures is still insufficient (Chikozho 2010). Adaptation is widely recognized as a vital component of any policy response to climate change and without adaptation, climate change would be detrimental but with adaptation, vulnerability can be significantly reduced (Gbetibouo 2008).

People, property, economic activities and environmental resources have always been at risk from climate and people have continually sought ways of adapting, sometimes successfully and sometimes not. The long history of adapting to variations and extremes of climate with respect to water includes crop diversification, irrigation, construction of water reservoirs and distribution systems, disaster management and insurance (Adger et al. 2007); (Abou-Hadid 2006). Rural economies, which are based upon and dominated by agricultural, pastoral and forest production, are highly sensitive to climate variations and change including the livelihoods and food security of those who participate directly in these activities, supply inputs to them, or use their outputs to produce other goods and services (Abou-Hadid 2006). Because the effects of and responses to climate change will depend on the local context, including geographic, demographic, social, economic, infrastructural, and other factors, many adaptation options were more effective if designed, implemented, and monitored with strong community engagement (Kristie and Semenza 2008).

Adaptation has been assumed to be a function of available adaptation technology and knowledge, and to apply either fully or partially. Van Aalsta et al. (2008) cautions that such a simplification begs many questions concerning adaptive capacity. Do the affected communities have access to the existing technology? Can they afford the technology? Are they receptive to it and motivated to make the necessary changes? Do they possess the necessary skills, knowledge or awareness to want to adapt and be able to do so? What other stresses are they subject to? How are their potential adaptation choices affected by the social,

economic, political, and environmental circumstances in which they live? These complicating questions have not been generally addressed in the classical scenario-driven approach and in most cases research papers only go to the extent of providing a list of possible adaptation options. Successful adaptation will therefore, require not only new farming technologies and increased investments in water security in rural areas, but also policy actions to give small-scale subsistence farmers better access to information, credit, and markets (IFPRI 2006). Padgham (2009) adds that achieving effective and equitable adaptation outcomes will require encouraging or reinforcing social processes that reduce risk and exposure and enhance knowledge and information flows. Efforts by farmers alone to adapt to changing climate will not be sufficient and inappropriate policies may end up stifling their efforts. There is need for a deliberate and systematic policy shift aimed at supporting and enhancing the effectiveness of various technical solutions (Chikozho 2010).

One product of the situational analysis can be storylines of possible local climate change impacts. Storylines, as opposed to quantitative projections that focus on impacts in one sector over long time frames, can enhance community engagement in discussing shorter and longer-term risks and possible interventions, including where, when, and how interventions could be implemented (Kristie and Semenza 2008). Key questions to be considered include; how have local communities adapted to climate change and rainfall variability in the past? What are their current response strategies to observed and perceived climatic changes? What can policy-makers and researchers learn from the experiences of local communities? Any interventions that sideline the farmers in the design process may turn out to be ineffective. Chikozho (2010) observed that another important dimension of the adaptation discourses is that the rural poor are often excluded from policy-making processes and as a result, policies formulated at central government level are not sufficiently responsive to the policy needs of citizens at the local level and, therefore, not conducive to local livelihood and adaptation strategies. Supporting the coping strategies of local farmers through appropriate public policy and investment and collective actions can help increase the adoption of adaptation measures that will reduce the negative consequences of predicted changes in future climate, with great benefits to vulnerable rural communities (Nhemachena and Mano 2007). Clearly, adaptation cannot be treated as an isolated event divorced from other policy and institutional imperatives. It takes place in the context of demographic, cultural, environmental and economic changes as well as rapid transformations in technological innovations and global policy processes (Adger et al. 2005). Some of the literature on climate change argues that

with adaptation, farmers' vulnerability can be significantly reduced (Kurukulasuriya and Rosenthal 2003; Odekunle et al. 2007; Gbetibouo 2009). However, the available information on vulnerability of specific communities to climate change and potential adaptation measures is still insufficient (Chikozho 2010).

In many parts of the world, and especially in semi-arid lands, there is an accumulated experience with phenomenon such as drought and floods. As climate extremes are predicted to increase in frequency and intensity in future, it is important to understand and learn from relevant past adaptations and indigenous knowledge. However, changes in climate variability and mean values will bring additional complications to many, especially those dependent on food systems that are particularly vulnerable to these additional stresses (Guijit 2007). There are several scientific uncertainties regarding the relationship between climate change and biological effects and between these effects and socioeconomic consequences (IPCC 2007). Hart (2009) suggests that livelihood strategies that determine households' sensitivity and resilience to stressors and their ability to accumulate necessary assets (resources and services) to acquire food should be understood in terms of the system in which they are embedded. Tear Fund (2006) emphasizes that a risk-based approach to stressors of climate change adaptation should be adopted, informed by bottom-up experiences of vulnerability and existing responses. Hendricks (2005) and Hart (2009) suggests that understanding causes, nature and impacts of changing conditions and stressors requires local level and in-depth qualitative studies of households experiences under 'normal' conditions. Such in-depth studies will provide information that is required for a better understanding of the context in which larger quantitative studies such as national assessments of food and nutritional insecurity can be undertaken. Ellis (2003) stresses that local people carry out their own assessments and diversifies their livelihood patterns according to their perceptions of risk and in terms of available risk management strategies. Van Aalsta et al. (2008) emphasizes that development and disaster preparedness interventions must operate at community level to support the design of programmes for national-level priorities and undertake activities with the communities themselves with the objective of catalysing a process that empowers the people in the community and supports their capacity to alter their own situation. Community-based adaptation recognises that environmental knowledge and resilience to climate impacts lie within societies and cultures and focus should therefore be on empowering communities to take action on vulnerability to climate change, based on their own decision-making processes (Mitchell and Tanner 2006).

Community leaders, experts from sectoral agencies and organizations, researchers, and others can jointly develop the storylines based on likely consequences of projected changes in weather variables and patterns in a particular place and time. Engaging all potentially affected sectors will provide a more realistic and nuanced description of possible futures using simple storylines. Factors contributing to reduced adaptive capacity at rural community level have included poverty, lack of access to credit, and lack of savings, insecure property rights, lack of markets, and lack of information and knowledge of appropriate adaptation measures (Gbetibouo 2008).

2.3 Climate change and food security

Climate change will affect all four dimensions of food security: food availability, food accessibility, food utilization and food systems stability with direct impact on human health, livelihood assets, food production and distribution channels, as well as changing purchasing power and market flows (FAO 2008; Trobe 2002). The challenge of reaching sustainable food security and delivering on it through 2050 is daunting with an awkward starting point, in 2010, a world with unacceptable levels of poverty and deprivation, as is clear from the 2010 report on the Millennium Development Goals with even greater difficulty by two looming challenges: a growing world population and increasingly negative productivity effects from climate change (Nelson et.al. 2010). Declining global population growth, rapidly rising urbanisation, shrinking shares of agriculture in the overall formation of incomes and fewer people dependent on agriculture are among the key factors likely to shape the social setting in which climate change is likely to evolve (United Nations Framework Convention on Climate Change (UNFCCC) 2006). Water availability is critical to plant growth, thus changes in precipitation will also strongly influence agricultural productivity. The frequency distribution of temperature and rainfall may change as a result of climate change, including changes in climate variability and the intensity of extreme events. This may lead to more severe droughts or flooding, depending on the timing and distribution of rainfall (Chikozho 2010). However, the results of the Working Group II studies highlight our lack of knowledge, particularly at the regional level and in areas most vulnerable to climate change (IPCC 1990). Current "business as usual" scenarios for likely agricultural production are confusing, under even specified patterns of climate change due to surprisingly large differences in assumptions made by different groups about the rate and pattern of future yield and demand changes in the water dependent food and agriculture sectors, and about the nature and limitations of

adaptation strategies used by farmers, consumers and industry (Clark et al. 2010). Access or entitlements to land, water, labour and other inputs to rural production processes are important determinants of the vulnerability of rural households, shaping the sensitivity of households' livelihoods and food security to variations in climate and land productivity which underpin the capacity of households to withstand and respond to the impacts (Abou-Hadid 2006).

Climate change were likely to reduce the length of growing season as well as force large regions of marginal agriculture out of production and projected reductions in yield in some countries could be as much as 50% by 2020, and crop net revenues could fall by as much as 90% by 2100, with small-scale farmers being the most affected, adversely affecting food security (IFPRI 2006; Boko et al.2007). Maddison (2006) argues that when farmers gradually learn about climate change, they will also learn gradually about the best techniques and adaptation options available which may include: (1) learning by doing, (2) learning by copying, and (3) learning from instruction. Nhemachena and Mano (2007) concluded that the adaptation strategies farmers perceived as appropriate include crop diversification; using different crop varieties; varying the planting and harvesting dates; increasing the use of irrigation; minimum tillage farming; increasing the use of water and soil conservation techniques, shading and shelter; shortening the length of the growing season; and diversifying from farming to non–farming activities. Farmers may also engage in rainwater harvesting and storage practices to mitigate mid-season dry spells. Maximizing rainfall infiltration and water holding capacities of soils through various systems of soil and water conservation combined with crop residue management, intercropping and cover cropping, may contribute to dry spell mitigation (Chikozho 2010).

2.4 Policy implications for climate change and food security

Projected impacts of climate change generally are more adverse for low latitudes, where most developing countries are located, than for higher latitudes and because of the high level of vulnerability. Many countries have carried out climate change projections and impact assessments, but few have started consultation processes to look at adaptation options and identify policy responses (Tear Fund 2006). There is an urgent need in the developing world to understand the threats from climate change, formulate policies that will lessen the risks and to take action (Abou-Hadid 2006). When the root causes and behavioural manifestations of

poverty and household food insecurity are not understood, then policy interventions are likely to be ill-informed and unlikely to succeed in moving the poor out of poverty and food insecurity (Mano, 2006). Acknowledging and incorporating global climate change and variability and their appropriate mitigation and adaptation measures into national development targets and policies is crucial for successful adaptation and mitigation (Breisinger et al. 2011).

Placing agricultural and food issues onto the national and international climate-change policy agendas is critical for ensuring an efficient and pro-poor response to the emerging risks (Von Baun 2007). It is imperative that national governments, provide the supporting policy and infrastructure environment; and for the global trading regime, to ensure that changes in comparative advantage translate into unimpeded trade flows to balance world food supply and demand (Gerald et al. 2010). Specifically, policies should ensure that farmers have access to affordable credit, which would give them greater flexibility to modify their production strategies in response to climate change. Reforming pricing, clearly defining property rights, strengthening farm-level managerial capacity and investing in extension services need to be expanded with highly qualified personnel and improving off-farm income-earning opportunities with the facilitation of a smooth transition from subsistence to commercial farming (Gbetibouo 2008). Policy responses directed to local management of water, breeding new plant cultivars, and agricultural management designed to cope with variability in water availability, could lessen the severity of impacts of water scarcity as anticipated in the Southern region of Africa (IPCC 1990). Policy responses that mitigate some of these challenges may exacerbate others, as illustrated by the repercussions of recent efforts to support bio-fuel production (Clark et al. 2010). Managing the complexity of the real world interactions among agriculture, food security and climate will require complex, context-appropriate responses and an ability to address inevitable trade-offs (Clark et al. 2010). Efforts by farmers alone will not be sufficient and inappropriate policies may end up stifling their efforts. There is need for a deliberate and systematic policy shift aimed at supporting and enhancing the effectiveness of various technical solutions (Chikozho 2010). Padgham (2009) argues that achieving effective and equitable adaptation outcomes will require coupling innovations in agricultural production with strong policy support aimed at encouraging or reinforcing social processes that reduce risk and exposure and enhance knowledge and information flows. Policy adaptations may become more mutually supportive if they are embedded within a broader development framework, and argues that adaptation

needs to take place synonymously with sustainable development to help reduce vulnerability, in order for it to be successful (Schipper 2007).

There is a need to prioritise policies and investments in adaptation to promote resilient agriculture and food security. Policies should support farmers to diversify and build resilience under institutional and climate uncertainty. Adaptation policies must address gender, equity, capacity building and distributional issues and build on local knowledge and emerging research and technologies (FANPARN 2010). Critical reflection in strategic alliances with unlikely partners, articulating theories of change and the role of stories to clarify and convey the complexity of transformation are part of a new emerging discourse and practice (Guijit 2007). Adaptation to climate change is a priority; disaster mitigation and preparedness (DMP) is a vital component of adaptation and must be undertaken at national and local levels (Trobe 2002). It is important to remember that climate-related disasters are expected to increase not only as a result of global warming but also as a result of human-induced environmental destruction, requiring national policies to take account of climate change as well as address other practices that destroy the environment such as illegal logging and unsustainable agricultural practices (Trobe 2002). Policies should ensure that farmers have access to affordable credit, which would give them greater flexibility to modify their production strategies in response to climate change and access to water for irrigation to increases farmers' resilience to climate variability with greater investments needed in smart irrigation (Gbetibouo 2009).

2.5 Adopting a conceptual framework for the study

A sustainable livelihoods conceptual framework (Figure 2.1) was used to assess the communities' response to stressors perceived as variability in water availability resulting from climate change and the impacts on household food security. A livelihood comprises the capabilities, assets (including both material and social resources) and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base (Chambers and Conway, 1992).

A livelihood of a person, household or community is comprised of assets, transformed by activities or strategies into outcomes where the "internal" relationship between assets, activities and outcomes is seen to be circular, taking place in the context of and influenced by the external environment (vulnerability context and policies, institutions and processes). The diagram also shows that the actions of people, households and communities themselves have an influence on these external forces.

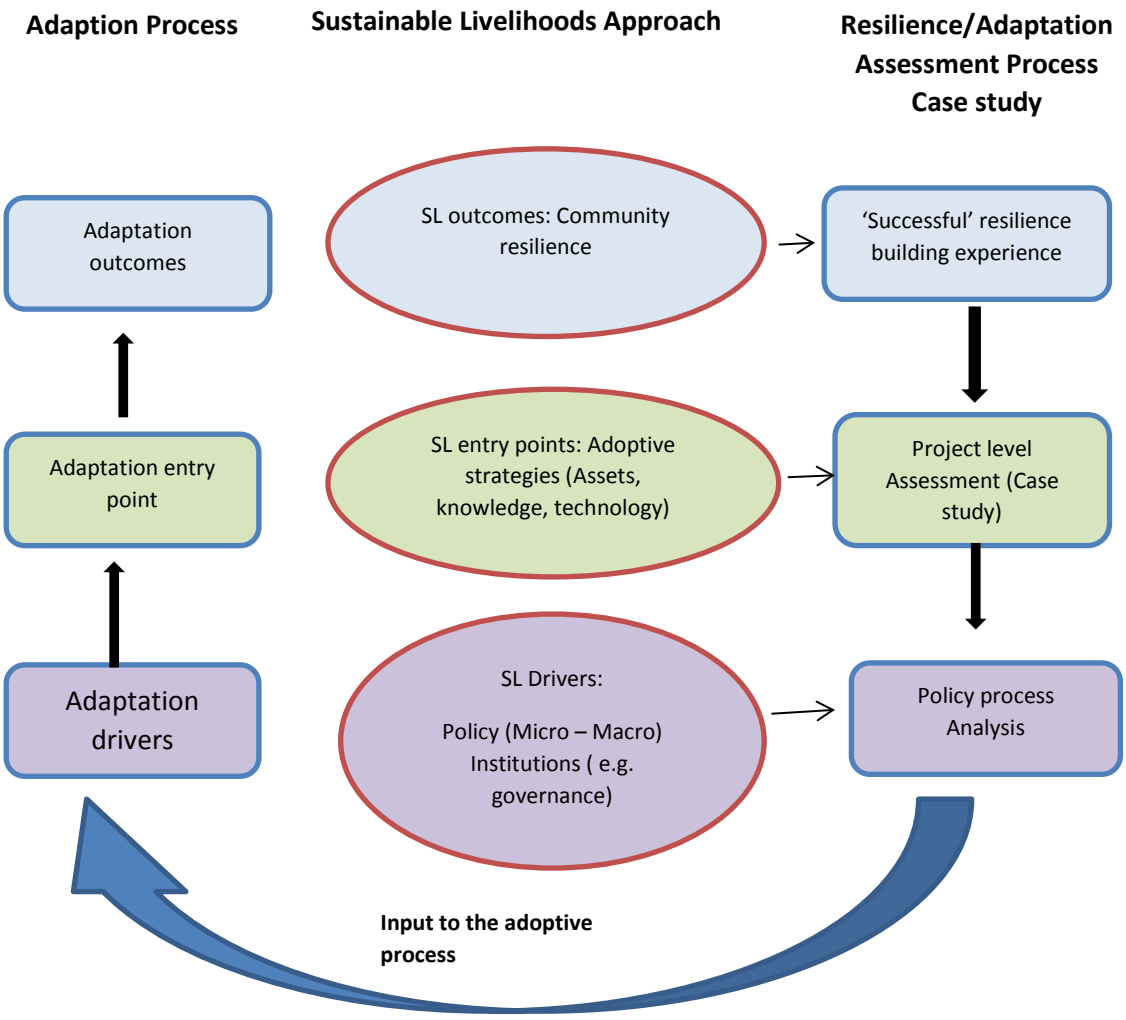

Figure 2.1: Adopted version of the UNDP (2003) approach to sustainable livelihoods (SL)

Assets are classified into:

- *Human capital*, e.g. education, formal and informal skills, health;
- *Natural capital*, e.g. natural resources such as farming and grazing land, forests and non-timber products, wildlife, and water;

- *Physical capital,* e.g. shelter, infrastructure such as roads and transport, buildings, irrigation systems, and productive assets such as seed, tools, livestock, fishing gear and other farm and processing equipment;
- *Financial capital,* e.g. cash income and remittances, credit, savings in kind and cash;
- *Social capital,* e.g. formal and informal institutions (including markets), associations (e.g. water users and savings and credit associations), extended families, and local mutual support mechanisms.

The sustainable livelihoods approach recognises that households need to possess assets essential to their livelihood strategies and households adjust to their physical, social, economic and political environments by using these assets, through a set of livelihood strategies designed to strengthen their wellbeing (Matshe 2009). In this study, a review of food security policies as an external environment were made with the intention of suggesting policy inclusions or exclusions in response to communities' adaption to variability in water availability resulting from climate change.

CHAPTER 3

MATERIALS AND METHODS

3.1 Assumptions of the study

The study assumed that significant differences existed among households in their response to different elements of climate change and this would have differentiated influence on their vulnerability and adaptation to climate change and household food security. It was also assumed that questionnaires were consistently administered and that respondents understood and answered the questions accurately.

3.2 Background of Study location and population characteristics

In the South African context, rural households access their food through direct purchase from markets and own production. To a large extent, most rural households do practice subsistence production of both crops and animals and in some cases; households depend on food transfers from government, development agencies or other households. Increased subsistence production has the potential to improve the food security of poor households in both rural and urban areas by increasing food supply, and by reducing dependence on purchasing food (Baiphethi and Jacobs 2009).

Agriculture is promoted widely as a means of overcoming food insecurity among the rural communities of KwaZulu-Natal (Hendricks 2005, Thamaga-Chitja 2008). Although, Ruel et al. (1998) observed that as much as 60- 80 percent of the total income of low-income households form the household food expenditure budget, (Bryceson, 2000) and Machethe (2004) argues that subsistence production of food is still a major component of livelihoods in rural communities in sub-Saharan Africa. Yet, few comprehensive studies have been carried out to understand why subsistence agricultural production is not contributing significantly to alleviating food insecurity among rural communities of South Africa including in KwaZulu-Natal.

3.2.1 Geographical location and climate characteristics.

The study area is found in the uMzinyathi District Municipality (DM) (District Code: DC 24), one of the 11 District municipalities of the province of KwaZulu-Natal of South Africa, located between latitudes 28° 33′ and 29° 04′ and longitudes 28° 53′and 29° 20′ (Figure 3.1). The area receives a Mean Annual Precipitation (MAP) that varies from550 mm to 1660 mm, mostly between October and March (Blignaut et al. 2010). Mid-summer (January) monthly means of daily maximum temperatures generally range from about 26°C to 28°C, with the highest values of up to 32°C while sub-zero means of minima not uncommon in July (Schulze, 1997).The rural communities rely heavily on natural resources and practice subsistence agriculture which includes both livestock and crop farming.

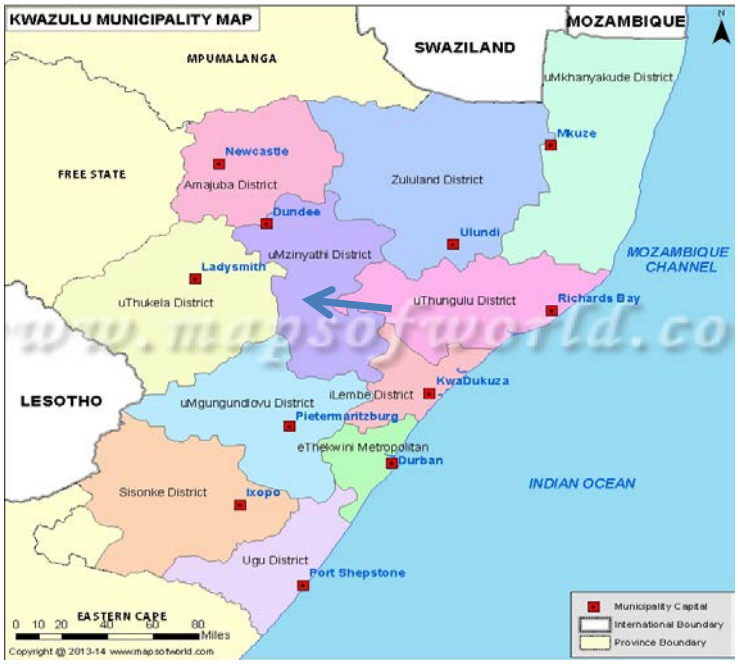

Figure 3.1: Location of the study area - uMzinyathi District municipality of KwaZulu Natal. Source: *www.mapsoftworld.com*

3.2.2 Social-economic/socio-institutional characteristics

Population estimates (2011) indicated that South African population was at 50 million people with 21.3% of them living in KwaZulu-Natal. The total population of uMzinyathi was estimated at 514 840 according to the Stats SA (2012) mid-year 2011estimates, of which 13.0% account for children less than five years, 7.0% account for sixty years and above and

55.0% of the population were females, 45.0% are males. It was also estimated that 72.0% of the population was under 35 years of age. Approximately 82.0% of the population is located within the rural areas. Community survey of 2007 estimated that 93,770 (4.4%) households were found in uMzinyathi DM compared to a total of 2,117,274 households in KwaZulu-Natal (Stats SA 2012).

uMzinyathi is deep rural and has a mountainous topography with poor basic infrastructure. The poverty index of the District is at 93.0% (Stats SA 2012). The District was identified in 2001 as one of the Presidential nodes due to its status as one of the municipalities with the highest poverty rate sitting at 68.0%. In 1996, 9.0% of the population lived below $1 per day and 26.2% lived below $2 per day. This figure improved to 1.6% living below $1 per day and 11.7% below $2 per day in 2009.

There is a weak social base, with the District having the highest levels of unemployment and illiteracy in KwaZulu-Natal. Only 26.4% of the adult population has only completed primary school education. The unemployment challenge in the uMzinyathi DM is significant, with an estimated unemployment rate of around 46.0% in 2007.

In uMzinyathi District Municipality, the HIV/AIDS infection rate for 2005 was 23.0% which is lower than the national average of 27.9% and significantly lower than the 37.5% average for the province of KwaZulu-Natal (uMzinyathi District Municipality 2001).

There is lack of economic activity taking place in the area because of limited social facilities. The main access to the community is by a gravel road and access to most households is by dirt roads or footpaths. There is neither electricity supply nor piped water, but water is supplied regularly about fortnightly by a tanker to a common point where members of the community can fetch. The area is serviced by a Health Clinic and High School at KwaSenge and three primary schools.

3.3 Data collection

A survey was conducted among 200 households. The study was carried out in five wards rather than in just one in order to represent the area better and to ensure that none of the study wards had very specific contexts that may influence results. Sub-samples of 44, 54, 46, 35 and 21 households respectively were randomly selected within the ward administrative areas

of the community. Households were randomly selected from villages and only those household members at the age of at least 40 years and participating in agricultural activities were asked to volunteer to participate in the survey. uMzinyathi District had a total of 93,770 households and a population of 514,840 (Stats SA 2012).

3.3.1 Questionnaire

A questionnaire was used to seek information on the general demographic characteristics of households (number of persons, ethnic group, age, etc.), their assets and livelihood strategies (on-farm and off-farm activities), farming systems information, and their perceptions of climate change characterizing their communities (see detailed questionnaire in the appendix). The questionnaire was written in English then tested and modified by well-trained enumerators who were selected from among the community and could be trusted by community members who freely responded to the questionnaire. The male household head or his wife was interviewed or, if both were absent, the eldest member of the household present.

A section of the questionnaire focused on events that respondents had experienced in the past and perceived as potentially affecting household livelihoods; the capacity of the community to cope with past and future threats; the barriers to successful natural resource management with greater focus on water; and ways to reduce threats and improve livelihoods through individual and collective action. The community are dependent on subsistence farming and the questionnaire also sought to find out what were some of the issues that affected agricultural production.

3.3.2 Focus groups

Three focus groups were used to generate information in the following areas: (a) water use in households; (b) crop production involvement; (c) means of coping with past and current climatic conditions; (d) foresight into future climatic conditions; (e) direction of future adaptive strategies; (f) AIDS and constraints to adaptation and (g) access to information. Three focus groups were chosen for the study because the area is heterogeneous in terms of farming activities that communities are involved in. In the low lying areas, households are actively involved in crops growing due to adequate rainfall. The upper areas of the District

are drier and animal keeping is predominant while in the intermediary areas, mixed farming is a common practice. Data and information obtained from the focus groups was used to explain some of the findings from the questionnaire. A summary of the respondents to the focus group discussions is presented in Table 3.1 below.

Table 3.1: Respondents to focus group discussions

Focus group	Males	Females	Total
1	5	9	**14**
2	8	3	**11**
3	6	10	**16**
Total	**19**	**22**	**41**

3.3.3 Key informants

Key informants who were knowledgeable about the community were carefully selected, to provide insights on climate change, adaptation and food security among the study community. Similar questions to the focus group were used to guide interaction with the key informants. The key informants included: a) Three traditional leaders from the community b) Agricultural extension officers for the area c) Local councillors.

3.3.4 Meteorological data

Rainfall (1981-2009), temperature (1993-2010) and humidity (1993-2010) of the study area were investigated over the indicated periods using meteorological data received from Meteorological Department of South Africa for the nearest weather station, Greytown station (0270155 9 – GREYTOWN) with latitude and longitude of -29.0830 and 30.6000 respectively and 1029m above sea level which is some 30kms away from the study area. The climate change investigation was to ascertain if community perceptions actually reflect the scientific measures of temperature, rainfall and humidity patterns.

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CHAPTER 4

HOUSEHOLD PERCEPTIONS TO CLIMATE CHANGE IN uMZINYATHI DISTRICT MUNICIPALITY OF KWAZULU-NATAL, SOUTH AFRICA

Abstract

Households will respond to climate changes according to their perceptions of a changing climate. Using a case study from uMzinyathi District of KwaZulu-Natal, a comparison was made between households' perception to climate change and the quantitative climate data. Quantitative data was collected through a survey among 200 households who were randomly chosen but who had lived in the community for over twenty years. Focus group discussions and key informant interviews were carried out to obtain qualitative data. The results show that communities' perception of climate change matched the quantitative data of climate of the area. The study area is becoming hotter and drier. Over the period 1993 – 2010, average annual temperature had increased by 1.5^{o}C. Rainfall generally decreased over the period 1981 - 2010 with the years 2004, 2007 and 2010 recording the least rainfall amounts of 368mm, 296mm and 319mm respectively below annual average rainfall of 784mm. Household perception on extreme climate conditions were a reflection of the quantitative climate data collected. Households observed increased frequency (73.0%) of droughts while incidences of floods had decreased over time by 52.0%. Farmers who were more educated were less likely to perceive changes in rainfall ($r = -0.257$, $p < 0.005$). Farmers who had access to information on climate change were more likely to perceive change in rainfall ($r = 0.025$, $p < 0.05$) and temperature ($r = 0.348$, $p < 0.10$). Farmers who carried out irrigation were more likely to perceive change in rainfall ($r = 0.258$, $p < 0.005$) but they were less likely to perceive change I temperature ($r = -258$, $p < 0.005$). Perceptions of communities to climate change should be considered by policy makers in advancing strategies to mitigate impacts of climate change.

Key words: Climate change, perception, local knowledge, Household, rural farmers

4.1 Introduction

Climate is important because it determines our localities and in general our livelihoods and how we organise our societies. It is expected that our climate will change over time and this may occur both naturally, as integral parts of how the global and regional climate systems function, as well as in response to additional influences due to human activity (Intergovernmental Panel on Climate change (IPCC), 2008; Davis, 2001). These changes that may occur over time may pause major challenges to humanity (Erda et al. 2007; Pender, 2008). The Fourth Assessment Report of the IPCC projects indicates that even with immediate implementation of climate mitigation policies, the global climate system will continue to shift and change for decades (Fussel and Klein, 2006; IPCC, 2007a). It is predicted that in the tropics, temperature will continue to increase, rainfall will decrease and frequency of floods and droughts will increase over time (IPCC 2001).

The state and dynamics of climate change processes differ from place to place and generate conditions that differ in character and degree to an extent that populations that are exposed to similar climatic phenomenon are not impacted the same (IPCC 2001). Sub-populations or groups inhabiting a region, and even from household to household within a group may experience changes in climate differently (Abou-Hadid 2006). For household to react to a changing climate, it will require that household will have to notice that climate has changed (Maddison 2006). Local knowledge about climate change will become very important in determining the way in which households will respond to climate change (Ogalleh et al. 2012). This knowledge will be used to shape the practices that communities will be engaged in. Local knowledge that is formed out of practice assists communities to make decisions on how to respond to changes in their environment and how the will act to minimise loses or take advantage of the change (Cabrera et al. 2006).

The paper aims to contribute to the climate change debate on cross-checking local knowledge with quantitative climate data to ascertain relevance for climate studies. The starting point is to establish if there has been climate change in the study area. Further exploration is made on how the rural community of uMzinyathi District perceives climate change by proposing an approach which focuses on practical on-the-ground experiences of households and individuals rather than on general climate change risks and threats discourses often

articulated by most scientists. A further investigation is carried out to look at some of the characteristics of households who perceived that there is indeed a change in climate.

Climate change will continue to be a major threat to rural livelihoods (Nhemachena, 2009). Southern Africa is widely recognised as one of the most vulnerable regions to climate change because of low levels of adaptive capacity (particularly among rural communities), combined with a high dependence on rain-fed agriculture (IPCC, 2007b; (United Nations Framework Convention on Climate Change (UNFCCC), 2006; German Advisory Council on Global Change (WBGU), 2008). With a changing climate, it is predicted that by mid-21st century, South Africa will have a broad rainfall reduction in the range of 5 to 10 percent with adverse negative impacts on agriculture especially in the rural areas accompanied with droughts and floods (Gbetibouo and Ringler 2009). Comprehensive studies have been done in South Africa on the impact of climate change on quantitative agricultural production and economic implications (Benhin, 2006; Challinor et al. 2007; (Department of Environmental Affairs and Tourism (DEAT), 2004). Limited studies have been done on the social aspects of climate change (Gbetibouo and Ringler 2009).

Of importance for communities to adopt to a changing climate is their ability to perceive climate change (Gbetibouo 2008). A number of studies have shown that communities' perception of climate change have matched quantitative data of climate elements. In a study conducted by Vedwan and Rhoades (2001) on the perception of apple farmers in the western Himalayas, they found that farmers' perceptions to climate change indeed corresponded to climatic data records. A similar study conducted by Hageback et al. (2005) on how small scale farmers of Danagou watershed in China perceived climate change also concluded that there was a strong correlation between farmers' perception and meteorological data. Slegers (2008) had similar findings in his study with farmers in semi-arid central Tanzania. However, other studies like the one carried out by (Rao et al. 2011) in the semi-arid parts of Kenya showed that communities' perception of climate change did not match quantitative data collected for the area.

Adoptive capacity of rural communities can be enhanced if practices that are already being implemented by farmers are incorporated into national strategies on climate change. Many scholars have pointed out the importance of local knowledge in developing effective strategies to a changing climate (Newsham and Thomas 2011; Thomas et al. 2007 and Mertz et al. 2009). Unfortunately many development agencies including national governments,

Non-governmental Organizations (NGOs), international donor communities do not consider rural communities' perceptions to climate change for inclusion in their interventions (FAO 2009, 2011). Hence the objective of this study was to determine rural famers' perception on climate change in uMzinyathi District Municipality.

4.2 Materials and methods

Meteorological data was collected from the meteorological department of South Africa for the nearest weather station, Greytown station (0270155 9 – GREYTOWN) with latitude and longitude of -29.0830 and 30.6000 respectively and an altitude of 1029m above sea level. Meteorological data for the different weather elements was available only over the indicated periods; rainfall (1981-2010), temperature (1993-2010) and humidity (1993-2010). This data was analysed for trends and variability. A total of 200 randomly sampled households were interviewed. uMzinyathi District has a total of 93,770 households and a population of 514,840 (Stats SA 2012). The kind of questions for this study were influenced by theory and research objectives which provided quantitative data on community responses to changes that could be attributed to climate change over the past 20 years. Through focus group discussions, community members were asked to respond to their perceptions to changes in climate. Interviews were also conducted with key informants. Focus group discussions and interviews with key informants was necessary so that data obtained from the surveys could be triangulated. Analysis of the weather elements and community responses to their perceptions on changes in climate was then analysed using the SPSS programme. A comparison was then made between the actual changes in weather patterns and the communities' perception on climate change. Further analysis is also done on the characteristics of households who perceived climate had changed compared to those who did not perceive that climate had changed.

4.3 Results

Household characteristics of the study sample are presented in Table 4.1 below

Table 4.1: Percentage distribution of the socio-economic indicators of the study households

Age of household head (Years)	40-50	51-60	61-70	71 and above
%	49.0	21.0	18.0	12.0
Gender of household head	Male	Female		
%	29.0	71.0		
Household members distribution	Adult men	Adult females	Children	Elderly
%	12.0	48.0	33.0	7.0
Education of household head	Not been to school	Primary	Secondary	Tertiary
%	28.0	44.5	27.0	0.5
Household head can read or write	Yes	No		
%	65.0	35.0		
Experience of water shortage	Everyday	Ones a week	Ones in two weeks	Ones a month
%	16.0	22.0	24.0	38.0
Household growing crops	Yes	No		
%	97.0	3.0		
Household keeping livestock	Yes	No		
%	65.0	35.0		

4.3.1 Rainfall pattern in uMzinyathi District Municipality (1981 – 2010)

uMzinyathi District Municipality received an average annual rainfall of 784.29mm (Average 1981 – 2010) but with quite large differences between years of low and high rainfall. (Figure 4.1). Over the period (1981 – 2010) there was a generally decreasing rainfall in the study area.

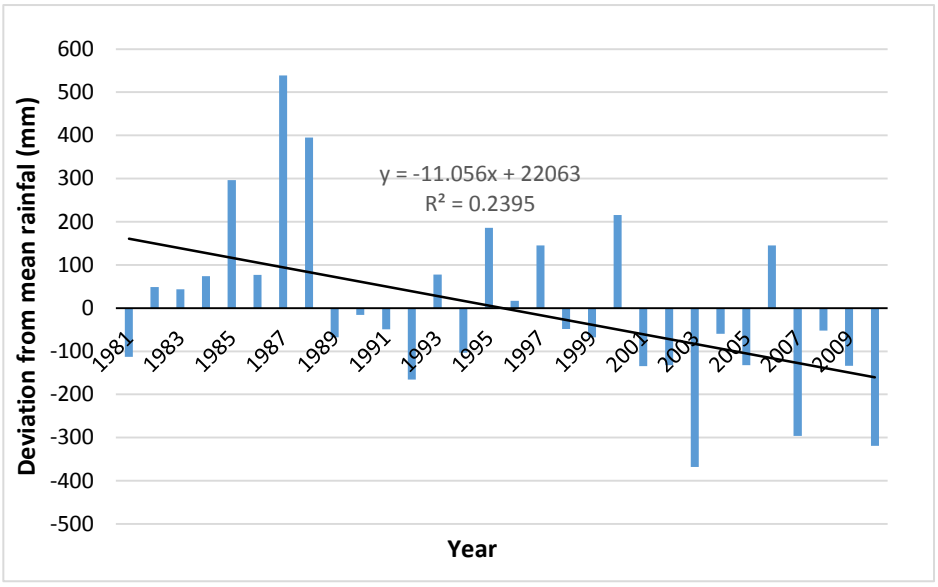

Figure 4.4: Annual deviation of rainfall from the mean (1981 - 2010)

The year 1987 registered the highest amounts of rainfall (539mm above average) while the year 2003 recorded the least volume of rainfall (368mm below average).The years 1985, 1987 and 1988 had generally high rainfall records, 296mm, 538mm and 395mm above average respectively. The years 2004, 2007 and 2010 recorded the least rainfall with volumes of 368mm, 296mm and 319mm below average rainfall respectively. The average annual rainfall over the period was 784.29mm.

4.3.2 Temperature pattern of uMzinyathi District Municipality (1993 – 2010)

Over the period 1993-2010, uMzinyathi District Municipality experienced annual average temperature range of between 16.2°C -17.7°C, with a period average annual temperature of 17.0^{0}C. Generally annual temperature increased over the period under review (Figure 4.2).

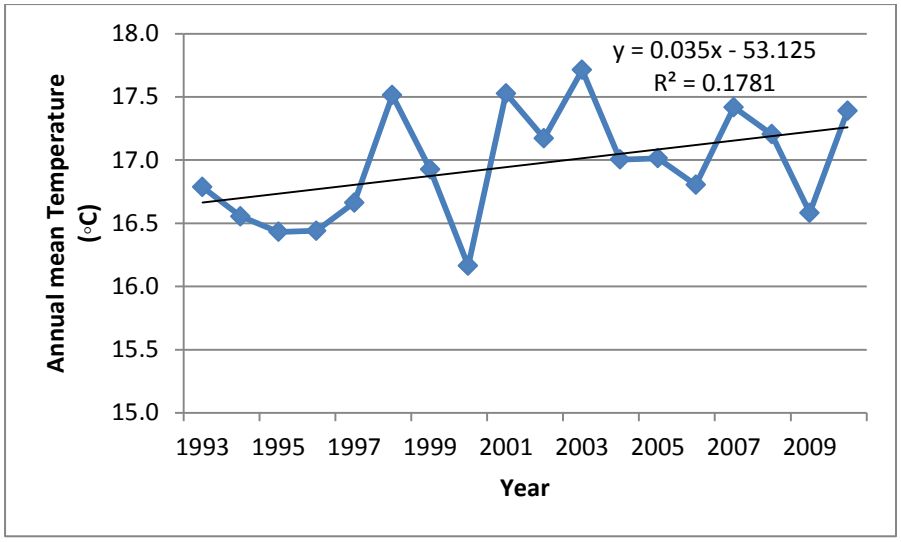

Figure 4.2: Annual average temperature (1993 - 2010)

The year 2003 registered the highest temperature of 17.7°C and the year 2000 registered the least temperature of 16.2°C. Over the 17 years under review, temperature had increased by 1.5°C.

4.3.3 Humidity pattern in uMzinyathi District (1993-2010).

An average annual humidity that ranged from 76% - 86.6% (Figure 4.3), was recorded for the uMzinyathi District.

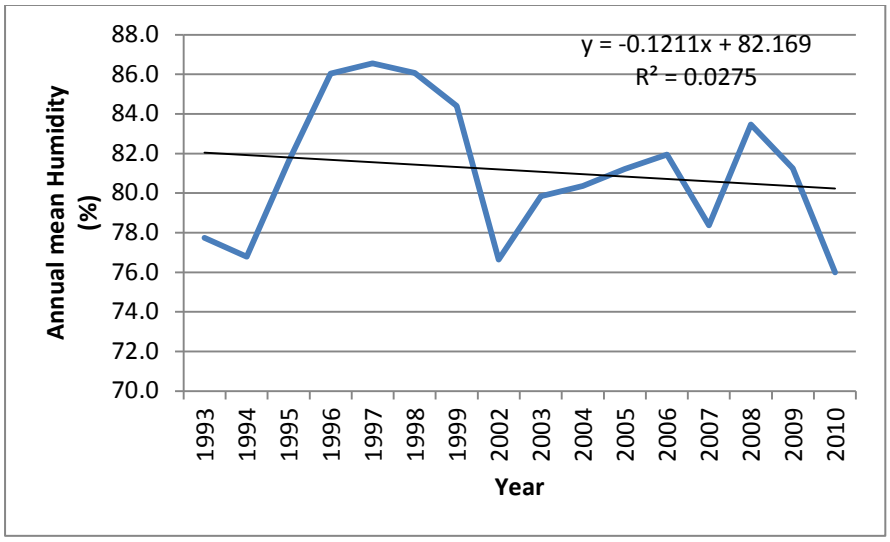

Figure 4.5: Annual average humidity (1993 - 2010)

The District experienced generally decreasing levels of average annual humidity with a period average annual humidity of 81.1%. The year 2010 registered the least humidity (76%) while the year 1997 recorded the highest humidity of 86.6%.

4.4 Community perceptions of climate change

Through focus group discussions and interviewing key informants, the local community was able to recollect precisely the years that had extreme events that affected their agricultural activities and this was compared to the meteorological data of the area (Table 4.2).

Table 4.2: Year of extreme climate condition of relevance to agricultural production in uMzinyathi District Municipality

Year	Observation by local community	Official records of annual rainfall (Data Source: SA Weather- Station [0270155 9] - GREYTOWN - 29.0830 30.6000 1029 m)
1981-1982	Drought	1981 rainfall was below average with 1982 having slightly above average rainfall (Average rainfall = 784.29)
1985-1988	Intensive rains with floods during the summer cropping seasons	1985-1988 were all above average rainfall period. Most of the rains in 1985 and 1988 intensified over the period December – February. In 1986 most of the rain was received in January (234mm) and in September for 1987 (385mm)
1992	Drought	1989- 1994 were dry years with below minimum rainfall. 1992 was most severe (619mm)
2003	Drought	2003 was a dry year(416mm), the driest since 1981
2007-2010	Dry years	The periods 1998-2010 experienced below average rainfall except for years 2000 (1000mm) and 2006 (929mm) that received above average rainfall
2007	Drought	2007 was a dry year (488mm) and most of the rain was received in October and November (288mm)
2010	Drought	2010 was a dry year (465mm) with only January receiving most rain (140mm)

Community observations did match the data that was recorded from the meteorological station. Community members were able to recollect the periods of extreme events of droughts and floods. Though some years were indicated as having exhibited extreme condition, in some instances these were carryover effects of the previous year.

From Table 4.3, households (78.0%) indicated that summer temperatures had generally increased and 62.0% said that hot periods had also increased. A majority (70.0%) of households indicated that winter temperatures were becoming warmer and 55.0% indicated that the length of cold season was getting shorter.

Table 4.3: Percentage of households' perceptions of climate change parameters in uMzinyathi District Municipality over the last 20 years (n=200)

Climate change parameters		Increase	Decrease	No change	Don't know
Noticed long term changes in the temperature in the last 20 years	Summer season temperature	78.0	11.0	5.0	6.0
	Winter season temperature	70.0	16.0	3.0	11.0
	Length of cold periods	19.0	55.0	23.0	3.0
	Length of hot periods	62.0	15.0	20.0	3.0
Noticed long term changes in rainfall in the last 20 years	Summer season rainfall	13.0	84.0	2.0	1.0
	Winter season rainfall	17.0	76.0	3.0	4.0
	Length of summer season rainfall	10.0	74.0	12.0	4.0
	Length of winter season rainfall	16.0	69.0	1.0	4.0
	Fluctuation in timing of rains	53.0	26.0	16.0	5.0
	Frequency of droughts	73.0	8.0	14.0	5.0
	Frequency of floods	39.0	52.0	8.0	1.0

Most of the households (84.0%) indicated that summer season rainfall had decreased and so was the rains received during the winter season (76.0%). Households indicated that both the summer and winter rainfall periods had decreased over time (74.0% and 69.0%) respectively. Households (53.0%) also indicated that there was an increased fluctuation in timing of rains and that there was increased frequency (73.0%) of droughts while incidences of floods had decreased over time (52.0%).

Further analysis was carried out to characterise households that were likely to notice climate change (temperature and/or rainfall changes) compared to those who were not likely to notice climate change by running a probit model. The independent variables used in this study included age, sex of household head, education, years of farming experience, access to information on climate, irrigation, visited by extension officers, received training on climate change. The results presented in Table 4.4 shows that age of farmers seemed to increase the probability that households were more likely to perceive long term changes in both rainfall ($r = 0.321$, $p < 0.005$) and temperature ($r = 0.536$, $p < 0.005$). Farmers who were more educated were less likely to perceive changes in rainfall ($r = -0.257$, $p < 0.005$). Farmers who had access to information on climate change were more likely to perceive change in rainfall ($r = 0.025$, $p < 0.05$) and temperature ($r = 0.348$, $p < 0.10$). Farmers who carried out irrigation were more likely to perceive change in rainfall ($r = 0.258$, $p < 0.005$) but they were less likely to perceive change I temperature ($r = -258$, $p < 0.005$).

Table 4.4: Results of unrelated probit model of households' perception of change in climate, uMzinyathi District (n = 200)

Household characteristic	Perceive change in temperature	Perceive change in rainfall
Age	0.321**	0.536**
Sex of household head	0.587	0.452
Education	0.369	-0.257**
Years of farming experience	0.213	0.118***
Access of information on climate change	0.025*	0.348**
Irrigation	-0.258**	0.310**
Visited by extension officer	0.756**	0.467**
Received training on climate change	0.015**	0.384***
Intercept	2.333**	1.798**
Log likelihood: -178.352		
Athrho: 0.453***		
Rho: 0.687		

*** Significant at 1% level; ** Significant at 5% level; * Significant at 10% level.

Households with longer farming experience were able to perceive long term changes in rainfall ($r = 0.118$, $p < 0.005$). On the other hand household who had received training on climate change were able to perceive changes in climate whether in temperature ($r = 0.015$, $p < 0.005$) or rainfall ($r = 0.384$, $p < 0.005$). Households who received extension services were more likely to perceive changes in both rainfall ($r = 0.756$, $p < 0.005$) and temperature ($r = 0.467$, $p < 0.005$).

4.5 Discussion

Analysis of temperature (1993 – 2010) showed an annual increase by 1.5^{o}C. Rainfall records showed generally decreasing levels of precipitation over the period 1981 - 2010. The results are in agreement with (IPCC 2001) indication that with climate change, temperatures will increase while total rainfall will generally decrease. Communities of uMzinyathi District are very much aware of what climate is and they are able to share their experiences on a changing climate. From both the focus group discussions and the household surveys, temperature and rainfall seemed to be the main climate elements of concern. Relative humidity was not of critical concern among the respondents. The overall results showed that communities of uMzinyathi District recognise that climate has changed over the past 20 years. The perceived climate change does correspond to the meteorological data of the study area. This findings are in agreement with similar studies (Vedwan and Rhoades 2001) who examined how apple farmers in the western Himalayas of India perceive climatic change and Hageback et al. (2005) who assessed small-scale farmers' perceptions of climate change in the Danagou watershed in China. Other studies that are in agreement with this finding include Slegers (2008), working with semi-arid communities in Central Tanzania.

The results show that uMzinyathi communities perceive that climate has become hotter and drier. This confirms the meteorological data presented earlier for the study area and (Hanjra and Qureshi 2010) observations that climate change will increase water scarcity. The implications could be decreased stream flow and groundwater recharge (IPCC 2001; Blignaut and van der Elst 2009) and generally insufficient water to sustain both crop and animal production consequently leading to high levels of food insecurity. Having access to water for irrigation provided a back-up system for households as such fluctuation in temperature and rainfall is not of concern. A similar observation was made by (Gbetibouo 2008) among a farming community in the Limpopo River Basin. Households who received extension services were likely to perceive climate change since they were exposed to information about climate. Experienced farmers in farming were more likely to perceive changes in climate because of the sensitivity they may have developed over time.

Increasing temperatures may lead to increased levels of pest and disease manifestation, further diminishing the already precarious household food levels. This result confirms (Hunter 2011) fears that with rural households relying heavily on climate-sensitive resources

such as local water supplies and agricultural land; climate-sensitive activities such as arable farming and livestock husbandry; and natural resources, the impact of climate change will be profound among these households. Generally declining amounts of rainfall received in uMzinyathi will have direct negative impacts on reduced crop yields which may require further investments in irrigation systems to improve crop yields. Overall shifts in the farming systems may be necessary to cope with reduced rainfall which may include growing of drought tolerant crops and varieties. Generally increasing levels of humidity and raising temperature may lead to prevalence of crops pests and diseases which will lead to reduced crop yields. The conditions may also lead to the proliferation of animal pests and diseases leading to reduced animal productivity. The changing climate will overall have major implications on household food security in uMzinyathi District.

4.6 Conclusion

This paper has attempted to look at how household perceptions to climate change relate to quantitative meteorological data. Climate data analysed for uMzinyathi District shows a general warming trend with a 1.5^{o}C annual temperature increase over the period 1993 – 2010. The area is becoming drier with a general trend of decreasing rainfall over the period 1981 – 2010. Households' perceptions to climate change were a reflection of climatic data records. Households were able to recognise that temperature had indeed increased while there was a reduction in the volumes of rainfall received. There is urgent need to incorporate indigenous knowledge in formulating climate change mitigation policies to further support communities' response to climate change. Due to the heterogeneity of climate factors for different areas, local knowledge will become more important for development agencies hence the need for such agencies to incorporate such knowledge in their interventions. Further research should be undertaken to establish the different factors that will contribute to accurate perceptions of climate change by households.

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CHAPTER 5

ASSESSING HOUSEHOLD VULNERABILITY TO CLIMATE CHANGE IN uMZINYATHI DISTRICT MUNICIPALITY OF KWAZULU-NATAL, SOUTH AFRICA

Abstract

The vulnerabilities of the rural small scale farming communities in the uMzinyathi District Municipality of KwaZulu-Natal, South Africa to climate change were analysed through the lens of individual household perceptions. Characterization of vulnerability consisting of adoptive capacity, sensitivity and exposure was employed in the study. The results showed that 76% of households were anxious that they will face negative impacts of climate change in future. Households were evenly distributed across the five vulnerability categories with extreme categories of 18% households being very highly vulnerable and 20% being less vulnerable. The results confirmed that indeed households were experiencing climate change and that they are reacting to this change by adopting differing agricultural and non-agricultural practices. Households responded by practicing coping mechanisms that were categorised as crop management coping strategies and farm management coping strategies. Vulnerability of households were significant reduced by the old age and disability grants ($r = -0.155$, $p < 0.10$) and ($r = -0.185$, $p < 0.005$) respectively. Vulnerability of farmers to climate change could be reduced by investing in early warning systems. Information on climate change will enhance farmers' responses to adverse climatic conditions. Alternative livelihoods other than the climate sensitive agriculture will considerably reduce farmers' vulnerability to climate change. Government grants played an important role in minimising household vulnerability to climate change. The paper argues that households are not homogenous and experience vulnerability to climate change differently, recommending that blanket interventions for communities should not be used to mitigate climate change but household specific interventions should be considered.

Key words: Climate change, vulnerability, adoptive capacity, households

5.1 Introduction

Limited studies have been done on the social aspects of vulnerability to climate change (Gbetibouo and Ringler 2009). Available information on vulnerability of specific communities to climate change and potential adaptation measures is still insufficient (Chikozho, 2010; IPCC, 2007a). Such information is necessary to enable policy makers to tackle climate change with some level of accuracy (Klein, 2005).

There is at present no consensus on the conceptual framework on how to define and measure vulnerability (Scaramozzino 2006). There is need for more comprehensive studies that reveal vulnerability of communities, in order to come up with timely information and options for adaptation.

Vulnerability is therefore a function of the character, magnitude and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity (Adger 1996; Aandahi, and O'Brien. 2001). Vulnerability to climate change does not manifest due to climate alone, but rather arises in the presence of multiple stressors which include socioeconomic factors and environmental factors (Deressa et al. 2008). The socioeconomic factors include the level of technological development, infrastructure, institutions and the political environment (McKenzie 2003). The environmental factors cited in literature include climatic conditions, quality of soil and water availability (Diaz, 2008; Belliveau et al. 2006; IPCC, 2007b). The variations of these socioeconomic and environmental factors across different social groups are responsible for the differences in their levels of vulnerability to climate change. Vulnerability is also mediated by institutional factors including rules, norms and policies (Gbetibouo and Ringler 2009). However, vulnerability is still a contested concept, and there is little agreement about how to convert it into policy and relevant measures for priority setting (Nelson et al. 2010).

This paper attempts to analyse vulnerabilities of the rural small scale farming communities to climate change in the uMzinyathi District Municipality of South Africa with the aim of expanding the knowledge on vulnerability analysis through the lens of individual household perceptions. Factors that contribute to household vulnerability to climate change are also investigated.

The IPCC's (2001) considers vulnerability to climate change to be the degree to which a system is susceptible or unable to cope with adverse effects of climate change, including

climate variability and extremes. Climate change has been the subject of intense debate in the global environment with the need to understand communities' vulnerabilities arising from these debates (Patnaik and Narayanan 2005). Whilst definitions of vulnerability are plentiful, the main area of contest has been finding a robust measurement of vulnerability that puts into account the basics of risk analysis. In general, (Nelson et al. 2007; IPCC, 2001; Pearson and Langridge, 2008) looks at vulnerability as the susceptibility of a system to disturbances determined by exposure to perturbations, sensitivity to perturbations, and the capacity to adapt. Specific to climate change, IPCC (2001) defines vulnerability as "the degree to which a system is susceptible, or unable to cope with adverse effects of climate change, including climate variability and extremes". In addition to the challenge of defining vulnerability, it is notoriously difficult to measure quantitatively (Schwarz et al. 2011; IPCC, 2007a). To a large extent, vulnerability concept remain largely academic and theoretical, and not of a great help in improving the way natural resources are managed or used in planning and management (Schwarz et al. 2011). Chambers (1989) has argued that the primary goal of applied vulnerability assessment should be to create contextually relevant measures of vulnerability that trigger action to reduce it. Scaramozzino (2006); Aandahi, and O'Brien (2001); and Adger, (1996) continue to emphasize that vulnerability is influenced by both physical and socioeconomic characteristics which are themselves not static, implying that vulnerability is context specific, and specific to place, time and the perspective of those assessing it. The context specific nature of vulnerability means that there can be no single, unified or general purpose approach to conceptualising it (Pearson and Langridge, 2008). Vulnerability analysis ranges from local or household (Adger 1999) levels to the global level (Brooks et al. 2005).

Pearson and Langridge (2008), IPCC (2001) and Deressa et al. (2008) observed that vulnerability can be conceptualized in many different ways along a continuum from outcome to contextual vulnerability. Outcome vulnerability is characterized by the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes i.e. existent state (Kelly and Adger 2000). Contextual vulnerability assesses 'the susceptibility of a system to disturbances determined by exposure to perturbations, sensitivity to perturbations, and the capacity to adapt (Kelly and Adger 2000). Schwarz et al. (2011) cautions of the importance of understanding people's perception about a particular climate event e.g. cyclone. It is important to note that communities are not homogenous in terms of exposure to the threat or resilience and will respond differently to different stimuli (Schwarz et al. 2011).

Deressa et al. (2008) identify three major conceptual approaches to analysing vulnerability to climate change: the socioeconomic (Focuses on socioeconomic variations in the community, ignoring the environmental variation), the biophysical (considers the level of damage from a given environmental stress, ignoring the individuals' capacity to adapt), and the integrated assessment approaches. Although each has its strong points and weaknesses, the integrated approach has much to offer in terms of policy decisions (Nelson et al. 2010; Fussel, 2007). The integrated approach combines both socioeconomic and biophysical approaches to determine vulnerability. As regards IPCC (2001) definition of vulnerability, (Deressa et.al. 2008) cautions that although the integrated approach corrects the weaknesses of the other approaches, its limitation is that there is no standard method for combining the biophysical and socioeconomic indicators, requiring care in the ranking of variables. Luers (2003) observed that the use of indicators is limited by considerable subjectivity in variable selection and their weighting. However, Leichenko and O'Brien (2002) showed that composite indices method captures the multi-dimensionality of vulnerability comprehensively and has more to offer practical decision making processes in terms of policy. Thus, this study adopted this method to analyse the vulnerability of rural farming households of uMzinyathi District Municipality of KwaZulu-Natal.

Methodological approaches in climate change literature include econometric and indicator methods (Deressa et al. 2008). The econometric method uses household socioeconomic surveys data to measure vulnerability (Davis 2011). The indicator method is based on selecting some indicators from a set of potential indicators and systematically combining them to indicate the level of vulnerability (Cutter et al. 2003; Easterling et al. 2007). Other approaches include two basic philosophical approaches to measuring vulnerability that are relevant to policy and decision making: deductive and inductive, often described as theory versus data driven approaches (Vincent, 2007; Adger, 2006; Adger and Vincent, 2005). This suggests that vulnerability research needs to be use-oriented, and capable of being integrated into the participatory and adaptive governance processes via which the contended values surrounding public choice are resolved (Nelson et al. 2010). It is suggested that indices designed deductively from integrated conceptual frameworks have potential to illuminate the multiple and emergent dimensions of vulnerability and adaptive capacity (Nelson et al. 2010).

Vulnerability is a function of the character, magnitude and rate of climate variation to which a system is exposed, its sensitivity and its adoptive capacity (IPCC's 2001). Since IPCC

definition accommodates the integrated vulnerability assessment approach, this study is based on this approach (Figure 5.1) that considers both biophysical and the socioeconomic indicators in assessing vulnerability of rural small-scale farming communities in UMzinyathi District Municipality to climate change.

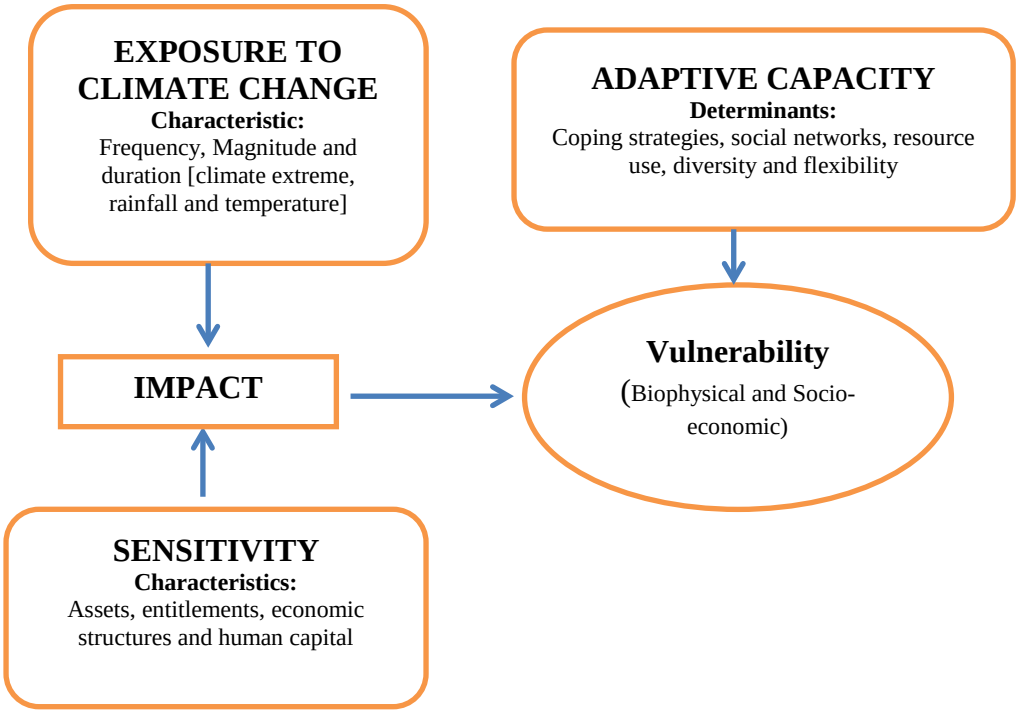

Figure 5.1: Conceptual framework to vulnerability assessment (Adapted from Gbetibouo and Ringler 2009)

Deressa et.al. (2008) showed that sensitivity and adaptive capacity are linked: Given a fixed exposure, the adaptive capacity influences the level of sensitivity; higher adaptive capacity (socio-economic vulnerability) results in lower sensitivity (bio-physical vulnerability) and vice versa. In other words, sensitivity and adaptive capacity add up to total vulnerability (The Energy Research Institute (TERI) 2003; Eakin and Luers 2006).

Exposure

Exposure relates to the degree of climate stress upon a particular unit of analysis which may be represented by frequency of climate extremes or predicted change in temperature or rainfall (Gbetibouo and Ringler 2009). Deressa et al. (2008) indicated that increasing

temperature and decreasing precipitation are both damaging to the already hot and water scarce African agriculture. Thus, regions with increasing temperature and decreasing rainfall were identified as regions more exposed to climate change. Indicators of exposure may include: Number of events of flood and droughts; Change in maximum temperature; Change in minimum temperature; and Change in rainfall.

Sensitivity

Sensitivity is the degree to which a system is modified or affected by an internal or external disturbance or set of disturbances which reflects the responsiveness of a system to climatic influences, as shaped by both socio-economic and ecological conditions and determines the degree to which a group was affected by environmental stress (Gallopín 2003). Gbetibouo and Ringler (2009) indicates that sensitivity describes the human–environmental conditions that can either worsen the hazard or trigger an impact. Some sensitivity indicators may include: Percentage of irrigated land; combined soil degradation or vegetation degradation; total rural population/Km^2; fertilizer use per hectare; and area under irrigation.

Adaptive capacity

Brooks (2003) and IPCC (2001) describes adaptive capacity as the potential or ability of a system, region, or community to adjust to the effects or impacts of climate change (including climate variability and extremes). Analysing vulnerability involves identifying not only the threat, but also the "resilience," or the responsiveness of the system and its ability to exploit opportunities and resist or recover from the negative effects of a changing environment (Gbetibouo and Ringler 2009). Moser (1998) observed that vulnerability and livelihoods (asset ownership) are closely linked, the more the assets, the lesser vulnerable the system and vice versa. Adaptive capacity is considered to be "a function of wealth, technology, education, information, skills, infrastructure, access to resources, and stability and management capabilities" (Benhin 2006). Livelihood assets may be grouped into human capital, social capital, financial capital and physical capital (Moser 1998).

5.2 Materials and Methods

5.2.1 Data collection

A survey was conducted among 200 households randomly sampled to have respondents of 40 years old or more and who have lived in uMzinyathi District for at least 20 years and participating in agricultural activities. uMzinyathi District had a total of 93,770 households and a population of 514,840 (Stats SA 2012). A questionnaire was used to seek quantitative information while qualitative information was collected through focus group discussions and key informant interviews. Topics of inquiry included in the interviews were: (a) crop production involvement; (b) means of coping with past and current climatic conditions; (c) foresight into future climatic conditions; (d) direction of future adaptive strategies; (e) aids and constraints to adaptation and (f) access to information. Quantitative data was captured and analysed using SPSS.

5.2.2 Construction of Vulnerability Indices

From our conceptual framework, vulnerability index was calculated using the formula:

$V = f(I - AC)$

$(-)$ *or* $(+)$

Where V is vulnerability index, I is potential impact and AC is adaptive capacity. In the calculation, both exposure and sensitivity were given negative signs. The justification is that areas that are exposed to damaging climate are more sensitive to damages given that the livelihoods of the community is agriculture based, assuming constant adaptive capacity (Deressa et al. 2008). In this relationship, the higher the net value indicates lesser vulnerability and vice versa. Varghese and Mordia (1982) showed that for indicators that have positive (↑) functional relationship with vulnerability e.g. variance in rainfall, their index values are calculated using the formula,

$$x = (x_i - Min(x_i)) / (Max(x_i) - Min(x_i))$$

Indicators with negative (↓) functional relationship with vulnerability, e.g. adult literacy, their index value is calculated using the formula,

$$y = (max\ (x_i) - x_i) / (Max\ (x_i) - Min\ (x_i))$$

After standardization of the indicators, weights were assigned to the indicators using the Principal Component Analysis (PCA) technique (Filmer and Pritchett 2001; Gwatkin et al. 2000; McKenzie 2003). PCA technique was used to develop principle components that will account for most of the variance in the observed variables which were then used as predictor or criterion variables in subsequent analyses (McKenzie 2003). The PCA is a multivariate statistical technique used to reduce the number of variables without losing too much information in the process (Helena et al. 2000; Sarbu and Pop 2005). The PCA technique achieves this by creating a fewer number of variables which explain most of the variation in the original variables (Giri 2004; Vyas and Kumaranayake 2006). The new variables which are created are linear combinations of the original variables. Those Principle Components (PCs) with Eigen values greater than one were selected as proposed by (Jeffers 1967). Rousson and Gasser (2003) cautions that in some cases, principal components often lack interpretability and may define some abstract scores which often are not meaningful, or not well interpretable in practice. However, in order to enhance interpretability, principal components are often rotated according to the varimax criterion of (Kaiser 1958).

For classification purposes, Iyengar and Sudarshan (1982) showed the suitability of the beta distribution in classifying levels of vulnerabilities characterized into the following fractile intervals:

1. Very highly vulnerable if $0 < y_i < z_1$
2. Highly vulnerable if $z_1 < y_i < z_2$
3. Vulnerable if $z_2 < y_i < z_3$
4. Moderately vulnerable if $z_3 < y_i < z_4$
5. Less vulnerable if $z_4 < y_i < 1$

Where y_i is the normalised vulnerability index and $(0,z_1)$, (z_1,z_2), (z_2,z_2), (z_3,z_4) and $(z_4,1)$ are the linear intervals such that each interval has the same probability weight of 20 per cent.

5.3 Results

From the survey results, 70% of households were aged between 40 and 60 years and 71% of household heads were female. It was also noted that most household members were female adults (48%).Only 0.5% of household heads had received tertiary education while 28% had not been to school at all and 44.5% having received primary school education. Most households (97%) were involved in growing of crops while 65% kept livestock.

5.3.1 Categories of vulnerability indicators

The conceptual framework for this study was used to categorise the bio-physical and the socio-economic vulnerabilities into vulnerability indicators (Table 5.1) showing the selected indicators for the study, how they impact on community vulnerability and their units of measurement.

Table 5.1: Vulnerability indicators and possible impact on level of vulnerability of rural farming community in uMzinyathi District Municipality

Determinants of vulnerability	Vulnerability indicators	Indicator description	Unit of measurement	Relationship between indicator and vulnerability
Exposure	Change in climate	Change in temperature	Community perception	The higher the change from normal the higher the vulnerability level
		Change in precipitation	Community perception	The higher the change from normal the higher the vulnerability level
Sensitivity	Extreme climate *(Land degradation index)*	Frequency of droughts and floods	Community perception	The higher the frequency, the higher the vulnerability level
Adoptive capacity	**Human capital** Literacy level Knowledge on Crop and water Management Irrigation potential	Quality of education	% of population	The higher the literacy level the lesser the vulnerability
	Social capital		% of population in community relationships	The more a household is involved in community relationships the lesser the vulnerability

Community exposure was determined by the indicators, change in temperature and change in precipitation and these were measured by community perceptions. Community sensitivity was determined by frequency of droughts and floods and similarly measured by community perceptions. On the other hand, adoptive capacity was considered to include two of the livelihood assets, human and social capital.

5.3.2 Household anxiety to climate change

When asked about the feeling about future climate (Table 5.2), most households indicated that they were worried that they will face droughts and floods (78.0% and 64.0% respectively). Interestingly most households (71.0%) indicated that they may not face crop failure.

Table 5.2: Percentage of households response to anxiety on future climate change (n = 200)

Household worry to:	Never	Rarely	Sometimes	Often
recurrent droughts	15.5	6.0	38.5	39.5
recurrent flood	12.0	24.0	38.5	25.5
crop failure	25.0	46.0	12.5	16.5
crop diseases	17.0	25.00	39.0	19.0
livestock diseases	19.0	24.5	33.5	23.0
price decline of farm products	51.0	18.0	20.5	10.5
soil fertility decline	49.5	20.0	17.0	13.5
price increase of inputs	51.50	22.5	18.5	7.5
late on-set of rains	18.0	32.5	32.5	17.0
shorter rainy seasons	17.5	22.5	38.0	22.0
climate variability	19.0	5.0	35.5	40.5

Most households (69.0%) were not anxious that they may face price decline of their farm products. Household were not concerned about soil fertility decline (69.0%) and increase in cost of farm inputs (74.0%). Households were also anxious that they could face crop and animal disease outbreaks (58.0% and 56.5% respectively) with the anticipated future change in climate. Overall, households (76.0%) were anxious that they will face adverse change in climate in future.

5.3.3 Principal Component Analysis

The result of the Principal Component Analysis (Table 5.3) shows that 14 components with Eigen value of 1 or greater accounted for 67.5% of the total variance on the coping strategies to climate change by households.

Table 5.3: Total variance on the coping strategies to climate change by households

	Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	6.818	15.496	15.496	3.531	8.025	8.025
2	4.814	10.940	26.436	3.444	7.828	15.854
3	2.635	5.988	32.424	3.271	7.433	23.287
4	2.022	4.594	37.019	2.444	5.554	28.840
5	1.853	4.211	41.230	2.428	5.518	34.358
6	1.626	3.695	44.925	2.035	4.625	38.983
7	1.525	3.466	48.392	1.918	4.358	43.341
8	1.424	3.235	51.627	1.690	3.841	47.183
9	1.337	3.040	54.667	1.645	3.738	50.921
10	1.254	2.849	57.516	1.586	3.604	54.525
11	1.175	2.671	60.188	1.563	3.553	58.078
12	1.133	2.575	62.762	1.508	3.426	61.505
13	1.067	2.425	65.188	1.438	3.269	64.773
14	1.028	2.335	67.523	1.210	2.750	67.523

Extraction Method: Principal Component Analysis.

The first component has an Eigen value of 6.818 and explains 15.4% of the variation in the original variables and each subsequent component explains a decreasing proportion of variance. The scree plot test (Cattell, 1966) in Figure 5.2, shows a plot of the Eigen values associated with each component and indicates a “break” between the components with relatively large Eigen values and those with small Eigen values.

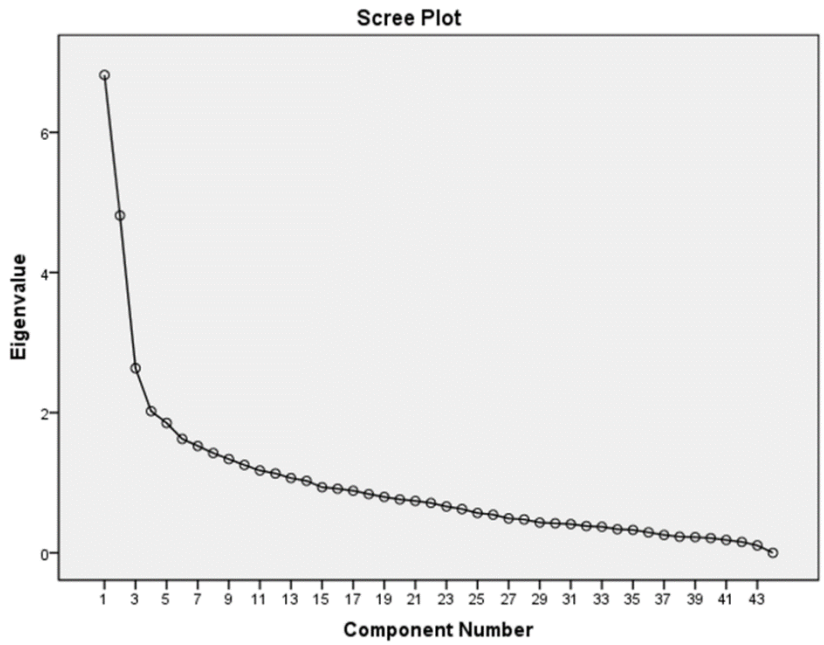

Figure 5.2: Scree plot showing the proportion of variance explained by each principle component

The components that appear before the break are assumed to be meaningful and are retained for rotation; those appearing after the break are assumed to be unimportant and are not retained (Cattell, 1966). In this case only components 1, 2 and 3 were used in the computation of household vulnerability indices. The component scores are shown in Table 5.4. Component 1 has got four component indicators; component 2 has eight indicators while component 3 has two indicators.

In the case of the first component which explained 15.5% of the whole dataset, has strong positive loadings on adapting to climate variability through coping strategies including rain water harvesting for irrigation, growing different crop varieties, crop diversification, praying for rainfall and cover cropping. This component may be called *crop coping strategies*. The second component that explains 10.9% of the dataset has a positive loading on adapting to climate change through eight factors that can be categorised as *crop management coping strategies*. The third component accounts for 6.0% of the dataset and is composed of two factors that can be categorised as *farm management coping strategies*.

Table 5.4: Rotated component matrix

Component indicators	Components		
	1	2	3
Rain water harvesting for irrigation	0.797		
Crop diversification	0.699		
Cover cropping	0.490		
Across slope cultivation	0.468		
Minimum tillage		0.680	
Crop residue management		0.672	
Tree planting alongside crops		0.596	
Intercropping		0.557	
Mixed farming		0.544	
Diversifying to non-farming activities		0.488	
Using organic manure		0.448	
Using moist valley bottoms		0.347	
Out migration			0.742
Leasing out land			0.698
Rotation Method: Varimax with Kaiser Normalization.			

5.3.4 Household vulnerability index

Figure 5.3 shows the computed household vulnerability index. Fewer households, 40 (20%) had positive household vulnerability index indicating that they were relatively not vulnerable to climate change while the rest 160 (80%) had negative household vulnerability index implying that they were relatively vulnerable to climate change.

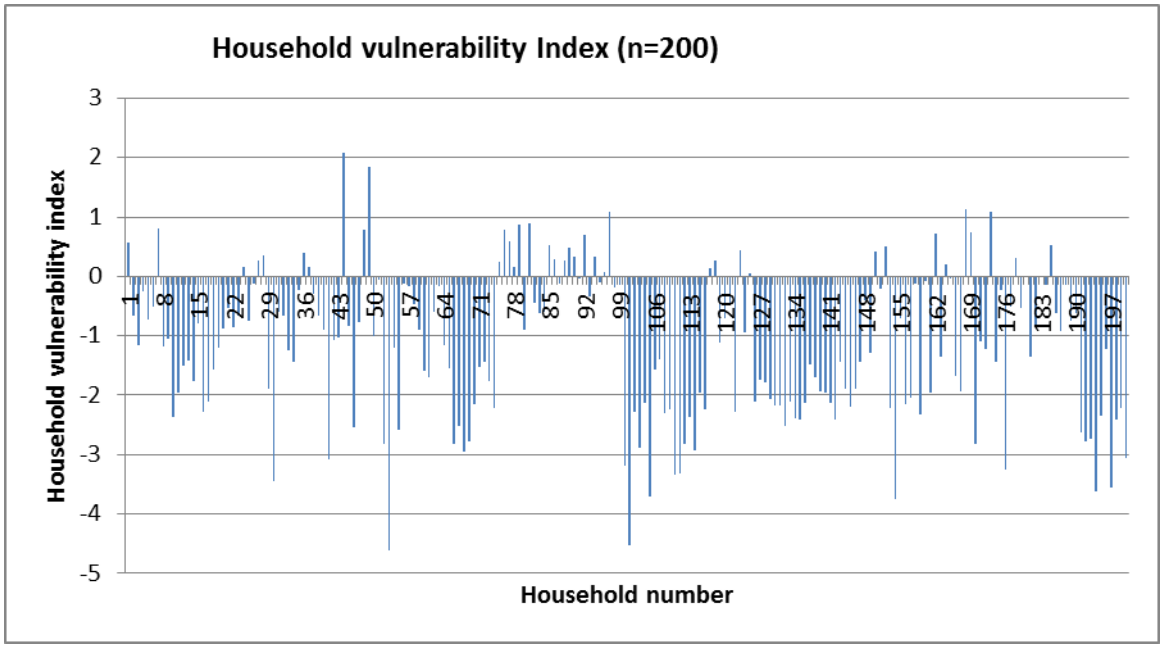

Figure 5.3 Individual household vulnerability index

5.3.5 Household vulnerability categories

Iyengar and Sudarshan (1982) showed the suitability of the beta distribution in classifying levels of vulnerabilities, where the distribution density is given by

$$\frac{z^{a-1}(1-z)^{b-1}}{\beta(a,b)}, 0 < z < 1 \; and \; a, b > 0$$

where $\beta(a,b)$ is the beta function defined by

$$\beta(a,b) = \int_0^1 x^{a-1}(1-x)^{b-1}dx$$

The two parameters *a* and *b* of the distribution were estimated using the SPSS software. Table 5.5 shows household vulnerabilities distributed across the five categories. There seem to be an even distribution of households among the different levels of vulnerability.

Table 5.5: Household vulnerability categories (normalized)

Statistics			
a	3.2801		
b	3.09		
Mean	0.5173		
STD DEV	0.1926		
Median	0.5225		
LQUARTILE	0.3727		
UQUARTILE	0.6650		
Vulnerability categories			
		n =200	**Percentage**
1. Very highly vulnerable	0.00<yi< 0.34	37	18.50%
2. Highly vulnerable	0.34 <yi< 0.46	43	21.50%
3. Vulnerable	0.46 <yi< 0.56	34	17.00%
4. Moderately vulnerable	0.56 <yi< 0.68	46	23.00%
5. Less vulnerable	0.68<yi< 1.00	40	20.00%

Category 3 (vulnerable had the least number of households (17.0%) while category 4 (moderately vulnerable had the most households (23%). 18.5% of households were very highly vulnerable while 20% were less vulnerable.

A Chi-square test was carried out between household vulnerabilities and household characteristics (Table 5.6).

Table 5.6: A Chi-square test of household vulnerability index and household characteristics (n = 200).

	Vulnerability Index		
Household characteristic	**Chi-square**	**Degrees of freedom**	**Asymp. Sig (2 sided) (*p* – value)**
Sex of household head	200	199	0.467
Highest level of education of household head	600	597	0.048
Household head can read and write	200	199	0.037
Household owns TV	200	199	0.467
Household owns radio	200	199	0.467
Household owns mobile set	200	199	0.467
Anxiety over climate change	5200	5174	0.397

Level of education of household head and household head can read or write had significant correlations to household vulnerability to climate change in both cases ($p< 0.05$). Other household characteristics considered did not have a significant relationship to household vulnerability.

A Pearson's correlation was carried out to establish if there existed any relationship between household characteristics and household vulnerability (Table 5.7).

Table 5.7: Pearson's correlation between household characteristics and household vulnerability (n = 200).

	Household vulnerability
Household Characteristic	
Total number of household members	0.064
Income per month from old age grant	-0.155*
Income per month from disability grant	-0.185**
Total Household income per month	0.020
Total area cultivated in square metres	0.420
Total money spent on food purchase in a month	-0.091
Value of inputs used in agricultural production	0.040
Value of livestock owned by household	-0.108
Number of children in household	0.027
Number of adults in household	0.039

** Correlation is significant at the 0.05 level (2-tailed).
* Correlation is significant at the 0.1 level (2-tailed).
Note: Numbers in brackets refer to *P* values

There was a negative and significant relationship between household vulnerability and old age and disability grants ($r = -0.155$, $p < 0.10$) and ($r = -0.185$, $p < 0.005$) respectively. Other household characteristics considered in the study did not have significant relationships to household vulnerability.

5.4 Discussion

Households' fear that in future floods and droughts will negatively impact on their livelihoods confirming (Trobe 2002) and (United Nations Environmental Programme (UNEP) 1999) observations that climate change will negatively impact on rural farming communities who rely largely on climate sensitive resources. Floods will negatively influence crops and animal productivity with direct consequence on decreasing household food security. Floods may be accompanied with waterborne diseases and this may further exacerbate household food insecurity.

Three components were found to significantly influence household vulnerability. In the case of the first component which explained 15.4% of the whole dataset, has strong positive loadings on adapting to climate variability through coping strategies including rain water harvesting for irrigation, growing different crop varieties, crop diversification, praying for rainfall, cover cropping and across slope cultivation. This component may be described as *crop management coping strategies*. The second component that explains 10.9% of the dataset has a positive loading on adapting to climate change through eight factors that can similarly be categorised as *crop management coping strategies*. Among other component factors included are; minimum tillage, crop residue management, tree planting alongside crops etc. The third component accounting for 5.9% of the dataset is composed of two factors that can be categorised as *farm management coping strategies*. Component factors included; out-migration, leasing out land and buying of insurance.

In considering household characteristics and household vulnerability to climate change, households with household heads who had higher level of education were less vulnerable to climate change, confirming (International Food Policy Research Institute (IFPRI) 2006) observation that better access to information by households will contribute to reduced vulnerability. It was observed that increased household incomes reduced household vulnerability. Incomes diminish dependency on climate sensitive resources like agriculture thus reducing household vulnerability to climate change as observed by (IFPRI 2006).

It was observed that households are nearly evenly distributed in all the five vulnerability categories. The indication is that even within the same locality vulnerability to climate change will vary significantly. This may imply that blanket recommendations on dealing with vulnerabilities to climate change may not be effective even at household level. This confirms

(Kristie and Semenza 2008) observation that addressing vulnerability need to be context specific even at household level. Households may need tailor made interventions to address their vulnerability situation.

5.5 Conclusion

This study analysed the vulnerability of households of rural farming communities in UMzinyathi District Municipality to climate change by creating vulnerability indices and comparing these indices across households. An index of household vulnerability to climate change has been constructed and presented for 200 households. The vulnerability analysis followed the IPCC (2001) definition of vulnerability, which explains it as a function of adaptive capacity, sensitivity, and exposure.

Although farmers were well aware of climatic changes and the different crop management practices to adapt to the changing climate, the famers remained very vulnerable to climate change in future. Farmers' vulnerability could be drastically reduced if there were mechanisms in place to forewarn famers of impending climate changes. This could allow them to take the necessary measures. The analysis revealed a rural community that is vulnerable at different levels to climate change now and in the future. The results indicated that vulnerability to climate change is highly masked by the fact that the community rely on government grants for their livelihoods and that agricultural activities are generally shrinking and becoming unimportant to the communities. This situation makes poor households vulnerable to national policy choices and politics. It is essential that creative and meaningful solutions are found to enable the rural community in the uMzinyathi District Municipality become self-reliant and look beyond government grants that can be abolished by a simple change in government policy. These results do not tell policy makers how to design adaptation interventions. The results do suggest, though, that activities other than agricultural might usefully form part of overall adaptation strategies including engaging in alternative income generating activities to compensate for the delicate agricultural activities that are totally reliant on the decreasing levels of rainfall.

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CHAPTER 6

RURAL FARMERS' ADAPTATION TO CLIMATE CHANGE IN uMZINYATHI DISTRICT MUNICIPALITY OF KWAZULU-NATAL, SOUTH AFRICA

Abstract

This paper examined the preferred adaptation methods to climate change among rural small scale farming communities in the uMzinyathi District Municipality of KwaZulu-Natal, South Africa. Adaptation to climate change results from a combination of sensitivity, exposure and adaptive capacity was used in the study. The results showed that 95% of surveyed households are aware that climate is changing and that they are expecting negative impacts of climate change in future especially on their crop production systems. Household will undertake crop management and soil management practices to respond to the changing climate. A large proportion (83%) of households anticipate that they will alter their livelihoods systems to respond to climate change with 59% of households indicating that government grants will play an important role in their adaptation to climate change. Households engaged in adaptation practices like growing different crops (v = -0.294, $p < 0.05$), growing crops at different times (v = -0.239, $p < 0.05$), involvement in non-farm income activities (v = -0.413, $p < 0.05$), intercropping showed reduced vulnerability (v = -0.574, $p < 0.05$) showed reduced vulnerability to climate change. Households with household heads who could read or write would prefer to use a variety of methods to adapt to a changing climate. Households will effectively adapt to a changing climate by governments putting in place mechanisms that will help finance the adaptation interventions. Capacity of households should be built through extension services so that households are well prepared to effectively undertake appropriate adaptation methods.

Key words: Climate change, adaptation, households, rural farmers

6.1 Introduction

Climate change is projected to increase with more frequent extreme weather events affecting all aspects of the hydrological cycle, with regions such as South Asia and Africa expected to be particularly vulnerable due to their large population, predominance of agriculture, and limited resource base (Aggarwal and Singh 2010). Indeed, heavy precipitation and related floods, landslides, storm surges; droughts and relatively higher temperatures have had devastating effects on agricultural systems in several parts of the world in recent years (Intergovernmental Panel on Climate change (IPCC) 2007). Southern Africa is experiencing inter and intra rainfall variabilities with shifts in tropical temperatures over the region (Usman and Reason 2004) Individuals, households, communities and nations will make deliberate changes and respond to these multiple climate change pressures through a process of adaptation with the intention of minimising the impacts of such threats (Adger et al. 2005). The time taken for a system (individual, household, community) to respond and effectively contain such threats is referred to as the adoptive capacity (Stringer et al. 2009). Adoptive capacity may involve a system modifying its characteristics or behaviour so as to cope better with the changes in external environment (Gbetibouo 2009).

Practically all soil processes important for agriculture are directly affected in one way or other by climate change, where precipitation patterns and amount, and temperature can influence soil water content, runoff, erosion, temperature, salinization, biodiversity, organic carbon and nitrogen content (Aggarwal and Singh 2010). Smallholder and subsistence farmers are likely to suffer complex, localized impacts of climate change, having limited adaptive capacity with a likelihood of experiencing negative effects of climate change on yields (Aggarwal and Singh 2010). Agriculture constitutes the backbone of most developing world economies, being the largest contributor to GDP; the biggest source of foreign exchange, accounting for about 40% of the continent's foreign currency earnings (Nhemachena and Hassan 2007; Wiggins 2006). Agriculture remains crucial for pro-poor economic growth especially in rural areas, supporting 70-80% of the total population with the potential to increase rural incomes and purchasing power for rural communities (Ludi 2009).

This paper examines the adaptation to climate change among rural farming communities in uMzinyathi District of KwaZulu-Natal. Three adaptation areas are considered for this study:

- Agricultural ecosystem
- Household livelihood system
- Farmers' agricultural livelihood system

The analysis begins by establishing household anxiety to future climate change. Investigations are then made on the adaptation mechanisms among the farming community. Finally relationships are drawn between established household vulnerabilities to climate change and household adaptation methods.

Adaptation may be described as the ability of social or environmental systems to adjust to change in order to cope with the change (Burton et al. 2002). In order to adapt to climate change, farmers must first perceive that changes are taking place. Easterling et al. (2007) observed that adaptation strategies need to take a number of factors into consideration, including globalization, population and income growth, the socio-economic and environmental consequences of alternative adaptation options. Hansen et al. (2004); Deressa (2008)indicated that farmers' memory of past climatic variability may be distorted in systematic ways, reflecting wishful thinking, shaped by personality characteristics and pre-existing beliefs and thus structuring the nature of adaptation. The nature of response to climate change will be determined by the degree of exposure, nature of the stress and the capabilities of the system being exposed (Smithers and Smit, 1997). At farm level, farmers may adopt to climate change through copying what others are doing, learning by doing or implementing what they have been instructed to do (Maddison 2006). Gbetibouo (2009) points out that farmers capabilities in terms of personal managerial and entrepreneurial capacities and family set-ups may lead to differential responses to similar climate change stimuli. Bates et al. (2008) observed that with regard to agricultural production, possible climate change adaptation may include:

- Adoption of varieties and species of crops with increased resistance to heat stress, shock and drought.
- Modification of irrigation techniques
- Adoption of water-efficient technologies to 'harvest' water, conserve soil moisture (e.g. crop residue retention, zero-tillage), and reduce siltation and saltwater intrusion;
- Improved water management to prevent waterlogging, erosion and nutrient leaching;
- Modification of crop calendars, i.e., timing or location of cropping activities;

- Integration of the crop, livestock, forestry and fishery sectors at farm and catchment levels;
- Implementation of seasonal climate forecasting;
- Land-use changes that take advantage of modified agro-climatic conditions.

A study of Canadian farmers showed that farmers' responses vary when faced with the same climate stimuli, even within the same geographic area, given different agricultural systems and markets systems in which farmers operate as well as different individual characteristics and contexts (Maddison, 2006; Nhemachena and Hassan, 2007). Aggarwal and Singh (2010) and Vincent (2007) observed that adaptations should occur at multiple scales, including the individual, society, farm, village, watershed, and national level. Possible adaptation practices (Aggarwal and Singh 2010) may include the following:

- Development of resource-conserving technologies
- Augmenting production and its sustainability
- Increasing income from agricultural enterprises
- Improved land use and natural resource management policies and institution
- Improved risk management through early warning systems and crop insurance
- Recycling wastewater and solid wastes in agriculture

Adger et al. (2005) cautions that adaptation initiatives need to be thought through holistically where, in some cases adaptation may reduce risk in the short run but increase exposure to risk in the long term. Stringer et al. (2009) alluded that in some cases, adaptation may be tactical like selling off of livestock, i.e. suitable for the circumstances, while in other case it may be strategic including structural changes in management like changing livelihood activities or crop types. Bryant et al. (2000), cautions that effective adaptation for a particular system to a specific stimuli may in some circumstances undermine the ability of others to adapt due to negative externalities for example irrigation upstream denying those downstream from being able to irrigate. Hence the objective of this study was to evaluate the experiences and adaptation mechanisms to climate change among rural small scale farming communities in uMzinyathi District Municipality.

6.2 Materials and methods

This study is based on a data set collected among 200 households of uMzinyathi District and looks at adaptation at farm level. uMzinyathi District had a total of 93,770 households and a population of 514,840 (Stats SA 2012). A conceptual framework (Figure 6.1) is employed in the study to comprehensively capture household responses to the vulnerability components: exposure, sensitivity and adoptive capacity in the context of household farming systems and adaptation to climate change. Quantitative data was collected through a questionnaire while qualitative data was collected through asking open ended questions to focus groups and key informants on what they do to counter perceived changes in temperature and rainfall.

Key informants helped to give a general picture of the community and a reflection on past climate risks. Data was collected on demographic characteristics and socio-economic conditions of family/households which included a review on yields and incomes of household's from both agricultural farming systems and non-farm activities. Detailed survey questionnaire and qualitative questions are in the appendix attached.

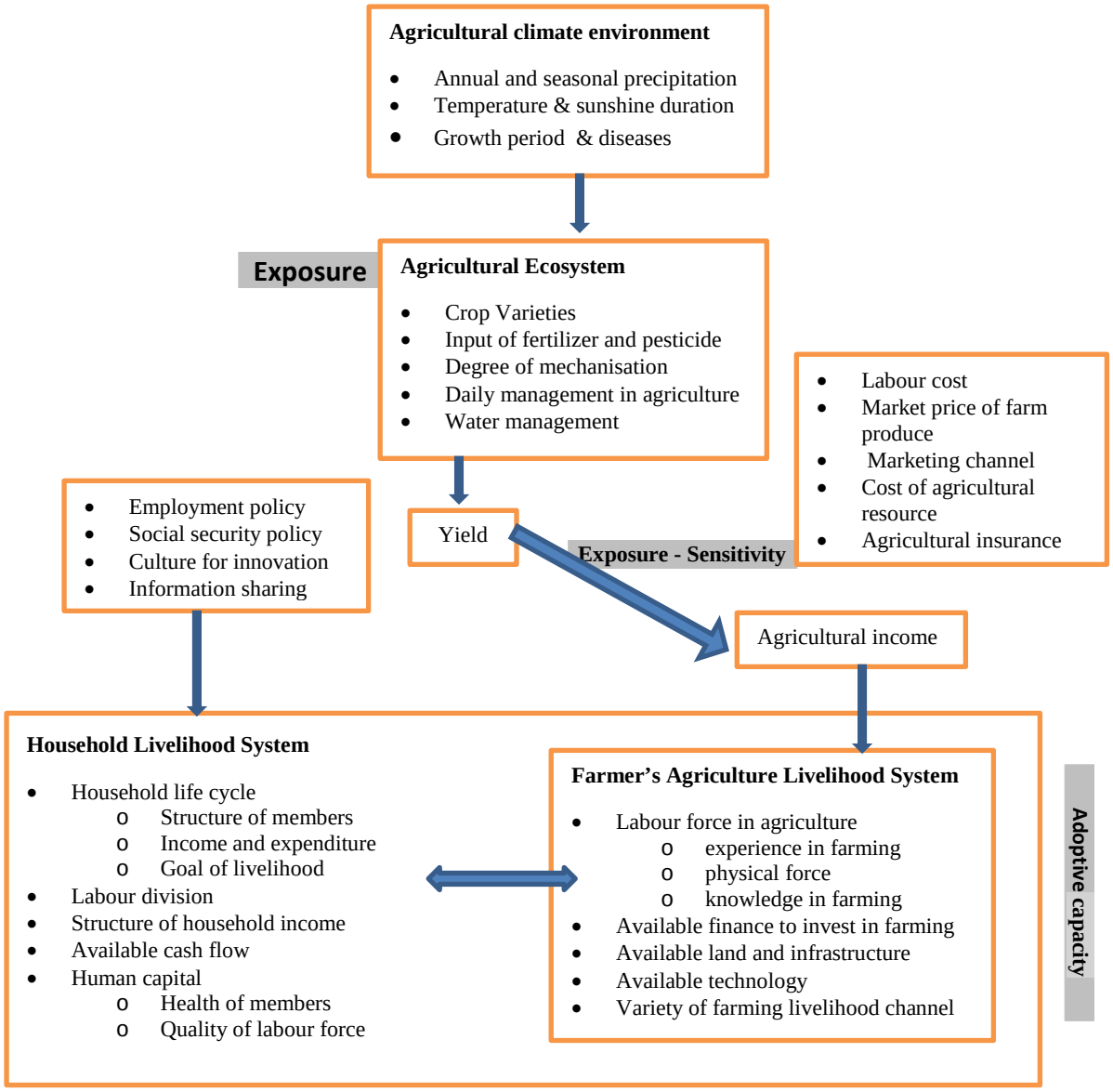

Figure 6.1: Conceptual Framework of Farmer's Adaptation to Climate Risk (Adopted from IPCC 2007 and Reid S. et al. 2007)

6.3 Results

From the survey results, 70.0% of households were aged between 40 and 60 years. 71.0% of household heads were female. It was also noted that most household members were female adults (48.0%). Only 0.5% of household heads had received tertiary education while 28.0% had not been to school at all and 44.5% having received primary school education. Most households (97%) were involved in growing of crops while 65.0% kept livestock.

6.3.1 Perceptions on future climate change

Households were asked about the feeling about future climate (Table 6.1). Most households indicated that they were worried that they will face droughts and floods (78.0% and 64.0% respectively). Interestingly 71.0% households indicated that they may not face crop failure even with perceived droughts and floods.

Table 6.1: Percentage of responses to household anxiety on future climate change and possible impacts (n=200)

Household worry to:	Never	Rarely	Sometimes	Often
recurrent droughts	15.5	6.0	38.5	39.5
recurrent flood	12.0	24.0	38.5	25.5
crop failure	25.0	46.0	12.5	16.5
crop diseases	17.0	25.0	39.0	19.0
livestock diseases	19.0	24.5	33.5	23.0
price decline of farm products	51.0	18.0	20.5	10.5
soil fertility decline	49.5	20.0	17.0	13.5
price increase of inputs	51.5	22.5	18.5	7.5
late on-set of rains	18.0	32.5	32.5	17.0
shorter rainy seasons	17.5	22.5	38.0	22.0
climate variability	19.0	5.0	35.5	40.5

Most households (69.0%) were not anxious that they may face price decline of their farm products. Household were not concerned about soil fertility decline (69.0%) and increase in cost of farm inputs (74.0%). Households were also anxious that they could face crop and animal disease outbreaks (58.0% and 56.5% respectively) with the anticipated future change in climate. Overall, households (76.0%) were anxious that they will face adverse change in climate in future.

6.3.2 Adaptation practices preferred by households

After considering the climatic events experienced, households were asked to respond to what practices they would prefer to be engaged in, to respond to the perceived changes in climate (Table 6.2). With specific reference to the crop management practices, households would prefer cover cropping, crop diversification and growing of different crop varieties (65.5%, 63.5% and 65.0% respectively in response to a changing climate.

Table 6.2: Results of the t – test of adaption methods households will employ with climate change (n=200)

Possible adaptation practice	t – value	df	*p* - value
Crops management practices			
Intercropping	2.131	199	0.034
Cover cropping	7.857	199	0.000
Growing of different crop types	5.744	199	0.000
Growing of different crop varieties	6.035	199	0.000
Soil management practices			
Crop residual management	0.778	199	0.438
Minimum tillage	2.786	199	0.006
Different fields planted at different times	6.116	199	0.000
Annual crop rotation	2.156	199	0.032
Carry out mulching	0.390	199	0.697
Across slope cultivation	6.905	199	0.000
Using organic manure	-4.335	199	0.000
Living fields fallow	-2.524	199	0.012
Tree planting alongside crops	0.751	199	0.435
Water harvesting for irrigation	10.090	199	0.000
Cropping moist valley bottoms	-9.097	199	0.000
Land use extensification	-6.947	199	0.000
Land use intensification	-1.066	199	0.288
Out migration	-8.931	199	0.000
Carry on as usual	-8.931	199	0.000
Leasing out land	-8.289	199	0.000
Purchasing of insurance	-9.160	199	0.000

In the crop management adaptation practices, household will consider practicing cover cropping, growing different crop types and cultivating different varieties of crops ($p< 0.001$

in all these cases). Household indicated that they may use a variety of soil management practices to cope with a changing climate. These practices include; planting different fields at different times, planting crops across a slope, using organic manure to fertilize their crops, harvesting of water from roof tops for irrigation ($p < 0.001$ in all these cases). Households were already harvesting water from roof tops for irrigation (Figure 6.2)

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Figure 6.2: Household rain water harvesting for irrigation

6.3.3 Household livelihood preference in response to climate change

Households were asked about their possible livelihood systems they believed would be appropriate in response to a changing climate (Figure 6.3).

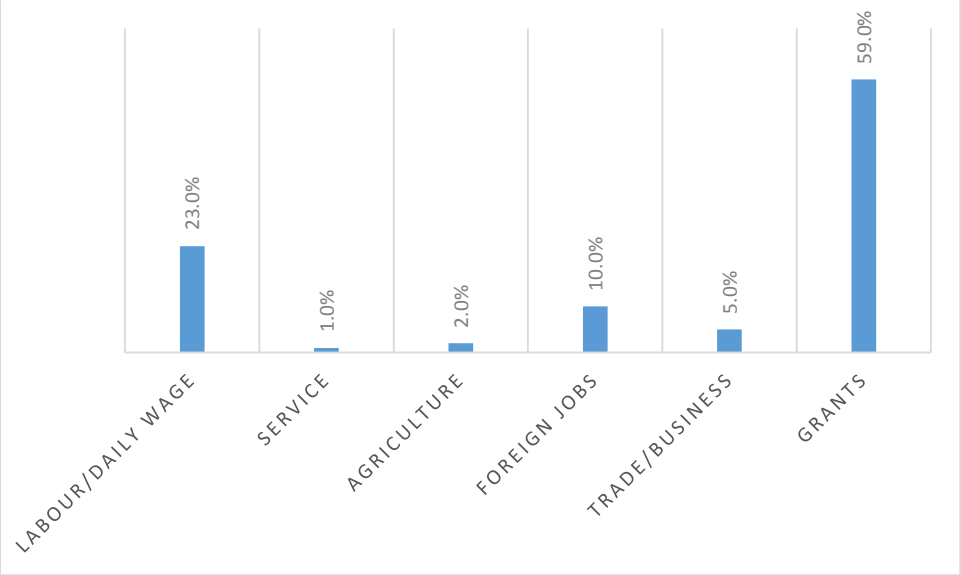

Figure 6.3: Percentage distribution of household responses to possible household livelihoods in response to a changing climate (n=200).

Although all of the households surveyed were involved in some form of agricultural production, only 2.0% considered practicing agriculture to be a possible source of livelihood, with (59.0%) considering government grants as a secure source of livelihood with a changing climate

6.3.4 Household vulnerability to climate change and adaptation methods

An analysis was carried out to establish if there was a correlation between pre-determined household vulnerability to climate change and the possible adaptation methods households would prefer to be engaged in, with a changing climate (Table 6.3).

Table 6.3: Results of Cramer's V correlation test of pre-determined household vulnerability index and desired adaptation method to climate change (n = 200)

Adaptation method	Cramer's *V*	Adaptation method	Cramer's *V*
Growing different crop varieties	-0.294**	Different fields planted at different times	-0.239**
Rain water harvesting for irrigation	0.111	Diversifying farming to non-farming activities	-0.413**
Mulching	0.144	Praying for rainfall	0.289
Intercropping	-0.574**	Across slope cultivation	-0.378
Applying chemical fertilizers	0.440	Crop rotation	0.113
Applying organic manure	-0.337**	Cropping moist valley bottoms	0.255**
Leasing out land	0.168*	Leaving fields fallow	-0.284**
Mixed farming	-0.457**	Minimum tillage	-0.658**
Tree planting alongside crops	-0.518**	Land use extensification	0.029
Land use intensification	-0.118	Out migration	0.217
Carrying on as usual	0.310	Purchase of insurance	0.053

** Correlation is significant at the 0.05 level (2-tailed).
* Correlation is significant at the 0.1 level (2-tailed).
Note: Numbers in brackets refer to *P* values

The results show that households that were less vulnerable to climate change would increasingly prefer to undertake a number of adaptive method in response to a changing climate. Significant negative correlations were observed for households who; preferred to grow different crops (v = -0.294, $p < 0.05$), preferred to grow their crops at different time(v = -0.239, $p < 0.05$), would diversify to other non-farming activities (v = -0.413, $p < 0.05$), would carry out intercropping (v = -0.574, $p < 0.05$), would undertake use of organic manure for their crops (v = -0.337, $p < 0.05$), would practice mixed farming (v = -0.457,

$p < 0.05$), practice minimum tillage ($v = -0.658$, $p < 0.05$), plant trees along the slopes($v = -0.518$, $p < 0.05$) and leasing out of land ($v = 0.168$, $p < 0.10$).

6.3.5 Household characteristics and preferred methods of adaptation

An investigation was carried out to determine the characteristic of households in relation to their preferred methods of adaptation (Table 6.4)

Table 6.4: Results of Spearman's (Rho) correlation between household characteristics and preferred adaptation method to climate change (n = 200)

	Household characteristic				
Preferred adaptation practice	Age of household head	Highest level of education	Household head can read or write	Income from old age grant	Income from child grant
Intercropping	-0.069	0.027	0.220**	-0.138	0.088
	(0.330)	(0.702)	(0.002)	(0.052)	(0.215)
Crop residue	-0.065	0.060	-0.109	0.214**	-0.019
management	(0.360)	(0.397)	(0.124)	(0.002)	(0.793)
Minimum tillage	0.026	0.070	0.152*	0.194**	0.020
	(0.720)	(0.325)	(0.032)	(0.006)	(0.781)
Mulching	-0.017	0.051	0.142*	0.060	0.007
	0.810	0.477	0.045	0.397	0.920
Across slope	0.103	0.073	0.259**	0.051	0.153*
cultivation	(0.148)	(0.306)	(0.000)	(0.469)	(0.030)
Mixed farming	0.039	0.009	-0.135	-0.116	0.041
	(0.588)	(0.898)	(0.056)	(0.101)	(0.568)
Land use	0.012	-0.036	0.090	-0.060	-0.087
extensification	(0.863)	(0.610)	(0.205)	(0.399)	(0.219)
Leasing out land	-0.098	-0.070	0.054	-0.077	0.013
	(0.166)	(0.323)	(0.448)	(0.280)	(0.850)
Purchase of	0.221**	0.095	0.035	0.013	0.058
insurance	(0.002)	(0.179)	(0.620)	(0.850)	(0.412)

** Correlation is significant at the 0.05 level (2-tailed).
* Correlation is significant at the 0.1 level (2-tailed).
Note: Numbers in brackets refer to *P* values

The results show that males would prefer to carry out minimum tillage (*Rho* = 0.186, $p<0.05$) in response to climate change. Households with older household heads would prefer to purchase insurance to minimise the impact of a changing climate (*Rho* = 0.221, $p< 0.05$). Households with household heads who could read or write preferred a number of practices to respond to a changing climate; intercropping (*Rho* = 0.220, $p< 0.05$), minimum tillage (*Rho* = 0.152, $p< 0.10$), mulching (*Rho* = 0.142, $p< 0.10$), across slope cultivation (*Rho* = 0.259, $p< 0.05$). Households who received old age grants would respond to a changing climate by preferring to utilise crop residues (*Rho* = 0.214, $p< 0.05$) and carrying out minimum tillage (*Rho* = 0.194, $p< 0.05$)

Further analysis was carried out to find the extent to which household preferred adaptation practices influenced household vulnerability (Table 6.5). Overall, the 14 adaptation practices explain 87.4% of the household vulnerability.

Table 6.5: Regression analysis of preferred adoptive practice and household vulnerability

Preferred adaptation Practice	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	1.855	.140		13.264	.000
Rain water harvesting	.071	.123	.020	.574	.566
Cover cropping	-1.491	.111	-.457	-13.460	.000
Crop diversification	.177	.135	.044	1.305	.194
Involved in nonfarm activities	-.399	.104	-.116	-3.832	.000
Practice intercropping	-.516	.104	-.162	-4.973	.000
Incorporate crop residue in soil	-.424	.106	-.131	-4.005	.000
Practice minimum tillage	-.567	.110	-.181	-5.138	.000
Practice across slope cultivation	-.578	.144	-.141	-4.003	.000
Utilizing moist valley bottoms	-.227	.122	-.059	-1.858	.065
Mixed farming	-.311	.101	-.099	-3.080	.002
Out migration	-.641	.117	-.173	-5.455	.000
Leasing out land	-.559	.145	-.122	-3.848	.000
Organic fertilization	-.333	.102	-.103	-3.252	.001
Tree planting alongside crops	-.459	.099	-.148	-4.636	.000
R SQUARE = 0.874					

Dependant variable: Vulnerability

All the adaptation practices are significant predictors of household vulnerability ($p < 0.05$) except for rainwater harvesting, crop diversification and utilization of moist valley bottoms ($p > 0.05$ in these three cases).

6.4 Discussions

Out of households' experience of a changing climate, household have real fears about a changing climate and will do what is within their means to prepare for it as observed by Benhin 2006. This result confirms that indeed adaptation to climate change is taking place at household level as was observed by (Kristie and Semenza 2008) and that adaptation will contribute significantly to the reduction of the negative impacts of climate change as suggested by (Gbetibouo 2008).A variety of possible adaptation possibilities have been suggested by households. This result is in agreement with Brooks (2003) observation that systems will adjust to a changing climate to wane off the negative impacts. This research went beyond providing a list of possible adaptation options and it showed that household are proposing current methods on crop and farm management to adapt to climate change but the effectiveness of the adaptation options was not studied. Although (Gbetibouo 2009) suggests that government policies should ensure that farmers have access to affordable credit and insurance, giving them greater flexibility to modify their agricultural production strategies in response to climate change.

It is required that households are prepared well in terms of appropriateness and effectiveness to be able to undertake these adaptation possibilities. Households hoped to use traditional adaptive mechanisms that were within their reach and understanding as suggested by Maddison 2006. In this case households will be limited in the way they would respond to climate change requiring that households are exposed to new and proven methods that have worked in other communities in responding climate change. Extension services to communities should be incorporated community adaptation systems taking care of local context with a strong community engagement, including geographic, demographic, social, economic, and infrastructural as suggested by (Kristie and Semenza 2008). Information is going to play a greater role in contributing to households' effective adaptation. This manifested in this study as households who could read and write suggesting a variety of methods in response to a changing climate. Households hoped to adjust their livelihoods in response to climate change. External factors are going to determine how households will respond to a changing climate, in case of this study, government grants. This may be looked at as a short-term response as observed by Nelson et al. 2007 who proposes that exposure to different stimuli will influence household adaptation to climate change.

6.5 Conclusion

This study evaluated how households of rural farming communities in UMzinyathi District Municipality proposed to address climate change. The main adaptation strategies farmers used included growing of different crop varieties, planting different fields at different times, use of organic fertilizers, leaving some of their fields fallow, practice of minimum tillage, planting trees alongside slopes, cropping of valley bottoms and carrying out mixed cropping. It is one thing for farmers knowing about the different mitigating practices and it is another to effectively practice them. Further research is required to investigate to what extend farmers are effectively undertaking the different mitigating practices.

Technology will play a greater role in enabling farmers to effectively adopt to climate change. Selection of varieties and crops that can cope with the changing crops growing environment may significantly enhance adaptation. Support to the farming communities through appropriate and effective extension services were necessary to deal with the new crop growing conditions arising among the agricultural community. Possibilities of utilizing the Tugela River for crops irrigation need to be investigated in order to compensate for the generally decreasing levels of rainfall in the region.

The result also showed that improving crop production practices contributed to enhancing adaptation to climate change. Thus, policy interventions should focus on strengthening household crop production through mitigating and coping practices aimed at reducing the damages from climate change. This should include encouraging the crop management practices that were seen to reduce vulnerability of households to climate change. Policies that support adaptation strategies at the household level should encourage ownership of income generation and asset holding that will enable households cope in the event that government changes its policy on giving grants. Other mitigation strategies might include water harvesting, resource conservation and management of especially land, irrigation systems, provision of household and agro-ecological extension packages, supporting social networks already existing in the areas in form of Self-Help Groups and a system of drought early warning systems.

Climate change mitigation policies should consider building the capacity of communities to effectively adapt to a changing climate. Research should be conducted to establish context specific adaptation intervention that are incorporating local knowledge in planning and

formulation of responses to climate change. Adaptation to climate change will come with a cost attached for effective responses. Communities should be prepared to put in place mechanisms to meet the costs required for adaptation.

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CHAPTER 7

IMPACT OF CLIMATE CHANGE ON HOUSEHOLD FOOD SECURITY AMONG RURAL FARMERS IN uMZINYATHI DISTRICT MUNICIPALITY OF KWAZULU-NATAL, SOUTH AFRICA

Abstract

Over time, food systems have been exposed to continuously changing environmental circumstances with the need to adopt in order to maintain continuous food production for the increasing population. This paper examines household food security among rural farming communities in uMzinyathi District of KwaZulu-Natal. The results are then compared with pre-determined household vulnerability index to climate change and household's preferred adaptation methods to a changing climate. Households assessed (97%) were found to be severely while 3% were moderately food insecure. Households were worried about the negative impacts of climate change which included droughts, floods and soil erosion. Households who were found to be vulnerable to climate change recorded high levels of food insecurity. Concerns over decline in prices of farm products, increase in cost of farming inputs and anxiety over occurrence of livestock diseases exacerbated household food insecurity. Households preferred to practice a variety of interventions in response to a changing climate with corresponding improvement in household food security. Non-farm incomes played a major role in alleviating food insecurity among households. Those households who could read and write recorded better levels of food security than their counterparts. Rural farmers should be assisted with packages that can help them undertake effective adaptation mechanisms to climate change. Information will play a critical role in ensuring farmers can do what is within their means to address household food security in a changing climate.

Key words: Climate change, food security, household, adaptation

7.1 Introduction

Climate variability is projected to increase with more frequent extreme weather events affecting the balance between food demand and supply (Intergovernmental Panel on Climate Change (IPCC) 2007). Africa is expected to be particularly vulnerable due to their large population, predominance of agriculture, and limited resource base (Aggarwal and Singh 2010). Such global climatic changes will affect agriculture through their direct and indirect effects on crops, soils, livestock, and pests (IPCC 2007). Agriculture constitutes the backbone of most developing world economies, being the largest contributor to GDP; the biggest source of foreign exchange, accounting for about 40% of the continent's foreign currency earnings; and the main generator of savings and tax revenues (NEPAD 2002; Wiggins 2006). Agriculture remains crucial for pro-poor economic growth in most African countries, as rural areas support 70-80% of the total population. More than in any other sector, improvements in agricultural performance have the potential to increase rural incomes and purchasing power for large numbers of people to lift them out of poverty and food insecurity (Ludi 2009). Although there has been rapid agricultural and economic growth up to 2007, food security has remained out of reach for more than 800 million people, most of whom are rural based (Ringler et. al 2010). Many factors underlay household food insecurity among rural communities, but unpredictable and erratic weather patterns remain the most important single factor (Merrey et al. 2003). Smallholder and subsistence farmers are likely to suffer complex, localized impacts of climate change, having limited adaptive capacity with a likelihood of experiencing negative effects of climate change on household food security (Aggarwal and Singh 2010).

This paper examines household food security among rural farming communities in uMzinyathi District of KwaZulu-Natal. The analysis begins by measuring household food insecurity using a Household Food Insecurity Access Scale (HFIAS). The results are then compared with pre-determined household vulnerability index to climate change and household's preferred adaptation methods to a changing climate.

Food security is regarded by many researchers as "the access by all people at all times to enough food for an active healthy life" (Ngigi 2003). Overarching this definition are the four food security dimensions namely food availability, food access, food utilization and stability of food supply (Food and Agriculture Organization (FAO) 2008). Food security is largely

determined by activities undertaken at the local or national scale and global factors, such as the global trade and finance systems, climate change and climate policy, energy policy, demographic changes, including migration, and foreign policies (Ringler et. al 2010). Although there has been rapid global agricultural and economic growth up to 2007, food security has remained out of reach for more than 800 million people Ringler et al. (2010), many of whom are residents of Africa. Approximately 80% of African population live in the rural sector and their state of food security depends directly on agricultural production or indirectly through providing for agricultural labour (Tomich et al. 1995). Whereas food security is affected by a myriad of factors including poverty, incomes and unemployment (Easterling 2007), climate change will have significant impacts on household food security through extreme weather events that will have direct and indirect negative effects on household food security (IPCC 2001).

It is anticipated that developing countries will be affected significantly and in highly uncertain ways by climate change largely because poverty levels are high and developing country capacity to adapt to global change is weak (FAO 2008). To ensure future food security, greater attention is now needed on adaptations to climatic change, which calls for increased diversification, improved land use and natural resource management policies, improved risk management through early warning systems and crop insurance in the agricultural systems (Aggarwal and Singh 2010). Emphasis will be given to rain-fed agricultural systems that are producing 90% of the stable foods in the sub-Saharan region (Rosegrant et al. 2002). Smallholder and subsistence farmers are likely to suffer complex, localized impacts of climate change, having limited adaptive capacity with a likelihood of experiencing negative effects of climate change on yields of tropical crops with high vulnerability to extreme events (Aggarwal and Singh 2010). As was the case for the green revolution in Latin America and Asia, smallholder producers should be targeted in Africa for increased household food security (Gladwin et al. 2001).

7.2 Materials and methods

Key informant interviews, focus group discussions and household semi-structured questionnaire were used to identify individual farmer's specific attributes of livelihood and household food insecurity. Key informants helped to give a general picture of the community

and a reflection on past climate risks. A survey was conducted among 200 households randomly sampled from uMzinyathi District. uMzinyathi District had a total of 93,770 households and a population of 514,840 (Stats SA 2012). Data was collected on demographic characteristics and socio-economic conditions of family/households which included a review on yields and incomes of household's from both agricultural farming systems and non-farm activities. Information was gathered on agricultural inputs and lastly open ended questions were asked about perceptions on agricultural resources e.g. precipitation and temperature, impact of government policies, markets, availability financial credits and levels of technological innovations. Food security data was collected using the Household Food Insecurity Access Scale (HFIAS) tool Table 7.1 (Coates et al. 2007). Data was then analysed using SPSS.

Table 7.1: Household Food Insecurity Access Scale (HFIAS) Generic Questions

No.	Occurrence Questions
Q1	In the past four weeks, did you worry that your household would not have enough food?
Q2	In the past four weeks, were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources?
Q3	In the past four weeks, did you or any household member have to eat a limited variety of foods due to a lack of resources?
Q4	In the past four weeks, did you or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food?
Q5	In the past four weeks, did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?
Q6	In the past four weeks, did you or any household member have to eat fewer meals in a day because there was not enough food?
Q7	In the past four weeks, was there ever no food to eat of any kind in your household because of lack of resources to get food?
Q8	In the past four weeks, did you or any household member go to sleep at night hungry because there was not enough food?
Q9	In the past four weeks, did you or any household member go a whole day and night without eating anything because there was not enough food?

7.2.1 Household Food Insecurity Access Scale (HFIAS)

HFIAS module yields information on food insecurity (access) at the household level on the following four types of indicators (Coates et al. 2007):

a. Household Food Insecurity Access-related ***Conditions***

The indicator reflects percent of households that responded, "yes" to a specific occurrence question.
For example: "Percent of households that ran out of food." is given by:

$$\frac{\text{Number of households with responses} = 1 \text{ to Q7}}{\text{Total number of households responding to Q7}} \text{ X } 100$$

b. Household Food Insecurity Access-related ***Domains***

The indicator provide summary information on the prevalence of households experiencing one or more behaviours in each of the three domains reflected in the HFIAS; Anxiety and uncertainty, Insufficient Quality, and Insufficient food intake.

For example: Percent of households that responded "yes" to any of the conditions in a specific domain is given by. For example: "Percent of households with insufficient food quality." Is given by:

$$\frac{\begin{array}{c}\text{Number of households with response} = 1 \text{ to Q2} \\ \text{OR 1 to Q2 OR 1 to Q3 OR 1 to Q4}\end{array}}{\text{Total number of households responding to Q2 OR Q3 OR Q4}} \text{ X } 100$$

c. Household Food Insecurity Access Scale ***Score***

Household Food Insecurity Access Scale Score was calculated for each household by summing the coded frequency of experience for each question (Coates et al. 2007). The maximum score for the HFIAS was 27 (the household response to all nine questions was "often" coded with response code of 3); the minimum score was zero.

HFIAS Score (0-27) = Sum frequency code (Q1 + Q2 + Q3 + Q4 + Q5 + Q6 + Q7 + Q8 + Q9)

The maximum score for a household is 27 (the household response to all nine (frequency of occurrence) questions was “often”, coded with response code of 3); the minimum score is 0 (the household responded “no” to all occurrence questions. The higher the score, the more food insecurity (access) the household experienced. The lower the score, the less food insecurity (access) a household experienced.

d. *Household Food Insecurity Access* ***Prevalence***

Households were categorized into four categories depending on their responses to the nine HFIAS questions using the HFIAS framework (Figure 7.1) to give the Household Food Insecurity Access Prevalence (HFIAP).

Question	Rarely	Sometimes	Often
	1	2	3
1			
2			
3			
4			
5			
6			
7			
8			
9			

Key:

Food secure

Moderately food secure

Mildly food secure

Severely food secure

Figure 7.1: Categories of Household food insecurity (access) (Coates et al., 2007)

Households were categorized as increasingly food insecure as they responded affirmatively to more severe conditions and/or experience those conditions more frequently (Coates et al., 2007). The categorization scheme is designed to ensure that a household’s set of responses will place them in a single, unique category:

- A food secure household experiences none of the food insecurity (access) conditions, or just experiences worry, but rarely.

- A mildly food insecure (access) household worried about not having enough food sometimes or often, and /or rarely ate a monotonous diet or less preferred food. The household did not cut back on quantity nor experience any of the three most severe conditions (going whole day without eating, going to bed hungry or running out of food).

- A moderately food insecure household sacrificed quality more frequently by eating a monotonous diet or less preferred food sometimes or often, and /or had started to cut back on quantity by reducing size of meals or number of meals rarely or sometimes.

- A severely food insecure household had deteriorated to cutting back meal size or number of meals often, and/or experienced any of the three most severe conditions (going a whole day without eating, going to bed hungry or running out of food), even as frequently as rarely. Any household that experience one of these three conditions even once in the past 30 days was considered as severely food insecure

7.3 Results

From the survey results, 70% of households were aged between 40 and 60 years. 71% of household heads were female. It was also noted that most household members were female adults (48%).Only 0.5% of household heads had received tertiary education while 28% had not been to school at all and 44.5% having received primary school education. Most households (97%) were involved in growing of crops while 65% kept livestock.

7.3.1 Household food security

Household food security was assessed using the HFIAS procedure described by (Coates et al., 2007). Household food insecurity access related to domains is shown in Table 7.2. All households (100%) in the study sample were anxious and uncertain about food supply. Most

households did experience the other two food insecurity domains (poor quality food and inadequate quantity of food consumption (89% and 84%) respectively.

Table 7.2: Household responses to Household Food Insecurity Access-related Domains (n = 200)

Household Food Insecurity Access-related Domains	**Percentage**
1. Anxiety and uncertainty	100.00
2. households with insufficient food quality	89.00
3. Insufficient food intake and its physical consequences	84.00

Further disaggregation of food insecurity is presented as Household food insecurity – access related to conditions (Table 7.3).

Table 7.3: Household Food Insecurity Access-related Conditions (n = 200)

Food insecurity conditions	Frequency of experience of food insecurity condition in past 4 weeks (%)			
	Once or twice	Three to ten times	More than 10 times	Total
Anxiety and uncertainty about food supply	12.00	36.00	52.00	100.00
Poor quality food consumption coping strategies				
Un-preferred kinds of food	14.50	25.50	60.00	100.00
Limited variety of food	16.50	26.50	57.00	100.00
Un-preferred food	15.00	23.50	61.50	100.00
Inadequate quantity of food coping strategies				
Ate a smaller meal than they needed	16.50	22.50	61.00	100.00
Ate fewer meals in a day	22.5	15.50	62.00	100.00
Experienced total lack of food due to lack of resources	15.50	59.00	25.50	100.00
Went to sleep at night hungry due to lack of food	18.00	67.00	15.00	100.00
Going whole day and night without eating anything due to lack of food	37.00	48.00	13.00	100.00

The frequency of households experiencing anxiety and uncertainty about household food supply was high. Households consumed poor quality food by eating un-preferred kinds of food; they ate a limited variety of food and also ate un-preferred food at higher frequencies. Similarly households consumed inadequate quantity of food. Most households experienced the mild coping strategies more frequently like eating a smaller meal. As the quantity of food coping strategies progressed in severity, the frequencies experienced among households reduced with fewer households going whole day and night without eating anything (most severe) less frequently.

Further household food security assessment was shown by calculating the Household Food Insecurity Access Scale Score (HFIAS Score) (Figure 7.2). Most household have a higher score of food insecurity indicating the high prevalence of food insecurity among households.

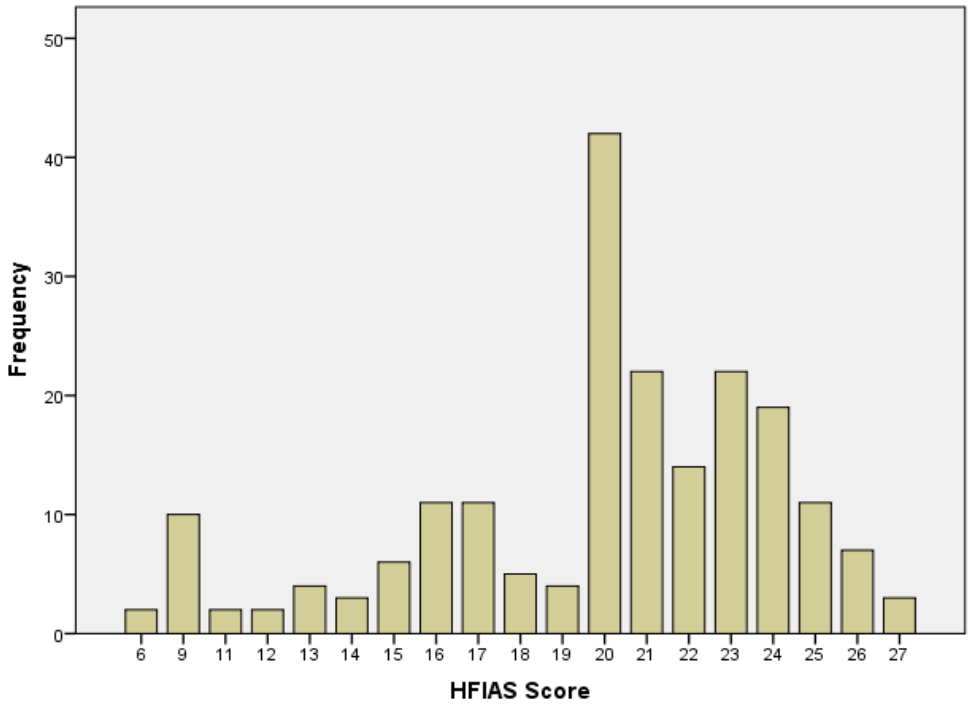

Figure 7.2: Bar chart of Frequency of Household Food Insecurity Access Scale (HFIAS) Scores (n = 200)

A final presentation of the level of food insecurity was developed by placing individual households into specific food security categories as they responded to the nine HFIAS scale questions (Table 7.4). Most household were found to be severely food insecure (97%).

Table 7.4: Proportion of household in each food security category (n = 200)

	Household Food security categories			
	Food secure	**Mildly food insecure**	**Moderately food insecure**	**Severely food insecure**
Number of household in each category	0	0	6	194
Proportion of households in each category (%)	0.00	0.00	3.00	97.00

No household were found in the categories of mildly food secure and food secure. Only six households (3%) were found to be moderately food insecure.

7.3.2 Perceived climate change effect on soil fertility, rainfall, floods, drought and Household Food Insecurity

Analysis of the relationships between perceived climate change effects and household food insecurity was carried out (Table 7.5). Households who indicated that they were worried of facing recurrent droughts had increasing levels of food insecurity in all the measures of food security. Households who were worried that they could face recurrent floods showed corresponding food insecurity only in the quality of food (*rho* = 0.183, $p < 0.01$).

Table 7.5: Results of Spearman's (Rho) correlation between perceived climate change effects and measures of food insecurity (n = 200)

	Measures of household food insecurity			
Household agricultural climate environment	**Overall HFIAS Score**	**Quality of food**	**Quantity of food**	**Anxiety over food supply**
Worried that household will face recurrent drought	0.191**	0.224**	0.150*	0.156*
	(0.007)	(0.001)	(0.034)	(0.028)
Worried that household will face recurrent floods	0.126	0.183**	0.115	0.075
	(0.076)	(0.010)	(0.105)	(0.291)
Worried that household will face late on set of rain	0.059	0.060	0.056	0.064
	(0.407)	(0.403)	(0.432)	(0.370)
Worried that household will face shorter rain season	-0.051	-0.019	-0.074	0.045
	(0.475)	(0.784)	(0.297)	(0.526)
Household vulnerability to climate change	-0.947**	-0.815**	-0.899**	-0.468**
	(0.000)	(0.000)	(0.000)	(0.000)
Worried that household will face soil fertility decline	0.343**	0.249**	0.321**	0.147*
	(0.000)	(0.000)	(0.000)	(0.037)

** Correlation is significant at the 0.05 level (2-tailed).
* Correlation is significant at the 0.1 level (2-tailed).
Note: Numbers in brackets refer to *P* values

A significant negative correlation was observed between household vulnerability to climate change and food security at all levels of household food insecurity measures. Households who were worried that they will face soils fertility decline had a significant positive correlation with all the food insecurity measures.

7.3.3 Agricultural Ecosystem

Spearman's (*Rho*) correlation was carried out to investigate the relationship between household agricultural ecosystem and measures of food insecurity (Table 7.6). Households who were worried about declining prices of farm products as a result of climate change had a positive significant relationship with three of the household food insecurity measures (HFIAS score, quality of food and quantity of food). A similar relationship was observed among households who were worried that prices of farming inputs would increase as a result of climate change. Households who were worried that they would face livestock diseases as a

result of climate change had a significant negative correlation with the three food insecurity measures.

Table 7.6: Results of Spearman's (Rho) correlation between household agricultural ecosystem and measures of food insecurity (n = 200)

	Measures of household food insecurity			
Agricultural Ecosystem	**Overall HFIAS Score**	**Quality of food**	**Quantity of food**	**Anxiety over food supply**
Worried that household will face crop disease	-0.001	-0.020	-0.032	0.072
	(0.989)	(0.778)	(0.655)	(0.309)
Worried that household will face price decline of farm products	0.281**	0.198**	0.281**	0.093
	(0.000)	(0.005)	(0.000)	(0.192)
Worried that household will face price increase of inputs	0.316**	0.212**	0.319**	0.097
	(0.000)	(0.003)	(0.000)	(0.174)
Worried that household will face livestock disease	-0.214**	-0.173*	-0.226**	-0.066
	(0.002)	(0.014)	(0.001)	(0.350)

** Correlation is significant at the 0.05 level (2-tailed).
* Correlation is significant at the 0.1 level (2-tailed).
Note: Numbers in brackets refer to *P* values

Analysis was carried out on some of the agricultural practices advised to farmers considering the three measures of food security (Food quality, food quantity and anxiety over food supply). Low levels of food insecurity were observed among households who practiced across slope conservation cultivation methods and utilised valley bottoms for crop production. These practices contributed to households having more area for crop production, directly contributing to food availability to households. Households who used organic manure in their fields also registered lower level of food insecurity resulting from subsequent expected high yields. Households who intentionally practiced crop diversification also showed decreased levels of food insecurity; Households who diversified from farm to non-farming activities did show lower level of food security as the proceeds from the non-farm activities were used to purchase food.

7.3.4 Farmer's Agriculture Livelihood System

Components of farmers' agriculture livelihood systems were compared to the measures of household food security (Table 7.7).

Table 7.7: Results of Spearman's (Rho) correlation between Farmer's Agriculture Livelihood System and measures of food insecurity (n = 200)

	Measures of food security			
Farmers' Preferred agricultural adaptation practices in a livelihood system	**Overall HFIAS Score**	**Quality of food**	**Quantity of food**	**Anxiety over food supply**
crop diversification	-0.329**	-0.251**	-0.306**	-0.072
	(0.000)	(0.000)	(0.000)	0.313
Diversifying to non-farming activities	-0.405**	-0.430**	-0.315**	-0.273**
	(0.000)	(0.000)	(0.000)	(0.000)
Intercropping	-0.557**	-0.428**	-0.557**	-0.118
	(0.000)	(0.000)	(0.000)	(0.096)
Cover cropping	-0.531**	-0.451**	-0.542**	-0.254**
	(0.000)	(0.000)	(0.000)	(0.000)
Annual crop rotation	-0.132	-0.068	-0.115	-0.145*
	(0.062)	(0.340)	(0.104)	(0.041)
Mulching	-0.159*	-0.176*	-0.142*	-0.116
	(0.025)	(0.013)	(0.045)	(0.101)
Across slope cultivation	-0.348**	-0.152*	-0.429**	-0.078
	(0.000)	(0.032)	(0.000)	(0.271)
Using organic manure	-0.288**	-0.298**	-0.253**	-0.216**
	(0.000)	(0.000)	(0.000)	(0.002)
Rain water harvesting for irrigation	-0.134	-0.026	-0.176*	0.091
	(0.058)	(0.715)	(0.013)	(0.198)
Praying for rainfall	-0.343**	-0.253**	-0.346**	-0.011
	(0.000)	(0.000)	(0.000)	(0.880)
Using moist valley bottoms	-0.243**	-0.246**	-0.179*	-0.188**
	(0.001)	(0.000)	(0.011)	(0.008)

** Correlation is significant at the 0.05 level (2-tailed).
* Correlation is significant at the 0.1 level (2-tailed).
Note: Numbers in brackets refer to *P* values

Households who received training in water and soil management showed a lower level of food security, impacting more on the quantity of food available to households. Households who intentionally practiced crop diversification showed lower level of food insecurity more specifically to quality and quantity of food available to households.

Households who diversified from farming to non-farming activities had decreased levels of food insecurity in all the categories of food insecurity measures. Differential planting time of different fields contributed to lower levels of household food insecurity. The use of organic manure in crop production significantly contributed to decreasing the level of household food insecurity. Households who prayed for rain also showed significant decrease in levels of household food insecurity. Utilizing moist valley bottoms for crop production had significant impact on decreasing food insecurity in all measures of food insecurity. Sale of crop produces did contribute to lowering the levels of household food security.

7.3.5 Farmer's household characteristics

A relationship between farmers' household characteristics was assessed (Table 7.8). Incomes from remittances significantly contributed to the quantity of food consumed in households. On the other hand there was a significant relationship between incomes from disabilities with the quality of food consumed. Incomes from pensions significantly reduced anxiety over household food supply.

Table 7.8: Results of Spearman's (Rho) correlation between Farmer's household characteristics and measures of food insecurity (n = 200)

	Measures of food security			
Farmer's household characteristics	**Overall HFIAS Score**	**Quality of food**	**Quantity of food**	**Anxiety over food supply**
Total number of household members	-0.065	-0.108	-0.048	-0.025
	(0.358)	(0.128)	(0.499)	(0.722)
Sex of household head	-0.081	-0.085	-0.056	-0.024
	(0.256)	(0.230)	(0.428)	(0.732)
Age of household head	0.011	-0.112	0.063	-0.102
	(0.874)	(0.113)	(0.377)	(0.152)
Highest level of education of household head	-0.045	0.051	-0.096	0.011
	(0.528)	(0.476)	(0.176)	(0.879)
Household head can read and write	0.187**	0.078	0.247**	-0.062
	(0.008)	(0.270)	(0.000)	(0.385)
Income per month from salary	0.138	0.073	0.140*	0.130
	(0.051)	(0.305)	(0.048)	(0.067)
Income per month from remittances	-0.195**	-0.072	-0.219**	-0.046
	(0.006)	(0.311)	(0.002)	(0.518)
Income per month from child grant	-0.168*	-0.069	-0.176*	-0.025
	(0.017)	(0.332)	(0.013)	(0.725)
Income per month from old age grant	0.179*	0.112	0.177*	0.056
	(0.011)	(0.116)	(0.012)	(0.429)
Income per month from disability grant	-0.140*	-0.201**	-0.118	0.031
	(0.048)	(0.004)	(0.095)	(0.661)

****** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).
Note: Numbers in brackets refer to *P* values

7.4 Discussions

This study set out to evaluate farmer's adaptation to climate risk and the impacts on household food security among the rural small-scale farming communities in uMzinyathi District, KwaZulu-Natal, South Africa. The study assessed the responses of household representatives (n = 200) to questions that gave information on agricultural climate environment, farmer's exposure-sensitivity, famer's agricultural outputs and farmers' food in/security. More information was generated by farmers response to issues related to off-farm activities including human, social, environmental and economic. Focus group discussions were held to get clarity on some of the issues raised in the questionnaire

Through group discussions, a number of explanations were given for the high prevalence of food insecurity among surveyed households. Respondents explained that they relied on purchases for their food supply. Household incomes were mainly from remittances which limited and unreliable which were not adequate for household needs. Households also relied on government grants that were also limited for purchase of food. This was an explanation to the effect that agriculture is becoming more unimportant among households in uMzinyathi District. Reliance on purchasing food with limited incomes meant household will purchase limited quantities and limited types of foods further contributing to higher levels of food insecurity. Similar results were realised from a study among households participating in community gardens in the region (Shisanya & Hendricks 2010). Although households were involved in agriculture, due to inappropriate agricultural practices and limited arable land for cultivation, limited food was realised from agricultural production. Food from agricultural activities was also unreliable due to the erratic nature of weather experienced in the area. Generally the area is agriculturally marginal confirming Wiebe et al. (2001) observation that the imbalance distribution of land by the apartheid system resulted black African communities occupying marginal land.

Households who were worried about recurrent floods and droughts showed corresponding high levels of food insecurity. This would be explained by the fact that households look at the future to come with devastating weather conditions and so their responses to the food security questions that measures anxiety had to be indicative of high levels of food insecurity. The

findings confirms (Merrey et al. 2003) indications that erratic weather patterns will have profound negatives impacts on rural household food security. As expected, household that were vulnerable to climate change showed significant levels of food insecurity. These households had very limited resource that could be used in addressing food security, confirming (Aggarwal and Singh 2010) observations that rural communities are prone to the devastating impacts of climate change resulting from low adaptation capabilities. Decreasing soil fertility resulting soil erosion and influenced by the erratic weather patterns spells doom for household food security. Yield from farmers field have over years been decreasing as a result of loss of top soil that is necessary for improved yields. Households preferred to use different methods to cope with the changing climate with resulting decrease in household food security.

7.5 Conclusions

This paper made a modest attempt to analyse farmer's adaptation to climate risk and the impacts on household food security among 200 rural small-scale farming communities in uMzinyathi District, KwaZulu-Natal, South Africa. The study found that 88.50% of the households surveyed were severely food insecure. Climate risk was analysed by looking at household experience of the agricultural climate environment; household exposure to climate risk, denoted by agricultural ecosystem; household adoptive capacity was studied by considering the interaction between household and agricultural livelihood systems.

This paper has argued that households were concerned about their agricultural climate environment, overall represented by household vulnerability to climate change and this had direct impacts on household food security. Providing farmers with information on good agricultural practice, including water and soil management had the direct impact on reducing the level of household food insecurity. Such information included coping mechanisms with regards to adverse climatic conditions hence the need for farmers' access to appropriate extension services. Farmers' preparedness for adverse climate outcomes was necessary given that out of their experience they knew of some of these outcomes including outbreak of crops and animal diseases. Farmers did not have enough resources and needed external support to be able to prepare for these climate challenges.

Boosting household incomes played an important role in reducing the impacts of climate risks to household food security. Diversifying from farming to non-farming activities was important for the households needed incomes. Households that received government grants showed higher resilience to climate risk impacts on household food security. Mechanisms to protect farmers from higher inputs prices and lower farm product prices need to be put in place to increase farmers' flexibility in dealing with the challenges of climate risk.

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CHAPTER 8

CONCLUSIONS AND RECOMMENDATIONS

8.1 Conclusions

This study investigated the interaction between household food security, rural communities' perceptions and responses to climate change in uMzinyathi District Municipality of KwaZulu-Natal, South Africa. There was a general warming trend with a 1.5^{o}C annual temperature increase over the period 1993 – 2010.Over the 19 years examined, there was a general decline in precipitation with increased cases of floods and droughts with rainfalls that were erratic. Households' perceptions to climate change were a reflection of climatic data records. There is urgent need to incorporate indigenous knowledge in formulating climate change adaptation policies to further support communities' response to climate change.

An analysis was carried out on the vulnerability of households to the changing climate using the integrated vulnerability assessment approach that combined both the biophysical and socioeconomic indicators. Although farmers were well aware of climatic changes and the different crop management practices to adapt to the changing climate, farming households remained very vulnerable to climate change in future. Households would prefer to use different methods to cope with future climate change. These included growing of different crop varieties, planting different fields at different times, use of organic fertilizers, leaving some of their fields fallow, practice of minimum tillage, planting trees alongside slopes, cropping of valley bottoms and carrying out mixed cropping. Technology will play a greater role in reducing farmers' vulnerability to climate change. Selection of varieties and crops that can cope with the changing crops growing environment may significantly reduce households' vulnerability. Support to the farming communities through appropriate and effective extension services were necessary to deal with the new crop growing conditions arising among the agricultural community. Non-agricultural incomes played a critical role in the response of households to climate change. Reliance of households on government grants tended to make agriculture unimportant to the extent that agricultural practices were shrinking among households. Sustainable practices including local economic development (LED) should be initiated among the rural communities rather than reliance on government

grants that can be withdrawn by a simple change in government policy which would render households more vulnerable. Other adaptive strategies might include water harvesting, resource conservation and management of especially land, irrigation systems, provision of household and agro-ecological extension packages, supporting social networks already existing in the areas in form of self-help groups and a system of drought early warning systems.

The study found that 88.5% of the households surveyed were severely food insecure. Providing farmers with information on good agricultural practices, including water and soil management had the direct impact on reducing the level of household food insecurity. Such information included coping mechanisms with regards to adverse climatic conditions. Hence the need for farmers' access to appropriate extension services. Farmers' preparedness for adverse climate outcomes was necessary given that out of their experience they knew of some of these outcomes including outbreak of crops and animal diseases. Farmers did not have enough resources and needed external support to be able to prepare for these climate challenges.

8.2 Recommendations

Early warning mechanisms on possible changes in weather patterns will prepare households to respond effectively to adverse climatic changes. This will drastically reduce vulnerability of households to changes in climate. Although households would prefer to use a variety of adaptive strategies in response to the changing climate, it is necessary that research is carried out to develop packages on adaptive mechanisms that are context specific. This will allow households to use appropriate methods to effectively respond to the changing climate hence reducing their vulnerability to climate change

The following areas are proposed for further research:

- The contribution of indigenous knowledge on rural farming households' adaptation to climate change

- The effectiveness of adaptation methodologies employed by rural farming households in response to climate change
- Development of local level early warning systems that can reduce vulnerability of rural farming communities to climate change.
- The gender analysis factor in understanding the impact of climate change on household food security of rural farmers
- What are the policies and institutions needed to support local adaptation to climate change among rural farming communities?

APPENDIX: RESEARCH QUESTIONNAIRE

RURAL HOUSEHOLDS' PERCEPTION OF THE EFFECT OF CLIMATE CHANGE ON FOOD SECURITY IN uMZINYATHI DISTRICT MUNICIPALITY OF KWAZULU-NATAL, SOUTH AFRICA

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CONTANT NUMBER: 033-2606342 or 0769012007

Data collection tool

A) GENERAL HOUSEHOLD INFORMATION

100	Date of interview	

101	Household code	

102	Enumerator code	

103	Do you own this house?	Yes	No
		1	0

104	What is the main livelihood strategy of your household	Agriculture/ Livestock	Foreign job	Tin	Trade/Business	Labour/Daily wage	Service	Other
		1	2	3	4	5	6	7

105	Major material exterior wall is made of:	Brick /Blocks	Traditional mud	Tin	Plank, wood	Others (specify)
		1	2	3	4	5

106	Major material floor is made of:	Concrete	Traditional mud	Wood	Floor tiles	Others (specify)
		1	2	3	4	5

107	Major material roof is made of	Corrugated iron	Grass thatch	Plastic paper cover	Roof tiles	Others (specify)
		1	2	3	4	5

108	Total number of out buildings excluding toilets	

109	How many people live in your household? (By "household" we mean those who eat from the same pot)	Children under 5 years	Other children	Adults female	Adults male	Elderly	Others (specify)
		1	2	3	4	5	6
	Number						

HOUSEHOLD ROSTER						
Say to the respondent: Please tell me about all the people who currently live in this household; Start with the head of household (if it is not you) and then the spouse, and their children, then other family members and non-family members.						
ID #	110 *Please list the names of household members*	111 What is [NAME]'s relationship to the household head? (See codes below)	112 Sex Female= 1 Male = 2	113 How old is [NAME]?	114 What is the highest level of education completed? (See codes below)	115 Can [NAME] read and write? Yes = 1 No = 2
01		|___|	|___|	|___|___|	|___|	|___|
02		|___|	|___|	|___|___|	|___|	|___|
03		|___|	|___|	|___|___|	|___|	|___|
04		|___|	|___|	|___|___|	|___|	|___|
05		|___|	|___|	|___|___|	|___|	|___|
06		|___|	|___|	|___|___|	|___|	|___|
07		|___|	|___|	|___|___|	|___|	|___|

08		|___|	|___|	|___|___|	|___|	|___|
09		|___|	|___|	|___|___|	|___|	|___|
10		|___|	|___|	|___|___|	|___|	|___|
11		|___|	|___|	|___|___|	|___|	|___|
12		|___|	|___|	|___|___|	|___|	|___|
13		|___|	|___|	|___|___|	|___|	|___|

Codes for 111	Relationship to household head	Self	Father	Mother	Husband	Grandparent	Brother	Sister	Foster parent	Other relatives (uncle, Auntie, cousin, nephew, niece)	Friends	Others (specify)
		1	2	3	4	5	6	7	8	9	10	11

Codes for 114	Household member highest level of education	Not been to school	Primary school level	Secondary school level	Tertiary education
		1	2	3	4

116	What type of toilet does your household have?	Flush	Pit, VIP	Bucket/ pot	None	Others (specify)

		1	2	3	4	5

117	How many people contribute to the total income (money) in your household?	None	One person	Two persons	Three-four persons	More than four persons	Do not know	Others (specify)
		1	2	3	4	5	6	7

118	What is the total household income **per month** from the following sources	Salary	Pension	Business	Remittances	Child grant	Old age grant	Disability grant	Other (specify)
	Amount (Rand)								

B) HOUSEHOLD WATER INFORMATION

201	Do you receive adequate water for all household needs?	Yes 1	No 2

202	I rate the quality of water we use in the households as good	Yes 1	No 2

203	How often do you experience shortage of water in your household?	Every day	Ones in week	Ones in two weeks	Ones in one month
		1	2	3	4

204	Type of water sources used by the household	Piped water (tap) inside dwelling	Piped water (tap) inside yard	Piped water on community stand: distance <200 m from dwelling	Piped water on community stand: distance >200 m from dwelling	Borehole	Spring	Rainwater tank	Dam/pool/stagnant water	River/stream	Water vendor	Other (Specify)
		1	2	3	4	5	6	7	8	9	10	11

205	How long does it take a member of your household to get water from the nearest water source	Hours	Minutes

206	Who in the household is involved in getting water from the water source to the household	Young girls	Young boys	Both young boys and girls	Mature females	Mature males	Both mature females and males	Anyone in the household	Hire person to get water from source
		1	2	3	4	5	6	7	8

207	Water is brought in the household for the following purposes	Household drinking and cooking	Household washing of clothes and utensils	Irrigation of crops	Livestock drinking	Other (Specify)
		1	2	3	4	5

208	How much money is spent in a **week** to bring water to the household? (**Rand**)	

209	How many **litres** of water do you use in **one day** in the household	

210	How recent has a member of your household received information on water management	Every day	In the past one week	In the past one month	In the past one year	Never
		1	2	3	4	5

211	What was the source of information on water management	Friend	Farmer	Development agent	Researcher	Government extension officer	Community based organisation
		1	2	3	4	5	6

212	What are some of the coping strategies you have used as a result of inadequate supply of water to the household	Rain water harvesting	Water rationing	Traditional norms	Construction of wells and boreholes	Planting of trees	Other (Specify)
		1	2	3	4	5	6

C) HOUSEHOLD FOOD SECURITY INFORMATION

301	What fuel is mostly used for cooking in your household? *(You can circle more than one)*	Electric	Gas	Paraffin	coal	Wood	Other (specify)
		1	2	3	4	5	6

		Self	Father	Mother	Husband	Grand parent	Brother	Sister	Foster parent	Friends	Others (specify)
302	Who decides on what food to be bought in your household?	1	2	3	4	5	6	7	8	10	11
303	Who decides on how much money is spent on food in your household?	1	2	3	4	5	6	7	8	10	11
304	Who is most involved with food preparation and meals in your household?	1	2	3	4	5	6	7	8	10	11

	How much money is spend on purchasing the following foodstuff in a month	Rand
305	Millie meal	
306	Bread	
307	Red meat	
308	Beans	
309	Fish	
310	Dairy products	
311	Green leafy vegetables	
312	Amadumbe	
313	Green maize	
314	Fruits	

315	Spinach	
316	Carrots	
317	Cabbage	
318	Potatoes	
319	Milk	
320	Sugar	
321	White meat	
322	Cooking fat	
323	Rice	
324	Baking flour	
325	Salt	
325	Sweet potatoes	

	Which of the following categories of people in your household suffer the most in case of food shortage in the wake of adverse environmental conditions	Strongly disagree	Disagree	Not sure	Agree	Strongly agree
326	Children	1	2	3	4	5
327	Pregnant and nursing women	1	2	3	4	5
328	Other women	1	2	3	4	5
329	Men	1	2	3	4	5
330	All suffer equally	1	2	3	4	5

331	How long does it take you to go to and from your nearest market where you purchase household food stuffs?	Hours	Minutes

332	How recent have you received agricultural production information?	Every day	In the past one week	In the past one month	In the past one year	Never
		1	2	3	4	5

333	What was the source of agricultural information you received	Friend	Farmer	Development Agency	CBO	Radio	Television	Government Agency
		1	2	3	4	5	6	7

334	When did you last receive training on natural resource (Water and soil) management	Yesterday	In the past one week	In the past one month	In the past one year	Never
		1	2	3	4	5

335	Main organization involved in contributing to household development and conservation activities	Government	NGO	INGO	CBO	None
		1	2	3	4	5

Household Food Insecurity Access Scale (HFIAS) Measurement Tool

NO	QUESTION	RESPONSE OPTIONS	CODE
336	In the past four weeks, did you worry that your household would not have enough food?	0 = No (skip to Q2) 1= Yes	….|___|
337	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	….|___|

338	In the past four weeks, were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources?	0 = No (skip to Q3) 1=Yes	….|___|
339	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	….|___|
340	In the past four weeks, did you or any household member have to eat a limited variety of foods due to a lack of resources?	0 = No (skip to Q4) 1 = Yes	….|___|
341	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	….|___|

342	In the past four weeks, did you or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food?	0 = No (skip to Q5) 1 = Yes	….|___|
343	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	….|___|
344	In the past four weeks, did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?	0 = No (skip to Q6) 1 = Yes	….|___|
345	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks)	….|___|

		3 = Often (more than ten times in the past four weeks)	
346	In the past four weeks, did you or any other household member have to eat fewer meals in a day because there was not enough food?	0 = No (skip to Q7) 1 = Yes	….|___|
347	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	….|___|
348	In the past four weeks, was there ever no food to eat of any kind in your household because of lack of resources to get food?	0 = No (skip to Q8) 1 = Yes	….|___|

349	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks)	….|___|

		3 = Often (more than ten times in the past four weeks)	
350	In the past four weeks, did you or any household member go to sleep at night hungry because there was not enough food?	0 = No (skip to Q9) 1 = Yes	….|___|
351	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	….|___|
351	In the past four weeks, did you or any household member go a whole day and night without eating anything because there was not enough food?	0 = No (questionnaire is finished) 1 = Yes	….|___|
352	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	….|___|

LIVESTOCK, LIVESTOCK PRODUCTS AND LIVESTOCK BY PRODUCTS

Livestock Type	363 Does your household raise or own any?	364 How many did you own exactly	365 If you were to sell one of the [livestock] today, how much would you receive from the sale? (Rands)
	1 = Yes, 2 = No		
01 Dairy cow			
02 Heifer			
03 Calf			
04 Fattening animal			
05 Bull and oxen			
06 Donkeys			
07 Chicken			
08 Ducks			
09 Male camel			
10 Female goats			
11 Male goats			
12 Female Sheep			
13 Male Sheep			

Livestock product and by-product type		366 Did your household produce any product?	367 What is the average quantity produced per month?		368 For how many months of the last 12 months did your household produce?	369 What was the average quantity of the product sold per month?	370 What was the total value of sales	371 Where did you sell most?	372 Who in the household is responsible for processing the product?	373 Who in your household controlled the earnings from the product?
No		1 = Yes 2 = No	Unit Codes below	Amount (Rand)		amount	Rand	market codes below	Record up to two ID# from Roster.	Record up to two ID# from Roster.
01	Cow milk									
04	Eggs									
05	Butter									
06	Cheese									
07	Honey									
08	Wool									
09	Skin & hide									
10	Manure									
11	Dung									

Product market Code

1=Local market
2=nearest town market
3=Cooperative
4=Private processor
5=Other household/ farmer
6=Restaurant
7=Collector

Unit code

1 = Kilogram
2 = litre
3 = number
4 = cup
5 = Others (specify)

Marketing

Product	374 Where do you sell [agricultural/ livestock product]?	375 On foot, how long does it take to this market from your home? Walking time in minutes	376 Is this market place your preferred market place? 1= Yes 2= No	378 Why don't you like to sell [agricultural product] in this market? Market preference codes 1=Limited buyers 2=Low price compared to other markets 3=Far from home 4=Others (specify)	Agricultural/livestock product sale codes 01 = local market 02 = district market 03 = distant market 04 = livestock trader/farm 05 = cooperatives 06 = restaurant 06=Others(specify)
01 Crop produce					
02 Livestock					
03 Livestock product					

D) HOUSEHOLD RISK and CLIMATE CHANGE

401	Have you noticed any long-term changes in the mean temperature over the last 20 years?	Increased	Decreased	More or less extreme	Others	No change	Don't know
		1	2	3	4	5	6

402	Have you noticed any long-term changes in the mean rainfall over the last 20 years?	Increased	Decreased	Change in timing of rains (earlier/ later/erratic)	Change in frequency of droughts/ floods	Others	No change	Don't know	Decrease in rainfall and change in timing
		1	2	3	4	5	6	7	8

403	Have you noticed any long-term changes in the frequency of floods over the last 20 years?	Frequent	Rare	Important	Constant	Little
		1	2	3	4	5

404	Have you noticed any long-term changes in the frequency of drought over the last 20 years?	Frequent	Rare	Important	Constant	Little
		1	2	3	4	5

405	Have you noticed any long-term changes in the water sources over the last 20 years?	Numerous	Constant	Fewer	Good	Bad
		1	2	3	4	5

For each of the following questions, consider what has happened in the past 20 years. Please answer whether this happened never, rarely, sometimes, or often? *(Circle the answer)*

		Frequency of event			
Event		Never (0 times)	Rarely (1-2 times)	Sometimes (3-4 times)	Often > 4 times
406	Did you worry that your household would face recurrent drought?	0	1	2	3
407	Did you worry that your household would face recurrent flood?				
408	Did you worry that your household would face crop failure other than from drought?	0	1	2	3
409	Did you worry that your household would face crop disease?	0	1	2	3
410	Did you worry that your household would face loss of livestock due to disease?	0	1	2	3
411	Did you worry that your household would face price decline for your products?	0	1	2	3
412	Did you worry that your household would face soil fertility decline?	0	1	2	3
413	Did you worry that your household would face price increase for your	0	1	2	3

	inputs?				
414	Did you worry that your household would face late on set of rain?	0	1	2	3
415	Did you worry that your household would face shorter rainy season?	0	1	2	3
416	Did you worry that your household would face climate variability?	0	1	2	3

	If, in your view, overall crop productivity is decreasing, especially as a result of climate variability, how does your household seek to adapt to or cope with this adverse situation?	Strongly disagree	Disagree	Not sure	Agree	Strongly agree	443 Reason for not using this method of adaptation (See codes below)
417	Crop diversification	1	2	3	4	5	
418	Growing different crop varieties	1	2	3	4	5	
419	Diversifying farming to non-farming activities	1	2	3	4	5	
420	Intercropping	1	2	3	4	5	
421	Cover cropping	1	2	3	4	5	
422	Crop residue management	1	2	3	4	5	
423	Minimum tillage	1	2	3	4	5	
424	Different fields planted at different times	1	2	3	4	5	
425	Annual crop rotation	1	2	3	4	5	
426	Practice mulching	1	2	3	4	5	
427	Across slope cultivation	1	2	3	4	5	
428	Use of organic manure	1	2	3	4	5	
429	Fields are left fallow	1	2	3	4	5	
430	Tree planting alongside crops	1	2	3	4	5	
431	Rain water harvesting for irrigation	1	2	3	4	5	

432	Praying for rain	1	2	3	4	5	
433	Application of chemical fertilizers	1	2	3	4	5	
434	Use of moist valley bottom	1	2	3	4	5	
435	Mixed farming	1	2	3	4	5	
436	Changing diet	1	2	3	4	5	
437	Land use extension	1	2	3	4	5	
438	Land use intensification	1	2	3	4	5	
439	Out – migration	1	2	3	4	5	
440	Carrying on as usual	1	2	3	4	5	
441	Lease your land	1	2	3	4	5	
442	Buy insurance	1	2	3	4	5	

443 Codes for Reason for not using [method] of adaptation	Lack of money	Lack of information	Shortage of labour	Other (specify)	Bad
	1	2	3	4	5

E) ADVICE /INFORMATION ON AGRICULTURE, CLIMATE CHANGE AND ADAPTATION

ID	Source	444. Have you received advice/information on AGRICULTURAL PRACTICES in the last 12 months 1 = Yes 2 = No If 2, go to C03	445. If yes, what advice did you receive? *Ask the main advice*	446. Have you received advice/information on CLIMATE CHANGE AND ADAPTATION in the last 12 months? 1 = Yes 2 = No	447. If yes, what advice did you receive? *Ask the main advice*
01	Friend/Neighbor/relative				
02	Model Farmer				
03	Follower farmer				
04	Farmer's group				
05	Development Agent				
06	Veterinarian: public				
07	Farmer field days				
08	NGOs				
09	CBOs				
10	Research centers/ researchers				
11	Universities/colleges				
12	FTC course/ training				
13	FTC demonstration plot				

CROP PRODUCTION INPUTS – OTHER INPUTS: List all the plots. This should include crops grown on all plots, including homesteads with vegetable gardens.									
Plot No.	448 Plot Size (M^2)	449. Did you use organic fertilizers during the last cropping season? 1= Yes 2= No	450 Did you use any chemical fertilizer: DAP, urea, or both during the last cropping season? 1= Yes 2= No	451 What was the total quantity of chemical fertilizer used during the last cropping season? (Kgs)	452 What was the total value of the amount of chemical fertilizer used? (Rands)	453 Why did you not use fertilizer on this plot?	454 Did you use any pesticides, herbicides, or fungicides on this plot?	455 What was the total value spent? (Rand)	456. Why did you not use insecticide, herbicides, or fungicides on this plot?
01									
02									
03									
04									
05									
06									
07									
D7 and D10 Codes 1 = price too high 2 = lack of credit 3 = not enough money 4 = not available locally 5 = lack livestock for application 6 = lack human labor 7 = skeptical of outcome 8 = do not know how to use it 9 = input unnecessary 10=other, specify						Unit codes: 1 = kilograms 2 = donkey load 3 = wheel barrow 4 = other (specify)			

Questions for community group discussions

A) Water

1) How is water management being promoted in your area?
2) Have you ever experienced conflicts over water use in the community and how have you resolved them?
3) In your opinion what affects water availability to your households?
4) To what extend do you interact with government departments on water use and management?
5) Describe some of the simple water management systems you practice to deal with erratic rains
6) How are you involved in controlling rain water, floods and residual soil moisture?
7) What are some of the challenges you encounter in adopting to water scarcity

B) Crop production

1) To what extend do you practice water and soil conservation?
2) To what extend have you modified your planting and harvesting times according to rainfall patterns and why?
3) How do you respond to you water situation to ensure that your household becomes food secure?
4) How accessible are basic farm inputs – seed, fertilizers (organic and inorganic) to ensure timely planting at the onset of rains

C) Household food security

1) What are the challenges facing households to be food secure
2) What are you doing to cope with food insecurity
3) What kind of support would you require to enable you to become food secure

D) Information availability

1) Are you able to access credible and timely information to enable you make appropriate livelihood decisions
2) How are your community networks contributing to your household food security
3) What are your suggestions to receiving adequate information on climate change

E) Government policies

1) What government programme has been conducted in you area in the last one year?

F) Observations on responses and adaptation to climate change

1) What are some of the observed impacts of climate change among households
2) What have households done to cope with climate change?
3) What are some of the barriers or principal constraints to adaptation to climate change and implementation of interventions to reduce vulnerability / facilitate adaptation

G) Expectations of environmental and socio-economic changes in the future and perceptions of vulnerability based on local observations and assessment of current trends

1) In your opinion, how would be the rainfall and the temperature in the future?

2) In your opinion, how would cyclone, flood and drought occur in the future?

3) According to the present context, how would be the use of land and natural resources in the future?

4) How do you perceive your livelihoods in the future with these climate changes (Food sufficiency, health, income, standard of living…)

5) In your opinion what should be done to minimize the negative impact of climate change at community level

6) In your opinion what type of assistances can help the community to minimize the negative impact of climate change