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An assessment of the local sociocultural concept of climate change and its perceived effect on forest-based livelihoods: Case study of rural communities of Vhembe District South Africa

By

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DEDICATION

To my late brother, Chinedu Innocent Ofoegbu

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DECLARATION

I, Chidiebere Ofoegbu, declare that the thesis, which I hereby submit for the degree of PhD in Forest Science at the University of Pretoria, is my own work and has not previously been submitted by me for a degree at this or any other tertiary institution.

Signature: 

Date: 12 January 2017

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ABSTRACT

Forests play an important role in climate-change management, particularly at rural community level. At the same time, forests are essential resources for human welfare and an important part of the landscape. In addition to providing vital environmental services, forests provide goods that are crucial to the wellbeing of many communities living in and around them. Thus, forests are valuable resources for poor and vulnerable populations in developing countries. However, the observed and predicted impact of climate change is projected to have an extensive range of consequences, many of which represent major threats to forest-dependent communities. Consequently, an investigation of the vulnerability of forest-dependent communities to climate change has become necessary and important.

Within academic and research circles on social vulnerability assessment at rural community level, the IPCC's [Intergovernmental Panel on Climate Change] concept of vulnerability has gained wider acceptance. The IPCC definition conceptualizes vulnerability as a product of exposure to a climatic event, the sensitivity of a system, and the system's adaptive capacity. Thus to assess the vulnerability of a community, the factors that contribute to the three elements of exposure, sensitivity, and adaptive capacity must be identified and analysed. Operationalizing the IPCC concept in vulnerability assessment often focuses on the use of empirical models and climate-change projections to assess potential impacts. This entails measuring exposure by the degree and magnitude of climatic hazard to which a community is exposed; sensitivity is measured by the degree to which a community is affected negatively by changes in climatic conditions; and adaptive capacity is quantified and measured by using assets and capitals as indicators of the community's ability to adapt. This concept and this approach to vulnerability assessment have been used widely to analyse communities' vulnerability to climate change. Although such studies have contributed immensely to our understanding of the bio-physical processes and impacts of climate change at global and regional level, they are unable to capture the micro-level specificities of climate change. Moreover, regardless of how 'climate change' is perceived by scientists, individual perceptions of its meaning are likely to relate more to the public discourse and wider debate about the extent of its impact.

This thesis addresses the need for detailed understanding of forest-based rural communities' vulnerability to climate change. The methodological novelty of the study entailed a modification of the IPCC vulnerability framework to tease out the key factors characterizing

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household vulnerability to climate variability and change at forest-based rural community level in Vhembe District, South Africa. Vegetation type was used as a criterion to select Makhado, Mutale and Thulamela municipalities, which together with Musina, constitute Vhembe District. Seven rural communities in each municipality were selected. Using the stratified proportionate random sampling procedure in combination with weighted enumeration area (EA) for these communities, 366 households were chosen and interviewed. The study used local knowledge gathered through a household survey to analyse rural people's conceptualization of climate change and its perceived impact on forest-based livelihoods in the communities.

This was done by extending the IPCC concept of exposure to include local sociocultural understanding of climate change. Sensitivity was modified so that it did not focus only on households' level of dependence on vulnerable forest resources, but examined their capacity to engage in sustainable forest use and management. This was based on the understanding that forest dependence could be a source of both vulnerability to and resilience against climate change. Adaptive capacity was extended to include examination of how people interact with social and institutional resources in their community, as well as how this enhances or constrains their adaptive capacity.

The study used a four-tiered approach to assess key factors that characterized household vulnerability to climate variability and change at forest-based rural community level in South Africa. The approach started by investigating the people's exposure to climate variability and change events. This entailed investigation of local sociocultural understandings of climate change, and how this connects with people's use and management of forests (Chapter 3). The second stage involved a perception-based analysis approach to assess people's perceptions of climate variability and change events and their effects on forest-based livelihood in their communities (Chapter 4). The third stage of the study involved assessment of households' level of dependence on forest resources and the people's capacity to engage in sustainable forest use and management as a means of reducing vulnerability to climate change (Chapter 5). The last stage of the study investigated how various intangible and dynamic processes – including human capital, information, household coping responses, institutional services, and social support services in the communities – interact to dictate the people's adaptive capacity and vulnerability to climate change (Chapter 6).

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The findings of this research highlighted the local conceptualization of climate change and its influence on the people's attitudes to forest use and management with respect to climate-change intervention initiatives. In addition, the study provided important insight on how the people perceived the risk of climate change to forest-based livelihoods in their community, and the relationship between climate change perception, and the people's socioeconomic characteristics. The findings of the study support the notion that improving communities' capacity to engage in sustainable forest use and management is essential to climate-change management at rural community level. The study also reveals vital information on the people's range of coping responses, the current role of forests in coping practices, and factors influencing the people's adaptive capacity

Overall, this thesis demonstrates that, for the future, a more holistic approach to understanding rural communities' vulnerability to climate change would entail recognition of the people's sociocultural understanding of climate change, their concerns, and perceptions of climate-change impacts on their lives and livelihood, as well as an understanding of how the various dynamics and intangible processes at community level interact to dictate households' adaptive capacity.

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CHAPTER 1

INTRODUCTION

1.0 Background of the study

The reality of climate change has increasingly gained acceptance in the scientific and political community over the past two decades (Dube & Phiri, 2013; Fisher *et al.*, 2010), with envisaged direct and indirect severe consequences for African societies and economies (Dube & Phiri, 2013; Somorin, 2010; Conway, 2009). However, rural communities in particular are believed to be more vulnerable to climate-change impacts (Dlamini, 2014; Turpie & Visser, 2013; Holmes, 2007). The vulnerability of rural households to climate change in Africa is caused not only by exposure to climate variability and extreme weather events, but by a combination of social, economic and environmental factors that interact with climate change (Naidoo *et al.*, 2013).

There is growing evidence that climate change is affecting forests resources in Africa, and therefore the livelihoods of forest-dependent communities (Chidumayo *et al.*, 2011). Climate variability and change threats to the livelihoods of rural poor communities and their realization of sustainable development are due mainly to their effects on forest resources on which the people are highly dependent for food, income and shelter, particularly in times of emergencies (Girot *et al.*, 2012; Byron & Arnold, 1999). Boon and Ahenkan (2012) reported the effects of climate-induced challenges such as drought and erratic rainfall on communities around Sui Forest Reserve in Ghana. Ataíde *et al.* (2011) recorded the impact of climate changes such as reduced availability and quality of pasture for livestock and a general increase in ecosystem degradation, leading to reduced forest products and other ecosystem goods and services in the Chicualacuala District of Mozambique. Ratsimbazafy *et al.* (2011) reported similar impacts in Madagascar, while Sonwa *et al.* (2010) reported the effects of climate change on forest-dependent communities in the Congo Basin of Central Africa. The influences of climate change are therefore a source of great concern to all African countries (Chidumayo et al., 2011).

In the same vein, the threat of climate change to forest resources and rural livelihoods in South Africa is increasingly being recognized (Davis *et al.*, 2010). Given that 40% of the

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South African population reside in rural areas, where they are highly dependent on forest resources (Turpie & Visser, 2013; SSA, 2005), addressing the outcomes of climate change on rural livelihood is a priority for the country. Any successful breakthrough in promoting sustainable development and alleviation of poverty in these rural communities would have to include climate-change adaptation strategies. However, the extent to which forest resources and the livelihoods of rural communities in South Africa are vulnerable to the effects of climate change, including coping strategies adopted by the people, are not well established (Linkd, 2013). Linkd (2013) suggested an urgent need to investigate options for improving the resilience of the people to the threats posed by climate change. Vulnerability assessment is therefore required to ascertain the nature, extent and influences of climate variability and change to which the rural communities of South Africa are exposed. Vulnerability assessment is in essence central to shaping any community-based climate-change intervention initiative (Hammill *et al.*, 2013; Downing & Patwardhan, 2002).

It is often argued that environmental variability and change are not new phenomena, and that forest-dependent communities have good perceptions and understandings of climate change, and has developed a wide range of adaptive strategies over the centuries (CARE, 2011). The question then remains whether the rural sociocultural concept of climate change and its perceived effect are commensurate with the people's coping and adaptive practices in enhancing their resilience against climate change. This study was therefore designed to test the hypothesis that an accelerated pace of climate-induced environmental variability and change hazards may exceed the capacity of forest-dependent communities in Vhembe District of South Africa to adapt on their own. The study thus explored local sociocultural understanding of climate change and its perceived effect on forest-based livelihoods in the rural communities of Vhembe District to gain relevant insights for rural community development in Africa.

1.2 Problem statement and rationale of the study

Despite the numerous challenges that the emerging reality of climate change poses to their overall wellbeing (Chidumayo *et al.*, 2011), forest-dependent people have not been adequately represented in vulnerability studies (Locatelli *et al.*, 2008). This challenge is expected to affect the livelihoods and sociocultural lifestyles of forest-dependent communities (Chidumayo *et al.*, 2011; Williamson *et al.*, 2005). However, unless adaptation

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initiatives address local perceptions, it cannot be expected that the community would agree to and adopt these practices (Bhusal, 2009). Piya *et al.* (2012) support this notion, arguing that understanding of how rural people perceive climate change is essential to designing any local-scale adaptation strategy. Deressa *et al.* (2011) support this by stating that it is vital to realize that certain changes are going on in order to take action to adjust to those changes. Cerroni (2012) opined that understanding of rural people's perceptions of climate change is essential to providing crucial information to policy makers. Moreover, since rural people have experience and knowledge of local climatic patterns, these could provide important insights into local climate variability and change that might not have been noticed or researched by scientists (Piya *et al.*, 2012). It is thus important to understand how rural forest-dependent people perceive and understand climate change.

Although climate change is a universal phenomenon, its indicators and manifestations are entirely local (Klein, 2004). Understanding a community's demographic characteristics and the people's level of dependence on vulnerable forest resources is thus essential. This would aid in understanding how climate change would probably manifest in the community. As supported by Malone (2009), similar climatic events could produce different levels of socio-economic impact. This depends not only on the location and timing of the occurrence, but also on the people's level of interaction with forest resources in their locality (Williamson et al., 2005; Davidson *et al.*, 2004).

It is well known that poor people are often directly dependent on forest resources (Vedeld *et al.*, 2004), but what has yet to be fully comprehended is how important this dependence is to their ability to cope with or adapt to climate change. Understanding rural people's level of dependence on forest resources is thus essential to evaluating their level of vulnerabilities. Forest dependence could be a source of vulnerability (IPCC, 2007). Ziervogel *et al.* (2014) therefore envisaged that forests should be integral to community-based adaptation initiatives. Consequently community-based forest management has become the focus of climate-change adaptation initiatives in several rural communities across South Africa (Linkd, 2013; Quinn *et al.,* 2011). It is thus important to investigate the people's aspirations and capacity to participate in community forest management of climate change intervention programmes.

In addition, understanding the context and the rationale behind the behaviour of rural people with respect to forest use and management and climate change is crucial to analysing their coping responses and adaptive capacity (Ziervogel *et al.*, 2014; Shackleton et al., 2008;

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Davidson *et al.*, 2004; Vedeld *et al.*, 2004). Tschakert (2007) has observed the issue of overlooking the adaptive role of rural forest-dependent populations, that is, the vulnerable 'target' population in recent adaptation studies. These studies failed to provide critical insights in terms of effective adaptation and coping strategies at household level. Analysing rural people's quality of coping options and risk management strategy is therefore critical to designing adaptation strategies for rural communities (Turpie & Visser, 2013). Understanding this could facilitate identification of indigenous strategies that are effective and sustainable, and could be built upon for longer-term adaptation plan. Also, understanding these dimensions of vulnerability would support efforts to address vulnerability and its underlying causes rather than merely its symptoms, thereby providing guidance on where to direct resources to build on existing coping mechanisms (Malone, 2009).

Vulnerability assessment is increasingly becoming a key component in developing adaptation strategies and building resilience against the anticipated impact of climate change (Kasperson *et al.*, 2005). Conventional vulnerability assessment approaches using climate change projections and empirical models have contributed immensely to understanding the bio-physical processes and impacts of climate change at global and regional level, but are unable to capture the micro-level specificities (IPCC, 2007; Vincent, 2004). However, considering the uncertainty that surrounds climate change projection, vulnerability analysis and adaptation development approaches should not be based merely on scenarios of the future (Ataíde, 2011; CARE, 2011; Klein, 2004). Besides, the vulnerability of forest-dependent communities is not limited to the impact of climate variability and change, but is affected by socio-economic factors such as poverty, hunger, high prevalence of disease, low levels of development and low adaptive capacity (Boon & Ahenkan, 2012; Somorin, 2010; Vincent, 2004). Also, given that rural people know about local climatic patterns and forest management practices, local knowledge could complement formal science in monitoring the effects of climate change and the formulation of strategies to adapt to such change (Piya *et al.*, 2012; Risto *et al.*, 2009). It is therefore essential to evaluate the relationships of people to forest ecosystems goods and services vis-à-vis their perceptions, accessibility, vulnerability and capacity to cope with and adjust to climate change impacts.

This study was therefore designed to use local knowledge, collected through a household questionnaire survey and field observation, to analyse rural people's perceptions of climate-change effects on their lives and forest-based livelihoods. The study framework (vulnerability assessment framework) operates on the premise that vulnerability is a function of exposure,

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sensitivity and adaptive capacity. Kriegler *et al.* (2012) supported this approach as an effective method for exploring the long-term consequences of climate-change impact and response options within a community.

1.3 Objectives and research questions

Climate change is projected to exacerbate deteriorating forest ecosystem resources. This would have dramatic consequences for forest-dependent communities. The main objective of this study was therefore to investigate the impact of climate variability and change on livelihoods of forest-dependent communities in Vhembe District, South Africa, with a view to gaining insight for scaling up interventions for climate change and sustainable forest use and management.

The specific objectives of the study and associated research questions are as follows

Specific objective 1: To examine attitudes and perceptions of forest-dependent people to climate change

Research questions

1. How do the people perceive and conceptualize climate variability and change, including their belief about its causes?
2. What are the people's concerns about effects of climate change on their livelihoods?
3. How do the people obtain information about climate change?
4. Is there any association between beliefs about causes of climate change and willingness to adopt intervention measures for climate change?

Specific objective 2: To evaluate the people's perceptions of the effects of climate change on forest-based livelihoods in their community

Research questions

1. What climatic variability and extreme events have been observed by the people over the past years?
2. How do they perceive the effects of these climatic phenomena (positive and negative) on forest-based livelihoods in their communities?

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3. Are there any forest products that are incurring more climate-associated threat? Why is this so and what are the implications for sustainable livelihoods in the communities?

Specific objective 3: To examine household dependence on forests, forest management capacity and community organization to foster sustainable forest management in response to challenges of climate change

Research questions

1. How do forests contribute to households' livelihood strategies vis-à-vis sustenance and income?
2. How do the people perceive the importance of forests to their livelihood resilience against climate variability and change?
3. Do the people have the aspiration, opportunity and community organization to engage in participatory forest management?
4. What technical capacity, education and skills are available in households to enable them to participate meaningfully in sustainable forest management?

Specific objective 4: To evaluate the coping strategy and adaptive capacity of rural households as well as socio-economic factors that constrains or enhances their adaptive capacity

1. How does a household respond (with coping strategies) to perceived climate variability and change? Do forests play a role in the coping strategies and how effective are these?
2. Are there factors that constrain or enhance households' adaptive capacity?
3. Which attributes of adaptive capacity are essential for coping strategies by households, and do these strategies need enhancement?
4. Do attributes of adaptive capacity influence households' choice of coping strategies?

1.4. Conceptual framework

The literature on the definition of vulnerability and methods of assessing the vulnerability of community to climate change is broad and extensive (Fellmann, 2013; Hoogeveen *et al.*,

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2012; MSB, 2010). This has resulted in diverse interpretations of the concepts of vulnerability and the resultant variety of methodological approaches for assessing it (Fellmann, 2013). Vulnerability assessment methods are often classified broadly as top-down and bottom-up approaches (Kalisch *et al.*, 2014). The starting point for top-down approaches is normally with an analysis of climate change and its impacts, while the starting point for bottom-up approaches is the people that are affected by climate change (Jones, 2011; MSB, 2010; Kasperson, 2005). Regardless of whether the chosen approach is top-down or bottom-up, the assessment procedure could be experimental, modelling, meta-analysis, and/or survey-based. This section aims to establish the theoretical and conceptual framework applied in this study in examining the vulnerability of forest-based livelihoods and communities in Vhembe District, South Africa. In particular, the section draws heavily on local indigenous knowledge in understanding how climate change is conceptualized and responded to in the study communities.

Community vulnerability to climate change has been studied from various perspectives, including history, sociology, psychology, economics and political science (CARE, 2011). In this study, the bottom-up survey approach has been adopted. The assessment procedure is consistent with the definition of the IPCC, which defined vulnerability in the context of climate change as 'the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes' (Fellmann, 2013; IPCC, 2007; Turner *et al.*, 2003). Thus, the vulnerabilities of forest-based rural communities to climate change were analysed with the focus on the exposure of communities and forest-based livelihoods to climatic events, the sensitivity of forest-based livelihoods to climatic events and the ability of households to adapt to the effects of this exposure and sensitivity (see Figure 1.1).

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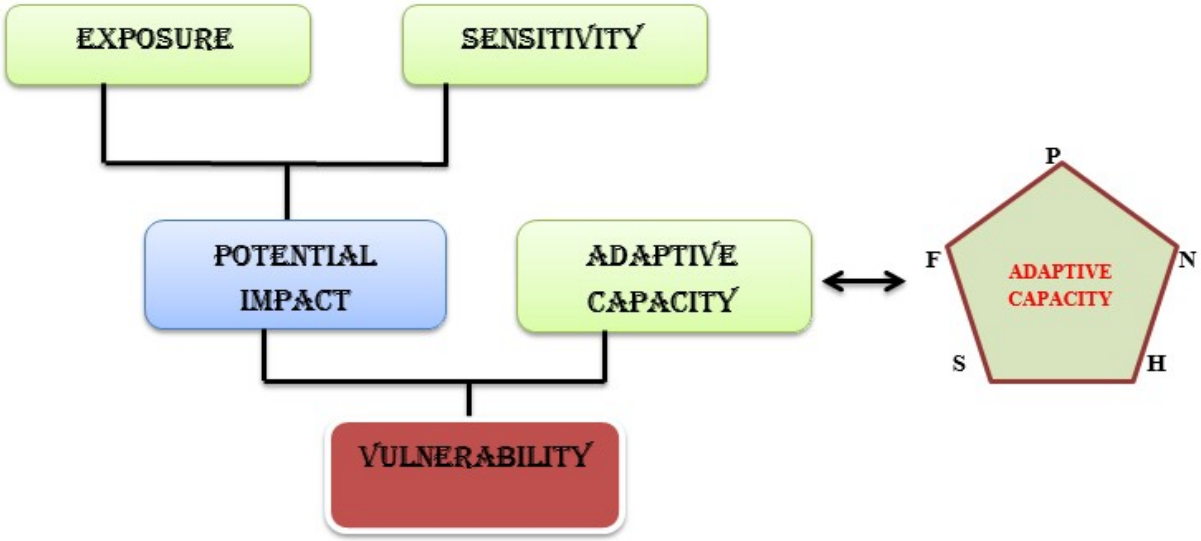

Where S=Social capital, N =Natural capital, P = Physical capital, H = Human capital, and F = Financial capital

Figure 1.1: Vulnerability assessment framework (modified from Wongbusarakum & Loper, 2011)

1.4.1 Assessing the vulnerability of forest-based livelihoods and people

Exposure: Exposure was defined as the extent to which a community comes into contact with climate hazards. Specifically, this includes areas of residency and resource use exposed to different climate hazards (Wongbusarakum & Loper, 2011; Locatelli *et al.*, 2010). As noted by Wongbusarakum and Loper (2011), exposure represents the context of climatic conditions in which a community operates. Exposure in this study focused on understanding perceptions of climate change and its effects on forest-based livelihoods in Vhembe District. This includes understanding of the local people's conceptualization of climate change and identification of opportunities for activities to increase resilience and mitigate the impact of climate change (Chapter 3) and observed climatic events to which communities are exposed and the impacts of these events on their forest-based livelihoods (Chapter 4). The investigation explored key questions relating to perceptions about sociocultural understanding of climate change, beliefs about causes of climate change, and how information about climate change was communicated at community level, communities' main concerns about climate change, and the actions they proposed for managing the impacts of climate change.

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Sensitivity refers to the degree to which a community is negatively or beneficially affected by changes in climate. This is determined largely by the relationships of individuals, households or communities to resources affected by climate change. The effects may be direct (e.g., a change in crop yield in response to a change in the mean, range or variability of temperature) or indirect (e.g., damages caused by an increase in the frequency of coastal flooding due to sea level rise) (IPCC, 2007). Sensitivity reflects the responsiveness of a community to climatic influences, and the degree to which changes in climate might affect it in its current form (Fellmann, 2013). Thus, the researchers assessed the responsiveness of community to climate change effects on their forest-based livelihood strategy (Chapter 5). A sensitive community is highly responsive to climate and could be significantly affected by slight changes in climatic condition.

Adaptive capacity here refers to the capability of a community to adjust to impacts of changing climate. A household's adaptive capacity is shaped largely by the assets (including natural, physical, financial, human, and social capital) and activities required for a means of living (CARE, 2011). Some studies have emphasized the importance of socio-economic factors for communities' adaptive capacity, highlighting the integral role of institutions, governance and management in determining the ability of a community to adapt to climate change (Wongbusarakum & Loper, 2011; Adger et al., 2005). Adaptive capacity assessment was expanded to include assessment of adjustment in local people's behaviour in relation to forest resource use and management in response to climate-change effects (Jones, 2011; Birkmann, 2008; Adger *et al.*, 2005) (Chapter 6). By departing from traditional asset-based frameworks for conceptualizing community's adaptive capacity, the study highlights the important role that various intangible and dynamic processes, such as knowledge and information, forest use and management capacity, and responsible behaviour towards forest use and management play in supporting adaptive capacity at community level.

The vulnerability assessment carried out in this study focused solely on the effect of climate change on households' adaptive capacity and livelihoods vis-a-vis their interaction with forest resources and dependence on forest income. The framework was holistic in considering how these aspects contribute to climate-change vulnerability at household level and subsequently at community level. However, it did not consider potential impacts on other sectors such as water resources, building requirements, public health, and municipal infrastructure.

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1.5 Thesis structure

This thesis is divided into seven chapters. Following this first introductory chapter, the second chapter discusses the theoretical framework and methodological design for this research. The aim of this introductory chapter is to establish the conceptual background that informs the study.

Chapter 3 is the first of four data-intensive chapters and cross-examines the socio-cultural constructs that inform how climate change is conceptualized, interpreted and communicated at rural community level. This chapter explicitly addresses the first of the study's four specific objectives. It uses household questionnaire surveys and statistical analysis to evaluate households' socio-cultural understanding and concerns of climate change. The people's behavioural intentions for forest use and management in climate-change intervention initiatives were also analysed. Individual results were then aggregated and scaled up to assess and characterize communitywide and municipal concepts of climate change.

The fourth chapter is dedicated to the second research question and analyses the effect of climate change on access to forests and forest-based livelihoods in the communities. Thus, this chapter used a perception-based assessment method to analyse the impact of climate change on essential forest products used for livelihoods in the communities under study. Binary logistic regression was used to identify key climatic impacting events in the communities. The same tool was used to analyse the sensitivity of essential forest products that are used for livelihoods to these key climatic impacting events. Chapter 5 investigates local forest dependency patterns and households as well as community capacity to engage meaningfully in sustainable forest use and manage climate-change intervention initiatives. Chapter 6 is the final data analysis chapter of this study and analyses households' coping strategies and adaptive capacity. Chapter 7 is the concluding chapter. It summarizes the findings of the preceding four data analysis chapters, and draws conclusion and lessons that are pertinent to understanding and managing climate-change vulnerability at rural community level in South Africa, with application to other communities in Africa.

In terms of publications, this thesis contains four manuscripts (Chapters 3–6), that were prepared and submitted to peer-reviewed journals. Thus there may be an apparent duplication in the description of the methodology between chapters. Chapter 3 has been accepted by *International Forest Review Journal* (2016, in press), Chapter 4 has been accepted by the *Journal of Disaster Risk Studies* (2016, in press), Chapter 5 is under review in the *Climatic*

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Change Journal, and Chapter 6 has been accepted by the *Journal of Environmental Development* (2016, in press). Additionally, at the time of submission of the thesis, this study provided other outputs, including one review paper and three conference papers, as follows:

Ofoegbu, C., Chirwa, P.W., Francis, J., Babalola, F.D. (under review). Vulnerability of rural communities to climate change: A review of implications to livelihoods of forest-based communities in South Africa. *International Journal of Sustainable Development and World Ecology* (under review).

Ofoegbu, C., Chirwa, P.W., Francis, J., Babalola, F.D.(2015) Assessing socioeconomic factors influencing household dependence on forests and its implication for forest-based climate change interventions, presented at the United Nations Food and Agriculture Organization's XIV World Forestry Congress.

Ofoegbu, C., Chirwa, P.W., Francis, J., Babalola, F.D. 2015. Understanding forest-based livelihood practices as a climate change mitigation and adaptation option in Vhembe Districts of South Africa, presented at the United Nations Food and Agricultures Organization's XIV World Forestry Congress, 7-11 September 2015, Durban, South Africa. https://www.researchgate.net/publication/281583615_Understanding_forest_based_livelihood_practices_as_a_climate_change_mitigation_and_adaptation_option_in_Vhembe_Districts_of_South_Africa

Ofoegbu, C., Chirwa, P.W., Francis, J., Babalola, F.D. 2014. Appraising climate change in rural forest dependent communities of South Africa: Community perceptions and attitudes, presented at the International Union of Forestry Research Organizations' XXIV World Congress, 5–11 October 2014, Salt Lake City, USA. www.iufro.org/download/file/16685/4139/iwc14-iufro-incubator-abstracts_pdf/

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CHAPTER 2

THEORETICAL FRAMEWORK AND METHODOLOGICAL DESIGN

2.0 Overview

This thesis is based on research conducted in 21 rural communities of Vhembe District, South Africa, from August 2013 to September 2014. The conceptual framework described in Chapter 1 serves as the foundation of this research and feeds directly into the methodological design applied in this work. The study design applies a four-tiered approach to assessing key factors characterizing household vulnerability to climate variability and change at forest-based rural community level in South Africa. The study objectives and associated research questions served as a guide to home in on the direct and indirect relationship between household, forest use and management, and community vulnerability to climate change impacts. Subsequently the study operationalized vulnerability with respect to households' understanding and perception of climate change (Figure 2.1). The study also investigated households' perceived impact of climate change on forest-based livelihoods and its influence on people's behaviour towards forest use and management; household forest use level and management capacity; and household coping strategy and adaptive capacity to climate change. Although climate change vulnerability assessment data could be collected by discussion groups or questionnaires (Appendix 1) survey; the study used a questionnaire survey approach because the method is more responsive to statistical analysis and for tracking change over time.

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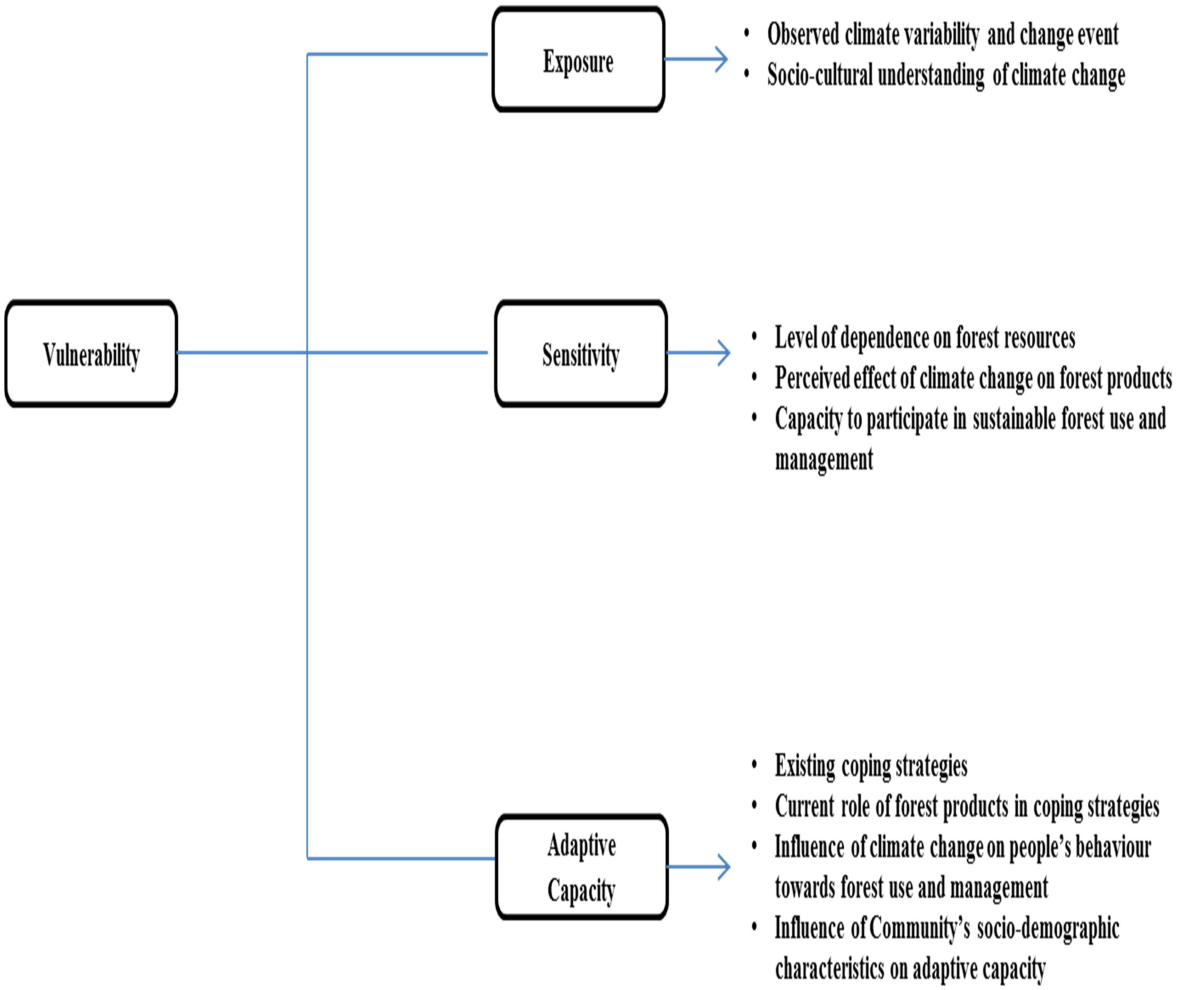

Figure 2.1: Operationalization of vulnerability assessment in relation to study objectives

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2.1 Assessment procedure: Household questionnaire survey

To respond systematically to each of the four objectives outlined in Chapter 1, a methodology unique to each objective was applied (Table 2.1). The assessment procedure was carried out in four phases

Table 2.1: Research objectives and corresponding methodological approach

Research Objective	Data Sets	Types of Data	Methodological Approach
Objective 1 (Chapter 3)	Household Survey	Sociocultural understanding of climate change Attitude to and belief about causes of climate change Concern about climate change; Willing behavioural change regarding sustainable forest management in the context of climate change	Quantitative: Pearson's chi–square and Bonferoni tests Binary logistic regression
Objective 2 (Chapter 4)	Household Survey	Priority climate risk identification via local observations perceived impact of prioritized climate risk forest products	Quantitative: Pearson's chi–square; Bonferoni tests; binomial test; binary logistic regression
Objective 3 (Chapter 5)	Household Survey	households' dependence on forest products for livelihood; forest products role in household adaptation to climate variability Households' capacity to participate meaningfully in forest management	Quantitative - Pearson's chi–square; Bonferoni tests; binomial test; binary logistic regression
Objective 4 (Chapter 6)	Household Survey	Coping responses to climate variability and change Community socio-demographic characteristics effect on coping responses and adaptive capacity	Quantitative: Pearson's chi–square; Bonferoni tests; binomial test; binary logistic regression

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The first phase (Chapter 3) sought to assess local conceptualization and understandings of climate change. The study therefore used household surveys for data collection. Survey respondents were asked about their demographic backgrounds, sources of information and observations about local changing climatic conditions, including the type and frequency of impacts. In particular, survey questions were designed to glean details about respondents' understanding of climate change, their awareness of it, their beliefs about causes of climate change, their concerns about climate-change effects on their forest-based livelihoods, and willing behavioural change regarding sustainable forest management in the context of climate change.

Data analysis involved computing frequencies and conducting chi-square and binomial tests, in addition to logistic regression analysis in relation to the study objective and research questions. The binomial test was used to test the significance of 'yes' and 'no' responses to observed ecosystem indicators of climate change (Berg, 2014). These ecosystem indicators included new plant species, new diseases in agricultural/tree crops, increased frequency of incidence of pests, changes in crop-ripening season, changes in flowering and fruiting time, changes in planting season, increased death of livestock, and water sources and availability becoming scarce (Kadir *et al.* 2013). Pearson's chi-square and Bonferoni tests were used to analyse associations between beliefs about causes of climate change and willingness to accept responsible attitudes to forest utilization and management, and association between concern about climate change and willingness to accept responsible attitudes to forest utilization and management (Clewer & Scarisbrick 2001). The Pearson chi-square was used where the expected cell frequency was ≥5, while maximum-likelihood (M-L) chi-square was adopted when the expected cell frequencies were lower than 5 (Turyahabwe *et al.* 2006). Logistic regression was used to determine the factors that drove the perceptions of climate variability and change, and beliefs about causes of climate change (Harrell, 2001). A p-value of $p < 0.05$ represented statistical significance in hypothesis testing, and 95% confidence intervals were used to describe the estimation of unknown parameters (Clewer & Scarisbrick 2001).

Specification of the logistic regression model

The standard binomial logit regression model with dichotomous categorical dependent variables was specified. To model perception of variability in climate, the dependent variable was 'perceive' and 'does not perceive'. With modelling beliefs in causes of climate change, the target variables were placed in these belief groups: anthropogenic causes,

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cultural/spiritual causes, and climate change as a natural phenomenon.

The list of possible explanatory variables used in the models included households and household head (HH) characteristics: employment status (yes = 1; no = 0), farming skills (yes = 1; no = 0), livestock-keeping skills (yes = 1; no = 0), carpentry skills (yes = ; no = 0), academic qualification (yes = 1; no = 0), years of residency in the community categorized as (≤ 38) (yes = 1; no = 0), (39-52) (yes = 1; no = 0), (53-65) (yes = 1; no = 0), (66+) (yes = 1; no = 0), and age of respondent categorized as (≤38) (yes = 1; no = 0), (39-52) (yes = 1; no = 0), (53-65) (yes = 1; no = 0), (66+) (yes = 1; no = 0). The chi-square test at 0.05 significance level was used to assess the goodness of fit of the models.

The second phase (Chapter 4) sought to analyse how the people perceived the effects of climate change on their forest-based livelihood strategies and to determine the resulting social, economic, and cultural outcomes. The questionnaire used for the assessment of climate change impacts was adapted from the Climate Risk Assessment Guide developed by UNDP Central Asia Climate Risk Management Program (UNDP, 2013). The guide uses a modification of the sustainable livelihoods framework to define climate change impacts by looking at how short- or long-term climatic events could affect various types of forest products used for livelihoods in the study communities. The use of the questionnaire enabled identification of community's risk priorities and comparisons of results in municipalities as well as between them. The first part of the questionnaire focused on identification of climatic and extreme weather events occurring in the community. The study used meteorological information and literature to identify climatic events occurring in Vhembe district (Davis *et al.,* 2010). Respondents were then asked to tick the events to which their households and livelihoods are exposed. The study then explored respondents' perceived impact of these events on forests and forest-based livelihoods in their community. A 4-point Likert scale was used to analyse perceived effect and sensitivity of essential forest products to climate risk (1 = No effect; 2 = Resources have become scarce; 3 = Increased difficulty in harvesting resource; and 4 = Resource has become expensive). A 3-point Likert scale was used to assess climate-change effects on access to forests (1 = No effect; 2 = Temporary reduced access 3–4 months; and 3 = Reduced access for extended period of five months and above). A similar rating technique was used by Asherleaf (2012), Lazo *et al.* (2000), and Williamson *et al.* (2005) in analysing climate-change effects on forest-dependent communities in Canada, and

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by Badjeck *et al.* (2010) in analysing the impacts of climate variability and change on fishery-based livelihoods.

A binomial test was used to analyse perceived increase and decrease of each climate and extreme event in each municipality to identify significant (priority climate hazard identification analysis) key climatic impact factors (Berg, 2014). The climate variability and extreme weather events that were studied included erratic rainfall, extreme temperatures, serious flooding, extreme drought, strong winds, and incidences of hailstones. In this study, climate variability refers to the natural fluctuations of the climate system, while extreme weather event is an occurrence that is significantly different from the average or usual weather pattern. A binomial test was used to analyse the 'yes' and 'no' responses of climate variability and change effect on forest products (Berg, 2014).

The researcher then analysed the sensitivity of essential forest products used for livelihoods in the study communities to these factors to ascertain whether any forest products were perceived to be incurring greater climate-associated threat. A binary logistic model was used to estimate sensitivity and the relationship between perceived changes in climatic events and the perceived effect of climate variability and change on essential forest products used by communities (Maddala, 1983). Odds ratios were used to measure the magnitude of strength of association or non-independence between two binary data values. The sensitivity of these essential forest products, namely woody products (firewood, charcoal, timber/construction wood) and non-woody products (mushrooms, medicinal plants, thatch grass, bush meat/wild edible insects and wild fruits/vegetables), was tested. Perceived change in climatic event was framed as a binary-choice model, which assumed that respondents' perception of the increase or decrease in woody and non-woody products dictated their perceived increase or decrease in climatic events. The perceptions are dependent on identifiable characteristics.

Let T_i represents a dichotomous variable that equals 1 if respondent perceived increase in climatic event over the years and 0 if the perception was decrease.

The probability of perceiving increase in climatic event, Pr ($T_i = 1$), is cumulative density function F evaluated at $X_i \beta$, where X_i is a vector of explanatory variables and β is a vector of unknown parameter (Maddala, 1983). This cumulative density function was modelled using logistic probability function, which has the following form:

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The probability of perceived increase = Pr (Ti = 1) = $\frac{exp(Xi\,\beta)}{1+exp(Xi\,\beta)}$

The estimated model was:

Perception of increase in climatic event = b_0+ b_1 (GND) + b_2 (EMP) + b_3 (FIRE) + b_4 (CHAR) + b_5 (TIM) + b_6 (MUSH) + b_7 (MEDI) + b_8 (WILD) + b_9 (FODD) + b_{10} (THAT) + b_{11} (HON)

The dependent variable is the perception of occurrence of a climatic event, which takes on the value of '1' if the respondent perceived increase in climatic event and
'0' if no decrease is perceived. The following climatic events were analysed separately; erratic rainfall, extreme temperature, extreme drought and flooding. Explanatory variables and justification are discussed below.

Gender (GND) is a dummy variable (male = 1; female = 0); employment status (EMP) (employed = 1; not employed = 0); firewood (FIRE) measures perceived effect of climatic event on firewood availability in the community (reduction in quantity = 1; no effect = 0); Charcoal (CHAR) measures perceived effect of climatic event on charcoal availability in the community (reduction in quantity = 1; no effect = 0); timber (TIM) measures perceived effect of climatic event on timber (reduction in quantity = 1; no effect = 0); mushroom (MUSH) measures perceived effect of climatic event on mushroom collection from the forest in the community (reduction in quantity = 1; no effect = 0); medicinal plants measures perceived effect of climatic event on medicinal plants collection from the forest in the community (effect of climatic event = 1; no effect = 0); wild fruits and vegetables measures perceived effect of climatic event on wild fruits and vegetables collection from the forest in the community (effect of climatic event = 1; no effect = 0). Fodder for livestock measures perceived effect of climatic event on livestock fodder in the community (effect = 1; no effect = 0); thatch grass (THAT) measures perceived effect of climatic event on thatch grass collection from the forest in the community (effect = 1; no effect = 0); and honey (HON) measures perceived effect of climatic event on honey collection from the forest in the community (effect = 1; no effect = 0).

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The third phase (Chapter 5) sought to assess local-level forest use and management capacity for climate-change management. Questions were designed to gain understanding of respondents' knowledge and experience of forest regulation and management in the community; households' dependence on forest products for livelihoods; the role of forest products in household adaptation to climate variability; households' capacity to participate meaningfully in forest management; and community leadership capacity to influence participation in forest management. A 4-point Likert scale (1 = high, 2 = medium, 3 = low, and 4 = no contribution) was used to analyse perceived benefits of forests to household income, sustenance, and livelihood resilience against climate variability and change. In this study, participation was perceived in line with the definition of Kalim *et al.* (2013), and Isager *et al.* (2002), that is, genuine involvement of local people in the planning, organization and decision-making processes of forest management.

Discrete variables were summarized by the frequency of each code in the questionnaire, and summary statistics were computed for all numeric variables. Categorical data on the opinions of respondents were analysed based on individual responses. Descriptive statistics and chi-square test were used to analyse households' dependence on forest resources, the current role of forest products in household coping strategies for climate variability and change; opportunities for participatory involvement in forest management; people's qualifications, skills and capacity to foster sustainable forest management; and factors that influence households' desire to engage in these practices. Chi-square and Bonferroni tests were used to analyse associations between respondents' age and lack of interest in participating in forest management. The Pearson chi-square was used where the expected cell frequency was ≥5, while M-L chi-square was used when the expected cell frequencies were lower than 5 (Turyahabwe *et al.,* 2006). However, to identify variables that were independent predictors of participation in forest management, the researchers used logistic regressions from which the estimated odds ratios (y) were derived to ascertain the effects of the predictors on respondents' participation in forest management. Odds ratios were used to measure the magnitude of strength of association or non-independence between two binary data values. A p-value of $p < 0.05$ represented statistical significance in hypothesis testing and 95% confidence intervals were used to describe the estimation of unknown parameters (Clewer & Scarisbrick, 2001).

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Specification of the logistic regression model

The target modelled variable was participation in forest management. The researcher took each indicator as a binary outcome, and used logistic regression to model a number of explanatory variables, including employment status (yes 1; no = 0), farming skills (yes 1; no = 0), livestock-keeping skills (yes 1; no = 0), carpentry skills (yes 1; no = 0), years of residency (≤38) (yes 1; no = 0), years of residency (39-52) (yes 1; no = 0), years of residency (53-65) (yes 1; no = 0), years of residency (66+) (yes 1; no = 0), age of respondent (≤38) (yes =1; no = 0), age of respondent (39–52) (yes =1; no = 0), age of respondent (53–65) (yes = 1; no = 0), age of respondent (66+) (yes = 1; no = 0), and academic qualification (yes = 1; no = 0). The chi-square test at a = 0.05 significance level was used to assess the goodness of fit of the models.

The fourth phase (Chapter 6) sought to assess existing coping strategies and the people's adaptive capacity for climate-change management. Households' coping strategies were analysed by asking respondents questions about the ways in which they respond to climate variability and extreme weather events, such as drought, erratic rainfall, extreme temperatures, flood, and hailstones, as well as the effectiveness and sustainability of these coping strategies. The respondents were asked to indicate, among the pre-determined coping strategies listed in the questionnaire, those that they had used in coping with climate variability and extreme events occurring in their locality. Respondents were also asked whether they perceived any difficulties in coping with climate change. The current role of forest products in the household coping strategy was investigated. The study also examined how sociodemographic characteristics (access to climate information, participation in and support from community organizations, education and skills, and access to water facilities) affected households' adaptive capacity.

2.2 A brief description of the study area

The field work was conducted in Vhembe District Municipality, Limpopo, South Africa (22° 56 S, 30° 28E), as shown in Figure 2.2. The district shares international borders with Zimbabwe and Botswana in the north and north-west, respectively (Mpandeli, 2014). The district has a total population of 1 199 886, of whom 54.4% are female. Approximately, half (48.72%) of the people in Vhembe District reside in Thulamela Local Municipality. The rest

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of the population are distributed as follows: Makhado (41.43%), Mutale (6.58%), and Musina (3.28%), (Department of Cooperative Governance and Traditional Affairs (DCoGTA), 2012; SSA, 2011). Vhembe has the second lowest access to infrastructure among districts in the province. The main languages are Tshivenda (69%) and Xitsonga (27%).

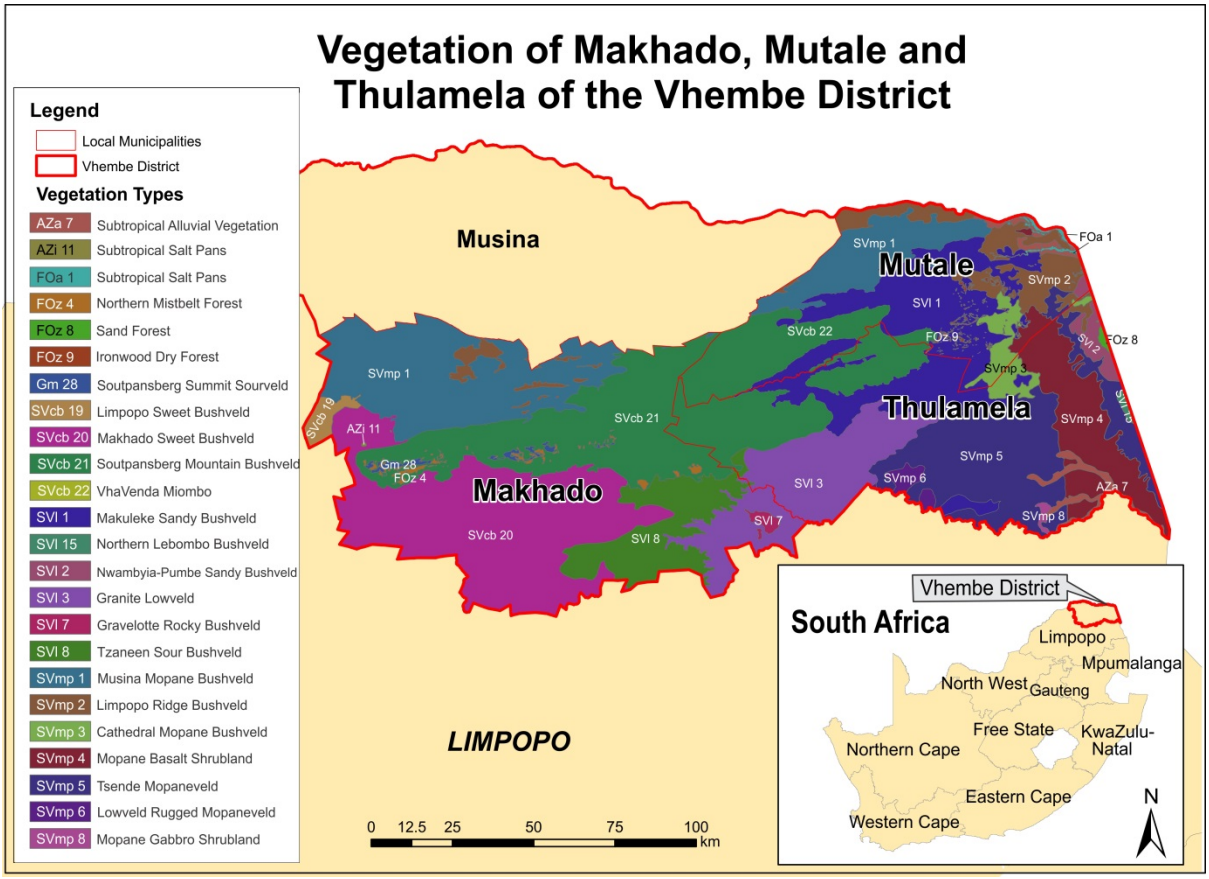

Figure 2.2: Vegetation map of Vhembe District of South Africa (Researcher own work)

2.2.1 Selection of case study community

To closely examine the roles that various forest types and social, economic and infrastructural contexts play in forest-based livelihood strategies and their influence on households' climate-change perceptions and vulnerability, three distinct research areas were selected in Vhembe District. Identifying how these dynamic characteristics aggregate to shape households and communities, vulnerability and response to climate change may provide useful details on the potential risks and opportunities climate change offers to forest-based livelihoods in the communities (Hoogeveen *et al.*, 2012; Marrewijk, 2011). The selected three municipalities were Makhado, Mutale and Thulamela. Vhembe is an ideal location for investigating the

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complex challenge of sustainable forest management and rural livelihood management in the context of the emerging climate-change challenge.

As shown in figure 2.2, the study area falls within the Savannah Biome (Mucina & Rutherford 2006). However, the vegetation of the study communities varied by municipality, in Makhado the dominant vegetation types is the Makhado sweet bushveld, in Mutale the dominant types are Makuleke sandy bushveld and Cathedral mopane bushveld, while in Thulamela the dominant vegetation type is the Tsende Mopaneveld. All of these veld types are described below:

Makhado Sweet Bushveld

The conservation status of this vegetation is vulnerable (DEA, 2009). The altitude ranges from about 850-1200 m (Prism EMS, 2015). The specie compositions are mostly short and shrubby bushveld with a poorly developed grass layer (Nel & Nel, 2009; Mucina & Rutherford, 2006). Essential specie listed by Mucina & Rutherford, (2006) for Makhado Sweet Bushveld include, *Acacia erubescens, A. gerrardi, A. rehmanniana, Combretum apiculatum, Terminalia sericea, Rhigozum obovatum, Hibiscus calyphyllus, Commiphora pyracanthoides, Lycium shawii,. Hirpicium bechuanense, Tephrosia purpurea* subsp. *Leptostachya.* This vegetation type can largely be described as open woodland (Mostert et al. 2008).

Makuleke Sandy Bushveld (SVI 1)

This vegetation type occurs on variable landscapes from low mountains to extremely irregular plains, to hills (Services, 2013). Erosion is moderate to high in some places (Mucina & Rutherford 2006). This vegetation type in the area has three endemic species (Prism EMS, 2015). Dominant plant species found in the area include: Acacia burkei, acacia nilotica, Afzelia quanzensis, Albizia adianthifolia, Combretum erythrophyllum, Ekebergia capensis, Erythrina lysistermon, Gardenia volkensii, Balanites maughamii (DEA, 2009).

Cathedral Mopane Bushveld (SVmp3)

This vegetation type is a moderately closed savannah (Mostert et al. 2008). They are mostly found on sandy, loamy to rocky soils (Mostert et al. 2008; Mucina & Rutherford 2006). The conservation status of the Cathedral Mopane Bushveld is least threatened (DEA 2009). Dominant plant species found in the area include: *Combretum apiculatum* (Red Bushwillow), *Colophospermum mopane* (Mopane), *Acacia tortilis* (Umbrella Thorn), *Dichrostachys cinerea* (Sickle Bush), *Sterculia rogersii* (Common Star-Chestnut),

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Adansonia digitata (Baobab), and *Grewia* spp (Raisin bush spp.) (Mucina & Rutherford 2006).

Tsende Mopaneveld

The conservation status of this vegetation is least threatened (DEA, 2009). This vegetation type is characterised by medium to high shrub dominated savannah, with scattered trees and a dense field layer (Mostert et al. 2008). Dominant plant species found in the area include: *Acacia. Nigrescens, Combretum. Mopane, C. apiculatum*, *Euclea divinorum, Clerodendrum ternatum, Bothriochloa radicans, Digitaria eriantha subsp. pentzii, Heteropogon contortus Blepharis integrifolia,* and *Ceratotheca triloba* (Mucina & Rutherford 2006).

The landscapes of selected communities in Thulamela, Makhado, and Mutale have typical woodland, savannah, and semi-arid zones characteristics, respectively (Rosmarin, 2013). These communities have a subtropical climate. Most of Makhado's rainfall occurs in the summer months, from November to March (Turpie & Visser, 2013; VBR, 2012; Quinn *et al.*, 2011). Mutale normally receives about 681 mm of rain per year, with most rainfall occurring in mid summer (VBR, 2012; Marrewijk, 2011). For Thulamela, most of the rainfall occurs from October to January (VBR, 2012). According to the South African National Climate Change Response Strategy projection for Vhembe, a temperature increase in the range of 1 ^{0}C and 3 ^{0}C by the mid twenty-first century is expected (DEAT, 2004). A broad reduction of rainfall in the range of 5% to 10% is also predicted for the region (DEAT, 2004). This is expected to pose severe consequences for dominant rural livelihood strategies, such as farming, livestock-keeping and forest-product use, thereby increasing the vulnerability of rural communities in the area (Turpie & Visser, 2013; Paumgarten & Shackleton, 2011). Unemployment rates are high in Vhembe and most rural households depend on social grants (VBR, 2012). Additionally, these communities are characterized by a complex disease burden (mostly in the form of human immunodeficiency virus (HIV) and tuberculosis (TB)), high mobility, subsistence-level existence, and informal settlement housing (DEA, 2011). Furthermore, the interconnectivity between social, ecological, and human systems makes these communities acutely sensitive to the impacts of climate change (IPCC, 2007).

In each of these municipalities, the study selected a replicate of seven rural communities. This gave a combined total of 21 rural communities, which were then surveyed. Using

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stratified proportionate random sampling in combination with the enumeration area (EA) for the selected communities (as developed by Statistics South Africa), the study selected and interviewed a total of 366 households from the chosen 21 communities that were sampled. The EAs are the second lowest layer in a census geography hierarchy. The EAs (Appendix 2) comprised dwelling units (DU). DU is the lowest level of the census geography hierarchy. A DU in this study is a structure occupied by one household. The EA for each village contains the selected DU and its coordinates. The coordinates were entered into Garmin etrex30 GPS and used to track the selected DU for questionnaire administration. Each selected household was then subjected to non-probability purposive sampling, whereby the researcher selected a respondent from the household who was over 20 years old, and had lived in the community or vicinity for more than five years. The study sample was subjected to weighting adjustment to correct for possible problems of over- or under-representation of variables for analysis (Bethlehem, 2015). The sample was weighed against the actual population to arrive at a weighted sample of 366 households.

2.2.2 Survey procedure

The interview team for the study comprised the researcher and eight enumerators. The enumerators were selected based on their academic qualifications and experience with questionnaire survey study. Given the strategic need to ensure that the study questions were communicated to respondents in their mother tongue for accurate understanding (Swanepoel & Beer, 2006), the study questionnaire was translated into the two dominant local languages (Tshivenda and Xitsonga). The translated questionnaire was then pre-tested to ensure its accuracy, and feedbacks were used to make final corrections. The field enumerators were put through a training workshop on the study objectives. The workshop was followed with a pilot survey to enable the enumerators to have field experience of the administration of the questionnaire before the actual study. Following the approach pattern used by Ham and Theron (2001), rural community chiefs and headsmen were briefed about the study months before the actual study. Direct observation, face-to-face interviews and administration of the questionnaire were the methods applied in gathering the data for this study. As recommended by Bless and Smith (1995), the survey process was thoroughly carried out to avoid bias.

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2.3 Climatic and socioeconomic description of study communities

The landscape of the selected communities in Thulamela, Makhado, and Mutale has typical woodland, savannah, and semi-arid zone characteristics, respectively (Rosmarin, 2013). The communities have a subtropical climate. Most of Makhado rainfall occurs in the summer months from November to March (Turpie & Visser, 2013; VBR, 2012; Quinn *et al*., 2011). Mutale normally receives about 681 mm of rain per year, with most rainfall occurring in mid summer (VBR, 2012; Marrewijk, 2011). For Thulamela, most of the rainfall occurs from October to January (VBR, 2012). According to the South African National Climate Change Response Strategy projection for Vhembe, a temperature increase in the range of 1 ºC and 3 °C by the mid twenty-first century is expected (DEAT, 2004). A broad reduction of rainfall in the range of 5% to 10% is predicted for the region (DEAT, 2004). This is expected to pose severe consequences for dominant rural livelihood strategies such as farming, livestock husbandry and forest-products use, increasing the vulnerability of rural communities (Turpie & Visser, 2013; Paumgarten & Shackleton, 2011). Additionally, unemployment rates are high in Vhembe and most rural households depend on social grants (VBR, 2012). Furthermore, the interconnectivity between social, ecological, and human systems makes these communities acutely sensitive to the impacts of climate change (IPCC, 2007).

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CHAPTER 3

Conceptualizing climate change in forest-based rural communities of South Africa: Community perceptions and attitudes

ABSTRACT

The perceptions of forest-based communities in Vhembe District, South Africa, were examined. Special attention was paid to the following aspects which are linked to climate change: sociocultural issues, views and awareness, beliefs about causes, concerns, and lifestyle adjustments that people are prepared to make. Vegetation type was used as the criterion to select Makhado, Mutale and Thulamela municipalities, which, together with Musina, constitute Vhembe District. Seven rural communities in each municipality were selected. Using stratified proportionate random sampling in combination with weighted enumeration area (EA) for these communities, 366 households were chosen and interviewed. Data analysis entailed conducting the Chi-square, binomial tests, and binary logistic regression analysis. It was found that although awareness of the term 'climate change' was poor, most respondents had good knowledge of it and its associated challenges. Increasing frequencies of erratic rainfall and forest fires were said to be visible manifestations of climate change. There was also strong concern about the effects of climate change on forests and forest-related products. The respondents expressed a desire to adopt responsible behaviour towards the use and management of forests as a climate-change intervention strategy. However, most community members were sceptical about the causes of climate change. Taking all these issues into account, activities were needed that would enlighten the people on the causes and consequences of climate change for their livelihoods. This would help promote awareness of climate change and encourage people's participation in crafting measures that could contribute to mitigating and adapting to climate change.

Keywords: climate change; climate variability; perceptions; forest, rural community[1]

[1] This chapter is based on published article cited as, "C Ofoegbu, P.W. Chirwa, J. Francis, F. Babalola. 2016. Conceptualising Climate change in Forest Based Rural Communities of South Africa: Community Perceptions and Attitudes. International Forestry Review Vol.18(3), 319-333"

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3.0 INTRODUCTION

The growing consensus among scientists that climate change is happening and will continue to do so into the future (Christensen et al., 2007) has placed the climate change debate in the spotlight of social research over the last two decades (National Planning Commission (NPC), 2011; Wolfsegger, 2005). There is increasing interest and concern about how observed and predicted changes in climate patterns would affect society and natural ecosystems (NPC, 2011; Wolfsegger, 2005). In South Africa, the debate on climate change is increasing. Apparently, this has been as a result of the observed increase in annual temperatures in the country of about 0.13 ^{o}C per decade between 1960 and 2003 and the predicted decrease in rainfall of approximately 5.4% by 2020 (Turpie & Visser, 2013). In addition, Gandure et al. (2013) predicted that the occurrence of erratic rainfall in South Africa was likely to become more frequent in the future. The South African Long-Term Adaptation Scenario (LTAS) study predicted significant warming, as high as 5–8 °C, over the interior by the end of this century (DEA, 2013). More specifically, the Limpopo area, and the Vhembe region in particular, is predicted to be particularly prone to rapidly rising temperatures (Engelbrecht et al., 2015). Widespread aridity in the Vhembe region would render it prone to limitations in water supply as a key vulnerability (DEA, 2011).

Consequently, climate change is expected to have serious environmental, economic, and social impacts on rural households (Gbetibouo, 2009). Regardless of how scientists perceive climate change, individual views of its meaning are likely to relate more to the public discourse and wider debate about the extent of its impact on human and natural systems (Rik *et al.,* 2008; Weingart *et al.,* 2000). Understanding of public values is therefore required for shaping people's engagement with climate change, and minimizing risks inherent in climate communication (Corner *et al.,* 2014; Wolf & Moser, 2011)

Wiid and Ziervogel (2012) noted that the effectiveness with which a community responds to the challenge of climate change depends on how well individual members understand it. Thus, understanding how climate change and variability are experienced and interpreted at rural community level is crucial (Wiid & Ziervogel, 2012). Growing awareness that scientific knowledge of the causes and impact of climate change is becoming inadequate in designing appropriate intervention measures is promoting this assertion (Nesha *et al.,* 2014).

Ishaya and Abaje (2008) and IPCC (2007) concurred that investigations based solely on climate-change projections using empirical models fail to capture micro-level specificities of

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local communities. Similarly, Piya et al. (2012) reported that these models fail to predict climate phenomena at local scale and few integrate socioeconomic variables that are relevant to rural communities and policy makers.

Most studies on public perception of climate change in South Africa, as in most African countries, have focused on understanding people's perceptions and awareness of it (Gandure *et al.* 2013; Turpie & Visser 2013; Turpie et al. 2002). They do not address the concerns and attitudes that might affect livelihood activities (Marsden *et al.* 2009) and climate-change intervention initiatives. Bryan *et al.* (2009) conducted studies in South Africa and Ethiopia, which revealed the importance of people's perceptions in understanding the role of education and creating awareness of adaptation options among farmers. Maddison (2007) reported that farmers from many African countries perceived that temperatures had increased and rains were less predictable, in addition to being received for shorter periods. Macharia *et al.* (2011) reported that farmers in Nyeri North and Laikipia East districts of Kenya identified destruction of natural resources, in particular indigenous trees, as a major contributor to climate change in the region. In Senegal, Mertz *et al.* (2009) observed that farmers were aware of climate change and identified wind and occasional excessive rainfall as the most significant factors that needed attention when adaptation measures are developed. In Nigeria, Ishaya and Abaje (2008) revealed that farmers perceived climate change to have occurred over the years because of diverse human activities.

However, very little is understood about the relationship between rural people's perceptions and understanding of climate change and its influence on people's attitudes towards forest-based livelihood strategies in South Africa.

The rural population makes up about 40% of South Africa's population. Moreover, most of these people depend mainly on forests, forest products and subsistence farming (Ofoegbu, 2014; Turpie & Visser, 2013; Vhembe District, 2013; Chamberlain et al., 2005). An understanding of the attitudes of rural households that live adjacent to forests towards climate change is therefore essential to crafting robust intervention measures. Understanding the attitudes of the rural people, as well as their perceptions of climate change, is pertinent to promoting sustainable practices in forest exploitation and management operations. Therefore, it is not surprising that questions on how rural people in South Africa perceive and interpret climate change are of interest to social scientists and policy makers (Turpie *et al*., 2002).

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Research into rural community perceptions and understanding of climate change helps to improve communication on the scientific discourse of climate change, influence positive behavioural change and inform policy makers better (Buys *et al.,* 2012). This sheds light on the conceptualization of climate change in rural forest-based communities of South Africa. The forest sector often plays a pivotal role in policies aimed at adaptation and mitigation of the effects of climate change (Dube & Phiri, 2013; Piya et al. 2012; Ishaya & Abaje 2008). It is therefore important to specifically examine attitudes and perceptions of forest-dependent people residing in rural areas regarding climate change. To achieve this, the chapter used the research questions associated with objective 1 in chapter one as a guide.

The concept of climate change was used in a broad context that included changes in variability and extreme weather events. It was designed to examine the ways in which households understood climate change in forest-based rural communities.

3.1 METHODOLOGY

In this study, climate change is conceptualized in terms of anthropogenic climate change. Given that there is no specific word for climate change in the local languages in which the study was conducted, the researchers defined climate change as a trend towards increasing manifestation in frequency and magnitude of climate variability and extreme weather events, mostly because of human activity.

Information on the study survey process and statistical analysis is already provided in chapter two in details.

3.2 RESULTS

3.2.1 Awareness of the term ‘climate change’

As revealed in Figure 3.1, poor awareness of climate change was generally high in Mutale (74. 3%) and Makhado (67.3%). However, in Thulamela only 14.9% of the respondents reported that they had never heard of climate change. Furthermore, the Pearson chi-square test showed that there was a significant difference ($p = 0.000$) in climate-change awareness among the three municipalities. The Bonferoni test confirmed that although the level of

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awareness of climate was the same in Makhado and Musina, the residents of Thulamela were significantly more aware of it ($P < 0.001$) than in the former municipalities.

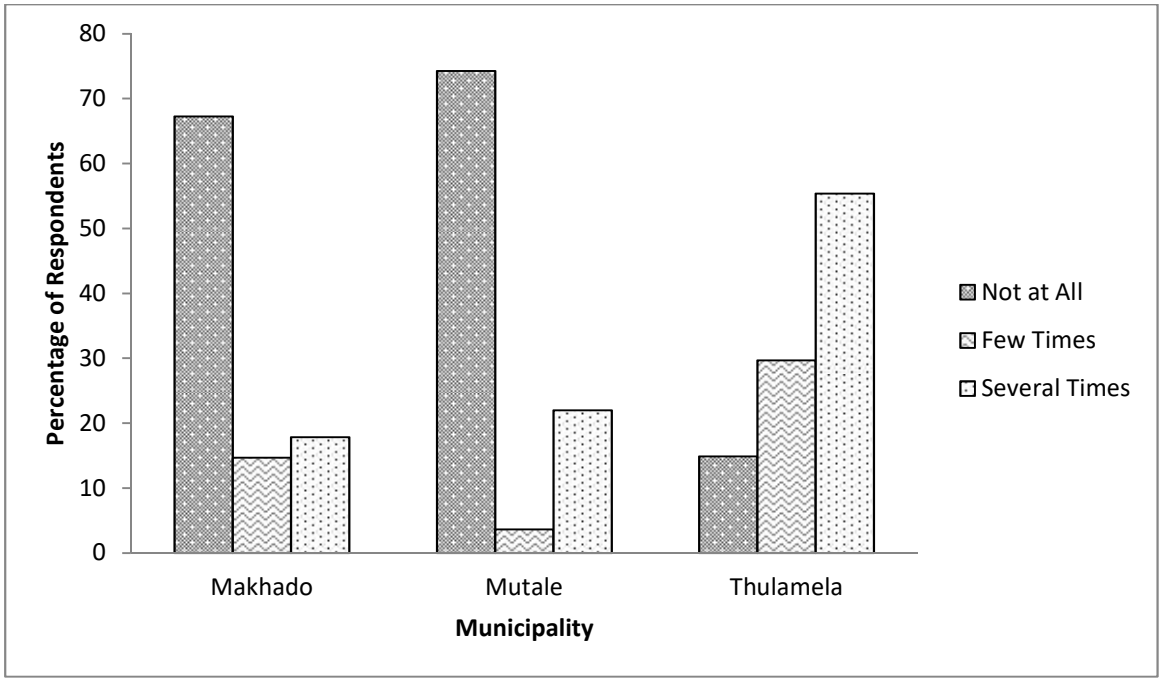

FIGURE 3.1 Respondent's awareness of the term 'climate change' in the study communities

3.2.2 Perception of variability in climatic events and season

Although there was poor awareness of 'climate change' in most of the communities, a high level of perception of changes in climatic events was observed in this study. More than half of the respondents (see Table 3.1) in Thulamela (58%), Makhado (59.2%) and Mutale (70%) highlighted increased variability in rainfall patterns. There was no difference in this phenomenon across the municipalities ($p > 0.05$). About 74% of the respondents in Thulamela, 75.8% in Makhado and 85.3% in Mutale revealed that there was an increase in the incidence of extreme temperatures. However, observed variations in extreme temperatures, extreme winds, and serious drought were found to differ significantly ($p<0.05$) across the three municipalities.

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TABLE 3.1 Perceptions of rural people on changes in climatic events

Climatic event	Response	Proportion of respondents (%) in		
		Makhado (n = 156)	**Mutale (n = 110)**	**Thulamela (n = 100)**
Erratic rainfall	Increasing	59.2[a]	70.0[a]	58.0[a]
	Decreasing	29.9[a]	22.7[b]	36.0[c]
	No change	10.8[a]	7.3[a]	6.0[a]
Extreme temperature	Increasing	75.8[a]	85.3[a]	74.0[a]
	Decreasing	20.4[a]	13.8[a]	12.0[a]
	No change	3.8[a]	0.9[a]	14.0[b]
Extreme wind	Increasing	47.8[a]	64.2[b]	41.4[a]
	Decreasing	40.1[a]	20.2[b]	34.3[a,b]
	No change	12.1[a]	15.6[a,b]	24.2[b]
Serious drought	Increasing	51.6[a]	72.5[b]	27.3[c]
	Decreasing	36.3[a]	20.2[b]	51.5[c]
	No change	12.1[a,b]	7.3[b]	21.2[a]

Each subscript letter denotes the Bonferroni test of responses of respondents in Makhado, Mutale and Thulamela and their statistical differences at the 0.05 level for each investigated climatic event

As well as perceptions of variability in climatic events, respondents perceived changes in the onset and end of seasons. The results in Table 3.2 show the proportion of respondents in Makhado (57.1%), Mutale (71.6%), and Thulamela (62.4%) that perceived an early onset of the summer season. Fewer proportions of respondents perceived a delayed onset or no change in the summer season. Furthermore, the Pearson chi-square test indicated that there was no significant difference ($p = 0.196$) in perceived variations in summer across the municipalities. However, perceptions of variability in winter and spring were found to be significantly different ($P<0.05$) across the municipalities.

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TABLE 3.2 Perceptions of rural people on changes in onset and end of seasons

Season	Response	Proportion of respondents (%) in		
		Makhado (n = 156)	**Mutale (n = 110)**	**Thulamela (n = 100)**
Summer	Comes early	57.1[a]	71.6[b]	62.4[a,b]
	Delays	27.6[a]	19.3[a]	25.7[a]
	No change	15.4[a]	9.2[a]	11.9[a]
Winter	Comes early	36.3[a]	41.3[a]	44.0[a]
	Delays	43.3[a]	49.5[a]	34.0[a]
	No change	20.4[a]	9.2[b]	22.0[a]
Spring	Comes early	30.8[a]	21.1[a]	29.0[a]
	Delays	44.2[a]	73.4[b]	53.0[a]
	No change	25.0[a]	5.5[b]	18.0[a]

Each subscript letter denotes the Bonferroni test of responses of respondents in 'Makhado, Mutale and Thulamela' and their statistical differences at the 0.05 level for each investigated seasonal event

The researcher then used a stepwise logit model to examine factors influencing perception of changes in climate variability and change. Among the predictor variables that were tested, 'having no qualification' and 'farming skills' were significant influencing factors that met the 0.05 significance level for entry and stay in the model (Table 3.3).

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TABLE 3.3 Factors influencing respondents' perception of climate variability and change

Analysis of maximum likelihood estimates					
Parameter	**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	
Intercept	1	1.6378	0.1571	108.6284	<.0001
No Qualification	1	-0.4245	0.1589	7.1363	0.0076
Farming	1	0.4123	0.1419	8.4480	0.0037

Having no qualifications decreases the likelihood that a respondent would perceive variability in climate and extreme weather event by 0.425. This is because people without qualifications are probably illiterate and would therefore be limited in their ability to access information on climate variability and change from the media sources in their locality. In contrast, possession of farming skills increases the likelihood that a respondent would perceive variability in climate and extreme weather event by 0.412.

3.2.2 Awareness of specific indicators of climate change

Evidence from the literature suggests that changes in ecosystems, such as increase in frequency of incidence of pests, and changes in crop ripening seasons, etc. could be linked to impacts of climate change (Ziervogel *et al.,* 2014; Kadir et al., 2013). The researcher consequently investigated respondents' awareness of changes in ecosystem in their locality as a probable indicator of climate change. The results in Table 3.4 show respondents' observations of ecosystem indicators of climate change in their locality.

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TABLE 3.4 Indicators of climate change

Ecosystem indicators	Response	Proportion of respondents (%) in		
		Makhado (n = 156)	Mutale (n = 110)	Thulamela (n = 100)
New plant species	Yes	48.1	64.2	63.0
	No	42.9	30.3	32
	Don't know	9.0	5.5	5.0
	Binomial test	ns	***	**
New diseases in agricultural/tree crops	Yes	55.1	72.5	58.0
	No	28.8	16.5	33.0
	Don't know	16.0	11.0	9.0
	Binomial test	**	***	*
Increased frequency of incidence of pests	Yes	61.8	86.2	66.0
	No	15.9	2.8	22.0
	Don't know	22.3	11.0	12.0
	Binomial test	***	***	***
Changes in crop-ripening season	Yes	73.7	61.5	52.0
	No	19.2	20.2	38.0
	Don't know	7.1	18.3	10.0
	Binomial test	***	***	ns
Changes in flowering and fruiting time	Yes	77.1	64.2	55.0
	No	16.6	19.3	40.0
	Don't know	6.4	16.5	5.0
	Binomial test	***	***	ns
Changes in planting season	Yes	84.6	60.6	57.4
	No	12.2	22.9	38.6
	Don't know	3.2	16.5	4.0
	Binomial test	***	***	*
Changes in frequency of occurrence of bush fire	Yes	87.2	52.3	38.6
	No	9.0	24.8	52.5
	Don't know	3.8	22.9	8.9
	Binomial test	***	**	ns
Extinction of some plant species	Yes	76.4	85.3	62.0
	No	16.6	8.3	30.0
	Don't know	7.0	6.4	8.0
	Binomial test	***	***	***
Water sources and availability is becoming scarce	Yes	75.0	93.6	62.0
	No	23.7	3.7	38.0

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	Don't know	1.3	2.8	0.0
	Binomial test	***	***	*
Increased death of livestock	Yes	86.6	93.6	63.0
	No	9.6	3.7	25.0
	Don't know	3.8	2.8	12.0
	Binomial test	***	***	***

Binomial test analysis of yes and no responses by respondents * = $p<0.05$ ** = $p<0.01$ *** = $p<0.001$ ns = not statistically significant

There was a high level of perception in the ecosystem indicators of climate change. However, not all observed indicators are significant for all municipalities. The observation of new plant species was not significant for Makhado. Likewise, observations of changes in crop ripening season, and changes in flowering and fruiting time were not significant for Thulamela. However, all tested ecosystem indicators of climate change were significant in Mutale.

3.2.2 Access to climate information

The researcher examined the respondents' access to climate information to ascertain effective media for communicating climate information as a means of improving climate change awareness in the study area. Access to climate information via 10 major media sources **(newspaper, radio, meteorological service, television, observation, school/teacher, visiting** climate scientists/experts, village leader, and family and friends) in use in the study area was examined. The results in Table 3.5 show the top five media sources used to access climate information by respondents.

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TABLE 3.5 Media as a source of climate information among rural people

Information source	Response	Proportion of respondents (%) in		
		Makhado (n = 156)	Mutale (n = 110)	Thulamela (n = 100)
From friends and family	Yes	91.6	72.0	13
Radio	Yes	98.7	100	83
Village head	Yes	32.9	37.4	13
Meteorological service	Yes	81.2	7.2	15
School/teacher	Yes	90.9	4.3	46

Although word of mouth from friends and family was not a popular medium for accessing climate information in Thulamela (13.0), it was a popular source in Makhado (91.6), and Mutale (72.0). Moreover, the Pearson chi-square showed that there was a significant difference (P = 0.000) in the use of this media source across the municipalities. Similarly, the use of radio, village head, meteorological service and a school teacher as media for accessing climate information was significantly different (P<0.05) across the municipalities. The radio appeared to be the most widely used media source for accessing climate information, reaching up to 100% of respondents' usage in Mutale.

3.2.3 Perceptions regarding belief in the causes of climate change

The results in Table 3.6 show trends in the respondents' beliefs about the causes of climate variability and change. The belief that climate change is a natural phenomenon, caused by natural variation in climatics, was high in the three locations: Makhado (78.2%), Mutale (87.3%), and Thulamela (73%). This might be an indicator of high scepticism among rural households about the causes and reality of climate change. However, the Pearson chi-square test indicated that there was no significant difference (p = 0.140) in this belief across the municipalities.

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TABLE 3.6 Respondents' perception of causes of climate variability and change

Belief Category	Causative factor	Response	Proportion of respondents (%) in		
			Makhado (n = 156)	Mutale (n = 110)	Thulamela (n = 100)
Spiritual causes	Anger of the gods	It is a cause	28.7	45.9	14.0
		It is not a cause	27.4	21.1	30.0
		Don't know	43.9	33.0	56.0
	Ancestors' ways of punishing our wrongdoing	It is a cause	28.8	48.2	19.0
		It is not a cause	26.3	20.0	30.0
		Don't know	44.9	31.8	51.0
Anthropogenic causes	Population growth	It is a cause	45.5	88.1	27.0
		It is not a cause	34.6	5.5	43.0
		Don't know	19.9	6.4	30.0
	Uncontrolled harvest of forest resources	It is a cause	82.7	91.7	63.0
		It is not a cause	9.0	4.6	20.0
		Don't know	8.3	3.7	17.0
	Poor farming practices	It is a cause	72.4	89.0	68.0
		It is not a cause	19.2	5.5	22.0
		Don't know	8.3	5.5	10.0
Natural Phenomenon	Natural variations in the climate	It is a cause	78.2	87.3	73.0
		It is not a cause	13.5	7.3	16.0
		Don't know	8.3	5.5	11.0

The researcher observed a significant difference ($p<0.05$) across the municipalities in the belief that climate change is caused by cultural/spiritual issues, such as anger of the ancestors and of the gods. This belief was particularly low in all the municipalities, as evidenced in the proportions of respondents in Thulamela (28.7), Makhado (45.9), and Mutale (14), who believed that climate change was punishment from ancestral spirits. Despite this, belief in anthropogenic causes of climate change was high in the study communities, as evidenced in the proportion of respondents in Makhado (82.7%), Mutale (91.7%), and Thulamela (63.0%) that believed that climate change was caused by uncontrolled harvesting of forest resources. Additionally, there was a strong belief among respondents in Makhado (72.4%), Mutale (89.0%), and Thulamela (68.0%) that climate change was caused by poor farming practices. The belief in anthropogenic causes of climate change was also observed to differ significantly ($p<0.05$) across the municipalities.

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The researchers then explored the factors that influence beliefs in the causes of climate change. The results of the logit regression analysis are presented in Table 3.7.

TABLE 3.7 Factors influencing belief in causes of climate change

Belief	Factors	Estimate	Significance
Natural phenomenon	Gender (female)	-0.4877	*
	Concern about increase in energy cost as a result of climate change	0.8103	*
	Possession of animal husbandry skills	0.3910	*
Anthropogenic causes	Gender (female)	-0.9793	*
	Willingness to stop unregulated harvest of forest resources	0.4307	*
	Concern about shift in planting season as a result of climate change	0.8925	*
	Possession of carpentry skills	-2.0789	**
Cultural/spiritual causes	Concern about climate change effect on public health	-0.8889	*
	Possession of farming skills	0.3149	*
	Possession of livestock-keeping skills	0.5222	***

* = p<0.05 ** = p<0.01 p<0.001

The results in Table 3.7 showed that the possession of farming skills and animal husbandry skills increases the likelihood that a respondent would associate causes of climate change with cultural or spiritual beliefs. Similarly, concern about the shift in planting season as a result of climate change, and willingness to embrace controlled harvesting of forest resources in response to climate-change impacts increased the likelihood that a respondent would believe in anthropogenic causes of climate change. However, gender, with reference to female, decreased the likelihood that a respondent would associate climate change with a natural phenomenon. But, there was a correlation between the belief that climate change is caused by cultural or spiritual issues and the belief that climate change is a natural phenomenon as both beliefs were significantly influenced by a common factor, namely possession of livestock-keeping skills.

3.2.6 Concern about climate change

Concern of the people about the effects of climate change on their lives and livelihoods was explored. The results in Table 3.8 revealed that the majority of the respondents were

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concerned about climate change and its impact on their lives and livelihoods. More than 90% of all respondents were strongly concerned about the direct and indirect effects of climate change on availability of water, public health, and food supplies.

TABLE 3.8 Concern about climate change impact and consequences

Concerns	Response	Proportion of respondents (%) in		
		Makhado (n = 156)	Mutale (n = 110)	Thulamela (n = 100)
Damage to forest resources	Not at all	9	7.3	6.9
	Less concerned	7.7	6.4	1.0
	Strongly concerned	83.3	86.4	2.1
Increase food cost	Not at all	1.3	4.5	1.0
	Less concerned	3.2	0.9	1.0
	Strongly concerned	95.5	94.5	98
Danger to public health	Not at all	1.3	2.8	2
	Less concerned	1.3	0.0	0.0
	Strongly concerned	97.4	97.2	98
Reduce water availability	Not at all	0.6	2.8	4
	Less concerned	1.3	0.0	0.0
	Strongly concerned	98.1	96.3	96
Shift in planting season	Not at all	2.5	3.6	8
	Less concerned	7.6	7.3	7
	Strongly concerned	89.8	89.1	85.0

The majority of respondents in Makhado (83.3), Mutale (86.4), and Thulamela (92.1) were strongly concerned about climate-change effects on forests and forest resources. However, a few respondents were not at all concerned about this. The Pearson chi-square test showed that no significant difference ($p = 0.182$) in concern about the climate-change effect on forest resources across the municipalities. Thus there was strong concern about the climate-change effect on forest resources across the municipalities. The researchers equally observed strong concern about climate-change effects on water availability, public health, food costs, and planting season across the municipalities.

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3.2.7 Willingness to adopt intervention measures for climate change

The results in Table 3.9 showed that the majority of respondents in all the study villages were willing to embrace several types of behavioural change towards responsible forest use and management by contributing to collective sustainable forest management as a strategy towards improving lives and livelihood resilience against climate change. More than 60% of the respondents in all the study communities agreed or strongly agreed that their adoption of responsible behaviour – such as stopping unregulated harvesting of forest resources, accepting training in good forest exploitation practices, planting more trees on farms, using alternative cooking energy to firewood and charcoal, and diversifying income by learning how to use non timber forest products (NTFPs) (e.g. beekeeping and mushroom collection/production) – would contribute positively towards the execution of effective forest-based climate-change intervention measures in their community.

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TABLE 3.9 Behaviour change for collective climate change management

Behaviour change	Response	Proportion of respondents (%) in		
		Makhado (n = 156)	Mutale (n = 110)	Thulamela (n = 100)
Stop unregulated harvest of forest resources	Strongly agree	17.3	94.5	30
	Agree	49.4	2.8	44
	Neither agree nor disagree	0.6	0.0	2
	Disagree	23.7	1.8	20
	Strongly disagree	9	0.9	4
Accept training in good forest exploitation practices	Strongly agree	20.9	0.9	37
	Agree	70.9	96.4	59
	Neither agree nor disagree	2.5	2.7	1
	Disagree	4.4	0.0	1
	Strongly disagree	0.6	0.0	2.
Willing to use alternative cooking energy other than firewood and charcoal	Strongly agree	7.6	78.2	25.3
	Agree	54.1	1.8	58.6
	Neither agree nor disagree	5.7	0.9	1.0
	Disagree	27.4	15.5	10.1
	Strongly disagree	5.1	3.6	5.1
Willing to plant more trees on farms	Strongly agree	24.4	92.7	31.0
	Agree	69.9	4.5	60.0
	Neither agree nor disagree	1.3	0.0	0.0
	Disagree	3.8	0.0	6
	Strongly disagree	0.6	2.7	3
Willing to diversify income by learning how to cultivate NTFPs such as beekeeping, mushroom production	Strongly agree	12.2	61.8	28
	Agree	66.7	0.9	49
	Neither agree nor disagree	8.3	1.8	1.0
	Disagree	11.5	20	16
	Strongly disagree	1.3	15.5	6

There was strong agreement by respondents in all the study communities to accept behavioural change as a way of participating in collective efforts of improving lives and livelihood resilience against climate variability and change in the study communities.

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3.3 DISCUSSION

3.3.1 Awareness

A disproportionate level of awareness of the term 'climate change', as observed in the communities assessed in this study, is a common trend in Africa. For instance, Nzeadibe et al. (2013) reported that over 60% of respondents in the Niger Delta region of Nigeria knew little or nothing about climate change. Egbe *et al.* (2014) reported a high level of awareness (71.7%) of the term among rural dwellers in Cross River State, Nigeria. Similarly, Ndhleve et al. (2014) reported that that about 70% of rural farmers in Ntabankulu local municipality, Eastern Cape Province, South Africa are aware of climate change. This trend highlights the need for more enlightenment campaigns to ensure a high level of awareness of climate change among the rural population in Vhembe. The high level of awareness observed in Thulamela showed that the rural populace are not completely oblevieance of climate change and its associated impacts, but intensification is needed across all municipalities. Poor levels of awareness of the term 'climate change' in Mutale and Makhado could hinder the people's meaningful participation in intervention programmes, which might result in increased vulnerability. As Gbetibouo (2009) and Maddison (2007) observed, awareness of climate change presents an opportunity to reduce vulnerability. There is therefore a need to improve climate-change communication efforts in the study area.

Despite poor awareness of the term 'climate change' in most of the study area, there was a high level of perception of changes in climatic events. Erratic rainfall, flood incidence, extreme temperatures and drought are climatic events that respondents observed to be showing high variability. Egbe *et al.* (2014) reported similar observations in climatic events in Nigeria. Aside from the perception of changes in climatic events, respondents perceived changes in the onset and end of seasons. Rural people have been observed to be able to perceive changes in the onset and end of seasons in their locality (Kalinda, 2011). This indicates that although rural people may not be aware of the term, they are alert to climate variability and extreme weather events in their locality. Thus linking climate information with prevailing extreme weather events in the locality could be an effective means of improving climate-change awareness in the community.

Additionally, a high number of respondents reported that they had observed an increasing occurrence of ecological changes, such as changes in crop ripening season, and flowering and fruiting times. This indicates the likelihood that climate-change-induced environmental

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change is occurring in the area. These ecological changes are often regarded as ecosystem indicators of climate change (Ziervogel *et al.,* 2014; Kadir et al., 2013). Similar trends have been observed by Nesha *et al.* (2014), in which 43% and 59% of respondents reported that they had observed the disappearance of species and environmental degradation, respectively. However, it is difficult to say with certainty that these observed ecosystem indicators of climate change in the study area are solely the result of climate change.

The study also showed that lacking qualifications decreased the likelihood that a respondent would be aware of the term 'climate change' or perceive variability in climatic events. On the other hand, having farming skills was found to improve the likelihood that a respondent would be aware of or perceive changes in climatic event. This line of thinking is supported by the findings of Apata *et al.* (2009) and Gbetibouo (2009), in which farmers were observed to have a higher level of perception of changes in their environment.

Observed factors that influence perceptions and awareness of climate change suggest that perceptions are influenced by the respondent's educational and socioeconomic profile. Efforts to improve climate-change awareness in the study communities would hence be more effective if the way in which climate-change communication is designed suits the community's educational and socioeconomic profile. This would improve their chances of understanding and relating to such information, thereby improving climate-change awareness in the area. Grounding a climate-change information dissemination approach on experiences that the people could understand in a local and personal context, particularly their livelihood activities would thus be a welcome strategy. Information based solely on the science, nature and causes of climate change is unlikely to improve people's understanding, awareness and perceptions of the phenomenon.

3.3.2 Access to climate information

The top five media sources popularly used by people in the study communities to access climate information could play a significant role in improving their climate-change awareness. Timely access to climate information is a key component of adaptation planning. As observed by Wiid and Ziervogel (2012), access to climate information improved farmers' productivity compared with those farmers that relied on past climate experiences. Incorporation of traditional leaders (village heads and chiefs) in climate-change awareness programmes could be an important strategy for improving climate-change awareness through

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improved access to information, given the communities' leadership structure and the significant role played by chiefs and village headmen in maintaining peace and order in the communities.

Overall, an integrated approach that utilizes all media sources simultaneously could be an effective means of improving climate-change communication in the area. This implies that policymakers and stakeholders who address climate change in the area should make full use of media channels to disseminate information to the rural people. In addition, new media sources for real-time delivery of climate information for efficient and effective delivery of climate information could be explored. This would be essential to improving climate-change awareness, and the people's adaptive capacity. Thus, dissemination of real-time climate information via mobile phones is a medium that is worth exploring.

3.3.3 Perceptions regarding belief in the causes of climate change

A high level of belief that climate change is a natural phenomenon, caused by natural variation in climatic conditions, might be an indicator of scepticism among rural households about the causes and reality of climate change. Scepticism about the reality of climate change among rural households is not entirely strange. Capstick (2012), Marsden *et al*. (2009), and Lorenzoni and Langford (2001), in their studies on public perception of climate change in Australia and UK, respectively, observed a great deal of disbelief among the public about the causes and reality of climate change. Scepticism has obvious implications for climate-change interventions in the area, which might be tough to sell to sceptics (Rejesus, 2012). The cause of this cynicism is difficult to ascertain as little published peer-reviewed research has explored how rural forest-based communities in South Africa conceptualize climate change. Nevertheless, the finding of high degrees of scepticism among rural households in the study area speaks to the need to educate rural people on the concept and causes of climate change. There were also a small proportion of respondents in the study communities who perceived cultural issues such as punishment from ancestral spirits as a cause of climate change. A similar trend was observed by Egbe *et al.* (2014), in which a negligible (4.7%) proportion of respondents perceived supernatural powers as the cause of climate variability and change. People with this type of belief may be difficult to convince to participate in climate-change interventions.

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Although scepticism about the cause and reality of climate change is great in the study area, the belief in anthropogenic causes of climate change is equally high. Strong belief in anthropogenic causes of climate change was also observed by Dube and Phiri (2013) and Egbe *et al.* (2014) among rural people in Africa. Belief in anthropogenic activities as a cause of climate change is a strong indicator of belief in the reality of climate change in the study area, and of possible public acceptance of climate-change intervention measures. The challenge for development officials in these communities would therefore be to convince sceptics and believers to cooperate and participate productively in climate-change interventions in the community.

3.3.4 Concern about climate change

Observed strong concern about climate-change effects on forest resources, public health, water, etc., among respondents in the study communities is consistent with what has been observed elsewhere. Duan and Hu (2014) reported that 77.6% of respondents in northern China were concerned about the impact of climate change on water availability. In the same vein, Spence *et al.* (2010), in a study about public perceptions of climate change and the energy future in Britain, reported that over two thirds (71%) of respondents were 'very concerned' (28%) or 'fairly concerned' (43%).

Theoretically, strong concern about climate-change impacts on forest resources might indicate that rural people in South Africa would readily embrace forest-based climate-change adaptation and mitigation programmes. Concern about climate-change effects on forest resources is more likely to influence the people to participate actively in forest management and embrace responsible behaviour towards forest exploitation and use. As observed by Ameur *et al.* (2001), behavioural change towards responsible forest-based livelihood practices is driven primarily by the level of concern about climate-change effects and consequences, with individuals striking a personal balance between these factors. The challenge for local authorities would be to translate concern about climate-change effects on forest resources into improved rural people's participation and ownership in forest management practices.

Although people's awareness and their perceived importance of environmental issues do not always translate into actions to change behaviour (Lonrenzoni & Langford 2001), evidence from this study shows a general strong will to change behaviour in favour of mitigation

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efforts at managing climate change. If people are informed about climate-change challenges and their effects on forests, behavioural change towards responsible forest use and management might be realized. As observed by Ajzen (1991), people's intentions towards responsible forest use and management could be inspired by their beliefs, attitudes, and knowledge and understanding of climate-change issues. Translating people's expressed behavioural change towards responsible forest use and management into action, and mobilizing them to participate meaningfully in forest management would thus be essential for climate-change intervention programmes in the area.

3.4 CONCLUSIONS AND RECOMMENDATIONS

This chapter examined the understanding of climate change and associated extreme weather events in the context of awareness and attitudes from the perspective of forest-based rural communities in South Africa. Although awareness of the term 'climate change' is generally low in Mutale and Makhado municipalities, but high in Thulamela, the majority of community members expressed a high level of mindfulness of the issues and challenges of climate change and extreme weather events. Nevertheless, widespread awareness and acceptance may not necessarily translate to widespread engagement with climate change. As was observed in the study, belief in anthropogenic causes and natural phenomena causes of climate change is high in the study area. This might pose a challenge when mobilizing believers in the reality of climate change and sceptics for collective participation in intervention programmes. In general, there was widespread concern about climate-change effects on lives and livelihoods. The researcher therefore recommend the use of multiple media sources and the association of climate information with people's livelihood activities as a strategy for improving climate-change awareness, addressing people's concerns and promoting their engagement in climate-change interventions in the study communities.

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CHAPTER 4

Perception-based analysis of climate change effect on forest-based livelihoods

ABSTRACT

Forests are vulnerable to climate change and are a major source of livelihood for many rural households in Africa. This study examines rural people's perceptions of climate-change impacts on forest-based livelihoods using rural communities of Vhembe District in South Africa as a case study. The study was based on the principles of perceived impact-based assessment and a sustainable livelihoods framework. Using the stratified proportionate random sampling procedure in combination with weighted enumeration area (EA) for the selected communities, 366 households were chosen and interviewed. Data analysis involved computing frequencies and conducting chi-square, binomial tests, and binary logistic regression analysis. The respondents identified erratic rainfall, extreme temperatures, extreme drought and flooding as key climatic impacting factors in their community. But not all these factors were perceived to constitute risks to forest products and forest-based livelihoods. Only extreme drought was indicated to constitute risk to availability of forest products. In addition, the binary logistic regression showed a significant difference ($p<0.05$) in the perceived risk of climate change to availability of essential forest products across the three municipalities. Hence forest development initiatives are needed that target vulnerable forest products per community as a means of enhancing resilience of forest-based livelihoods to climate change n rural community development in South Africa.

Keywords: forest-based livelihood, climate change, climate variability, perception, forest-based communities[2]

[2] This chapter is based on published article cited as, "Ofoegbu, C., Chirwa, P.W., Francis, J. & Babalola, F.D., 2016, 'Perception-based analysis of climate change effect on forest-based livelihood: The case of Vhembe District in South Africa', Jàmbá: Journal of Disaster Risk Studies 8(1), a271. http://dx.doi.org/10.4102/jamba.v8i1.271"

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4.0 INTRODUCTION

Household livelihoods in most rural communities in South Africa, like elsewhere in Africa, are highly dependent on forest resources (Malone & Rovere 2012; Davies *et al.,* 2009; Hachileka, 2009; Mertz *et al.*, 2009; Charnley, 2005; Clarke & Isaacs, 2005), with farming, animal husbandry, and harvesting and trade in forest resources being the dominant livelihood activities (Vhembe 2013; Kyei, 2011; Chamberlain et al., 2005). Forest resources are in essence crucial to rural development in South Africa. However, observed and predicted impacts of climate change are projected to have an extensive range of consequences, many of which represent major threats, for example droughts, flash floods, and decline in crop productivity (Chinara *et al.*, 2013; Capstick, 2012; Ogalleh *et al.,* 2012; Kalinda, 2011; Mengistus, 2011; Bryan *et al,.* 2009; Mertz *et al*., 2009). These effects also pose significant threats to forests, livelihoods, and rural development, which might result in increased intensity of poverty.

Key sectors that are vital for rural development in South Africa, such as forests, water resources, tourism and agriculture, are vulnerable to climate change (IPCC, 2007; Lazo *et al.,* 2000). Specifically, there is growing evidence that climate change impacts would diminish the capacity of forests to provide goods and services with serious implications for the livelihoods of forest-based rural communities (Okali, 2011). Moreover, close proximity and strong linkages to climate-sensitive environs of forest-based communities make them uniquely vulnerable to climate change (Boon & Ahenkan, 2012; Davidson *et al.,* 2004). Because of their geographic location, forest-based communities are extremely exposed to recurrent environmental threats such as forest fires, pest and disease outbreaks, and strong winds (Davidson *et al.,* 2004); and these risks could be exacerbated by climate change. In addition to being exposed to climate-change shocks, forest-dependent rural communities in South Africa are faced with socioeconomic challenges such as high unemployment, poverty and low economic development opportunities (Vhembe 2013).

Several authors have investigated the impact of climate change on the forestry sector. Williamson *et al.* (2005) examined forestry experts' perceptions of climate-change impacts on forest ecosystems and forest-based communities. Davidson *et al.* (2004) reported that forest fires are on the increase in Canada. Chinara *et al.* (2013) observed that possible changes in climate could make current livelihoods unsustainable, resulting in deeper poverty

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and a shift into poverty of those who are currently not poor. In the same vein, Kalinda (2011) reported that climate change is a major challenge to the attainment of sustainable development in most African countries and could adversely affect poverty reduction efforts in rural communities. Furthermore, Mengistus (2011), Ogalleh et al. (2012) and Mertz *et al.* (2009) predicted that climate change would have negative effects on forest resources and rural livelihoods, which would pose a significant threat to Africa's attainment of sustainable development.

Although perceptions of climate change impact are increasingly gaining recognition in disaster assessment (Williamson *et al.,* 2005), concerns about rural people's ability to perceive climate-change effects are equally increasing. Maddison (2007) is of the view that rural farmers may take time to realize that unusual weather represents a permanent shift in the climate. Claas (2011) argues that the majority of people rate the impact of climate change on an abstract, cognitive level, which might lead to an underestimation of the hazards of climate change. However, efforts towards effective resilience improvement strategies and formulation of climate change intervention policies are difficult without an understanding of individuals' perception of climate-change impacts (Spence *et al.,* 2010). As noted by Davidson *et al.* (2004), people's perceptions of impacts would influence how and when households start to take action to adapt to climate change. An understanding of rural people's perception of climate-change impact on their livelihoods is therefore crucial to improving the people's resilience against it (Hansen *et al.,* 2007). This is essential in assuring that efforts to address climate change impacts correspond with actual concerns (Chinara *et al.,* 2013).

Most studies on the effects of climate change on forests and rural development in South Africa have focused on biophysical impacts vis-à-vis temperature rise and erratic rainfall (Turpie & Visser, 2013; Naidoo *et al.,* 2013; Lindner et al., 2008; Davidson et al., 2004) and forest ecosystem functioning (Fairbanks & Scholes, 1999), and their economic implications to society, while human dimensions, including socioeconomic implications of climate change at rural community level, have been overlooked. As reported by Piya *et al.* (2012), climate change manifestations in any community are unique to the economic, ecological and social characteristic of that community. In fact, there is increasing scientific evidence that highlights the importance of understanding the context-specific impacts of climate change (Claas *et al.* 2011; IPCC, 2007), hence, the need to understand the susceptibility of forest-based communities to climate change influences in South Africa. This understanding is fundamental

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to expounding climate-change manifestations at a level where practical local intervention action is possible (Chinara *et al*., 2013).

Perceptions of climate consequences at household level have not received much attention from researchers in South Africa. Most importantly, the effects of climate change on local contexts, particularly in rural forest-based communities, are poorly understood (Turpie & Visser 2013; Williamson *et al*., 2005). This knowledge gap is pertinent to the forestry sector, which forms the basis of most rural livelihoods in the country (Chigavazira, 2012; Quinn, 2011; Nzuma et al., 2010). This study therefore sought to address this gap by examining perceptions of local people on climate-change impacts and ways in which forest-based livelihoods in rural communities are affected by climate variability and extreme weather events. It evaluated climate-change impacts in the context of perceived exposure and sensitivity of essential forest products to climate variability and extreme events. The case study communities were forest-based rural communities in Vhembe District of South Africa.

With respect to the foregoing, the study intended to provide answers to the research questions associated with objective two of the study.

Findings of this study could initiate the formulation of policies and development of initiatives toward effective and sustainable climate-change intervention in rural communities of South Africa.

4.1 METHODOLOGY

Information about sampling procedure and data analysis has been provided in detail in Chapter 2.

4.2 RESULTS AND DISCUSSIONS

4.2.1 Demographic characteristics of respondents

The results of the demographic information presented in Table 4.1 show that majority of the respondents were within the age range of ≤35–69. Thulamela had the smallest proportion of population in the age range of ≥70. Furthermore, women were the majority in all the

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municipalities (71.6–83.3%), largely because men migrate to urban areas for work and send remittances to their families in the rural areas. The majority of respondents in Makhado (64.6%) and Mutale (73.4%), and fewer respondents in Thulamela (45.5%) did not have formal education. Length of residency of most respondents was in the range of 1 to 5 years (Makhado), 11to 15 years (Mutale), and 20 years and above (Thulamela).

Table 4.1: Demographic profile of respondents

Demographic characteristics	**Makhado (%)**	**Mutale (%)**	**Thulamela (%)**
Age (years)			
≤ 35	17.8	15.5	34
36 – 47	18.5	12.7	27
48 – 58	21	18.2	20
59 – 69	21.7	27.3	14
≥ 70	21	26.4	5
Gender (%)			
Male	16.7	28.4	20
Female	83.3	71.6	80
Length of residency			
1–5	23.1	16.4	26
6–10	18.6	18.2	19
11–15	22.4	29.1	12
16–20	19.9	24.5	16
More than 20	16	11.8	27
Highest level of education (%)			
No formal education	64.6	73.4	45.5
Grade 11 or Lower	16.5	17.4	23.2
Grade 12(Matric, Std 10)	12.0	2.8	21.2
Post-matric diploma	3.8	4.6	4
Baccalaureate degree (s)	1.9	0	1
Postgraduate degree(s)	1.3	1.8	5.1

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4.2.2 Perception of climate change impacts

The results in Table 4.2 show that the majority of respondents in Makhado (59.2%), Mutale (70%) and Thulamela (58%) perceived that the incidence of erratic rainfall had increased. In addition, the Bonferroni test showed that these perceptions did not differ significantly. The comparison analysis of perceived increase and decrease in erratic rainfall event in the three municipalities showed that there was a significant increasing trend in erratic rainfall events in all municipalities (p = 0.00). Similarly, the researcher observed a significant increasing trend in the occurrence of extreme temperatures and flooding in all the municipalities (p = 0.00). This is consistent with the findings of Davies *et al.* (2009) in which mounting evidence of increase in climate variability and climate change were observed in many climatic zones of South Africa. Similarly, Naidoo *et al.* (2013) observed evidence of rising temperatures at local level in Vhembe and semiarid regions of South Africa.

Table 4.2: Perceived increase and decrease in climatic events in the study communities

Climatic event	Response	Proportion of respondents (%) in		
		Makhado (n = 156)	Mutale (n = 110)	Thulamela (n = 100)
Erratic rainfall	Increasing	59.2[a]	70.0[a]	58.0[a]
	Decreasing	29.9[a]	22.7[b]	36.0[c]
	No change	10.8[a]	7.3[a]	6.0[a]
	Binomial test	0.00*	0.00*	0.00*
Extreme temperature	Increasing	75.8[a]	85.3[a]	74.0[a]
	Decreasing	20.4[a]	13.8[a]	12.0[a]
	No change	3.8[a]	0.9[a]	14.0[b]
	Binomial test	0.00*	0.00*	0.00*
Flooding	Increasing	47.8[a]	64.2[b]	41.4[a]
	Decreasing	40.1[a]	20.2[b]	34.3[a,b]
	No change	12.1[a]	15.6[a,b]	24.2[b]
	Binomial test	0.00*	0.00*	0.00*
Serious drought	Increasing	51.6[a]	72.5[b]	27.3[c]
	Decreasing	36.3[a]	20.2[b]	51.5[c]
	No change	12.1[a,b]	7.3[b]	21.2[a]
	Binomial test	0.00*	0.00*	0.00*

*Each subscript letter denotes a subset of community categories whose row proportions do not differ significantly from each other at the .05 level. Binomial test analysis of increasing and decreasing responses by respondents *significant at 0.05; ns = not significant at 0.05*

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In contrast, the researcher observed only a significant increasing trend in the occurrence of serious drought in Makhado and Mutale (p = 0.0000). In Thulamela, the incidence of serious drought was observed to be significantly decreasing (p = 0.00). The observed differences in the trend of occurrence of serious drought events in the three municipalities could be attributed largely to the state of water supply facilities. In Thulamela, a tap water facility is widespread in all the rural communities and there is a high level of satisfaction with it. Hence the effect of serious drought is substantially managed and less felt by the people. However, in Mutale and Makhado, where there was a high level of dissatisfaction with the water supply facility, the effect of serious drought is greatly felt by the people. The situation is more alarming in Mutale, which is located in an arid region characterized by increased water-stress challenges.

In addition, binomial test analysis of respondents' prioritized perception of the risk of climate variability and extreme events in their community showed that all four climatic events (erratic rainfall, extreme temperatures, serious drought, and flooding) were prioritized as key climatic impact factors for Makhado and Mutale municipalities. However, for Thulamela only erratic rainfall, extreme temperature, and extreme wind were prioritized. Consequently, the researcher postulated that forest-based livelihoods in Mutale and Makhado might be more at risk of climate variability and change than those in Thulamela. Increased occurrence of these climatic events could have significant effects on forests and forest-based livelihoods in the study communities. As observed by Maponya and Mpandeli (2013), and Lindner *et al.* (2008) rising temperatures and decreasing rainfall would lead to an increased occurrence of drought periods in semiarid regions of Vhembe. This may lead to an increase in fire risks.

4.2.3 Perceived effects of climate variability and change on access to forest

There are complex ways through which climatic variability and change could affect forests and forest-based livelihoods directly or indirectly. Table 4.3 shows the results of an analysis of the perceived effects of climate variability and change on access to forest for essential forest products used for livelihoods in the study communities. There were generally significant differences across the municipalities in perceived effect of climate variability and change on access to forest products (P = 0.000). For all four climatic events analysed, in Makhado the response in access to the forest resource was similar (28–42%). However, for Mutale there tended to be temporarily reduced access to the forest resource as a result of all

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the climatic events (73–91%). Interestingly, in Thulamela, more people (50–58%) felt that there was no effect on access to forests. The difference in perceived effect of climate variability and change on access to forest could be attributed largely to more forests around and within study communities in Thulamela area.

Table 4.3: Perceived effects of climate variability and change on access to forest

Climatic event	**Responses**	**Proportion of respondents (%) in**		
		Makhado (n = 156)	**Mutale (n = 110)**	**Thulamela (n = 100)**
Erratic rainfall	No effect	30.1[a]	24.8[a]	58[b]
	Temporary reduced access (3-4 months)	34[a]	73.4[b]	37[a]
	Extended reduced access (5 months and above)	35.9[a]	1.8[b]	5[b]
Extreme temperature	No effect	35.9[a]	8.3[b]	57[c]
	Temporary reduced access (3-4 months)	34[a]	90.8[b]	32[a]
	Extended reduced access (5 months and above)	30.1[a]	0.9[b]	11[c]
Flooding	No effect	28[a]	12.8[b]	50[c]
	Temporary reduced access (3-4 months)	34.4[a]	86.2[b]	35[a]
	Extended reduced access (5 months and above)	37.6[a]	0.9[b]	15[c]
Extreme drought	No effect	24.2[a]	7.6[b]	57.6[c]
	Temporary reduced access (3-4 months)	33.8[a]	91.4[b]	31.3[a]
	Extended reduced access (5 months and above)	42[a]	1[b]	11.1[c]

Each subscript letter denotes a subset of community categories whose row proportions do not differ significantly from each other at the .05 level.

The researcher investigated the perceived effect of climate variability and change on availability of essential forest products used in the communities for livelihoods. Table 4.4 shows similarity in the proportions of respondents in Makhado (68.2%) and Mutale (56.9%) that believed firewood was becoming scarce as a result of the effects of climate variability and change. The belief that climate variability and change effect is reducing availability of firewood was significant in Makhado ($p = 0.0000$), but not in Mutale (0.1096). Similarly, 74% of respondents in Thulamela significantly believed that climate variability and change were not having negative effects on the availability of firewood ($p = 0.0000$). The difference in perceived effect of climate variability and change on firewood across the municipalities is

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similar to the trends observed in access to forest. Generally, it appears that forests in Thulamela are more resilient to current climate risks and are in a better condition to sustainably provide rural dependents with essential goods.

Table 4.4: Perceived vulnerability of forest products to climate change and variability

Forest product	Effect on product availability	Proportion of respondents (%) in		
		Makhado (n = 156)	Mutale (n = 110)	Thulamela (n = 100)
Firewood	No	31.8[a]	43.1[a]	74.0[b]
	Yes	68.2[a]	56.9[a]	26.0[b]
	Binomial test	0.00*	0.11[ns]	0.00*
Forest fruits and food	No	12.7[a]	40.4[b]	64.0[c]
	Yes	87.3[a]	59.6[b]	36.0[c]
	Binomial test	0.00*	0.04*	0.00*
Timber/construction wood	No	40.8[a]	85.3[b]	45.5[a]
	Yes	59.2[a]	14.7[b]	54.5[a]
	Binomial test	0.004*	0.00*	0.24[ns]
Charcoal	No	59.9[a]	87.2[b]	10.0[c]
	Yes	40.1[a]	12.8[b]	90.0[c]
	Binomial test	0.03*	0.00*	0.00*
Thatch grass	No	24.2[a]	46.8[b]	76.0[c]
	Yes	75.8[a]	53.2[b]	24.0[c]
	Binomial test	0.00*	0.25[ns]	0.00*
Wild vegetables	No	13.4[a]	27.3[b]	66.0[c]
	Yes	86.6[a]	72.7[b]	34.0[c]
	Binomial test	0.00*	0.00*	0.00*
Mushroom	No	20.4[a]	85.3[b]	32.0[a]
	Yes	79.6[a]	14.7[b]	68.0[a]
	Binomial test	0.00*	0.00*	0.00*
Honey	No	22.9[a]	75.5[b]	36.0[a]
	Yes	77.1[a]	24.5[b]	64.0[a]
	Binomial test	0.00*	0.00*	0.00*
Medicinal plants	No	37.8[a]	17.4[b]	73.0[c]
	Yes	62.2[a]	82.6[b]	27.0[c]
	Binomial test	0.00*	0.00*	0.00*
Fodder for livestock	No	22.4[a]	30.0[a]	67.0[b]
	Yes	77.6[a]	70.0[a]	33.0[b]
	Binomial test	0.00*	0.00*	0.00*

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*Each subscript letter denotes a subset of community categories whose row proportions do not differ significantly from each other at the .05 level. Binomial test analysis of yes and no responses by respondents *significant at 0.05; ns = not significant at 0.05*

In general, the availability of other forest products (fodder for livestock, medicinal plants, honey, mushroom, wild vegetables, thatch grass, timber, and forest fruits and food) surveyed in Makhado was perceived to have been significantly affected by climate variability and change ($p = 0.0000$). The perception was in the range of 59.9% to 87.3%. In Mutale, the availability of firewood and thatch grass was perceived not to have been significantly affected by climate variability and change ($p>0.05$). The obtainability of other forest products, namely fodder for livestock, medicinal plants, wild vegetables, and forest fruits and foods, was perceived to have been significantly affected by climate variability and change ($p<0.05$). The perception ranged from 53.2% to 87.2%. However, in Thulamela, only certain forest products, namely honey, mushrooms and charcoal, were perceived to have been significantly affected by climate variability and change ($p<0.05$). These results indicate that forest products in Makhado and Mutale might be more exposed to climate risk than those in Thulamela. More specifically, forest products in Makhado seem to be the most exposed to climate risk. Theses results could also indicates that forest area and population density per community have significant influence on the peoples´s perception of the vulnerability of forest-based livelihoods. For example, in Makhado, where there is a higher population density per community and consequently more human pressure on forests, forest product availability was perceived to have been more impacted by climate variability and change. However, in Mutale, where the population density per community was lower, but which has a higher proportion of degraded forest, forest product availability was perceived to have been less impacted by climate variability and change. This notion was strengthened by the Pearson chi-square test, which showed that there was a significant difference in observed variation in perceived effect of climate variability and change on availability of forest products among the municipalities ($p<0.05$).

4.2.4 Sensitivity of essential forest products to key climatic impacting factors

The researcher has gained insight into respondents' beliefs about the effects of climate variability and change on access to forest and availability of forest products in the study communities. However, the perceived sensitivity of each essential forest product to key climatic factors is not yet known. Thus, binary logistic regression was used to examine

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sensitivity of forest products to each of the key climatic impacting factors. This was done to ascertain whether any forest products were perceived to be more vulnerable to particular climatic events. These forest products were tested: woody products (firewood, charcoal, timber/construction wood) and non-woody products (mushrooms, medicinal herbs, thatch grass, and wild fruits/vegetables).

The result of the analysis showed that the people do not perceive any of the essential forest products to be particularly vulnerable ($p>0.05$) to erratic rainfall and extreme temperature events. However, increased incidence of flooding and extreme drought were perceived to have significant association ($p<0.05$) with availability of essential forest products in the study communities (Tables 4.5 and 4.6).

Table 4.5: Perceived sensitivity of forest products to increase incidence of flooding

Analysis of Maximum Likelihood Estimates					
Parameter	**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
Intercept	1	1.0018	0.3595	7.7652	0.01
Timber/construction wood	1	-0.2737	0.1050	6.7990	0.01

Most of the surveyed forest products, namely firewood, charcoal, mushrooms, medicinal plants, thatch grass, and wild fruits and vegetables, were observed to have no significant association with increased incidence of flooding ($P>0.05$). Timber/construction was the only product observed to have a significant association with flooding ($P<0.05$). Increased incidence of flooding is shown to reduce the likelihood that the people would report scarcity of timber or construction wood by 27%. This may imply that the people do not perceive flooding to be a risk to availability of timber. In general, flooding was not perceived to be a risk to any of the forest products used for livelihoods in the study communities.

However, the incidence of extreme drought was perceived to be a risk to availability of firewood alone in the study communities (Table 4.6). The occurrence of extreme drought increases the likelihood that the people would experience scarcity by 33%. This may imply that the people do perceive extreme drought as a risk to firewood availability.

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Table 4.6: Perceived sensitivity of forest products to increase incidence of extreme drought

Analysis of Maximum Likelihood Estimates					
Parameter	**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
Intercept	1	1.0018	0.3595	7.7652	0.0053
Firewood	1	0.3320	0.1138	8.5023	0.0035

Apart from firewood, forest products tested were timber, charcoal, mushrooms, medicinal plants, thatch grass, and wild fruits and vegetables. They were not perceived to have a significant association with increased incidence of extreme drought.

4.2.5 Implications of climate change impact perception for disaster management

Across the entire sampled communities, most respondents perceived increased occurrence of climatic and extreme weather events. These climatic events were perceived to have varying effects on access to forests and forest products availability. Observed variations in the perceptions of climate change impact on forest products and sensitivity of forest products to key climatic impacting factors raised concern about the ability of rural people to accurately perceive climate-change effects on their livelihoods. Specifically, erratic rainfall and temperature were perceived to pose no risk to forest-based livelihoods, yet these climatic events have been empirically proven to have significant impacts on forest growth and vitality (Gauthier *et al.,* 2014; Maponya & Mpandeli, 2013; Naidoo *et al*., 2013; Lindner et al., 2008). Additionally, in instances where some forest products (e.g. firewood) were perceived to be at risk to some key climatic impacting factors, the perceptions showed contrasting results. For instance, people perceived firewood to be at risk to extreme drought event, but did not perceive timber to be at risk to the same event. This contrast suggests that perception-based analysis is insufficient to accurately determine climate-change impact on forest-based livelihoods and the vulnerability of forest products to climate change at rural community level. Another plausible explanation was that respondents were more observant about products they used daily than those they used periodically. It could also be that respondents overwhelmingly underestimated climate-change outcomes in their community. This notion was argued by Claas (2011), who postulated that the general public often rate climate change impacts on an abstract, cognitive level, which might lead to an underestimation of climate

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change hazards. Similarly, Etkin and Ho (2007) argued that in the absence of empirical data, (as in the climate change issue), there are persistent biases in people's risk perceptions.

The findings that more forest products in Makhado were perceived to be vulnerable to climate variability and change effect than in Mutale and Thulamela provided insight into possible influencing factors of climatic risk perceptions in the study community. In Thulamela, where there was an abundance of forests that are in good condition, the least number of forest products were perceived to be vulnerable to climate change effects. In Makhado, although there were forests in good condition, the high population and associated socioeconomic pressure made the people perceive that most forest products were vulnerable to climate risk. Although Mutale was located in the arid zone, with more exposure to adverse effects of climatic events, fewer forest products were perceived to be vulnerable to climate risk than in Makhado. Sustainable forest management and forest-based adaptation initiatives in the study communities would hence benefit from paying attention to socio-demographic characteristics of host communities.

4.2.6 Implications of climate change impact perception for forest-based local livelihoods

In the context of perceived sensitivity of forest-based livelihoods to climatic events, although most respondents perceived increasing trends in climatic events, they did not identify it as a risk to forests and forest-based livelihoods in their community. In Thulamela, more people perceived that climatic events do not affect their access to forests. In Mutale, the majority of people perceived the effects of climatic event on forests as temporal, while in Makhado there was no clear pattern. Generally, the people perceive climate change impacts on non-wood forest products. Hence, honey, fodder for livestock, medicinal plants, wild vegetables, and forest fruits and foods were seen as being most affected by climate change. However, the people were unable to perceive climate change effects accurately on woody forest products. For example, the people's perception of climate change consequences on availability of firewood and timber showed no clear pattern across the municipalities. This has important implications for forest and climate change management initiatives in the area because knowledge and perceptions of the potential hazards of climate change forces on forests is likely to affect their engagement (Davis, 2011; Crona *et al.,* 2009; Davies *et al.*, 2009; Van Aalst et al., 2008).

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The study findings on the effects of climate change impacts on forest products and sensitivity of each essential forest product to key climatic impact factors provided vital information that could be scaled up and used to ensure that sustainable forest use and management for climate change are maintained. Generally, the findings suggest that perceptions of climate variability and extreme weather impacts on forest-based livelihoods are influenced more by socioeconomic pressure than actual manifestation of climatic events. This could be mainly as a result of the growing interaction between climate and socioeconomic pressure that influences forest use and management in the area. Ensuring resilience of forest-based livelihoods in the study communities would require attention to overall socioeconomic development.

The slight differentiation across municipalities in perceived effects of climate change on the availability of essential forest products implies a need for an area-specific approach to climate risk and forest management. The survey of ten essential forest products (Table 4) commonly used for livelihoods in the district, especially those that have been perceived to have been significantly affected by climate variability and change, calls for sustainable management and conservation of these forest products through forest development initiatives.

4.3 CONCLUSION

This study used perception-based analysis to examine the effects of climate variability and change on forests and and on the sensitivity of forest-based livelihoods to climatic events at rural community level in South Africa. It highlighted the weakness of this method in analysing climate change-effects. However, the method is insightful in understanding climate change manifestation at rural community level. The assessment suggests that manifestations of climate variability and extreme weather events are perceived to be increasing in the study communities. Analysis of the perception of these events as a threat to forest products and forest-based livelihoods showed mixed results. Extreme drought was perceived to be a significant threat only to firewood availability. However, other climatic events, such as erratic rainfall, extreme temperatures and flooding, were not regarded as constituting threats to any of the forest products used for livelihoods. This non-perception of climate change impacts on forest products could mean that the communities may be more vulnerable to climate change than envisaged by government.

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The findings suggest that perceptions of climate change impact are influenced more by socioeconomic pressure than manifestations of climatic events. In addition, the researchers observed that the perceived effects of climate variability and change on forest products used for livelihoods varied significantly across the municipalities. Understanding these factors is essential when developing initiatives for climate-risk management through forest management in the study communities. Forest development initiatives that target vulnerable forest products in each area could deliver immediate and effective forest and climate change management benefits to the study communities.

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Chapter 5

Assessing local-level forest use and management capacity with respect to climate protection

ABSTRACT

Community-based participatory forest management is a key climate change adaptation initiative in South Africa. It is aimed at enhancing sustainability of rural household livelihoods and livelihood resilience against climate variability and change. However, lack of aspirations and capacity at local household level could negate the intended benefits of community-based participatory forest management initiatives. This paper examines the local-level forest use and management capacity of rural households in Vhembe district of South Africa. This was done by investigating households' forest use and management capacity and community leaders' ability to facilitate participatory forest management. The researchers used stratified proportionate random sampling technique to select 366 households from the study area, which were then sampled through household questionnaire survey. The researchers found that household capacity to participate in, and community leadership ability to mobilize people for participatory forest management was low. This suggests a need for significant technical support for households and community leaders towards promoting participatory forest management as a way of ensuring efficiency and effectiveness of forest-based adaptation interventions.

Keywords: participatory forest management, rural community, forest resources, climate change, capacity, coping strategy[3]

[3] This chapter is based on article titled, "Assessing local-level forest use and management capacity as a climate-change adaptation strategy in Vhembe District of South Africa" under review with Springer: climatic change journal

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5.0 INTRODUCTION

Forests provide important socioecological benefits, and are essential components of climate-change mitigation and adaptation strategies at local, national, and regional level (Dlamini, 2014; Williams *et al.,* 2005). Over 60% of Africa's population depends on forests for food, firewood, charcoal, medicines, building materials, fodder, etc. (Muoghalu, 2012; Wiersum, 1997). Globally, forest-based adaptation initiatives, for example community-based forest management, are recognized to have cost advantages over other adaptation initiatives (Ribot, 2003; Smith & Scherr, 2002). Forest-based adaptation initiatives have strong linkages with sustainable rural development (Patosaari, 2007), and enhancement of rural lives and livelihood resilience against climate variability and change (Dlamini, 2014; Bowler *et al.,* 2010; Castro & Nielsen, 2001; Dubois, 1999). Thus, forests are an important component of the adaptation strategies needed to address the direct and indirect effects of climate change on rural people and their livelihoods (Naidoo *et al.,* 2013; Locatelli et al., 2010; Nkem *et al*, 2007).

In South Africa's rural communities, the dominant livelihood strategies are based on forestry and agriculture (Isaacs & Mohamed, 2000). Forest products such as firewood, wild berries, and Mopane worms are a significant component of these rural households' livelihood strategies for coping with climate variability and extreme weather events (Paumgarten & Shackleton, 2011; Paavola 2008; Shackleton, 2004; Vedeld *et al.,* 2004). In addition, the South African National Climate Change Response Strategy recognized the forest sector as being central to rural household livelihood sustenance and resilience against climate variability and change (Ziervogel *et al.,* 2014; DEA, 2011; Department of Environmental Affairs and Tourism (DEAT), 2004). However, poor management and exploitation of forests resources, coupled with weak capacity in forest management have become major challenges, characterizing forest use and management in most rural communities (Department of Agriculture Forestry and Fisheries (DAFF), 2010; Holmes-Watts & Watts, 2008; Nelson & Agrawal, 2008). Inclusion of rural people in forest management has consequently become an important legislative and political target for attaining sustainable forest management, and resilient rural development (Turpie & Visser, 2013; Bowler *et al.,* 2010; DAFF, 2010; Berliner, 2005; Von Maltitz *et al.,* 2003).

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As a result, community-based forest management has become the focus of climate change adaptation initiatives in several rural communities (Linkd 2013; Quinn et al., 2011). The South African government's approach to community participation in forest management is premised on the principle of shared benefit, responsibilities, control, and decision making over forest use and management between state and local communities (Chirwa et al., 2015; Arrikum, 2014; DAFF, 2010; Holmes-Watts & Watts, 2008; Nelson & Agrawal, 2008). However, the implementation of community participatory forest management initiatives has experienced pitfalls (Holmes, 2007; Isaacs & Mohamed, 2000). There is thus growing concern over ways in which to implement sustainable community-based forest management that would maximally deliver sustained benefits, employment, income, forest goods and services to local participants as a way of ensuring their livelihood sustenance and resilience against climate variability and change (Arrikum, 2014; Linkd, 2013; Holmes-Watts & Watts, 2008).

In spite of the efforts to understand the failure of participatory forest management (Holmes-Watts & Watts, 2008; Holmes, 2007; Fabricius, 2004; Isaacs & Mohamed, 2000), there are considerable gaps. Questions about rural people's and communities' capacity to meaningfully participate in forest management remain largely unanswered. Holmes-Watts and Watts (2008) observed that several community participatory forest management projects have focused on benefit sharing through employment, while ignoring the sharing of management responsibilities and decision making (Holmes-Watts & Watts, 2008). Additionally, lack of experience and innovation on the part of officials operating in grassroots communities was identified as a limiting factor to the implementation of effective people-centred community forest management (Holmes, 2007; Fabricius, 2004;). Furthermore, Holmes (2007) and Isaacs and Mohamed (2000) observed limited state capacity to implement participatory forest management policies effectively. Fabricius (2004) and Holmes-Watts and Watts (2008) noted that capacity-building initiatives aimed at promoting effectiveness and efficiency of community participatory forest management initiatives concentrated solely on state forest department personnel. Capacity enhancement of rural people for meaningful participation in forest management has consequently been grossly neglected (Underwood, 1999).

This present study attempted to fill this gap. The study examined households' dependence on forests, forest management capacity, and community's organization to foster sustainable forest management. This study provided insight into ways in which to enhance sustainable

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utilization of forest resources and improve forest management capacity at rural community level in South Africa as a way of ensuring sustained forest-based livelihoods and household livelihood resilience against climate change. This is pertinent to understanding how effectively and efficiently forest-based climate-change adaptation initiatives could be implemented.

5.1 METHODOLOGY

Information about sampling procedure and data analysis has been provided in Chapter 2

5.2 RESULTS

In this section, the researcher presents the results of the survey of households' dependence on the forest sector, and their capacity to participate meaningfully in forest management.

5.2.1 Household dependence on forests

Households' dependence on forests was examined in terms of formal and informal forest sector contribution to household income. The researcher used the work of Arrikum (2014), Ole-Meiludie and Mwihomeke (2006), and results from the reconnaissance survey to identify key formal forest sectors in the areas of tourism, sawmills, tree plantations, furniture and woodwork and carving, and examined their contributions to household income. The contribution of the informal sector was examined in terms of provision to household income and subsistence.

Despite the abundance of forests in the area, including plantations, the contribution of formal forest sector to household income was generally low, and varied significantly ($P = 0.000$) per sectors and municipalities (Table 5.1). In Thulamela, tree plantations (60.4%), sawmills (56%), and tourism (51%) were the three top contributing sectors to household income. In Makhado and Mutale, the contributions of the formal forest sector to household income were lower; all surveyed sectors made less than 42% contribution to household income. However, income from the informal forest sector in the area was relatively high.

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Table 5.1: Contribution of selected formal forest sectors to household income

Forest sector	Contribution rating	Proportion of respondents (%) in		
		Makhado (n = 156)	Mutale (n = 110)	Thulamela (n = 100)
Tourism	High	12.7[a]	31.2[b]	45.0[b]
	Medium	0.6[a]	2.8[a]	4.0[a]
	Low	4.5[a]	1.8[a]	2.0[a]
	No contribution	82.2[a]	64.2[b]	49.0[b]
Sawmill	High	15.9[a]	33.9[b]	50.0[b]
	Medium	3.2[a]	3.7[a]	3.0[a]
	Low	4.5[a]	3.7[a]	3.0[a]
	No contribution	76.4[a]	58.7[b]	44.0[b]
Tree plantation	High	26.3[a]	38.2[a,b]	53.5[b]
	Medium	6.4[a]	4.5[a]	5.9[a]
	Low	4.5[a]	2.7[a]	1.0[a]
	No contribution	62.8[b]	54.5[a]	39.6[b]
Furniture	High	12.1[a]	25.5[b]	48.0[c]
	Medium	3.8[a]	2.7[a]	3.0[a]
	Low	2.5[a]	1.8[a]	1.0[a]
	No contribution	81.5[a]	70.0[a]	48.0[b]
Woodwork/carving/artisan	High	10.3[a]	32.1[b]	46.5[b]
	Medium	3.2[a]	2.8[a]	1.0[a]
	Low	1.9[a]	.9[a]	1.0[a]
	No contribution	84.6[a]	64.2[b]	51.5[b]

Each superscript letter denotes a subset of community categories whose column proportions do not differ significantly from each other at the 0.05 level.

Firewood and construction wood/timber were the most commonly traded forest products in the area and the highest contributors to household income. Firewood's contribution to household income was observed to be significantly different (p = 0.000) in the municipalities. The majority of respondents in Makhado (97.5%), Mutale (97.2%), and Thulamela (68%) rated the firewood contribution to their household income as high. The Bonferroni test, however, showed that firewood contribution to household income did not differ significantly between Mutale and Makhado, but showed a significant difference from Thulamela. Unlike other parts of Africa, charcoal and mushroom were not popularly traded for income by households in the area. The majority of respondents in Makhado (81.2%), Mutale (71.4%), and Thulamela (84%) were not involved in sale of charcoal. This was mainly because

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culturally people prefer firewood and rarely use charcoal for cooking. Likewise, most respondents in Mutale (58%) and Thulamela (57%) were not involved in the sale of mushrooms (Table 5.2).

Households in the area used various types of forest products for subsistence. Common products used by households in the area included firewood, forest fruits and food (e.g. wild berries), timber/construction wood, charcoal, thatch grass, bush meat/edible insects, weaving fibre, fodder, medicinal plants, honey and mushrooms These products were generally used for subsistence and as safety nets in times of shocks. The five top ranked forest products in use in the area and their rated contribution in terms of subsistence use by households are presented in Table 5.2.

Table 5.2: Respondents' level of subsistence use of forest product

Forest product	Contribution rating	Proportion of respondents (%) in		
		Makhado (n = 156)	Mutale (n = 110)	Thulamela (n = 100)
Firewood	High	98.1[a]	96.3[a]	81.0[b]
	Medium	0.6[a]	2.8[a]	12.0[b]
	Low	1.3[a]	0.9[a]	1.0[a]
	No contribution	0.0[a]	0.0[a]	6.0[b]
Forest fruits and food	High	79.5[a]	89.9[a]	63.0[b]
	Medium	11.5[a,b]	4.6[b]	19.0[a]
	Low	3.2[a]	4.6[a]	5.0[a]
	No contribution	5.8[a,b]	0.9[b]	13.0[a]
Thatch grass	High	56.4[a]	71.8[b]	64.0[a,b]
	Medium	7.1[a]	4.5[a]	17.0[b]
	Low	9.0[a,b]	10.0[b]	2.0[a]
	No contribution	27.6[a]	13.6[b]	17.0[a,b]
Wild vegetable	High	76.9[a]	87.3[a]	60.0[b]
	Medium	10.3[a]	1.8[b]	12.0[a]
	Low	6.4[a]	2.7[a]	6.0[a]
	No contribution	6.4[a]	8.2[a]	22.0[b]
Bush meat/wild edible	High	71.3[a]	92.7[b]	63.0[a]
insect	Medium	9.6[a]	3.6[a]	11.0[a]
	Low	5.1[a]	2.7[a]	4.0[a]
	No contribution	14.0[a]	0.9[b]	22.0[a]

Each superscript letter denotes a subset of community categories whose column proportions do not differ significantly from each other at the .05 level.

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Bush meat and edible insects, particularly mopane worms, were consumed widely in the study communities. The consumption of this forest product was highest in Mutale (92.7%), followed by Makhado (71.3%), and lowest in Thulamela (63%). The Pearson chi-square test shows a significant difference (P = 0.000) in the rate of consumption across the municipalities. The Bonferroni test, however, showed that there was no significant difference between the rate of consumption of this product in Makhado and Thulamela.

Use of forest products as a coping mechanism for direct and indirect impacts of climate variability and extreme weather events in the study area was very high. Trade in non-timber forest products (NTFPs) such as amarula fruits and mopane worms was often used by households as income diversification strategies in coping with extreme weather events such as drought, erratic rainfall and crop failure. More than 60% of respondents in Makhado and Thulamela and 49% in Mutale rated their use of forest products as coping mechanisms when affected by climate variability and extreme weather events as very high (Table 5.3). The relatively lower percentage recorded at Mutale could be attributed largely to the current conditions of most forests in the region. Mutale is in a semi-arid region, and most forests there are degraded, and have low capacity to provide essential goods and services needed by households for livelihoods. Consequently, they play a lesser role in current household coping strategies.

Table 5.3: Respondents' level of dependence on forest product when affected by climate hazards

Forest product	**Contribution rating**	**Proportion of respondents (%) in**		
		Makhado (n = 156)	**Mutale (n = 110)**	**Thulamela (n = 100)**
Erratic rainfall	High	61.0	34.8	67.0
	Low	26.6	54.5	3.0
	No change	9.1	2.7	12.0
	No contribution	3.2	8.0	18.0
Serious flood	High	53.9	33.0	67.0
	Low	24.7	52.7	5.0
	No change	9.7	6.3	16.0

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	No contribution	11.7	8.0	12.0
Drought	High	59.7	33.9	60.0
	Low	22.7	54.5	5.0
	No change	8.4	7.1	20.0
	No contribution	9.1	4.5	15.0
Extreme temperature	High	68.8	35.7	62.0
	Low	22.7	53.6	9.0
	No change	3.9	6.3	20.0
	No contribution	4.5	4.5	9.0

The highest use rate of forest products as a coping mechanism among respondents in Makhado and Mutale occurred when responding to the effects of extreme temperatures. However, for respondents in Thulamela, the highest use of forest products as a coping mechanism occurred when dealing with the effects of erratic rainfall and floods.

5.2.2 Forest management capacity and participation in forest management

One way of improving forest-based adaptation strategies at community level is to strengthen local capacity so that communities are able to adjust, and participate meaningfully in sustainable forest management (Pramova *et al.,* 2012). Thus, the researchers examined people's capacity to take part significantly in forest management.

5.2.2.1 Knowledge and awareness of forest regulations as a prerequisite to meaningful participation

Figure 5.1 shows variations in household knowledge and awareness of forest regulation practices in their community. Pearson's chi-square test showed that variability in knowledge of forest regulations, as reported by respondents, was significant in all municipalities ($p = 0.000$). In all municipalities, opinions varied over the authority that was responsible for regulating forest use and management in the community. This suggests that uncertainty about the authority that is accountable for enforcing forest management regulations is widespread in all the study communities.

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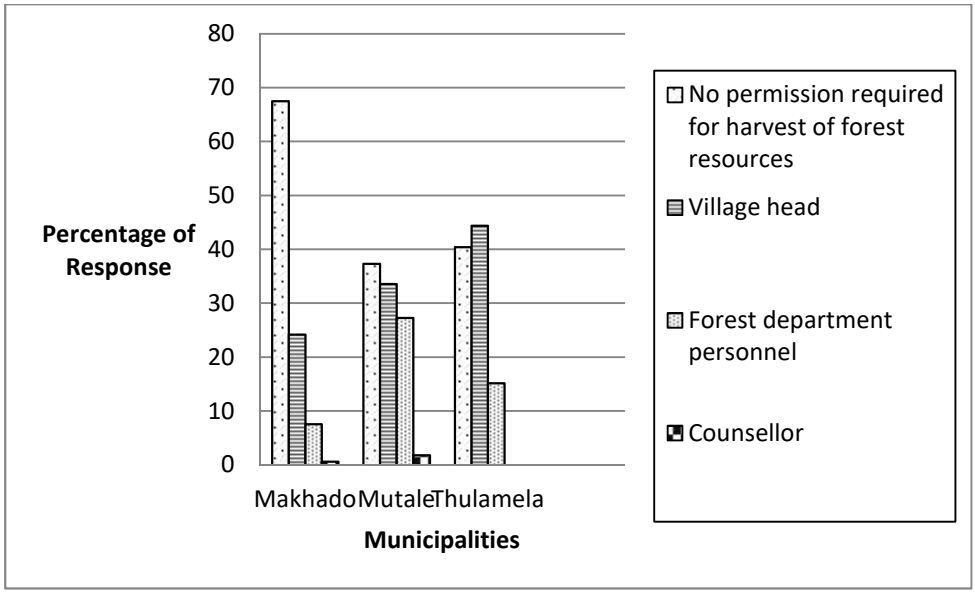

Figure 5.1: Respondents' knowledge and awareness of forest regulating authority in their community

A Bonferroni test showed that no significant difference between respondents in Mutale (37.3) and Thulamela (40.4), who were convinced that permission was not required to harvest resources from the forest. However, when compared with respondents in Makhado (67.5), there was a significant difference. Likewise, there was no significant difference in the proportion of respondents across the three municipalities that expressed the conviction that counsellors were the designated authority for forest regulation and management.

5.2.2.2 Current level of participation in forest management

The level of participation in forest management was examined by asking the respondents if they were involved in any way in forest management in their community. Although the Bonferroni test showed that the level of participation in forest management in Makhado (5.8) was significantly different from that in Mutale (16.4) and Thulamela (16), there was generally a low rate of participation in the study communities. Figure 5.2 shows that over 70% of respondents were not involved in any way in forest management in their community. Additionally, the chi-square indicated a significant difference ($p = 0.009$) in the current level of participation in forest management across the municipalities.

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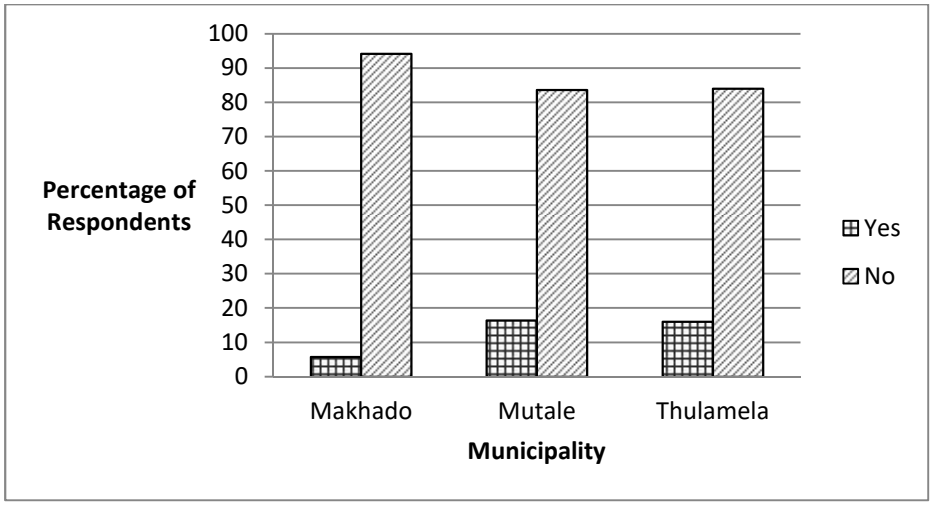

Figure 5.2: Respondents' participation in forest management in Vhembe District

The researchers then investigated factors that drive participation in forest management as a way of determining a strategy to improve their involvement. The researchers used logistic regression to examine socioeconomic variables that boost participation in forest management. Table 5.4 shows that participation in forest management in the study communities was significantly influenced by possession of farming skills, while employment status, years of residency, age and other skills (carpentry and animal husbandry) were not.

Table 5.4: Factors influencing respondents' participation in forest management

Dependent variable	Independent variable	Odds ratio	Lower	Upper	P Value
Participation in forest management	Employment status (employed)	0.633	0.246	1.630	0.343
	Farming skills	3.662	1.493	8.980	0.005*
	Livestock keeping skills	1.037	0.495	2.175	0.923
	Carpentry skills	2.431	0.455	12.995	0.299
	Years of residency (≤38)	0.339	0.078	1.466	0.148
	Years of residency (39–52)	1.651	0.301	9.047	0.564
	Years of residency (53–5)	0.514	0.131	2.020	0.341
	Years of residency (66+)	0.302	0.082	1.109	0.071
	Age of respondent (≤38)	0.572	0.132	2.491	0.457
	Age of respondent (39–52)	0.475	0.135	1.677	0.247
	Age of respondent (53–65)	0.619	0.194	1.976	0.418
	Age of respondent (66+)	1.003	0.311	3.234	0.995
	Academic qualification	0.776	0.343	1.757	0.544

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5.2.2.3 Capacity to participate in sustainable forest management

Meaningful participation in forest management requires that households should have adequate capacity to manage forest resources. Turyahabwe *et al.* (2006) described capacity as possession of the appropriate legal framework, knowledge, skills and abilities to fulfil a given role. The researchers examined educational level as an enabler of that capacity. Figure 5.3 shows the education levels of respondents in the community.

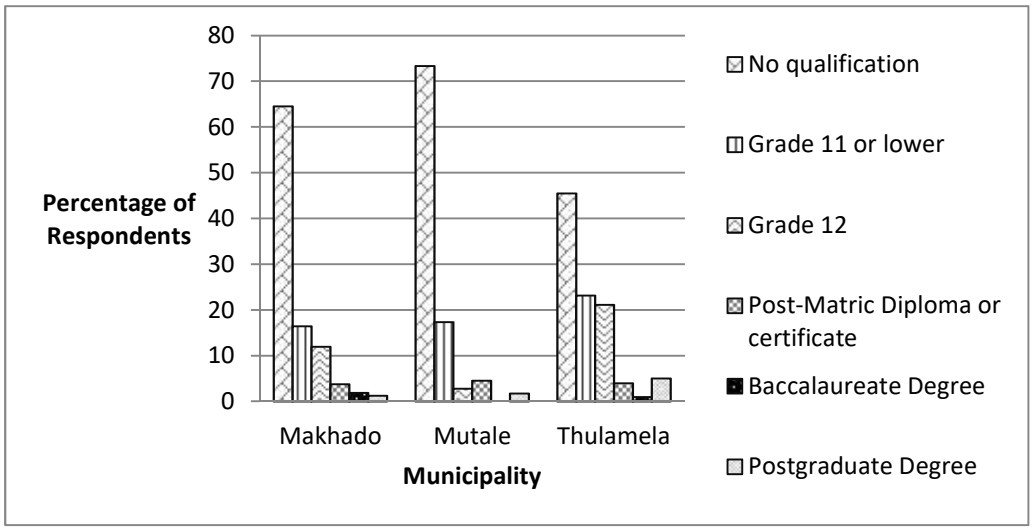

Figure 5.3: Respondents' highest level of qualifications in the study communities

Pearson's chi-square shows a significant association (p = 0.001) between respondents and educational level. Mutale (73.4) had the highest rate of respondents without qualifications. This was followed by Makhado (64.6), then Thulamela (45.5). Furthermore, the Bonferroni test showed that the proportion of respondents without qualifications was not significantly different in Makhado and Mutale. Thulamela, however, had a greater proportion of respondents with academic qualifications.

In addition, the researchers examined skills related to forest management and forest business that respondents had acquired through experiential learning and informal training. Possession of these types of skills was found to be low (Figure 5.4). Possession of hunting, farming, and livestock-keeping skills was found to differ significantly ($p<0.05$) while possession of carpentry and wood carving/craft work skills did not differ significantly ($P>0.05$) across the municipalities. Possession of farming skills was very high in Makhado (65.4%), and Mutale (78%), but low in Thulamela (40.2%). Similarly, having livestock-keeping skills was high

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only in Mutale (80.7%), and below 24% in Makhado and Thulamela. However, possession of other skills, such as carpentry and wood carving, was generally poor, below 5% in all the municipalities. Owning these skills could enhance people's participation in forest enterprises for sustenance and livelihood resilience.

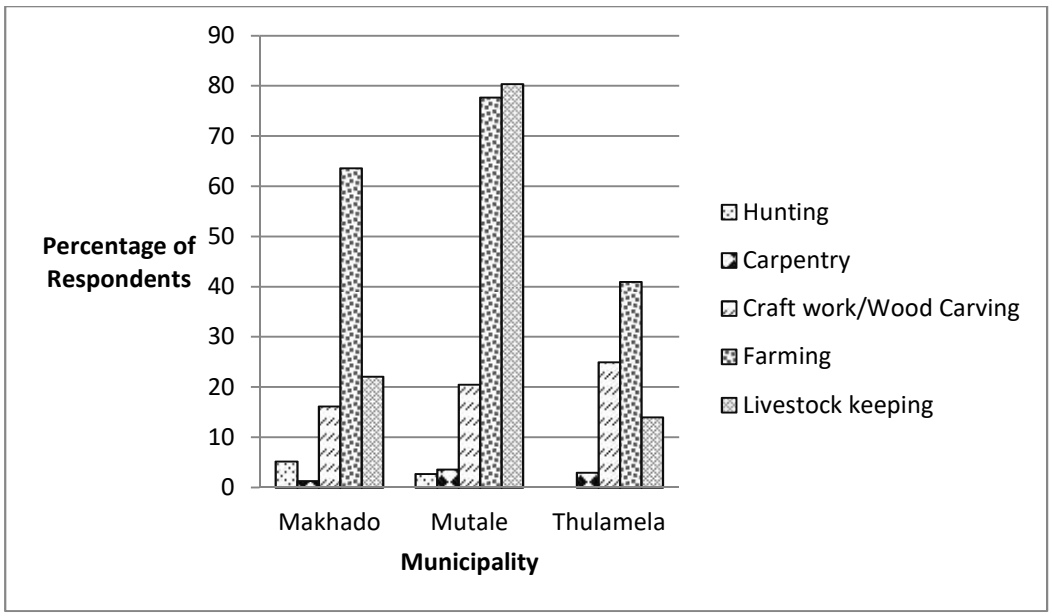

Figure 5.4: Respondents' possession of forest management and forest business-related skills in Vhembe District

In addition, capacity enhancement opportunities in the community vis-à-vis participation in forest management training programmes were examined. Respondents were asked how often they attended training in forest management practices (Figure 5.5).

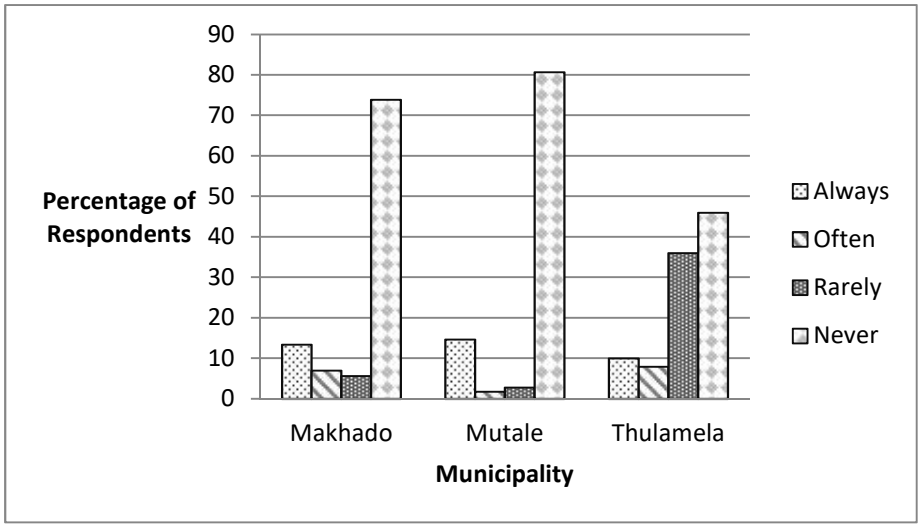

Figure 5.5: Respondents participation in forest management training in Vhembe District

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Training opportunities for capacity improvement in forest management were very poor in all the study communities. This was especially worrisome in Makhado (73.4), and Mutale (81.3), where the majority of respondents had not attended any form of training in forest management. In addition, the Pearson chi-square test showed a significant difference ($p = 0.000$) in frequency of participation in forest management training across the municipalities.

Furthermore, the researchers assessed the training needs of the people for capacity improvement towards meaningful participation in forest management by asking them to indicate the types of training that would most interest them in order to improve their ability to participate meaningfully in forest management (Table 5.5).

Table 5.5: Respondents' required skills and knowledge for active forest management

Training	Proportion of respondents (%) in		
	Makhado (n = 156)	Mutale (n = 110)	Thulamela (n = 100)
Sustainable forest resource harvest practices	33.3	35.5	14.9
Training on best practice in forest regeneration	18.6	23.6	23.8
Business opportunity in non-timber forest resources such as honey, thatch grass	11.5	2.7	11.9
Training in agroforestry practice	12.8	7.3	21.8
None	23.7	30.9	27.7

The majority of respondents expressed the need for in-depth training in several types of forest management practices to improve their capacity to participate meaningfully in integrated sustainable forest management (Table 5.5). Respondents in Makhado (33.3%) and Mutale (35.5%) were more interested in training in sustainable forest-resource harvest practices, while respondents in Thulamela (23.8%) were more interested in training in best practices in forest regeneration. Provision of these skills would facilitate participation in forest rehabilitation and sustainable forest management programmes. Interestingly, there was also high interest in training in business skills, NTFPs and forest product marketing.

However, some respondents, namely Makhado (23.7), Mutale (30.9), and Thulamela (27.7), indicated that they were not interested in participating in any form of training to enhance their

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capacity to take part meaningfully in forest management. Descriptive analysis of this category of respondents (Figure 5.6) showed that the majority (66.17) were in the age bracket of 53 and above.

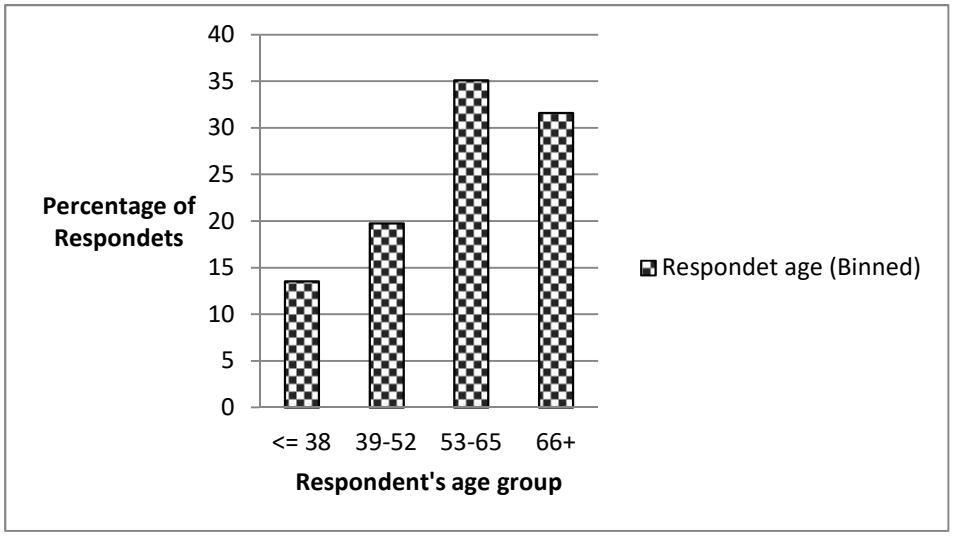

Figure 5.6: Age distribution of respondents that are not interested in training opportunities

5.2.2.4 Ability of community leadership structure to influence participation in forest management

Recognizing that community leadership structures are essential to mobilizing the people to participate meaningfully in forest management, the researchers examined the community level of contentment with their leadership structure by probing their satisfaction with opportunities to contribute to local decision making. Apart from Makhado, where 51.3 of respondents were satisfied or very satisfied, satisfaction was generally low in Thulamela (47) and Mutale (29.6). Satisfaction with community leadership did not differ significantly between Mutale and Thulamela, but did differ significantly between Makhado, and Mutale/Thulamela.

5.3 DISCUSSION

5.3.1 Household dependence on forests

Results from this study indicate a high level of household dependence on the informal forest sector for subsistence and income. This sector had been a significant contributor to rural

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household income and subsistence in South Africa (Munyanduki, 2014; DWAF, 2005; Shackleton, 2004; Vedeld *et al.,* 2004). In addition, forests currently play a significant role in household livelihood coping strategies for climate shock. Most respondents are involved in small-scale trading of forest products as a strategy for coping with socioeconomic pressures such as unemployment, and climate variability and change, for example drought and erratic rainfall. This is consistent with the report by DWAF (DWAF, 2005), which recorded widespread informal trade in forest products in rural communities and in urban areas. Indeed, the use of forest products as a coping mechanism for climate change is a common livelihood strategy in several African countries (Pramova *et al.,* 2012; Somorin, 2010).

Forests could therefore form the basis of household livelihood adaptation to climate change in the study communities. However, evidence from this study suggests that the potential role of forests in rural development and household resilience against climate risk has not been fully utilized. This is evident in the current low contribution of the formal forest sector to household income. This seems to be a common trend in rural communities, particularly those in natural forests or on the periphery, as evidenced in previous studies (Lewis *et al.,* 2005; 2003). Nevertheless, evidence from other regions of South Africa, where the formal forest sector is well developed, shows that the formal forest sector could be a major contributor to rural development and household income (Chamberlain *et al.,* 2005). Improving the contribution of the forest sector to household livelihoods and livelihood resilience in the study communities would therefore require development of the formal forest sector. Thus, exploring the important role of the formal sector in promoting green growth and forest entrepreneurship would be essential. This would require the adoption of strategies to improve household capacity to participate in forest enterprise and forest management as a way of decoupling current forest-based livelihood activities from destructive forest exploitation practices. In fact, the sustainability of the forest contribution to household livelihoods and resilience against climate risk is not possible without participation by the local people in formal and informal forest sector management (Boon & Ahenkan, 2011).

5.3.2 Forest management capacity and participation in forest management

However, ensuring the sustainability and effectiveness of rural people's participation in forest management requires that they have the capacity to participate meaningfully. Evidence from this study suggests that the people have weak capacity to participate meaningfully in forest management in terms of skills, education, knowledge of forest regulation legislation, and community organization in all the study communities. This challenge is a widespread

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phenomenon in Vhembe and has been cited as a significant threat to sustainable development in the district (Mpandeli, 2014; DCoGTA, 2012). In the same vein, weak capacity at rural community level has serious implications for promoting sustainable forest utilization and management in the study communities. As observed by Nelson and Agrawal (2008), capacity development at rural community level has a positive correlation with the sustainability and effectiveness of community forest and forest-based adaptation initiatives. In the same vein, Shackleton et al. (2002) observed that in places where local people were well organized and had associations with non-governmental organizations (NGOs), the effectiveness of community forestry was ensured, and local participants enjoyed greater benefits from the initiative. Similarly, local people's awareness of their rights and knowledge of forest policy documents and legislation significantly affected the level of benefit they obtained from community forest initiatives (Shackleton & Campbell, 2001).

Despite their inadequate capacity to participate in forest management, there is widespread aspiration in the study communities to take part in forest management and development initiatives. Respondents expressed interest in training in various aspects of forest management as a way of enhancing their capacity to participate sustainably. Providing the people with the requisite skills is therefore necessary for effective forest-based adaptation initiatives in the communities (Perlis, 2009; Holmes-Watts & Watts, 2008; Turyahabwe *et al.* 2006; Ribot, 2003). Rural household capacity enhancement is an important tool for promoting green entrepreneurship and decoupling household livelihood activities from destructive forest-use practices in the rural areas of Vhembe (Musyoki, 2012). However, the challenge lies in the lack of or inadequate opportunities to participate in forest management training in all the study communities. In most cases, respondents indicated that they have never participated in forest training programmes. The onus therefore is on Department of Forestry personnel to provide these opportunities. They need to expend more effort in operationalizing South African forest policy and green growth strategy provisions for local people to have meaningful engagement in green forest enterprise development and sustainable forest management.

Moreover, the South African Forestry Department does not have sufficient human resources to directly manage all forests in all rural communities in South Africa (Berliner, 2005). A more reasonable approach would be for the department to take advantage of local leadership structures in the study communities, in providing the people with required skills and training.

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This might entail involving local leaders in facilitating the provision of forest training and forest enterprise opportunities. However, this would require the strengthening of the local leadership structure particularly where there is dissatisfaction with local leaders. As noted by Larson (2003), when community leadership lacks the required capacity, their control of forest management often leads to greater levels of deforestation. Moreover, trust in community leadership is crucial to acceptance of community-led forest management initiatives (Benkenstein *et al.,* 2014; Wongbusarakum & Loper, 2011). A concerted effort is therefore required by the department to enhance capacity for meaningful participation in forest management to ensure the sustainability of current and potential roles of forests in household livelihoods and livelihood resilience against climate risk.

5.4 CONCLUSION AND RECOMMENDATION

Sustainability of forest contributions to household livelihood and livelihood resilience against climate change, and meaningful participation in forest management are inseparably linked. Findings from this study show that forests and forest products play a significant role in people's livelihoods and livelihood resilience against climate change. However, the people's inadequate capacity and lack of meaningful participation in forest management is limiting the maximization of forest contributions to household livelihood and livelihood resilience. This is also a significant limiting factor in attaining sustainable forest management and forest-based green growth in the study communities. Thus a concerted effort towards providing the people and community leaders with technical assistance to promote the sustainable use of forest resources and enhance their capacity for meaningful participation in forest enterprise business and forest management is recommended as a way of ensuring the sustainability of forests' contributions to people's livelihoods and livelihood resilience against climate risk.

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CHAPTER 6

Assessing forest-based rural communities' adaptive capacity and coping strategies for climate variability and change

ABSTRACT

In this study, coping strategies used by forest-based rural communities in Vhembe District of South Africa in response to climate variability and change were investigated. The effects of community sociodemographic characteristics on the adaptive capacity, choice and effectiveness of coping strategies were examined. Household- level data were collected from 366 respondents selected from 21 rural communities using the proportionate random sampling procedure. The Pearson chi-square test was used to analyse these strategies. The effects of household and community socio-demographic characteristics on choice and effectiveness of coping strategies were determined using the binary logit model. It was observed that the respondents used diverse coping strategies, depending on the nature of climate variability and extreme weather events with which they were confronted. Rainwater harvesting was the most popular strategy in Makhado (90%), Mutale (96.3%), and Thulamela (50%) for erratic rainfall. Tree planting around houses and on farmland were the most popular strategies (90–100%) to counter the effects of extreme temperatures. Furthermore, household and community demographic characteristics, in particular education and skills levels, forest products, institutional services and infrastructure in the communities, such as markets, and water supply facilities, significantly ($p<0.05$) influenced the choice of coping strategies. Therefore, it could be hypothesized that efforts that enhance household capacity and community infrastructural development might be viable and sustainable ways of improving rural communities' resilience against climate change and variability.

Keywords: climate variability and change, community resilience, coping strategy, livelihood, adaptation, adaptive capacity[4]

[4] This chapter is based on published article cited as "C Ofoegbu, P.W. Chirwa, J. Francis, F. Babalola. 2016. Assessing forest-based rural communities' adaptive capacity and coping strategies for climate variability and change: The case of Vhembe district in South Africa. Environmental Management 18. 36-51".

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6.0 INTRODUCTION

Forest-based rural communities in Africa are increasingly becoming the focal point in the climate-change discourse, mainly because of their vulnerability to climate variability and change (Coulibaly et al., 2015). This is because of their high level of dependence on forests and natural resources for livelihoods (Coulibaly et al., 2015; Robledo et al., 2012). Prolonged effects of climate change might result in increased poverty and unsustainable rural development (Hammil et al., 2013; Boon & Ahenkan, 2011). Thus, there is a growing need to address vulnerabilities of rural people to climate change (Helgeson et al., 2013).

The 2015 Paris agreement of the United Nations Framework Convention on Climate Change (UNFCCC) which is aimed at advancing and fostering international cooperation towards implementation of programmes that might accelerate transition towards a low-carbon economy and climate-resilient society (Sebastian et al. 2015), added impetus to the many national and multilateral commitments, actions and initiatives that seek to address climate change through capacity enhancement (Viljoen, 2013). For many developing countries, particularly in Africa, this represents a unique opportunity for international cooperation and attracting technical and financial support towards the establishment of an improved modality for reducing the vulnerability of communities facing climate impacts. This would facilitate meaningful incorporation of rural communities in climate-change adaptation and mitigation initiatives.

Residents of rural areas rely on their own coping mechanisms that help them to cushion the effects of climate variability and extreme weather events (Coulibaly et al., 2015; Perlis, 2009). Indigenous knowledge and utilization of natural resources such as NTFPs as a safety net have been useful coping strategies (Wilk et al., 2013; Pramova et al., 2012; Angela et al., 2010; Locatelli et al., 2010; Shackleton et al. 2008; Valdivia et al., 2005). However, despite past success in dealing with climate variability and extreme weather events, there are concerns that the coping strategies in use could be less effective in handling the accelerated pace of climate-change-induced occurrences of extreme weather (Wilk et al., 2013; Adger et al., 2007). This highlights the need for determining whether current coping strategies of rural households could be transformed into sustainable adaptive practices to ensure livelihood security under climate-change challenges (Thomas et al., 2007; Wall & Marzall, 2006).

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Coping strategies are short-term actions to ward off immediate risk and are seldom relevant to reducing vulnerability in the long term (International Centre for Integrated Mountain Development (ICIMOD), 2007; Turner et al., 2003). Nevertheless, they provide useful insights into ways to develop more practical, sustainable, and localized adaptation strategies (Fisher et al., 2010; Twomlow et al., 2008). Moreover, coping strategies are often location specific. Thus, it is necessary to assess coping strategies that are distinctive to forest-based communities in order to develop appropriate policies and interventions (Nkomwa et al., 2014; Williams & Kalamandeen, 2013). In support of Wilk et al.'s (2013) argument, interventions designed to enable adaptation are likely to be successful if they are localized. This is because adaptation to climate change is inevitably local. Therefore, this study was based on the notion that incorporating current local coping strategies into climate-change policies and interventions could lead to cost-effective, participatory, locally relevant and sustainable interventions (Nkomwa, et al., 2014; Twomlow et al., 2008).

Past experience of manifestations of extreme weather events in rural communities suggests that not all households have the capacity to adapt to the challenges of climate change (CARE, 2011), and that not all of their current coping strategies are effective in combating the risks associated with climate change (Angela et al., 2010). In addition, several studies (Egyir et al., 2015; Byrne, 2014; CARE, 2014; Goldman & Riosmen, 2013; Moghal, 2011) have revealed that households, even in the same community, adopt different coping strategies. Adaptive capacity is a consequence of the extent of vulnerability and resilience against climate change (Byrne, 2014; Helgeson et al., 2013). Joerin et al. (2012) found similar results in Chennai, India. In this study, despite the households' past experience of flood-related disasters, their resilience remained very low owing to their limited adaptive capacity. This implies that without appropriate ability to adjust, the resilience of households to climate disaster is limited to the cycle of absorbing, managing and bouncing back (Joerin et al., 2012; Robledo et al., 2012).

The extent to which households and communities adapt to the impact of climate change significantly affects sustainable development (Byrne, 2014). However, it does not mean that high adaptive capacity translates to improved resilience against climate change (Amisah et al., 2009). Sometimes, there are underlying socioeconomic conditions that facilitate or hinder adaptive capacity (Hughey & Becken, 2014). Several authors (Byrne, 2014; CARE, 2014; Adeniji-Oloukoi et al., 2013; Williams & Kalamandeen, 2013) have reported that adaptive

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capacity at household or community level depends on demographic factors, such as access to information, social, human, institutional, natural and economic resources, and technologies. Thus, studies are needed that identify attributes and socio-demographic factors that aid the adaptation capacity of households (Panda et al., 2013).

Scholars such as Alberini et al. (2006) and Elrick-Barr et al. (2015) have pointed out the difficulty of identifying and carrying out empirical analyses of the relative importance of sociodemographic factors in household adaptive capacities. Moreover, most studies on capacity to adapt to climate change (Lemos, 2013; Tembo, 2013; Arnall, 2012; Nzuma et al., 2010) focus on national-level assessments that utilize indicators and indices (Byrne, 2014). Yet national scale indicators of adaptive capacity are too broad for practical application at local community level (Tembo, 2013). Nevertheless, adaptive capacity assessment contributes significantly to climate-change management at household and local community level (Elrick-Barr et al., 2014).

Taking these issues into account (above), this study was carried out to clarify the complex human-environment interaction in forest-based rural communities of Vhembe District, Limpopo, South Africa. The socioeconomic conditions that affected their coping strategies and the adaptive capacity of households to climate change were investigated. Specifically, the study was designed to identify the coping strategies of the households to climate variability and the roles of forests in this regard. Additionally, it sought to establish the adequacy and effectiveness of the coping strategies.

6.1 METHODOLOGY

The methodological approach for this study was discussed in Chapter 2. Here the researchers present additional information that is unique to this chapter.

6.1.1 Sampling framework

Analysis of coping strategies

The coping strategies of households were analysed by asking questions about the ways in which the residents respond to climate variability and extreme weather events, such as drought, erratic rainfall, extreme temperature, flooding and hailstones. Questions were also asked about the effectiveness and sustainability of coping strategies. In this study, average

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daily temperatures of 31.6°C and above were regarded as extreme. Information from the literature, discussions with village heads, and reconnaissance surveys were used to compile a list of coping strategies. The respondents were then asked to indicate, from the strategies listed in the questionnaire, those that they had used to counter the adverse effects of climate variability and extreme weather events. They were also asked whether they perceived difficulties in coping with climate change. Empirical analyses were used to examine the role of forest products in the coping strategies of the households.

Analysis of adaptive capacity

In this study, 'adaptive capacity' refers to the potential of the people to adapt, rather than actions in response to adverse conditions emanating from climate change. Sociodemographic characteristics, such as access to services and infrastructure, and socioeconomic conditions affect the adaptive capacity of the households. To understand how adaptive capacity varied across rural communities, a framework (see Figure 2) was developed that took into account the guidelines of the sustainable livelihoods approach (SLA). Questions included assessing socioeconomic factors that enhanced or hindered the adaptive capacity of the households (Mendis *et al.,* 2003; Valdivia *et al.,* 2005; Marshall *et al.,* 2010; Adeniji-Oloukoi *et al.,* 2013).

The socio-demographic factors influencing household adaptive capacity that were assessed in the study area included i) access to information; ii) participation or support from community-based organizations; iii) acquired knowledge and skills; and iv) access to infrastructure.

Access to information explains availability of knowledge of coping strategies and provides a basis from which households could anticipate or react in order to minimize the impact of climate variability and change.

Participation or support from community-based organizations: This describes relationships of trust and exchange among community members. It is reflected in the community's ability to act as a collective. Thus, participation of a household in community support organizations was assessed. The attitudes and perspectives of the people to their responsibilities and actions towards climate change adaptation were investigated by asking respondents questions relating to who should be responsible for taking action against climate change. Questions were based

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on a Likert scale, which ranged from 'Strongly disagree' (equal to 1) to 'Strongly agree' (equal to 5).

Acquired knowledge and skills: Knowledge and skills influence the adaptive capacity of households. They enable the households to anticipate changes and modify their livelihood opportunities appropriately. Levels of education and skills of members of households were assessed, together with their impact on the coping responses and adaptive capacity. The literature was used to draw up a list of skills for sustainable rural livelihoods, focusing on forest-based livelihoods. Respondents were then asked to indicate the skills they possessed.

Access to infrastructure: The role of institutions vis-à-vis access to infrastructure and facilities in determining adaptive capacity is a widely accepted notion (Adger *et al.,* 2007). Therefore, household satisfaction with vital services such as water, healthcare, and markets in their communities and their impact on coping responses and adaptive capacity were assessed.

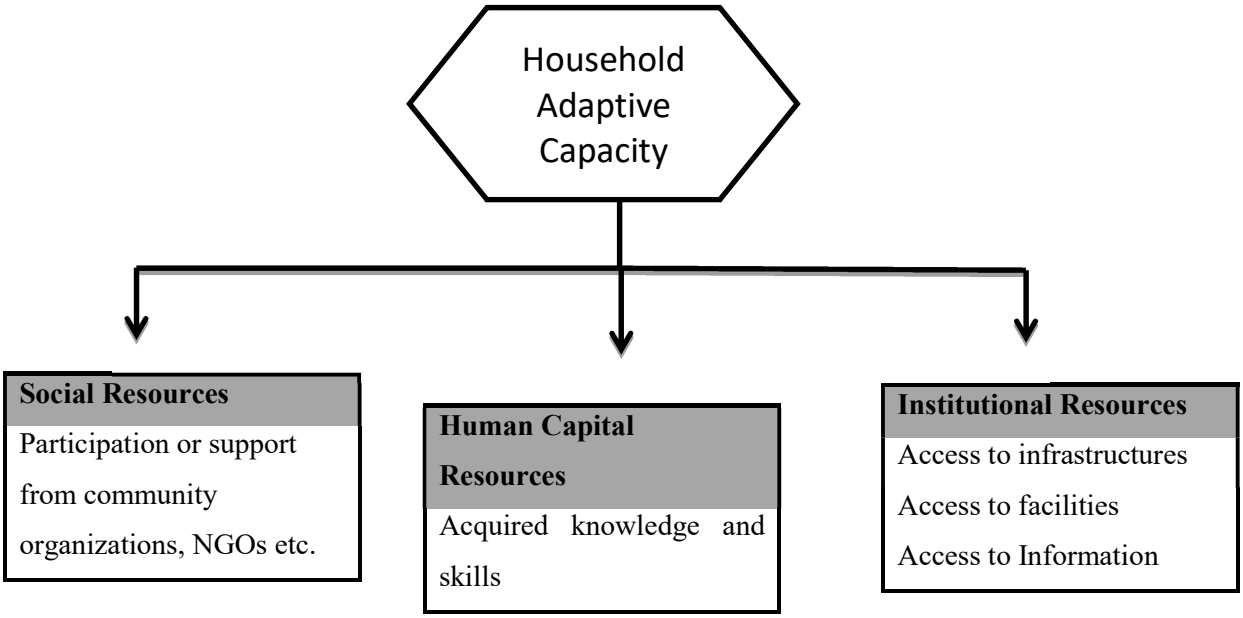

Figure 6.1: Household adaptive capacity analysis framework

6.1.2 Data analysis

Data collected with the questionnaire survey were subjected to weighting adjustment to correct for possible problems of over- or under-representation of variables (Bethlehem,

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2015). The sample was weighed against the actual population to arrive at the weighted sample. The weighted data were then analysed with SPSS version 20 (Levesque, 2007).

Discrete variables were summarized using the frequency of each code in the questionnaire. Summary statistics were computed for all numeric variables. Categorical data regarding the opinion of respondents were analysed taking individual responses into consideration. Descriptive statistics and chi-square test were used to analyse the range of household coping responses, current role of forest products in household coping strategies in response to climate variability and change, and influence of household and community' demographic characteristics on choice of coping strategies. Bonferroni's test was used to analyse differences across municipalities, following the approach of Berg (2014). The chi-square test was used to determine whether there was association between support from the social group and expressed difficulties in coping with climate variability and change. The Pearson chi-square was used where the expected cell frequency was ≥5. The M-L chi-square was used when the expected cell frequencies were lower than 5 (Turyahabwe *et al.,* 2006).

Binary logistic regression was used to analyse the influence of social resources, human capital and institutional resources on household choice of coping strategies and challenges. The binary logistic regression technique was used because predictor variables in the data were categorical. Odds ratios were used to measure the magnitude of strength of association or non-independence between two binary data values. If $p \leq 0.05$ (less than or equal to 0.05), was observed, it was concluded that there was a statistically significant difference in what was being tested (Clewer & Scarisbrick, 2001).

Satisfaction with social and institutional resources was framed as a binary-choice model, which assumed that respondents were satisfied or not satisfied with social resources and institutional resources in their communities. Human capital vis-à-vis educational level was framed as binary (educated or not educated). Satisfaction with social resources, institutional resources, and human capital were dependent on identifiable characteristics. Thus, let T_i represent a dichotomous variable that equals 1 if respondents are satisfied with social, human and institutional resources in their communities, and 0 if they are not satisfied.

The probability of being satisfied with social and institutional resources, and human capital were in each case, Pr ($T_i = 1$), which is the cumulative density function F evaluated at

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$X_i \beta$, where X_i is a vector of explanatory variables and β is a vector of unknown parameters (Maddala, 1983). The cumulative density function was modelled using the following logistic probability function:

$$\Pr(Ti = 1) = \frac{\exp(Xi\,\beta)}{1+exp(Xi\,\beta)} \qquad (1)$$

Dependent variables were satisfaction with social and institutional resources, and human capital, which take the value of 1 if the respondents were satisfied and 0 if not. Social resources, human capital and institutional resources were analysed separately. For social resources, satisfaction with the social support group in the community was used. For institutional resources, satisfaction with the water supply was considered. Level of education of the respondent constituted human capital. The explanatory variables that were included in the model are presented in Table 6.1. The chi-square test at p = 0.05 significance level was used to assess the goodness of fit of the models.

Table 6.1: Explanatory variables used in the binary logistic model

Explanatory variables	**Possible response**	
	1	**0**
a) Employment status	Employed	Not employed
b) Farming skills	Yes	No
c) Livestock-keeping skills	Yes	No
d) Carpentry skills	Yes	No
e) Education level	Educated	Not educated
f) Less than or equal to 38 years of residency in the community	Yes	No
g) 39–52 years of residency in the community	Yes	No
h) 53–65 years of residency in the community	Yes	No
i) 66 years and above length of residency in the community	Yes	No
j) Respondents age category: ≤38	Yes	No
k) Respondents age category: 39–52 years	Yes	No
l) Respondents age category: 53–65 years	Yes	No
m) Respondents age category: 66 years and above	Yes	No

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6.2 RESULTS AND DISCUSSION

6.2.1 Coping strategies applied by local communities

In this study, it was observed that the residents of Makhado, Musina and Thulamela municipalities used various coping strategies to cushion the effects of climate variability and extreme weather events on their lives and livelihoods. The strategies varied, depending on the type of extreme weather event with which they were confronted. Some of the strategies were not appropriate for long-term adaptation. For instance, a strategy such as growing crops around streams in response to erratic rainfall events might not be suitable for long-term adaptation. If erratic rainfall persisted for many seasons, streams might dry up. Likewise, a strategy such as migration to urban areas in search of employment opportunities to cope with a drought is an inappropriate long-term adaptation. Rural-urban migration precipitates service delivery problems in informal settlements in urban areas. To draw better meaning from the results of the current study, the coping strategies were categorized.

6.2.1.1 Coping strategies for dealing with erratic rainfall events

In Table 6.2, it is shown that the households in the surveyed communities relied on several livelihood strategies that helped them cope with the negative effects of erratic rainfall. Taking up off-farm activities was a strategy that was confined mainly to Mutale municipality. This was practised mostly in response to erratic rainfall. It entailed engaging in off-farm activities in or outside the municipal area. Although this is effective in the short term, limited opportunities for off-farm employment in the district make it unsustainable. This is particularly significant since Vhembe is largely rural, with the unemployment rate reaching 40% in some places (SSA, 2011). Because of this challenge, the continuous practice of off-farm activities might lead to considerable rural-urban migration challenges and hinder local development. Thus, it is necessary to promote socioeconomic development of the communities as a way of reducing household dependence on off-farm activities to cope with erratic rainfall.

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Table 6.2: Coping strategies for erratic rainfall among forest-based rural households in Vhembe District of South Africa

Coping strategies	Responses	Proportion of respondents (%)		
		Makhado (n = 156)	**Mutale (n = 110)**	**Thulamela (n = 100)**
Shifting planting period to coincide with the start of rainy season	Yes	51.6[a]	78.0[b]	38.0[a]
	No	48.4[a]	22.0[b]	62.0[a]
	Binomial test	0.4679[ns]	0.0000*	0.0105*
Taking off-farm activities	Yes	40.1[a]	65.1[b]	43.0[a]
	No	59.9[a]	34.9[b]	57.0[a]
	Binomial test	0.0014*	0.0016*	0.0284*
Depending on use and marketing of non timber forest products	Yes	41.0[a]	45.9[a]	13.0[b]
	No	59.0[a]	54.1[a]	87.0[b]
	Binomial test	0.0853[ns]	0.2543[ns]	0.0000*
Cropping around streams	Yes	50.6[a]	4.6[b]	22.0[c]
	No	49.4[a]	95.4[b]	78.0[c]
	Binomial test	0.2342[ns]	0.0000*	0.0000*
Using dug-out wells for irrigation	Yes	82.2[a]	96.4[b]	31.0[c]
	No	17.8[a]	3.6[b]	69.0[c]
	Binomial test	0.0000*	0.0000*	0.0000*
Planting drought-resistant crops e.g. watermelon	Yes	89.2[a]	92.7[a]	37.0[b]
	No	10.8[a]	7.3[a]	63.0[b]
	Binomial test	0.0000*	0.0000*	0.0105*
Rainwater harvesting	Yes	92.3[a]	96.3[a]	50.0[b]
	No	7.7[a]	3.7[a]	50.0[b]
	Binomial test	0.0000*	0.0000*	0.3822*

*Each subscript letter denotes a subset of community categories whose row proportions do not differ significantly from each other at the .05 level. Binomial test analysis of yes and no responses by respondents *significant at 0.05; ns = not significant at 0.05*

Shifting the crop planting period to coincide with the onset of the rainy season in response to erratic rainfall was more common in Mutale (78%) than Makhado (51.6%) and Thulamela (38%) municipalities. This was not surprising because Mutale is the driest part of Vhembe. As a result, the residents of Mutale municipality are more exposed to direct and indirect consequences of erratic rainfall. Shifting the planting and transplanting seasons to cope with

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erratic rainfall was also observed in Mruthyunjaya and Selvaraja's (2002) study in rural communities of Coastal Orissa, India. However, the effectiveness and efficiency of this strategy depend on the households' continued access to climate information to make decisions. This information enables local people to schedule their planting operation 'in sync' with prevailing climatic conditions.

Growing crops on stream banks was not practised significantly in the three municipalities of Vhembe. This was not surprising because there are no streams in most of the villages that were studied. In the villages where there are streams, crops were planted mostly in inaccessible terrains far from dwellings.

Subsistence use of and trade in NTFPs were not common practice in all three municipalities. In general, these strategies are not associated with the challenges of climate variability and change. Another plausible explanation for the non-significant use of NTFPs as a coping strategy could be the current poor development and organization of the informal forest sector. As a result, the people did not derive maximum benefit from the sector, thus discouraging widespread participation in trade in forest products.

Approximately, 50% to 96.3% of the household representatives indicated that rainwater harvesting was one of the coping strategies they relied on. Rainwater harvesting has been observed as a popular coping strategy among rural communities in Nigeria (Boon & Ahenkan, 2011) and Ghana (Ajani *et al.,* 2013). The effectiveness and sustainability of rainwater harvesting techniques often depend on the volume of the storage tanks that households install. Because of widespread poverty in the study communities, most households found it difficult to utilize this strategy effectively. The residents either installed small tanks or did not have storage tanks at all. They relied on a few large containers they owned. As a result, these households stored water that lasted for a few days. This means that this strategy is inappropriate for dealing with prolonged, erratic rainfall events. Types of housing also affect the effectiveness of rainwater harvesting. Most often, people who live in traditional thatched-roof mud houses cannot adopt this strategy effectively. In general, lack of access to credit is a major constraint to coping with and adapting to climate change in rural communities of most African countries (Tembo, 2013; Chigavazira, 2012; Bryan et al., 2010).

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Planting drought-resistant crops such as water melons and using dug-out wells for irrigation were some of the strategies used to cope with erratic rainfall. Perlis (2009) reported similar results from research into risks such as excessive or low rainfall, drought and crop failure in rural communities in Chad. Growing crops that are resistant to erratic rainfall and drought serves as a safety measure for facilitating household livelihood resilience. The effectiveness of this strategy is dependent largely on the financial capacity of households and their access to improved planting stock.

6.2.1.2 Coping strategies for dealing with drought event

There was a link between the occurrence of and coping with erratic rainfall and drought in the communities in Vhembe. The coping strategies are presented in Table 6.3.

Table 6.3: Common strategies used to cope with drought in forest-based rural households in Vhembe, South Africa

Coping strategies	Responses	Communities		
		Makhado	Mutale	Thulamela
Improve water storage	Yes	77.1[a]	100.0[b]	21.0[c]
	No	22.9[a]	0.0[b]	79.0[c]
	Binomial test	0.0000*	0.0000*	0.0000*
Reuse water	Yes	82.1[a]	98.2[b]	56.0[c]
	No	17.9[a]	1.8[b]	44.0[c]
	Binomial test	0.0000*	0.0000*	0.0967[ns]
Depend on use and marketing of non-timber forest products	Yes	43.6[a]	49.1[a]	12.0[b]
	No	56.4[a]	50.9[a]	88.0[b]
	Binomial test	0.2342[ns]	0.4624[ns]	0.0000*
Migrate to urban areas for work	Yes	15.9[a]	7.3[a]	6.0[a]
	No	84.1[a]	92.7[a]	94.0[a]
	Binomial test	0.0000*	0.0000*	0.0000*
Increase water capture e.g. borehole, rainwater harvesting	Yes	73.9[a]	87.3[b]	22.8[c]
	No	26.1[a]	12.7[b]	77.2[c]
	Binomial test	0.0000*	0.0000*	0.0000*
Ration water e.g. reduce water use per person per day	Yes	96.2[a]	96.3[a]	76.0[b]
	No	3.8[a]	3.7[a]	24.0[b]
	Binomial test	0.0000*	0.0000*	0.0000*

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Switch to drought resistant crop	Yes	84.0[a]	98.2[b]	31.7[c]
	No	16.0[a]	1.8[b]	68.3[c]
	Binomial test	0.0000*	0.0000*	0.0002*
Crop around streams	Yes	59.0[a]	11.0[b]	21.0[b]
	No	40.4[a]	89.0[b]	79.0[b]
	Binomial test	0.0038*	0.0000*	0.0000*
Irrigate crops	Yes	66.9[a]	37.6[b]	28.0[b]
	No	33.1[a]	62.4[b]	72.0[b]
	Binomial test	0.0000*	0.0089*	0.0000*

*Each subscript letter denotes a subset of community categories whose row proportions do not differ significantly from each other at the .05 level. Binomial test analysis of yes and no responses by respondents *significant at 0.05; ns = not significant at 0.05*

Improved water storage and reuse were common in all three municipal areas where the study was carried out. In general, more people tended to conserve and reuse water in areas that experienced poor water supply. Storage and reuse enabled households to improve efficiency of water use and management in the communities. It is crucial to promote such strategies so that they become regular practices.

As observed in household coping strategies for erratic rainfall, dependence on use and trade in NTFPs as a strategy for coping with drought was uncommon. Nevertheless, there was potential for improved use and trade in NTFPs as an alternative strategy for strengthening household resilience against climate-change-induced challenges. Crop irrigation was practised significantly in Makhado municipality only. Presumably, this was because of varying levels of functionality of water supply facilities in the municipalities. Migration to urban areas in search of work opportunities in response to drought challenges was not a common coping strategy in the communities. The non-significant practice of rural-urban migration as a coping strategy was worth exploiting in the quest for local development. For example, because of limited outward migration, developmental projects such as forest plantations established in the communities would possibly not experience severe shortages of labour.

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6.2.1.3 Coping strategies for dealing with extreme temperatures

Extremely high temperatures were recorded with varying consequences on the lives and livelihoods of residents of Makhado, Mutale and Thulamela municipalities. The strategies that the people developed to cushion themselves from these extreme temperatures are shown in Table 6.4.

Table 6.4: Common strategies used by forest-based rural households in Vhembe District, South Africa, to cope with extreme temperatures

Coping strategies	Responses	Communities		
		Makhado (%)	Mutale (%)	Thulamela (%)
Plant trees on farm to shade crop	Yes	73.2[a]	97.2[b]	33.0[c]
	No	26.8[a]	2.8[b]	67.0[c]
	Binomial test	0.0000*	0.0000*	0.0004*
Plant trees around house to provide shade	Yes	98.1[a]	99.1[a]	89.0[b]
	No	1.9[a]	0.9[a]	11.0[b]
	Binomial test	0.0000*	0.0000*	0.0000*
Stay indoors (reduce the number of hours spent on farming activity)	Yes	64.7[a]	96.3[b]	44.0[c]
	No	35.3[a]	3.7[b]	56.0[c]
	Binomial test	0.0003*	0.0000*	0.2421[ns]
Buy air-cooling appliance e.g. fan	Yes	80.3[a]	99.1[b]	51.0[c]
	No	19.7[a]	0.9[b]	49.0[c]
	Binomial test	0.0000*	0.0000*	0.4602[ns]

*Each subscript letter denotes a subset of community categories whose row proportions do not differ significantly from each other at the .05 level. Binomial test analysis of yes and no responses by respondents *significant at 0.05; ns = not significant at 0.05*

More than 70% of respondents confirmed that members of their households planted or retained trees around their homes and farms to provide shade. This helped to combat intense sunshine and associated extremely high temperatures that were expected to induce heat stress. As shown in Table 4, this practice was common in all three municipal areas. The results confirm those of other authors who indicated that this was widely practised in many developing countries. For example, Pramova *et al.* (2012) observed this practice in rural communities of Malawi, Zambia and South Africa. As well as providing shade, retaining

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trees on farms and around the house ensured that cultural, ecological and economic benefits that add to household resilience and adaptive capacity are enjoyed (Robledo *et al.,* 2012).

Coping strategies such as staying indoors to reduce the number of hours spent carrying out farming activities, as reported in Makhado and Mutale municipalities, result in loss of productive time and inability to take advantage of livelihood improvement opportunities. Consequently, they hinder the growth of the household economy. Because of this, it could be concluded that this is not a sustainable coping strategy.

6.2.1.4 Current role of forests in household coping strategies

Empirical evidence generated in this study revealed that forests and forest products played a wide range of roles in household response to climate variability and extreme weather. Firewood, wild fruits and food, for example wild berries, thatching grass *(Hyparrhenia filipendula),* wild vegetables such as green amaranth *(Amaranthus hybridus)*, game meat, edible insect species, in particular mopane worms *(Gonimbrasia belina),* locusts and white termites were among the commonest forest products on which local households relied to deal with climate variability and change. Trees were also planted and retained around homesteads and croplands (above). The common tree species that were planted or retained included fruit-bearing species such as mango *(Mangifera indica),* avocado *(Persea americana)*; exotic timber species such as eucalyptus and pine, and indigenous species for example mopane *(Colophospermum mopane)* and those used for firewood. Subsistence use of and trade in forest products in the communities was viewed more as a strategy to enhance wellbeing. This means that they were less regarded as a strategy to combat the effects of climate change and variability challenges. These findings were in stark contrast to the situation in several rural communities in West Africa in which subsistence use of and trade in forest products were regarded as strategies for coping with climate variability and change (Belcher *et al.,* 2007).

Forests and associated products are commonly known for providing important goods and services that serve as safety nets to counter climate variability and extreme weather hazards. This makes them crucial assets for rural-based households. For instance, Paumgarten and Shackleton (2011) observed that 70% of households in the Eastern Cape and Limpopo, South Africa, used NTFPs to help cope with shocks, including those resulting from climatic

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variability. In addition, tree planting is widely used in developing countries to cope with climate variability and change events. For example, in Ghana, farmers planted trees, including commercial timber species, to protect their crops from intense sunshine and enhance their livelihoods (Boon & Ahenkhan 2011). In Kenya, Bryan *et al.* (2011) observed that about 39% of respondents in their study identified tree planting as their most desired adaptation strategy. Similarly, rural communities in the Congo Basin were observed to use forests extensively to cope with the challenges of climate variability, such as delayed onset of the rainy season (Belcher et al., 2007). However, in the current study, forest products did not play a prominent role. Musyoki (2012) attributes this to poor access of forest products to markets and poor organization of the informal sector.

In the current study, the influence of access to markets on popularization of forest-based coping strategies and its implication for the development of enterprises in this sector were examined. Analysis of association between satisfaction with access to market and adoption of forest-based coping practices gave mixed results. Only 10% of the respondents were satisfied with access or nearness to markets for forest products as an opportunity to counter the effects of erratic rainfall and extreme drought. Use of forest products as a coping strategy was not significantly associated ($p>0.05$) with erratic rainfall and extreme drought. However, there was a significant association ($p<0.05$) between satisfaction with access or nearness to local markets and use of forest products to cope with extreme temperatures. Thus, it was possible to maximize the benefit of using forests to enhance resilience of household livelihood. This means that there is scope for adopting coping strategies that promote the domestication of forest products, in particular NTFPs. According to Musyoki (2012), domestication of NTFPs is an important strategy for stimulating forest entrepreneurship and green growth and enhancing of forest-based livelihoods in the communities. These are essential components of forest-based adaptation initiatives for strengthening livelihood resilience against climate change and variability in the rural areas.

6.2.2 Perceived barriers or challenges to coping strategies

In this study, the respondents identified various issues that restricted the implementation of effective coping strategies in dealing with climate variability and extreme weather events. It was observed that some coping strategies were used widely, while others were relied on only

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sparingly. In addition, they yielded varying outcomes for household resilience. As shown in Table 6.5, many challenges hindered the success of commonly used coping strategies.

Table 6.5: Challenges or barriers to strategies used to cope with climate variability and change in some parts of Vhembe, South Africa

Challenges	Response	Municipality		
		Makhado (%)	Mutale (%)	Thulamela (%)
Insufficient information about weather or long-term climate change	Yes	87.0[a]	75.0[b]	45.0[c]
	No	13.0[a]	25.0[b]	55.0[c]
	Binomial test	0.0000*	0.0000*	0.3086[ns]
Lack of knowledge/skills about appropriate coping strategy	Yes	80.4[a]	74.3[a]	41.0[b]
	No	19.6[a]	25.7[a]	59.0[b]
	Binomial test	0.0000*	0.0000*	0.0666[ns]
Lack of money or access to credit	Yes	87.0[a]	80.6[a,b]	71.0[b]
	No	13.0[a]	19.4[a,b]	29.0[b]
	Binomial test	0.0000*	0.0000*	0.0000*
Unavailability of desired forest product	Yes	76.6[a]	76.9[a]	41.0[b]
	No	23.4[a]	23.1[a]	59.0[b]
	Binomial test	0.0000*	0.0000*	0.0967[ns]
Poor access to market	Yes	79.9[a]	72.2[a,b]	61.0[b]
	No	20.1[a]	27.8[a,b]	39.0[b]
	Binomial test	0.0000*	0.0000*	0.0105*
Changed farming practice	Yes	85.1[a]	75.0[a]	50.5[b]
	No	14.9[a]	25.0[a]	49.5[b]
	Binomial test	0.0000*	0.0000*	0.3822[ns]
Inadequate supply of improved planting materials	Yes	79.2[a]	75.9[a]	44.0[b]
	No	20.8[a]	24.1[a]	56.0[b]
	Binomial test	0.0000*	0.0000*	0.2421[ns]
Erosion of traditional skills and knowledge among younger generation	Yes	81.2[a]	75.9[a]	53.0[b]
	No	18.8[a]	24.1[a]	47.0[b]
	Binomial test	0.0000*	0.0000*	0.1841[ns]

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Breakdown in communities'	Yes	77.9[a]	74.1[a]	48.0[b]
communal nature	No	22.1[a]	25.9[a]	52.0[b]
	Binomial test	0.0000*	0.0000*	0.5398[ns]

*Each subscript letter denotes a subset of community categories whose column proportions do not differ significantly from each other at the .05 level. Binomial test analysis of yes and no responses by respondents *significant at 0.05; ns = not significant at 0.05*

Poor access to markets, insufficient money and lack of access to credit were pronounced in all three municipalities. More than 60% of the respondents identified these challenges as impediments to adopting strategies for coping with climate variability and change. This problem was slightly more pronounced in Makhado than in Mutale and Thulamela municipalities. Probably, this could be attributed to high unemployment rates and the difficulty of securing credit. Access to credit and markets severely limits household adaptive capacity. The need for funding to improve coping strategies cannot be underestimated. Additionally, access to markets enables households to trade their produce and procure products that are needed to improve their resilience against climate risks (Egyir *et al.,* 2015).

The inadequate supply of improved planting materials was another major challenge, especially in Makhado (79.2%) and Mutale (75.9%) municipalities. However, this was not a significant ($p>0.05$) challenge in Thulamela. Access to improved planting materials such as drought-tolerant varieties could greatly improve rural household livelihood resilience against erratic rainfall and drought (Quinn *et al.,* 2011).

Insufficient knowledge of traditional and modern coping strategies was widely identified as a challenge that curtailed the ability to effectively combat the negative effects of climate variability and change. Among the challenges that the respondents cited were insufficient location-specific information about weather or long-term climatic conditions, inadequate knowledge of and skills to implement modern coping strategies such as switching to drought-resistant crops, and erosion of traditional skills and knowledge, resulting in the younger generation being ignorant of them. Insufficient knowledge to aid effective and efficient implementation of traditional and modern coping strategies has been reported in other rural communities in Africa and Asia (Chigavazira, 2012; Wilk *et al.,* 2012; Nzuma et al., 2010). Lack of information about improving traditional coping strategies to make them relevant to climate change could exacerbate rural communities' vulnerability. It is also important to

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package climate information in a manner that is tailored to the needs of forest-based rural communities. In the current study, the respondents were interested in the relevance of climate information to their livelihood improvement strategies. It seemed this was one of the reasons that most of the climate information that respondents harnessed was insignificant in contributing to the improvement of household livelihood practices for combating climate change challenges.

Communities in the studied areas tended to be more individualistic in their response to communal challenges. This was in contrast with past practices when communal challenges were approached collectively. The unavailability of desired forest products in coping with climate variability and change was also highlighted. The respondents opined that individualistic approaches to forest use and uncontrolled management of communal resources were the main reasons for the scarcity of forest products. In support of this view, local traditional leaders confirmed that they no longer had regulatory control over forest product use and management in the communities. This has also been observed among rural communities in the Offin River Basin of Ghana (Gyampoh *et al.,* 2009).

Most of the challenges reported in this study are synergistic, implying that a common approach could be adopted to improve the adaptive capacity of people. For example, an inadequate supply of improved planting materials is closely related to lack of access to credit facilities. Wilk *et al.* (2012) made similar observations among commercial farmers in South Africa. In their study, access to finance was reported to be contributing to farmers' resilience against drought because it enabled them to spend money on drought-resistant seeds, fertilizers and irrigation, among other inputs. Moreover, access to credit often enabled households to diversify into non-forest-based livelihood activities and helped reduce their sensitivity to climate variability and extreme weather.

6.2.3 Attributes of household adaptive capacity

The demographic characteristics of the communities in Vhembe and the ways in which they influenced the strategies that households used to cope with adverse weather and climate change are presented. Although the households adopted diverse strategies for coping with the effects of climate variability and change, there were mixed results. Differences in the adaptive capacities of households to respond positively to adverse effects of climate

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variability and change depended on various factors, including institutional resources, social support and human capital. These are elaborated below.

6.2.3.1 Institutional resources

Institutional resources are known to have considerable influence on household coping practices and adaptive capacities in response to climate change and variability. Table 6.6 shows that remarkably high proportions of respondents in Mutale (74.4%), Thulamela (59%) and Makhado (52.9%) municipalities were very dissatisfied or dissatisfied with water supply facilities in their areas. The proportions of respondents who were very dissatisfied or dissatisfied with access or closeness to markets were 90.9% for Mutale, followed by Makhado (67.3%) and Thulamela (60%) municipalities. The levels of satisfaction with communication services also varied across the municipalities. The proportions of respondents who were very dissatisfied or dissatisfied were 70.3%, 67.7% and 35.6% for Makhado, Mutale and Thulamela municipalities, respectively.

Table 6.6: Demographic factors influencing adaptive capacity in some areas of Vhembe District in South Africa

Attributes of households adaptive capacity	Response	Proportion of respondents (%) in		
		Makhado (n = 156)	Mutale (n = 110)	Thulamela (n = 100)
Water supply services	Very dissatisfied	16.6[a]	60.6[b]	33.0[c]
	Dissatisfied	36.3[a]	13.8[b]	26.0[a,b]
	Neither satisfied nor dissatisfied	0.6[a]	0.9[a]	1.0[a]
	Satisfied	28.0[a]	10.1[b]	16.0[a,b]
	Very satisfied	18.5[a]	14.7[a]	24.0[a]
Access or closeness to market	Very dissatisfied	25.0[a]	68.2[b]	23.0[a]
	Dissatisfied	42.3[a]	22.7[b]	37.0[a,b]
	Neither satisfied nor dissatisfied	2.6[a]	0.9[a]	0.0[a]
	Satisfied	25.0[a]	3.6[b]	11.0[b]
	Very satisfied	5.1[a]	4.5[a]	29.0[b]
Communication services	Very dissatisfied	12.2[a]	51.4[b]	10.0[a]

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Dissatisfied	58.1[a]	16.3[b]	25.6[a,b]
Neither satisfied nor dissatisfied	5.1[a]	0.0[b]	1.0[a,b]
Satisfied	40.4[a]	14.7[b]	24.0[b]
Very satisfied	42.7[a]	29.9[b]	27.4[c]

Each subscript letter denotes a subset of community categories whose column proportions do not differ significantly from each other at the .05 level.

The results of the investigation of the relationship between satisfaction with institutional resources, water supply facilities and household adoption of strategies to cope with climate variability are presented in Table 6.7

Table 6.7: Influence of satisfaction with water supply facilities on adoption of coping strategies for climate variability in some areas of Vhembe District, South Africa

Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > Chi Sq
Intercept	1	0.1312	0.1895	0.4791	0.4888
Off-farm work	1	-0.5900	0.2358	6.2600	0.0123
Cropping around streams	1	0.5265	0.2493	4.4609	0.0347

Table 6.7 indicates that satisfaction with water supply in a community decreased ($p<0.05$) the likelihood that the household would adopt off-farm activity as a coping strategy by 0.59. In addition, satisfaction with water supply facilities in a community increased by 0.52 ($p<0.05$) the likelihood that a household would adopt cropping around streams as a coping strategy. This implies that an improved water supply facility has a positive impact on the resilience of a household's crop farming strategy. Ishaya and Abaje (2008) reported that access to improved functioning of institutional resources enhanced farmers' adaptive capacity. Improving institutional facilities in a community within the framework of climate change adaptation positively influences the realization of sustainable development, and reduces rural-urban migration. Therefore, in support of Goldman and Riosmen (2013), it could be posited that sound institutional facilities serve as a catalyst for the adoption of effective coping strategies among rural households.

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6.2.3.2 Social support

The many social support mechanisms that existed in the communities are shown in Table 6.8. They provided assistance that helped local people cope with the vagaries of climate variability and change.

Table 6.8: Functioning social support group in the study communities

Social group	Response	Municipality		
		Makhado (%)	Mutale (%)	Thulamela (%)
Family members living outside community	Yes	88.4[a]	70.6[b]	65.0[b]
	No	11.6[a]	29.4[b]	35.0[b]
	Binomial test	0.0000*	0.0000*	0.0000*
Neighbours	Yes	87.1[a]	82.6[a]	39.0[b]
	No	12.9[a]	17.4[a]	61.0[b]
	Binomial test	0.0000*	0.0000*	0.0000*
Local community organization	Yes	79.4[a]	67.0[a]	20.0[b]
	No	20.6[a]	33.0[a]	80.0[b]
	Binomial test	0.0000*	0.0001*	0.0000*
The municipality	Yes	83.2[a]	50.9[b]	51.0[b]
	No	16.8[a]	49.1[b]	49.0[b]
	Binomial test	0.0000*	0.4248[ns]	0.5398[ns]
Provincial government	Yes	63.9[a]	54.6[a]	8.9[b]
	No	36.1[a]	45.4[a]	91.1[b]
	Binomial test	0.0000*	0.1713[ns]	0.0000*

*Each subscript letter denotes a subset of community categories whose column proportions do not differ significantly from each other at the .05 level. Binomial test analysis of yes and no responses by respondents *significant at 0.05; ns = not significant at 0.05*

Family members, neighbours, and local community-based organizations were reported to provide significant assistance to households. However, the support provided by municipalities and provincial government was regarded as not so important across all communities. There is usually concern that social support initiatives of municipalities and

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provincial government departments are laden with political motives. Twomlow (2002) and David (2007) pointed out that political interests, rather than a desire to cushion households against drought, guide the launch of governmental social support services.

The relationship between support from family members, neighbours and local community-based organizations and barriers to adoption of coping strategies at household level were investigated. There was a significant association ($p<0.05$) between assistance from neighbours and expression of difficulty in coping with climate variability and change. Apart from the challenge of lack of money or access to credit, which was not significant ($p>0.05$), all other expressed challenges observed in this study were significantly associated with assistance from neighbours as a support group. In most cases, less than 14% of the respondents that enjoyed support from neighbours expressed difficulty in coping with climate variability and change. Thus, social support groups such as neighbours are crucial in helping households cope with climate variability and change challenges in their locality.

The influence of support from local community organizations on respondents' expressed difficulty in coping with climate variability and change is shown in Table 6.9. Only three of nine challenges to adopting coping strategies to counter the effects of climate variability and change that respondents revealed were statistically important. This meant that the households that enjoyed support from local community-based organizations coped well with climate variability and change. Moreover, insufficient access to credit facilities – or lack of it -- was observed to have a negative relationship with support from local community-based organizations. Insufficient information on climate variability and change events and an inadequate supply of improved planting materials were the only challenges that were significantly associated with support from local community-based organizations. Thus, support from local community-based organizations was important in ensuring that households coped effectively with climate variability and change.

Table 6.9: Effect of support from local community-based organizations on households' strategies for coping with climate variability and change in some parts of Vhembe District, South Africa

Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq

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Intercept	1	2.4095	0.7873	9.3665	0.0022
Lack of or insufficient information on climate variability and change event	1	1.3450	0.3995	11.3336	0.0008
Lack of or insufficient access to credit facility	1	-0.9353	0.4311	4.7073	0.0300
Inadequate supply of improved planting materials	1	1.1964	0.3595	11.0737	0.0009

There are many examples of how social support groups affect the capability of communities to adapt to risks related to climate change (Robledo *et al.,* 2012). This view finds support from an earlier study by Valdivia *et al.* (2005), which revealed that informal non-monetary arrangements and social networks helped rural communities in Samoa to cope with storm damage. Social support groups such as local community-based organizations, neighbours, and family members have significant capacity to enhance collective action and use group advantage to access other capitals in facilitating the resilience of people to climate variability and change.

6.2.3.3 Human capital resources

Human resources development affects significantly people's ability to adapt efficiently to climate change challenges (Striessnig *et al.,* 2013). In the current study, the effects of human resources such as farming skills and highest level of education on coping efficiency and adaptive capacity were examined. It was found that the lack of access to credit facilities and break down in the communal nature of society were not significantly associated ($p>0.05$) with farming skills. However, possession of farming skills was significantly associated ($p<0.05$) with the other challenges that local households experienced, namely erosion of traditional skills and knowledge among the younger generation and an inadequate supply of improved planting materials. These results imply that, in general, households with inherent farming skills are less likely to experience challenges in coping with climate variability and change than those without. Thus, investment in appropriate skilling of residents of the communities would help to improve households' capacity to cope with climate change.

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The relationships between respondents' highest level of education and choice of strategy and challenges experienced in attempts to cope with changes in climate are presented in Table 6.10.

Table 6.10: Influence of level of education on choice of coping strategies

Dependent variable	Independent variable	Odds ratio	Lower	Upper	P Value
Possession of academic qualification	Dependence on use and marketing of NTFPs in response to erratic rainfall event	2.622	1.080	6.361	0.033
	Migration for work as a coping response to extreme drought event	0.177	0.063	0.502	0.001
	Increased water capture in response to extreme drought	2.189	1.059	4.525	0.035
	Planting drought-resistant crops in response to extreme drought	2.681	1.092	6.580	0.031
	Irrigation with stream water in response to extreme drought	0.428	0.197	0.931	0.032
	Reliance on social group in response to flood	0.469	0.230	0.955	0.037
	Sale of household assets in response to flood	4.527	1.655	12.384	0.003
	Flood control wall built around homestead	2.534	1.213	5.294	0.013
	Insufficient knowledge of appropriate coping options	3.057	1.020	9.159	0.046
	Breakdown in community's communal nature	0.313	0.098	0.998	0.050

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In the current study, it was observed that the level of educational attainment impacted significantly on an individual's choice of coping strategy, including the types of challenges experienced in implementation. Of eight coping strategies commonly used in response to erratic rainfall, only two were practised significantly by more educated people. These were dependence on use and marketing of NTFPs. The more educated individuals relied mostly on four of the nine coping strategies that could help counter the effects of extreme drought. They tended to rely on non-forestry and agriculture-based livelihood strategies. Their strategies seemed to be few and more carefully selected, in contrast with their less-educated counterparts, who adopted multiple options.

These results (Table 6.10) have highlighted that improving human capital in terms of skills and education would reduce the challenges experienced in the communities significantly as they attempt to cope with climate variability and change. According to David (2007), adequate human capital resources in terms of skills and educational level allows for effective adaptation to climate change. Apart from improved human capital, this allows households to effectively utilize traditional coping strategies and explore alternative coping strategies based on new information and innovativeness (Egyir *et al.,* 2015). Given the uncertainty regarding understanding of the impact of manifestations of climate change on people's lives and livelihoods at rural community level (Striessnig *et al.,* 2013; Turpie & Visser, 2013), human capital improvement seems to be the most sensible option for increasing rural households' resilience against risks of climate change. Striessnig *et al.* (2013) noted that improved human capital implied better access to climate information, and the ability to utilize it, for example seasonal prediction of drought. Improved human capital often leads to higher incomes at individual and household level, and greater economic growth within communities (Striessnig *et al.,* 2013; Patt *et al.,* 2010). This yields indirect benefits to climate-change mitigation through decoupling livelihood strategies from unsustainable forest use and management practices (Muyoski, 2012).

6.3 CONCLUSION AND RECOMMENDATION

Forest-based rural communities in Vhembe employed a range of strategies to cope with the biophysical and socioeconomic effects of climate variability and extreme weather. In most

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cases, the respondents tended to use strategies that did not affect their livelihoods negatively. Although some strategies were effective, concerned households encountered many challenges. In general, the choice, effectiveness and efficiency of any coping strategy depend on the nature of the communities in question and their socioeconomic characteristics. Poor markets for forest products and poor organization of the informal forest sectors in the communities hampered widespread adoption of forest-based coping strategies. Similarly, lack of access to credit was a major barrier to effective adoption of most of their coping strategies. Institutional facilities, social support groups and human capital resources are crucial to the success of household coping strategies. More specifically, people's skills and educational levels are the major determinants of choice of coping strategies and proficiency in adopting them. Inadequate skills and lack of education among residents in the study communities limit their ability to participate in the formal economic sector. This relegates them to subsistence farming and reliance on forest products as a means of earning secure livelihoods. Given the uncertainty surrounding the precise manifestations of climate change in specific areas, it may be better to invest in skills development and acquisition of education to increase people's flexibility and ability to adapt effectively to risks associated with climate change. It could be hypothesized from the current study that development of a suite of support initiatives such as facilitating access to credit facilities for the rural poor, developing markets for forest products, particularly under-exploited NTFPs, and enhancement of capacities of residents of rural areas to do things for themselves are likely to improve their ability to cope with the adverse effects of climate change.

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CHAPTER 7

OVERVIEW AND CONCLUSION

This chapter integrates insights from the four analytical chapters (3, 4, 5 and 6). Additionally, it highlights how each research objective has been achieved in relation to a holistic understanding of the vulnerability of forest-based rural communities, linking the findings of the study to the literature. The chapter presents issues for further research and provides general conclusion from this research.

7.0 OVERVIEW

The vulnerability of rural communities to climate change is an evolving and multifaceted process that involves an interaction of physical, socioeconomic, cultural and institutional factors (Locatelli *et al*., 2010; Malone, 2009). Knowledge of how this process influences or reduces household livelihood vulnerability to climate change is of great importance, particularly in helping to guide the implementation of climate-change intervention initiatives (Wardekker, 2011). Consequently, rural community vulnerability to climate change has been studied from various perspectives, including history, sociology, psychology, economics and political science (CARE, 2011).

Within the academic and research circle of social perspective of community-level vulnerability study, the IPCC concept of vulnerability has gained wider acceptance (Birkmann, 2008a; Birkmann, 2008b; Turner et al., 2003). The IPCC defined vulnerability as the degree to which a system, for example a rural community, is susceptible to adverse impacts of climate change, and unable to cope with them (Wongbusarakum & Loper, 2011). The IPCC definition conceptualizes vulnerability as a product of exposure to climatic events, the sensitivity of a system, and its adaptive capacity. Thus to assess the vulnerability of a community, the factors that contribute to the three elements of exposure, sensitivity, and adaptive capacity must be identified and analysed (CARE, 2011; Wongbusarakum & Loper, 2011; Locatelli et al. 2010). Operationalizing the IPCC concept in vulnerability assessment often involves a model-driven or impacts-based approach. This entails measuring exposure by the degree and magnitude of climatic hazard to which a community is exposed, while sensitivity is measured by the degree to which a community is negatively affected by changes in climatic condition, and adaptive capacity is quantified and measured by using assets and

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capitals as indicators of communities' capacity to adapt (Birkmann, 2008a; Birkmann, 2008b). This concept and approach to vulnerability assessment has been used widely to analyse communities' vulnerability to climate change (Ataíde *et al.,* 2011; Klein, 2004; Turner et al., 2003). At rural community level, the approach has been helpful in understanding community's exposure to climate change and its potential impact by including the socioeconomic drivers of vulnerability, and the range of coping practices and adaptive capacity (Ban, 2012; Ataíde *et al.,* 2011; CARE, 2011; Basu, 2010).

However this methodological design fails to capture local conceptualization of climate change vis-à-vis local sociocultural beliefs and understanding of the phenomenon and how it drives the engagement of people with climate change. The approach also often fails to capture how local dependence on the use and management of natural resource (e.g. forests) interacts with household's access to services and infrastructure (e.g. markets and water supply) in dictating communities' vulnerability to climate change. In addition, the unique characteristics of forest-based rural communities require an approach that helps understanding not only the underlying sociodemographic drivers of vulnerability, but also the vital human-forest resource use and management interplay at community level (Williamson, *et al.,* 2007).

This is an important missing link in our understanding of vulnerability to climate change. To fill this gap, the researchers modified the IPCC vulnerability framework (Figure 2.1, see Chapters 1 and 2), to develop the methodological innovation applied in this study. The methodology applied a four-tiered approach in order to understand the key factors that characterize household vulnerability to climate variability and change at forest-based rural community level. This was done by extending the IPCC concept of exposure to include local sociocultural understanding of climate change. Sensitivity was modified so that it did not focus only on households' level of dependence on vulnerable forest resources, but examined people's capacity to engage in sustainable forest use and management. This was based on the understanding that forest dependence could be a source of both vulnerability to and resilience against climate change (Dlamini, 2014; Chia *et al.,* 2013; Chishakwe *et al.,* 2012; Chidumayo et al., 2011). Adaptive capacity was extended to include examination of how people's interactions with social and institutional resources in their community enhanced or constrained their adaptive capacity.

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In applying the vulnerability assessment framework, the researcher sought to establish a forest-based rural community friendly approach. By assessing exposure not solely from the perspective of magnitude and frequency of climatic event to which a community is exposed; the study provided an understanding of how rural people understand and conceptualise climate change, its effect on forest-based livelihoods, and how it influences their attitudes towards forest use and management. This information is crucial for local climate-change intervention initiatives in South Africa. By examining households' levels of dependence on forest products and their capacity to engage in sustainable forest use and management, the study provided an understanding of the susceptibility of community's forest-based livelihoods to climate change effects. Finally, by departing from the traditional asset-based framework for conceptualizing local adaptive capacity (Jones, 2011; Carmen *et al.,* 2014), the study highlighted the important role that various intangible and dynamic processes -- such as knowledge and information, forest use and management capacity, and behaviour towards forest use and management -- could play in supporting adaptive capacity at forest-based rural community level.

7.1 ADDRESSING THE RESEARCH OBJECTIVES

This section outlines how each objective has been achieved by briefly highlighting the research motivation, methodology, and main results and discussion. Their linkage to the understanding of the vulnerability of forest-based livelihood and community to climate variability and change events is also discussed.

7.1.1 Appraising climate change in forest-based rural communities of South Africa

Research into rural community conceptualization of climate change could help understand sociocultural view and awareness of climate change at household and community level, improve communication on the scientific discourse of climate change, influence positive behavioural change towards climate change adaptation, and better inform policy makers. The objective of Chapter 3 was therefore to assess how forest-based rural communities in South Africa conceptualize climate change as a way of gaining robust understanding of the exposure of the people to climate change and engagement with it. Previous studies have concentrated solely on the magnitude and frequency of climatic events to which a community is exposed and neglected the angle of how the people conceptualize and engage with climate change (Gandure *et al*., 2013; Turpie & Visser, 2013; Bryan et al., 2009; Gbetibouo 2009;

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Maddison, 2007; Turpie et al., 2002). To assess how people conceptualize climate change as a way of gaining robust understanding of their exposure to climate change, the study explored the people's sociocultural understanding of climate change, including their awareness of climate change, their beliefs about its causes, and their concerns. The approach included integration of questions that explored the people's behavioural intentions towards sustainable forest use and management in response to climate-change impact.

This helped in capturing important information that is often omitted when a study on local exposure to climate change focuses on the magnitude and frequency of climatic event to which a community is exposed. In Chapter 3, it was shown that there was generally poor understanding and awareness of the term 'climate change'. Similar findings have been reported in several rural communities in Africa (Nzeadibe *et al.,* 2013). However, despite poor awareness of the term, in the study communities' people generally showed good understanding of the issues and challenges of climate change. In the study communities, the people often referred to climate change as prolonged climate variability and associated extreme weather events. While several studies have investigated awareness of climate change at rural community level in South Africa and Africa in general (Dlamini, 2014; Turpie & Visser, 2013; Gbetibouo 2009; Maddison, 2007; Turpie *et al.,* 2002), these studies fail to capture the ways in which people's sociocultural understanding of climate change relate to their exposure to its threats.

Thus, the findings from this study provided important insights into the ways in which forest-based rural people understand and engage with climate change in forest use and management. These insights could be used to adjust current policies and to develop new policy initiatives to facilitate implementation of effective and sustainable initiatives for improving climate-change communication at rural community level. The insights from the study would also be essential to facilitating wider engagement with climate-change intervention initiatives in the communities. For instance, the study findings showed that there were believers in anthropogenic causes of climate change and sceptics in the communities. However, these sceptics and believers are generally concerned about the effects of climate variability and associated extreme weather events on lives and forest-based livelihoods in their communities. This level of concern could influence individuals or communities to take conscious action or participate in climate-change intervention initiatives in their community (Buys *et al.,* 2012; Marsden et al., 2009; Weingart *et al.,* 2000). In this study, this was reflected in people's willingness to embrace behavioural change towards responsible forest use and management

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in contributing to collective sustainable forest management as a strategy towards improving lives and livelihood resilience against climate change (see Table 3.9). This creates an opportunity for national and local authorities to explore means of translating people's concerns about climate-change effects on forests and forest-based livelihoods into establishing socially inclusive forest-based adaptation initiatives in the communities. Integrating the concerns of both sceptics and believers into a climate-change management strategy at rural community level would provide a good strategy for promoting wider engagement in climate-change intervention initiatives at rural community level in South Africa.

Additionally, the study showed that traditional media sources such as meteorological stations, radio and word of mouth from friends and family, village heads and school teachers are major sources of climate information in the study communities. On the other hand, innovative media sources for example real-time SMS phone messages are being canvassed for as tools for improving climate-change communication (Capstick, 2012; Marsden *et al.,* 2009; Weingart *et al.,* 2000). Insights from this study showed that efficient and effective use of traditional media sources still offer productive means of improving awareness and climate-change communication at rural community level. In the same vein, awareness of climate change was observed to be influenced by respondents' ability to link socioeconomic challenges with environmental problems. For instance, evidence from this study revealed that people with farming skills – and hence knowledge and experience in linking challenges in farming practices with climatic variability issues – showed greater awareness of climate change than people who do not have these skills. This has significant implications for improving climate-change awareness at rural community level and rural engagement with the climate-change discourse in South Africa. This is supported by the conclusions of Bernie and Schoene (2009), in which they stated that linking physical events to their socioeconomic impacts are the necessary impetus for fully informing the general public and policymakers.

Furthermore, inference from the study findings showed that factors influencing people's perceptions of climate change are integral to the efficiency of climate information dissemination. For example, based on the findings that people that possess farming skills are more likely to perceive climate change than those who do not, it could be hypothesized that packaging climate information in a way that relates to farming and forest-based livelihoods would facilitate wider engagement than packaging climate information in a manner that

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relates purely to climate science. For example, instead of disseminating information on how climate change is manifested through sea level rise, increase in temperature, etc., this could be circulated through highlighting the manifestation of climate change such as forest fires, and outbreaks of pests and disease.

When people are effectively informed about climate-change challenges and its effects, behavioural change towards responsible forest use and management would be realised. Achieving communal responsible behaviour towards forest use and management at community level would be key to the success of any forest-based climate-change intervention initiatives to be established in the community. To this end, embedding local sociocultural understanding of climate change into the scientific discourse of climate change at national and local community level would be a required strategy for achieving sustainable and effective engagement of rural people in climate-change intervention.

7.1.2 Perception-based analysis of climate-change effects on forest-based livelihoods

Climate change may pose considerable challenges to forest-based livelihoods at rural community level. Climate change effects at rural community level are associated with substantial uncertainties. However, a growing body of literature is advocating for the use of local indigenous knowledge in assessing climate-change bearings on lives and livelihoods at community level (Boon & Ahenkan, 2012; CARE, 2011; Somorin, 2010; Malone, 2009; Vincent, 2004). This approach is believed to offer competent means of understanding climate-change impact on livelihoods under deep uncertainty at rural community level (Kasperson *et al.,* 2005; Vincent, 2004). It could be argued that none of this literature has investigated the reliability of indigenous knowledge in effectively analysing climate-change impacts on forest-based livelihoods at rural community level. The central objective of Chapter 4 was thus to analyse how rural people perceive the effects of climate change on forest-based livelihoods in their community.

The study explored climate variability and change effects on forest-based livelihoods using a perception-based analysis procedure. The methodological approach used in the study draws on insight from the Climate Risk Assessment Guide developed by UNDP Central Asia Climate Risk Management Program (UNDP, 2013). The guide uses a modification of the sustainable livelihoods framework to define climate-change impacts by looking at how short-

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or long-term climatic events could affect various types of forest products used for livelihoods in the study communities.

The study showed that the perception-based approach is effective in understanding the nature and types of climatic impact and events in a community. In this case study, the major climatic events that were perceived to affect forest-based livelihoods in the communities were erratic rainfall and extreme temperatures. Drought and floods are perceived to affect forest-based livelihoods moderately. These climatic events have been observed to cause disturbances, ranging from temporarily reduced access to forests to scarcity of essential forest products.

However, there was a weakness in the usefulness of perception-based approach in accurately understanding the impact of climate change on essential forest products used for livelihood in the study communities. Generally, the people were able to perceive climate-change consequences on non-wood forest products. Hence, honey, fodder for livestock, medicinal plants, wild vegetables, and forest fruits and foods were perceived to be most affected by climate change. However, the people were unable to accurately perceive the effects on woody forest products. For example, people's perceptions of climate change outcomes on the availability of firewood and timber did not show a clear pattern across the municipalities.

To be precise, people's perceptions of climate-change impacts on forest-based livelihoods could not reveal which forest product was more at risk to the climatic events that were occurring in their community. For example, an analysis of the sensitivity of essential forest products to major climatic events showed that essential forest products that are used for livelihoods, except for firewood, are not sensitive to all observed major climatic events in the community. Firewood was the only product that was found to be sensitive, specifically to extreme drought. This questions the ability of rural people to perceive climate change effectively in their locality. For example, erratic rainfall and temperatures were not perceived to pose a risk to forest-based livelihoods, yet these events have been empirically proven to have significant effects on forest growth and vitality (Gauthier *et al.,* 2014; Maponya & Mpandeli 2013; Naidoo et al., 2013; Lindner *et al.,* 2008). Similarly, it is confusing when the people perceived firewood to be at risk to drought and timber not to be at risk to the same event.

In addition, the vulnerability of forest-based livelihoods was not found to depend solely on exposure and sensitivity to climate variability and change. Forest area and population density per community were found to significantly influence the vulnerability of forest-based

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livelihoods. For example, in Makhado, where there is a higher population density per community and consequently more human pressure on forests, forest product availability was perceived to have been more impacted by climate variability and change. However, in Mutale, where the population density per community was lower, but which has a higher proportion of degraded forest, forest product availability was perceived to have been less impacted by climate variability and change. This finding suggests that perceptions of climate risk are influenced more by socioeconomic pressure than manifestations of climatic events. Another important point from this observation is that perception-based assessment is insufficient in understanding the detailed impact of climate change at rural community level because of the growing interaction between climate and socioeconomic pressure that affects forest use and management.

Nevertheless, forest-based rural communities display some understanding of climate-change manifestations in their community. Hence a thorough recognition of local perspectives of climate change effect on forest-based livelihoods is necessary. However, local perspectives of climate-change effects on forest-based livelihoods should be supplemented with evidence from sound scientific studies, for example model-based studies.

7.1.3 Assessing local-level forest use and management capacity as a climate-change adaptation strategy at rural community level

Relations to and practice of forest use and management at household and community level may affect the vulnerability of community and forest-based livelihoods to climate change. Although dependence on forest resources could increase the sensitivity of a rural community to climate change (Wongbusarakum & Loper, 2011; Turner *et al.,* 2003), community engagement in sustainable forest use and management holds significant potential for improving communities' resilience against climate-change impacts (FAO, 2015; Dlamini, 2014; Chidumayo *et al.,* 2011). The interplay between rural people's dependence on forests and sustainable forest management could thus aggravate or reduce their vulnerability to climate change.

Chapter 5 assessed local-level forest use and management capacity as a climate-change mitigation and adaptation strategy. The methodological approach used in the study entailed the use of a household questionnaire survey to examine respondents' knowledge and experience of forest regulation and management in the community; households' dependence on forest products for their livelihoods; the role of forest products in household adaptation to

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climate variability; household capacity to participate meaningfully in forest management; and the capacity of community leadership to influence participation in forest management.

The study revealed that despite the abundance of forests, including plantations, in the area, the contribution of the formal forest sector to household incomes was generally low and varied significantly. From the results of the study, types of forest appear to play significant roles in the contribution of the formal forest sector to household income. Thus in Thulamela communities, with typical woodland forest, coupled with an abundance of tree plantations, the formal forest sector was observed to make a greater contribution to household income. Expanding the forest resource base of a community is thus a precondition for developing a vibrant formal forest sector in a community and by implication for improving the contribution of the formal forest sector to household incomes and livelihoods. Similar findings have been reported in which the formal forest sectors were found to be a dominant contributor to household incomes and livelihoods in rural communities that are situated in industrial tree plantation areas (Ofoegbu, 2014, Chamberlain *et al.,* 2005).

However, despite the low contribution of the formal forest sector to job creation and household income in the study area, there is widespread informal trade in forest products in the study communities. This form of livelihood strategy is a significant contributor to household incomes and livelihood sustainability. Firewood and timber were the most commonly traded wood products and the highest contributors to household income. Informal trade in forest products is a major livelihood diversification strategy used by respondents in the community to cope with the direct and indirect impact of climate variability and change events. Informal trade in forest products is mostly because of poor development of markets and structures for regulating the production, harvesting and trade of these forest products. Managing these issues would create an opportunity for maximizing benefits, including coping benefits, from production and trade of forest products in the communities. Thus, there is need to distinguish between management objectives for products traded ‘formally’ and those traded ‘informally’ when instituting forest management guides and practices at rural community level. This is essential to accommodate community rules, norms and unique characteristics.

The study revealed that household capacity to participate in forest management, and community leadership’s ability to mobilize people was low. Poor capacity to sustainably use and manage forests and forest products, and limited opportunities for alternative livelihood

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strategies, coupled with poor infrastructure and services, are huge constraints to the capacity of most forest-based rural communities to respond effectively and recover from climate change and related impacts (Rennaud *et al.,* 2013; Shackleton *et al.,* 2002). Although reacting to climate variability and change events and their impacts is important, it is crucial to focus on building the capacity of rural people and local traditional authorities to ameliorate the impacts of climate variability and change events currently and into the future (Hajost & Zerbock, 2013; Rahlao *et al.,* 2012). From the study, it could be suggested that capacity enhancement for sustainable forest use and management should pervade all adaptation strategies and policy options at forest-based rural community level

Thus, enhancing local traditional leadership capacity to foster sustainable forest use and management would be of strategic importance. This is because traditional leaders in most rural communities across South Africa are the custodians of customary lands and have been part of the regulating authority for forest use and management (Arrikum, 2014; DAFF, 2010; Shackleton & Campbell, 2001).

7.1.4 Assessing adaptive capacity and climate-change coping strategies of forest-based rural communities

Coping strategies and the capacity to adapt to climate change at forest-based rural community level is rarely determined by physical impacts alone, but by a combination of social, economic, technological and physical factors (CARE, 2011; Jones, 2011). Conceptualizing adaptive capacity at this level is a complex task because of the need to recognize the dynamic social, economic, and physical context in which adaptation takes place (Turyahabwe *et al.,* 2006; Jones, 2011). This complexity provides numerous challenges for our understanding of adaptive capacity at rural community level. Moreover, many analytical frameworks for assessing adaptive capacity have focused on larger scales, such as national level, with little applicability for representing capacity at rural community level, where most adaptation action would most likely occur (Jones, 2011).

The question of how forest-dependent people would adapt to climate change is a growing area of research and has been at the heart of a number of recent studies (CARE, 2011; Somorin, 2010; Nkem et al., 2007). In this study, however, the researcher paid particular attention to the complex human-environment interaction in which rural forest-based communities operate by investigating socioeconomic conditions that affect households'

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coping strategies and adaptive capacity for effective climate-change intervention. Chapter 6 investigated households' ranges of coping responses and how they interact with household access to services and infrastructure (e.g. markets, and water supply facility) in dictating communities' vulnerability to climate change. This helped in understanding how these services and infrastructure might facilitate or constrain adaptive capacity at rural community level. This provided important insights into potential policy making on the services and infrastructure that should be improved to enhance adaptive capacity at forest-based rural community level.

The study showed that households draw on various coping strategies to cushion the effects of climate variability and change. Most of the ranges of coping strategies in the study communities are used in several rural communities across Africa (FAO, 2015; Boon & Ahenkan, 2012; Chidumayo *et al.,* 2011). In most cases, the respondents tend to use strategies that do not have direct negative impact on their livelihoods. Additionally, forests and forest products currently play diverse roles in household coping strategies for climate variability and extreme weather events. Respondents in the study communities often planted and retained trees around their houses and on farms to provide shade for homes and crops. Common tree species planted or retained by households included fruit trees such as mango *(Mangifera indica)* and avocado *(Persea americana),* timber species such as eucalyptus and pine and other important indigenous species, including mopane *(Colophospermum mopane)* and those used for firewood. Nevertheless, in the study communities, the role of forest products in household coping strategies was generally low. The widespread adoption of forest-based coping strategies seemed to be hampered by poor markets for forest products, and poor organization of the informal forest sectors in the community.

With the majority of the population in the study communities engaged in the informal forest sector for subsistence and income, the informal forest sector provides an appropriate foundation for improving the contribution of forests to household livelihood sustainability and resilience against climate-change challenges. However, the sustainability and profitability of such initiative would depend largely on implementation of forest management practices that promote equitable and socially inclusive access to forests and responsible forest usage practices (Hajost & Zerbock, 2013; Shackleton & Campbell, 2001). This would require enhancement of the people's capacity to participate in responsible forest use and management (Shackleton *et al.,* 2002).

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In general, the implementation of forest management strategies that would effectively connect the informal forest sector with climate-change intervention initiatives requires an understanding of the informal forest sector that extends beyond assumptions that informal activities are unorganized and chaotic in form and practice (Smit & Musango, 2015). A hybrid forest management approach is needed that is open to such duality; embraces the traditional and the modern, small scale and large scale, informal and the formal; addresses power imbalances; and protects the vulnerable (Smit & Musango, 2015; Holmes-Watts & Watts, 2008). For this reason, an approach that recognizes complexity and contextual realities should be explored when planning for the informal sector in forest management in response to climate change challenges.

While some of the coping strategies in the study communities are used efficiently, the adoption of most of these strategies is hampered by barriers. In general, the choice, effectiveness, and efficiency of adopting any coping strategy are dependent on a range of social, economic and social factors that are dictated by respondents' and communities' socioeconomic characteristics. Analysis of how household and community socioeconomic characteristics interplay with household coping strategies revealed lack of access to credit as a major barrier to effective adoption of most strategies in the study communities. Institutional facilities, social support groups and human capital resources are crucial to the success and choice of household's coping strategies. People's interaction with institutional facilities such as water supply and access to markets played a significant role in households' adaptive capacity (McNamara, 2011; Twomlow *et al.,* 2008). Therefore, provisioning efficient and functional institutional facilities in a community is crucial to improving resilience against climate change.

More specifically, human capital vis-à-vis people's skills and educational levels is a significant determinant of choice of coping strategy and efficiency of adopting this strategy. Low human capital resources in the form of poor skills and lack of education in the study communities limit the people's ability to participate in the formal economic sector, thereby restricting them to subsistence farming and the use of forest products for their livelihoods. Additionally, given the uncertainty about the precise manifestations of climate change in certain areas, it is postulated that improving human capital vis-à-vis skills acquisition and education as a means of enhancing the people's flexibility and ability to adapt to climate change is a worthwhile strategy for rural communities. Similarly, given the significant influence of social support groups in enhancing households' adaptive capacity and coping

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efficiency, climate-change intervention initiatives at rural community level should target improvement of relationships in the community. Given the complex nature of the interaction between human beings and forest resources in most of the study communities, adapting to climate change is not just a technical issue and should not be addressed as a single-faceted challenge.

7.2 LINKING STUDY CONCEPTUAL FRAMEWORK TO THE STUDY KEY FINDINGS

The vulnerability of rural people and their forest based livelihoods to climate variability and change challenges in South Africa is complex and dynamic. However, drawing from the insight from linking the study conceptual framework to the key findings from this study, it can be deduced that to reduce rural people and their forest based livelihood vulnerability to climate change challenges. Actions should be targeted at reducing the people and their livelihood exposure, and sensitivity to climate change challenges, while improving their adaptive capacity. In this regard, to reduce exposure, action should be geared towards improving awareness and engagement of rural communities with climate change issues. Climate information dissemination should be structured in manner that clearly demonstrates the relationship between climate change and the people livelihood activities. Similarly climate information should be disseminated in a manner that non literate people can understand its message. In the long run, exposure reduction activities should be targeted at decoupling rural livelihood activity from high dependence on forest and natural resources. Furthermore to reduce, the people sensitivity actions should be targeted at improving the impact and effectiveness of forest management and conservation programs in the communities. In this regard, concerted efforts should be directed at improving the people, knowledge and capacity to participate in sustainable forest use and management. Similarly, local leadership should be provided with required assistance and capacity enhancement opportunity to foster sustainable forest use and management activity in their domain. As shown by the study conceptual framework, there is significant relationship between the effectiveness and choice of coping practices applied by the people and the community demographic characteristics. Thus to improve adaptive capacity, actions should be targeted at overall community development including improvement of services and infrastructure. Additionally programs should also make concerted effort at improving social cohesion and social inclusiveness in the community. These actions as can be inferred from the study

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findings will help to reduce vulnerability of people and forest based livelihood to climate change in rural communities of South Africa.

7.3 POLICY IMPLICATION OF STUDY FINDING ON SUSTAINABILITY AND MANAGEMENT OF FORESTS

Evidence from the study findings affirms the critical role of the forest sector in rural livelihood sustainability and resilience to climate and socioeconomic challenges. The continuous availability of forest products in healthy quality and in a timely manner is therefore critical for households' livelihood sustainability and resilience to climate and socioeconomic challenges (Shackleton, 2005). Furthermore, the study focus on local forest use and management practices from the 'livelihoods' perspective highlight the need to shift the focus on the sustainability of forest management away from the narrow parameters of cultivation/production, and growth of the forest products to a much more holistic view which embraces the sociocultural and economic dimensions, and environmental sustainability, all within the context of building on local capacities and priorities.

It is therefore important that forest policy and policy development processes continue not only to foster and encourage sustainable development of the rural communities and forest estates (Sample, 2004), but also to ensure that use and management of all forest types in South Africa rural communities is inclusive and in line with the principles of sustainable development (Shackleton et al. 2007). In this regard, sustainable use and management of forest products in South Africa rural communities will need to address - the balance of economic, social and environmental demands on the forest landscape (Sample 2004). The study findings therefore presents some important insight with implication for implementation of sustainable forest management projects in South Africa.

7.3.1 Policy implications for sustainable forest management

The study assessments of the sustainability and resilience of forest based livelihood to climate variability and change challenges has yielded important insights. The findings that certain forest products maybe incurring more climate risk than other products calls for a strategic management of forests in a manner that will ensure the sustainable supply of forest products that are consumed per community per forest type. The findings that the informal forest sector makes contribution to household income more than the formal forest sectors do not contradict findings from several authors (Shackleton & Shackleton, 2011; Shackleton et al. 2007; Shackleton et al 2000) that the forest sector makes significant contribution to households' income. However, this also highlights the need for policy action to promote the

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development of the formal forest sector in the Vhembe region to improve the overall development of the forest sector contribution to households' livelihood sustainability and resilience to climate variability and change challenges. The findings that use of forest products in households coping strategy is not maximally utilised and characterised with numerous barriers further strengthens the need for policy support for informal traders in forest products to ensure they make more profit from their effort while sustainably using the forests (Shackleton et al. 2007). As suggested by Shackleton & Shackleton (2011), a supportive policy environment which recognises that forest resources can make a significant and sustainable contribution to the livelihoods of rural people should be promoted as a complementary rural development option.

There is a sufficient evidence to infer that sustainability in forest use and management in the study communities can be achieved through inclusion of host communities and local leadership in formulations of forest management decisions and policy. Although there has been recognition for the inclusion of rural host communities in management and use of forests in South Africa policy documents (Shackleton & Shackleton, 2011), insight from this study further strengthens this need, and also added a fresh insight on the need to capacitate local leadership for fostering sustainable forest use and management communities in South Africa´s, rural communities.

7.4 LIMITATIONS AND FUTURE RESEARCH DIRECTIONS

7.4.1 Limitations of the study

The study adopted a case study approach in which the research sites were purposively selected. This limited the investigations on vulnerability of forest-based livelihoods and rural communities to climate variability and change events to the selected sites in Vhembe District, Limpopo. This implies that the findings from this study cannot be generalized to other forest-based rural communities in the country. Due mainly to limitations of time and funding, the vulnerability assessment concentrated on the effect of climate change on households' adaptive capacity and forest-based livelihoods vis-a-vis their interaction with forest resources and dependence on forest income. The framework was holistic in considering how these aspects contribute to climate-change vulnerability at the household level and subsequently at the community level. However, it does not consider potential impacts on other sectors, such as water resources, building requirements, public health, and municipal infrastructure.

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7.4.3 Future research directions

This study has undertaken a comprehensive assessment of the vulnerability of forest-based livelihood at rural community level to climate change. Important academic and problem-solving contributions have been made. However, unanswered questions and gaps remain that should be addressed in the future. The thesis refined the social vulnerability assessment approach and used it to assess the vulnerability of forest-based rural communities to climate change. Because the thesis concentrated on forest-based livelihood, an extension of this work would be to apply the method to all livelihood strategies at rural community level. Based on the findings of this study, further investigations are suggested in these areas:

- The survey-based vulnerability assessment framework approach applied in this study has been helpful in identifying vulnerable forest products per community, but has been weak in analysing the sensitivity of these forest products to major climatic events occurring in the community. It is proposed that a different methodological approach should be used for example a model-based approach, to identify the sensitivity of forest products that are essential to livelihoods in the communities to major climatic and extreme weather events.

- Forests and forest products are important components of livelihood strategies in most rural communities. However, communities mostly lack the capacity to engage in sustainable forest use and management in response to climate change and socioeconomic challenges. It is thus recommended that training needs assessment of rural forest users to improve their capacity to engage in sustainable forest use and management practices should be done. In addition, given the overwhelming contribution of the informal forest sector to household livelihood sustainability and resilience against climate change in the study communities, an investigation of modalities for organizing and engaging the numerous informal forest sectors in the communities in sustainable forest use and management practices for effective climate change mitigation and adaptation initiatives at community level should be undertaken.

- This study investigated socioeconomic variables that influence household dependence on forest resources and its influence on people's coping responses and adaptive capacity to climate-change challenges. In future, an extension of the study should include investigations of psychosocial factors that influence rural people's intentions to engage in

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sustainable forest use and management practices in response to climate-change challenges. This would contribute towards the development of modalities for comprehensively improving the contribution of sustainable forest use and management to households and community resilience against climate-change challenges.

7.5 CONCLUDING REMARKS

This thesis focused on the vulnerability of forest-based rural communities to climate change in South Africa by using a social vulnerability assessment approach to assess the underlying causes of vulnerability.

This study has demonstrated how understanding of local conceptualizations of climate change; household perceptions of climate change and its impact; household dependence on forests and their capacity to engage in sustainable forest use and management; and coping responses and adaptive capacity could combine to offer contextual insights into the vulnerability of forest-based rural communities to climate change. This work would help to focus adaptation initiatives on a range of social, economic and physical factors that interacts at household and community level in dictating their vulnerability to climate change. From the case study, improving households' capacity to engage in sustainable forest use and management, water supply services, market facilities, social support group services and human capital vis-à-vis education and skills acquisition are critical to reducing forest-based rural communities' vulnerability to climate-change challenges in South Africa.

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APPENDIX 1: QUESTIONNAIRE FORM: ENGLISH VERSION

Questionnaire survey for climate change impact on rural livelihood in South Africa

Date of interview: _____day _____ month _____ year

Survey ID Number: _____

Community/Village Name: _____ Respondent Language: _____

Respondent Name: _____

For Office Use Only

V0 [ ]

Perception and Awareness of Climate Change

1. Respondent age: _____ V1 [ ][ ][ ]

2. What is your Gender? V2 [ ]

Male	1
Female	2

3. For how many years have you been living in this village? _____ V3 [ ]

4. Please fill out the following for each household member

Member Number	Age	Sex		Employment status						
		Male	Female	Unemployed	Retired	Student	Seasonal work	Self employed	Temporary	Permanent
1		1	2	1	2	3	4	5	6	7
2		1	2	1	2	3	4	5	6	7
3		1	2	1	2	3	4	5	6	7

	Age	Sex
4.1.1		
4.1.2		
4.1.3		
4.1.4		
4.1.5		
4.1.6		
4.1.7		
4.1.8		

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4		1	2	1	2	3	4	5	6	7
5		1	2	1	2	3	4	5	6	7
6		1	2	1	2	3	4	5	6	7
7		1	2	1	2	3	4	5	6	7
8		1	2	1	2	3	4	5	6	7

5. How much have you heard about climate change before receiving this survey?

V5 ☐

Not at All	1	**Few Times**	2	**Several Times**	3

6. Have you observed any changes in the onset and offset of seasons?

Seasons	**Comes early**	**Delays**	**No change**
Summer	1	2	3
Winter	1	2	3
Spring	1	2	3

V6.1 ☐
V6.2 ☐
V6.3 ☐

7. Have you observed any of the following changes? **Tick the relevant section**

Biological system	**Check all that apply**		
	Yes	**No**	**Don't know**
New Plant species seen (in farms and forests)	1	2	3
New diseases in agricultural/tree crops	1	2	3
Increased frequency of incidence of pests,	1	2	3
Changes in crop ripening season	1	2	3
Changes in flowering and fruiting time	1	2	3
Changes in Planting season	1	2	3
Frequency of bush fire is increasing	1	2	3
Extinct of some plant species	1	2	3
Water source and availability is becoming scarce	1	2	3
Increased death of livestock	1	2	3

V7.1 ☐
V7.2 ☐
V7.3 ☐
V7.4 ☐
V7.5 ☐
V7.6 ☐
V7.7 ☐
V7.8 ☐
V7.9 ☐
V7.10 ☐

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8. What is your understanding of the occurrence of these climatic events over the Years? **Tick the appropriate box**

Climatic events	Increasing	Decreasing	The Same
Erratic rainfall	1	2	3
Incidence of high temperature	1	2	3
Serious flood	1	2	3
Serious drought	1	2	3
Increase frequency of hailstone	1	2	3
Increase frequency of strong wind	1	2	3

V8.1 V8.2 V8.3 V8.4 V8.5 V8.6

9. How did these climatic events affect you or your household income? **Tick all that apply**

Climate Event	Effects		
	No loss of income or capital assets	Temporary loss of income – less than six months	Loss of income for extended period – more than six months
Erratic rainfall	1	2	3
Incidence of high temperature	1	2	3
Serious flood	1	2	3
Serious drought	1	2	3
Increase frequency of strong wind	1	2	3
Increase frequency of hailstone	1	2	3

V9.1 V9.2 V9.3 V9.4 V9.5 V9.6

10. What is your perception about frequency of occurrence of diseases attributable to climate variability such as temperature related sicknesses and cold related sicknesses in your community?

Increased	1	Decreased	2	No change	3

V10

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11. To what extent do you agree that your embracement of these lifestyle changes would contribute towards managing climate change in your community?
Please indicate your answer by ticking the appropriate box

Lifestyle	Strongly agree	Agree	Neither agree nor Disagree	Disagree	Strongly disagree
Stop unregulated harvest of forest resources	1	2	3	4	5
Accepts training in good forest exploitation practices	1	2	3	4	5
Willing to use alternative cooking energy other than firewood and charcoal	1	2	3	4	5
Willing to plant more trees on farms	1	2	3	4	5
Willing to diversify income by learning how to cultivate NTFPs such as beekeeping, mushroom production etc.	1	2	3	4	5

V11.1	
V11.2	
V11.3	
V11.4	
V11.5	

12. How concerned are you about the following occurrences with regard to the effect of climate change?

CONCERN CLIMATE EVENT	Not at all concerned	Less concern	Strongly concerned
Damage to forest resources	1	2	3
Increase food cost	1	2	3
Danger to public health	1	2	3
Reduce water availability	1	2	3
Increased energy cost	1	2	3
Increase in the number of severe weather event	1	2	3
Shift in planting season	1	2	3

V12.1	
V12.2	
V12.3	
V12.4	
V12.5	
V12.6	
V12.7	

13. Which of the following do you believe is/are causing climate variability and

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change?

Causes	It is a cause	It is not a cause	Don't know
Anger of the gods	1	2	3
Ancestors ways of punishing our wrong	1	2	3
Population growth	1	2	3
Uncontrolled harvest of forest resources	1	2	3
Poor farming practices	1	2	3
Natural variations in the climate	1	2	3

V13.1
V13.2
V13.3
V13.4
V13.5
V13.6

Dependence of forest Resources

14. Indicate if you or any of your household members work in any of these organizations, and rate the importance of their contribution to household income. **Tick all that apply**

Sector	Contribution			
	High	Medium	Low	No Contribution
Tourism	1	2	3	4
Environmental/Conservation	1	2	3	4
Sawmill	1	2	3	4
Tree Plantation	1	2	3	4
Furniture	1	2	3	4
Woodwork/carving/artisan	1	2	3	4
Charcoal Production	1	2	3	4
Pension/Social security	1	2	3	4

V14.1
V14.2
V14.3
V14.4
V14.5
V14.6
V14.7
V14.8

15. How would you rate the importance of your household dependence on these forest resources for sustenance?

Forest Resources	Importance			
	High	Medium	Low	Not in Use
Firewood	1	2	3	4
Forest fruits and food	1	2	3	4
Timber/construction wood	1	2	3	4
Charcoal	1	2	3	4
Thatch grass	1	2	3	4
Wild vegetables	1	2	3	4
Mushroom	1	2	3	4
Honey	1	2	3	4
Medicinal plants	1	2	3	4
Fodder for livestock	1	2	3	4
Weaving fibre for baskets, mats and	1	2	3	4

V15.1
V15.2
V15.3
V15.4
V15.5
V15.6
V15.7
V15.8
V15.9
V15.10
V15.11
V15.12

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ropes.				
Bush Meat/wild edible insects e.g. Mopani worms	1	2	3	4

16. How would you rate the importance of these forest resources to your household for income generation

Forest Resources	**Importance**			
	High	**Medium**	**Low**	**Not in use**
Firewood	1	2	3	4
Forest fruits and food	1	2	3	4
Timber/construction wood	1	2	3	4
Charcoal	1	2	3	4
Thatch grass	1	2	3	4
Wild vegetables	1	2	3	4
Mushroom	1	2	3	4
Honey	1	2	3	4
Medicinal plants	1	2	3	4
Fodder for livestock	1	2	3	4
Weaving fibre for baskets, mats and ropes.	1	2	3	4
Bush Meat/wild edible insects e.g. Mopani worms	1	2	3	4

V16.1
V16.2
V16.3
V16.4
V16.5
V16.6
V16.7
V16.8
V16.9
V16.10
V16.11
V16.12

17. Who is responsible for granting access permit to the forest for harvest of resources in your community?

V17.

No permission required for harvest of forest resources	1
Village head	2
Forest department personnel	3
counsellor	4

V18.

18. What type of constraint or difficulty do you experience in obtaining permit for

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accessing forest resource in your community?

No difficulty or constraint experienced	1
Delay in issuance of permit	2
Travel distance to the permitting office is far	3
Permit cost is too high	4

19. How did these climatic events affect access and availability of forest resources in your area? **Tick all that apply**

Climate Event	Effects			
	No damage to forest resources.	Reduced access to forest resources for 3-4 months needed to meet normal needs.	Temporary reduced access to forest resources needed to meet basic needs.	Extended reduced access to forest resources needed to meet normal needs.
Erratic rainfall	1	2	3	4
Incidence of high temperature	1	2	3	4
Serious flood	1	2	3	4
Serious drought	1	2	3	4
Increase frequency of strong wind	1	2	3	4
Increase frequency of hailstone	1	2	3	4

V19.1	
V19.2	
V19.3	
V19.4	
V19.5	
V19.6	

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20. Tick any of these reasons why your household engage in use of forest resources for income generation. **Tick all that apply (Y = yes, N = No)**

Reasons	**Income generation**		
Abundance of forest resources	1	V20.1	
Relative low cost of using forest resources	2	V20.2	
Easy accessibility of forest resources	3	V20.3	
Inability to spend on alternatives e.g. gas, electricity etc.	4	V20.4	
To survive household temporally shocks (such as loss of job, crop failure, theft, fire outbreak etc.) period of crop failure	5	V20.5	
To augment household income	6	V20.6	
Unemployment	7	V20.7	
unavailability of alternative job opportunities	8	V20.8	
Safety-net (temporarily while searching for a job)	9	V20.9	

21. Tick any of these reasons why your household engage in subsistence use of forest resources. **Tick all that apply (Y = yes, N = No)**

Reasons	**Subsistence Use**		
Abundance of forest resources	1	V21.1	
Relative low cost of using forest resources	2	V21.2	
Easy accessibility of forest resources	3	V21.3	
Inability to spend on alternatives e.g. gas, electricity etc.	4	V21.4	
To survive household temporally shocks (such as loss of job, crop failure, theft, fire outbreak etc.) period of crop failure	5	V21.5	
To augment household income	6	V21.6	
Unemployment	7	V21.7	
unavailability of alternative job opportunities	8	V21.8	
Safety-net (temporarily while searching for a job)	9	V21.9	

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22. Indicate whether the following forest activities are mainly carried out by children, women, or men.

Forest Resources	Men	Women	Children
Firewood	1	2	3
Forest fruits and food	1	2	3
Timber/construction wood	1	2	3
Charcoal	1	2	3
Thatch grass	1	2	3
Wild vegetables	1	2	3
Mushroom	1	2	3
Honey	1	2	3
Medicinal plants	1	2	3
Fodder for livestock	1	2	3
Weaving fibre for baskets, mats and ropes.	1	2	3
Bush Meat/wild edible insects e.g. Mopani worms	1	2	3

V22.1	
V22.2	
V22.3	
V22.4	
V22.5	
V22.6	
V22.7	
V22.8	
V22.9	
V22.10	
V22.11	
V22.12	

23. What training would interest you most in order to reduce forest degradation in your area?

Sustainable forest resource harvest practices	1
Training on best practice in forest regeneration	2
Business opportunity in non-timber forest resources such as honey, thatch grass etc.	3
Training on agroforestry practice	4
None	5

V23. [ ]

24. How often do you attend training or seminar on forest management practices?

Always	1
Often	2
Rarely	3
Never	4

V24. [ ]

25. Are you in anyway involved in the planning and management of the forests in your village?

Yes	1
No	2

V25. [ ]

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26. Which of the following activities would interest you most in order to improve forest monitoring and evaluation in your village?

V26. ☐

Take part in decision regarding monitoring activities	1
Enforcement of local laws (taboo days)	2
Monitoring and evaluation of implemented of forest projects	3
Part of reinforcement surveillance team	4
None	5

Vulnerability to climate Change

V27. ☐

27. What is your highest educational qualification?

Educational qualification	Please tick
No qualification	1
Grade 11 or Lower (std 9 or lower)	2
Grade 12 (Matric, std 10)	3
Post-Matric Diploma or certificate	4
Baccalaureate Degree (s)	5
Postgraduate Degree(s)	6

V28. ☐

28. Which of the following skills do you possess?

Skills	Please tick
Hunting	1
Cultural or language training	2
carpentry	3
Wood carving	4
Farming	5
Livestock keeping	6
Art and craftwork	7
Others: please specify	8

29. How would you rate your household reliance on forest resources when impacted by the following climate events? Tick all that apply

Climate Event	Level of Reliance			
	Low	No Change	High	Not Applicable
Erratic rainfall	1	2	3	4

V29.1 ☐
V29.2 ☐
V29.3 ☐
V29.4 ☐

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Incidence of high temperature	1	2	3	4	V29.5
Serious flood	1	2	3	4	V29.6
Serious drought	1	2	3	4	
Increase frequency of strong wind	1	2	3	4	
Increase frequency of hailstone	1	2	3	4	

30. Please indicate your level of satisfaction with the following infrastructure and services in your community

Infrastructure /Services	Very Dissatisfied	Dissatisfied	Neither Satisfied nor Dissatisfied	Satisfied	Very Satisfied	
a. Access to health care	1	2	3	4	5	30.a
b. Access to water supply	1	2	3	4	5	30.b
c. Access to market centre	1	2	3	4	5	30.c
d. Nearest school	1	2	3	4	5	30.d
e. Emergency services (e.g. police, fire etc.	1	2	3	4	5	30.e
f. Opportunities to contribute to local decision making	1	2	3	4	5	30.f
g. communication services	1	2	3	4	5	30.g
h. representation of your needs by community leaders	1	2	3	4	5	30.h

31. Are there any forest resources your household are now finding it difficult to access? **Tick the appropriate box for the resource. (Y = Yes, N = No)**

Forest Resources	Tick appropriate	Tick	
Firewood	1	V31.1	
Forest fruits and food	2	V31.2	
Timber/construction wood	3	V31.3	
Charcoal	4	V31.4	
Thatch grass	5	V31.5	
Wild vegetables	6	V31.6	
Mushroom	7	V31.8	
Honey	8	V31.9	
Medicinal plants	9	V31.10	
		V31.11	
		V31.12	

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Fodder for livestock	10
Weaving fibre for baskets, mats and ropes.	11
Bush Meat/wild edible insects e.g. Mopani worms	12

32. Which of the following do you believe is/are reasons for the scarcity of forest resources in your community? **Tick all that apply**

Reason for scarcity	**It's a reason**	**It's not a reason**	**Not sure**
Bad exploitation practices	1	2	3
Increase in Demand	1	2	3
Deteriorating soil condition	1	2	3
Increasing climate variability	1	2	3
Reduction in forest size	1	2	3
Failure to replant trees	1	2	3
Overgrazing by livestock	1	2	3

V32.1 V32.2 V32.3 V32.4 V32.5 V32.6 V32.7

33. How has climate variability and change affected your usage of these resources? **Tick all that**

Forest Resources	**Effects**			
	No effect on resource	**Resource have become scarce,**	**Increased difficulty in harvesting resource**	**Resource have become expensive**
Firewood	1	2	3	4
Charcoal	1	2	3	4
Timber/construction wood	1	2	3	4

V33.1 V33.2 V33.3

V34.1

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34. How has climate variability and change affected your usage of these resources? **Tick all that**

Forest Resources	**Effects**			
	No effect on resource	**Resource have become scarce and difficult to find**	**Resource have become expensive r**	**Most variety of resource have become extinct**
Mushrooms	1	2	3	4
Medicinal plants	1	2	3	4
Thatch grass	1	2	3	4
Wild fruits and vegetables	1	2	3	4

V34.2
V34.3
V34.4

Coping Mechanism and Adaptive Capacity

35. How did you and your household cope with the effect of erratic rainfall? **Tick all that apply**

Coping Mechanism	**Tick**	**Coping Mechanism**	**Tick**
Shifts in planting period to coincide with the start of rain season	1	Taken off-farm activities (i.e. wage labour)	2
Depended on use and sell of wild food/NTFP	3	Cropping around streams	4
Use of dug out wells for irrigation	5	Planting drought resistant crop varieties and fruits e.g. water melon	6
Rainwater harvesting and storage	7	Other mechanism (specify)	8

V35.1
V35.2
V35.3
V35.4
V35.5
V35.6
V35.7
V35.8

36. How did you cope with the effect of Incidence of high temperature? **Tick all that apply**

Coping Mechanism	**Tick**	**Coping Mechanism**	**Tick**
Planting trees on farm to shade crops	1	Planting of trees around home to provide shade	2
Stay in-door (reduced the number of hours spent on farming activity)	3	Bought air cooling appliance e.g. fan, air-condition etc.	4

V36.1
V36.2
V36.3
V36.4

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37. How did you cope with the effect of serious drought? **Tick all that apply**

Coping Mechanism	Tick	Coping Mechanism	Tick
Improve water storage capacity: e.g. installing tanks	1	water reuse e.g. water used for domestic activities is also used for backyard gardening	2
Depended on use and sell of wild food/NTFP	3	Migrated for work	4
Increase water capture: e.g. bores for groundwater, rain water harvest.	5	Water rationing e.g. reduce water use per person per day	6
Switch to planting of drought and resistant crops	7	Cropping around streams	8
Irrigating crops with water from streams	9	Other mechanism (specify)	10

V37.1	
V37.2	
V37.3	
V37.4	
V37.5	
V37.6	
V37.7	
V37.8	
V37.9	
V37.10	

38. How did you cope with the effect of serious flood? **Tick all that apply**

Coping Mechanism	Tick	Coping Mechanism	Tick
Rely on social networks	1	HH members sought shelter in other communities (displaced)	2
Depended on use and sell of wild food/NTFP	3	Migrated for work	4
Sold HH assets (incl. small animals,)	5	Support from friends and relatives	6
Food aid and other relief	7	Planted trees for flood control	8
Build flood control wall around homestead	9	Other mechanism (specify)	10

V38.1	
V38.2	
V38.3	
V38.4	
V38.5	
V38.6	
V38.7	
V38.8	
V38.9	
V38.10	

V39.1	

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39. Which of the following challenge are you facing in coping with the aforemention climate hazards. **Tick all that apply and also indicate the hazards** (Q?)

Challenge	Tick
No challenge	1
lack of information about the weather or long-term climate change	2
lack of knowledge/skillss about the appropriate coping options/adaptations	3
lack of money or access to credit	4
Desired forest resources no longer available	5
lack of market access	6
Change of farming practices	7
Inadequate supply of improved planting materials	8
Erosion of traditional skills and knowledge amongst the younger generation	9
Break down in communal nature of our society	10

V39.2	
V39.3	
V39.4	
V39.5	
V39.6	
V39.7	
V39.8	
V39.9	
V39.10	

40. Which of the following assisted your household to deal with the effects of climate hazard? (**tick the appropriate box**)

Agency	Tick	Agency	Tick
Family members living outside the community	1	Insurance company	2
Neighbours	3	Financial institution	4
Local community organization	5	National government	6
NGO	7	The Municipality	8
International Organization (e.g. WFP, FAO)	9	Provincial government	10

V40.1	
V40.2	
V40.3	
V40.4	
V40.5	
V40.6	
V40.7	
V40.8	
V40.9	
V40.10	

41. For any of the climate hazard that your household experienced, did you get warning of such incidence?

Climate/Socioeconomic Risk	Tick the appropriately	
	Yes	No
Erratic rainfall	1	2
Incidence of high temperature	1	2
Increase incidence of flash flood	1	2
Serious drought	1	2
Increase frequency of strong wind	1	2
Increase frequency of hailstone	1	2

V41.1	
V41.2	
V41.3	
V41.4	
V41.5	
V41.6	

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42. From which source do you access the warning information? **Tick all that apply**

Sources of climate-related Knowledge	Tick	Sources of climate-related Knowledge	Tick
Newspapers	1	Visiting climate scientists/experts	2
Radio	3	Village leader	4
Meteorological services	5	From family and friends	6
TV	7	Government information	8
Observation	9	NGO's	10
School/teachers	11	Other (please specify)	12

V42.1	
V42.2	
V42.3	
V42.4	
V42.5	
V42.6	
V42.7	
V42.8	
V42.9	
V42.10	
V42.11	
V42.12	

43. The following parties should be responsible for taking action against climate change:

Parties	Strongly Disagree	Disagree	Nether Agree nor Disagree	Agree	Strongly Agree
Environmental groups	1	2	3	4	5
Individuals and their families	1	2	3	4	5
Industry/ Companies	1	2	3	4	5
Local authorities	1	2	3	4	5
Provincial Government	1	2	3	4	5
National Governments	1	2	3	4	5
The International community	1	2	3	4	5

V43.1	
V43.2	
V43.3	
V43.4	
V43.5	
V43.6	
V43.7	

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APPENDIX 2: QUESTIONNAIRE FORM- TSHIVENDA VERSION

Questionnaire survey for climate change impact on rural livelihood in South Africa

Date of interview: _____day _____ month _____ year

Survey ID Number: _____

Community/Village Name: _____ Respondent Language: _____

Respondent Name: _____

For Office Use Only

V0 [ ]

Ku vhonelo kwavho na ndivho ha u tshentsha ha mutsho

V1 [ ][ ][ ]

1. Minwaha ya mufhinduli _____

2. Mbeu?

Munna	1
Mufumakadzi	2

V2 [ ]

3. Ndi lwa minwaha mingani vha tshi dzula kha heli shango?_____

V3 [ ]

4. Kha vha dadze zwidombedzwa zwa mirado ya muta

Mirado ya muta	minwaha	mbeu		mushumo						
		Munna	mufumakadzi	U sa shuma	Ndo litsha	Nwana wa tshikolo	Mushumo wa dzi khalanwaha	U di shuma	Wa tshifhinga nyana	Wa tshothe
1		1	2	1	2	3	4	5	6	7
2		1	2	1	2	3	4	5	6	7
3		1	2	1	2	3	4	5	6	7
4		1	2	1	2	3	4	5	6	7
5		1	2	1	2	3	4	5	6	7
6		1	2	1	2	3	4	5	6	7
7		1	2	1	2	3	4	5	6	7

	Minwaha	mbeu
4.1.1		
4.1.2		
4.1.3		
4.1.4		
4.1.5		
4.1.6		
4.1.7		
4.1.8		

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8		1	2	1	2	3	4	5	6	7

5. Vho no pfha lungana ngaha u tshanduko ya mutsho vhasathu vhudzisiwa nga nne?

V5 ☐

Vhasathu zwipfa	1	**Vho zwipfa nyana**	2	**Vho no zwipfha lu vhalaho**	3

6. Vho no sendzulusa tshanduko dzine dza itea kha khalanwaha?

khalanwaha	**U tavhanya**	**U lenga**	**A huna tshanduko**
Tshilimo	1	2	3
Vhuria	1	2	3
Lutamvula	1	2	3

V6.1 ☐
V6.2 ☐
V6.3 ☐

7. Vho no vhona tshanduko dzi tevhelaho? **Kha vha swae**

He vha zwala hone	**Kha vha sendzuluse zwi yelanaho**		
	ee	**hai**	**Vha sa divhi**
Zwimela zwiswa zwo vhonalaho(matsimuni na dakani)	1	2	3
Malwadzwe maswa kha zwimeledzwa	1	2	3
U engedzea ha zwikhokhonono zwo vhanga malwadze kha zwifuwo	1	2	3
U shanduka ha tshifhinga tshau vhibva ha mitshelo	1	2	3
Tshanduko kha u anwa ha mitshelo	1	2	3
U shanduka ha tshifhinga tsha u thavha	1	2	3
Nyengedzedzo ya mulilo wa dakani	1	2	3
U sa tsha vha hone ha zwinwe zwimela	1	2	3
Zwiko zwa madi na u savha hone ha madi	1	2	3
U engedzea ha ufa ha zwifuwo	1	2	3

V7.1 ☐
V7.2 ☐
V7.3 ☐
V7.4 ☐
V7.5 ☐
V7.6 ☐
V7.7 ☐
V7.8 ☐
V7.9 ☐
V7.10 ☐

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8. Vha pfesesa mini kha ku shandukele kwa mutsho kha minwaha yo fhelaho?
Kha swae tshibogisi tsho teaho

Mutsho	**U engedzea**	**U fhungudzea**	**Hu sina tshanduko**
Mvula i songo lavheleliwaho	1	2	3
Mufhiso wa ntha	1	2	3
U engedzea ha Midalo	1	2	3
U engedzea ha Gomelelo	1	2	3
U engedzea ha tshifhango	1	2	3
U engedzea ha mimuya mihulwane	1	2	3

V8.1	
V8.2	
V8.3	
V8.4	
V8.5	
V8.6	

9. Tshanduko dza mutsho dzi thithisa hani muholo wa muta wavho? Kha vha tanegedze zwo fanelaho

Mutsho	**Masiandoitwa**		
	A hungo vha na u fhelelwa ha tshelede	Ho vha na u fhelelwa ha tshelede lwa fhasi ha minwedzi ya 6	U fhelelwa ha tshelede lwa tshifhinga tshilapfu lwa ntha ha minweddzi ya 6
Mvula i songo lavheleliwaho	1	2	3
Mufhiso wa ntha	1	2	3
U engedzea ha Midalo	1	2	3
U engedzea ha gomelelo	1	2	3
U engedzea ha mimuya mihulwane	1	2	3
U engedzea ha tshifhango	1	2	3

V9.1	
V9.2	
V9.3	
V9.4	
V9.5	
V9.6	

10. Ku vhonele kwavho ndi ku fhio kha kudele kwa malwandze ono vhangiwa ngaha hu tshanduko ya mutsho, hu ngavha hu mufhiso wa ntha kana vhuria?

U engedzea	1	**U fhungudzea**	2	**A huna tshanduko**	3

V10 ☐

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11. Ndi zwifhio zwine vhanga tendelana nazwo khau shandukisa kutshilele zwine zwa do ita uri vha kone u langa tshanduko ya mutsho? **Kha vha sumbedze phindulo yavho nga u fhindula kha tshibogisi tsho teaho**

Kutshilele	**U tenda nga mannda**	**U tenda**	**U hana kana u tenda**	**U hana**	**U hana nga mannda**
U imisa u remiwa ha daka	1	2	3	4	5
U tenda u gudisiwa u thogomela daka	1	2	3	4	5
U di imisela u shumisa dzinwe ndila dza u bika nga nnda ha khuni na malasha	1	2	3	4	5
U di imisela u tavha miri tsimuni	1	2	3	4	5
U di imisela u wana masheleni nga ndila dzo fambanaho, sa tshumbo u rhengisa ngowa	1	2	3	4	5

V11.1	
V11.2	
V11.3	
V11.4	
V11.5	

12. Zwi vha kwama hani u itea kha zwithu zwi tevhelaho zwo itisiwa ngaha u tshanduko ya mutsho?

Masiandoitwa a tshanduko ya mutsho	**U sa kwamea na luthihi**	**U kwameanya na**	**Ukwamea**
U tshinyandza zwi shumiswa zwa madaka	1	2	3
U engedzea ha mutengo wa zwiliwa	1	2	3
Khombo ya mutakalo wa vhathu	1	2	3
U fhungudzea ha u wanala ha madi	1	2	3
U engedzea ha mutengo wa mudagasi	1	2	3
U engedzea ha mutsho	1	2	3
U shandukisa khalanwaha ya u tavha	1	2	3

V12.1	
V12.2	
V12.3	
V12.4	
V12.5	
V12.6	
V12.7	

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13. Ndi zwifhio kha zwitevhelaho zwine vha tenda uri zwia shela mulenzhe khau shanduka ha mutsho?

Zwivhangi	**Tshivhangi**	**A si tshivangi**	**A vha divhi**
U kwata ha vha midzimu	1	2	3
U shengedziwa zwo itiswa ngo khakhale vhadzimu vha fhasi	1	2	3
U dala ha vhathu	1	2	3
U sa langea ha u shumisa zwishumiswa zwa daka	1	2	3
U sa zwala zwavhudi	1	2	3
U fhambana ha u tshentsha ha mutsho	1	2	3

V13.1 V13.2 V13.3 V13.4 V13.5 V13.6

U ditika nga zwishumiswa zwa daka

14. Kha vhasumbedze arali vhone kana munwe wa murado wa muta wavho a tshi shuma kha madzangano a tevhelaho na u shela tshanda kha muholo wa muta.**vha nange zwothe zwo teaho**

sekithara	**U shela tshanda**			
	Ntha	**vhukati**	**fhasi**	**Usa shela tshanda**
Vha endela mashango	1	2	3	4
U tsireledza daka	1	2	3	4
U runga	1	2	3	4
U tavha miri	1	2	3	4
Thundu dza nndu	1	2	3	4
U vhada	1	2	3	4
U bveledza malasha	1	2	3	4
U shuma u linda	1	2	3	4

V14.1 V14.2 V14.3 V14.4 V14.5 V14.6 V14.7 V14.8

15. Vha nga vhea hani vhuthogwa ha zwishumiswa zwa daka kha u shela tshanda kha u ita zwiliwa?

Zwi shumiswa zwa daka	**Vhundeme**			
	ntha	**vhukati**	**fhasi**	**Ari zwi shumisi**
Khuni	1	2	3	4
Mitshelo na zwiliwa zwa daka	1	2	3	4

V15.1 V15.2 V15.3 V15.4 V15.5 V15.6 V15.7

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Mibomo na u bveledzwa ha khuni	1	2	3	4
Malasha	1	2	3	4
Mahatshi a u fhulela	1	2	3	4
Miroho ya daka	1	2	3	4
Ngowa	1	2	3	4
mutoli	1	2	3	4
Miri ya mishonga	1	2	3	4
Zwiliwa zwa zwifuwo	1	2	3	4
Majesi a u luka	1	2	3	4
Nama ya daka/ zwikhokhonono zwi no liwa, sa tshumbo mashondzha.	1	2	3	4

V15.8	
V15.9	
V15.10	
V15.11	
V15.12	

16. Vha nga vhea hani vhuthogwa ha izwi zwishumiswa zwa daka kha u shela tshanda kha muholo wa muta wavho?

Zwi shumiswa zwa daka	**Vhundeme**			
	ntha	**vhukati**	**fhasi**	**Ari zwi shumisi**
Khuni	1	2	3	4
Mitshelo na zwiliwa zwa daka	1	2	3	4
Mibomo na u bveledzwa ha khuni	1	2	3	4
Malasha	1	2	3	4
Mahatshi a u fhulela	1	2	3	4
Miroho ya daka	1	2	3	4
Ngowa	1	2	3	4
mutoli	1	2	3	4
Miri ya mishonga	1	2	3	4
Zwiliwa zwa zwifuwo	1	2	3	4
Majesi a u luka	1	2	3	4
Nama ya daka/ zwikhokhonono zwi no liwa, sa tshumbo mashondzha.	1	2	3	4

V16.1	
V16.2	
V16.3	
V16.4	
V16.5	
V16.6	
V16.7	
V16.8	
V16.9	
V16.10	
V16.11	
V16.12	

17. Ndi nnyi are na vhu di fhinduleli ha u tendelela vhathu uri vha reme miri kha vhupo havho?

A huna tendelo kha u shumisa zwishumisiwa zwa daka	1
Vhamusanda	2
Vha muhasho wa zwa madaka	3
Mukhantselara	4

V17.

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18. Ndi vhuleme vhufhio he vha vhuya vha tangana naho kha u wana thendelo ya u rema daka kha vhupo wavho?

A huna vhuleme he vha tangana naho	1
U lenga u wanala ha thendelo	2
Ofisini dza u wana thendelo dzi kule	3
U wana thendelo zwi a dura	4

V18. ☐

19. U tshentsha ha mutsho zwo kwama hani ku wanele kwa mbuyelo dza madaka vhuponi havho?,**kha vha swae**

mutsho	**Masiandoitwa**			
	Ahuna tshinyalelo ya zwishumiswa zwa daka	U fhungudzea ha u tendelwa u shumisa zwishumiswa zwa daka uya kha minwedzi 3-4.	U fhungudziwa ha u tendeliwa u shumisa zwishumiswa zwa daka lwa tshifhinga nyana.	U engedzea ha u fhungudzea u tendeliwa u shumisa zwi shumiswa zwa daka.
Mvula i songo lavheleliwaho	1	2	3	4
Mufhiso wa ntha	1	2	3	4
U engedzea ha Midalo	1	2	3	4
Gomelelo la shishi	1	2	3	4
U engedzea ha madumbu	1	2	3	4
U engedzea ha zwi fhango	1	2	3	4

V19.1 ☐
V19.2 ☐
V19.3 ☐
V19.4 ☐
V19.5 ☐
V19.6 ☐

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20. Kha vha nange tshine tsha khou itisa uri vha muta wavho vha shumise zwishumisiwa zwa daka. **Kha vha nange zwo teaho.**

zwiitisi	**U dzhenise tshelede**
U latekanya ha zwishumiswa zwa daka	1
U sa dura kha u shumisa zwishumiswa zwa daka	2
U leluwa kha u shumisa zwishumisiwa zwa daka	3
U sa konda u shumisa dzinwe ndila tsumbo mudagasi na zwinwe.	4
U konda u langula tshiimo tsha muta(u sa shuma lwa tshifhinga nyana)	5
U vhulunga muholo wa muta	6
U sa shuma	7
U sa wana ndila dza u wana mushumo	8
U di tsireledza u tshi kha di todana na mushumo lwa tshifhinga nyana	9

V20.1
V20.2
V20.3
V20.4
V20.5
V20.6
V20.7
V20.8
V20.9

21. Kha vha nange tshine tsha khou itisa uri vha muta wavho vha shumise zwishumisiwa zwa daka. **Kha vha nange zwo teaho.**

zwiitisi	**U swikelela thodeo dza muta wavho**
U latekanya ha zwishumiswa zwa daka	1
U sa dura kha u shumisa zwishumiswa zwa daka	2
U leluwa kha u shumisa zwishumisiwa zwa daka	3
U sa konda u shumisa dzinwe ndila tsumbo mudagasi na zwinwe.	4
U konda u langula tshiimo tsha muta(u sa shuma lwa tshifhinga nyana)	5
U vhulunga muholo wa muta	6
U sa shuma	7
U sa wana ndila dza u wana mushumo	8
U di tsireledza u tshi kha di todana na mushumo lwa tshifhinga nyana	9

V21.1
V21.2
V21.3
V21.4
V21.5
V21.6
V21.7
V21.8
V21.9

22. Kha vha sumbedze uri mishumo itevhelaho ya daka i itesiwa nga vhana, vhafumakadzi kana vhanna.

Zwi shumiswa zwa daka	**vhanna**	**vhafhuma kadzi**	**vhana**
Khuni	1	2	3
Mitshelo kana zwiliwa zwa daka	1	2	3
Mibomo na u bveledzwa ha khuni	1	2	3
Malasha	1	2	3

V22.1
V22.2
V22.3
V22.4
V22.5
V22.6
V22.7
V22.8
V22.9
V22.10
V22.11
V22.12

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Mahatshi ha u fhulela	1	2	3
Miroho ya daka	1	2	3
Ngowa	1	2	3
Mutoli	1	2	3
Miri ya mishonga	1	2	3
Zwiliwa zwa zwifuwo	1	2	3
Majesi a u luka	1	2	3
Nama na zwikhokhononozwo no liwa zwa daka sa tsumbo , mashonzha	1	2	3

V23. ☐

23. Ndi dzi fhio ngudo dzine vha nga takalela u dzhena khadzo u I tela u fhungudza u remiwa ha madaka vhuponi havho?

U dzhenelela ngudo dza kuremele kwa vhudi kwa miri na daka	1
U dzhenelela ngudo dza u tavha miri	2
U dzhenelea kha zwa vhubindudzi nga zwinwe zwa zwibveledzwa zwa madaka	3
U dzhenelela ngudo ya u tanganisa u tavha miri na u tavha tsimuni	4
A huna	5

V24. ☐

24. Ndi lungana hune vha di wana vha khou dzhenelela kha ngudo dza u langiwa ha madaka?

U dzulela u dzhenelela	1
Sa zwezwo	2
Zwi a konda	3
Na luthihi	4

V25. ☐

25. Vhono di wana vha khou dzhenelela kha pulani na ndango ya madaka vhuponi havho?

Ee	1
Hai	2

V26. ☐

26. Ndi zwifhio kha zwitevhelaho zwine vha nga takalela u itela u khwinisa kha u linda na u sedzulusa madaka vhuponi havho?

U dzhenelela kha tsheo dza u lindiwa na u sedzulusa madaka	1
U vheiwa ha milayo	2
U linda na u sedzulusa phurodzhekiti dzo thomiwaho dza madaka	3
u vha tshipida tsha u nangiwa ha thimu ya u sedzulusa	4
A huna	5

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Ndado ya tshanduko ya mutsho ya tshifhinga tshilapfu

27. Ndi zwi fhio zwe vhagudela?

V27. ☐

Ngudo	Kha vha swae
A huna zwe vha gudela	1
Gireidi ya 11 kana fhasi ha gireidi 11	2
Vhana gireidi 12	3
Vhana dipuloma kana sitifikheti tsha gireidi 12	4
Vhana digiri ya zwa milayo	5
Vhana digiri kana vha kha di guda	6

V28. ☐

28. Vha na tshendzhemo i fhio kha zwi tevhelaho?

Tshendzhemo	Kha vha swae
U zwima	1
Mutalutshedzi wa dzinwe nyambo	2
Mulugisi	3
U vhada	4
Vhu limi	5
U fuwa zwifuwo	6
U luka	7
Zwinwe(kha vha sumbedze)…..	8

29. Vha nga sumbedzisa hani u di tika ha muta wavho kha zwi shumiswa zwa daka zwino tshinyiwa nga u shanduka ha mutsho? Kha vha swae

Mutsho	Kha vha kale u di tika havho			
	Fhasi	A huna u tshentsha	ntha	A huna
Mvula i songo lavheleliwaho	1	2	3	4
Mufhiso wa nthaa	1	2	3	4
U engedzea ha Midalo	1	2	3	4
U engedzea ha Gomelelo	1	2	3	4
U engedzea ha madumbu	1	2	3	4
U engedzea ha tshifhango	1	2	3	4

V29.1 ☐
V29.2 ☐
V29.3 ☐
V29.4 ☐
V29.5 ☐
V29.6 ☐

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30. Kha vha sumbedze u fushea havho kha tshumelo na zwifhato kha tshitshavha tshavho

Zwi fhato na shumelo	U sa fhushea nga mannda	U sa fhushea	U fhushea kana u sa fhushea	U fhushea	U fhushea nga mannda
a. tshumelo kha zwa mutakalo	1	2	3	4	5
b. tshumelo ya madi	1	2	3	4	5
c. tshumelo kha mimakete	1	2	3	4	5
d. zwikolo zwa tshini	1	2	3	4	5
e. tshumelo dza shishi	1	2	3	4	5
f. vha wana zwi khala khau dzhia tsheo kha tshitshavha	1	2	3	4	5
g. nyambedzano	1	2	3	4	5
h. tshumelo ya vha rhanga phanda	1	2	3	4	5

V30.a	
V30.b	
V30.c	
V30.d	
V30.e	
V30.f	
V30.g	
V30.h	

31. Huna zwinwe zwa mbuelo zwa madaka zwine zwa kho konda u wanala kha tshifhinga tsha zwino**? Kha vha swae ho teaho vha dovhe vha sumbedze zwinwe zwine vha zwi shumisa.**

Zwi shumiswa zwa madaka	Kha vha swae
Khuni	1
Mitshelo na zwiliwa zwa daka	2
Mibomo na u bveledza ha khuni	3
Malasha	4
Mahatsi a u fhulela	5
Miroho ya daka	6
Ngowa	7
mutoli	8
Miri ya mishonga	9
Zwiliwa zwa zwifuwo	10
Majesi a u luka	11
Nama na zwikhokhononozwo no liwa zwa daka sa tsumbo , mashondza	12

V31.1	
V31.2	
V31.3	
V31.4	
V31.5	
V31.6	
V31.8	
V31.9	
V31.10	
V31.11	
V31.12	

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32. Ndi zwi fhio zwine vha vona unga zwi khou shela mulenzhe khau sa wanala ha mbuelo dza madaka kha tshitshavha tshavho? **Kha vha swae**

Tshi itisi tsha u sa wanala ha mbuelo	**Ndi tshi itisi**	**A si tshi itisi**	**U kanakana**
Ku shumisele ku si kwa vhudi	1	2	3
U aluwa ha thodea	1	2	3
Nyimelo isi ya vhudi ya mavu	1	2	3
U shanduka ha mutsho	1	2	3
U fhungudzea ha madaka	1	2	3
U kundelwa u tavhiwa ha miri	1	2	3
U fula ha zwi fuwo	1	2	3

V32.1
V32.2
V32.3
V32.4
V32.5
V32.6
V32.7

33. U famabana ha mutsho zwi shela mulenzhe hani kha ku shumisele kwa mbuelo dza madaka? **Kha vha swae**

Zwi shumiswa zwa madaka	**Masiandoitwa**			
	U sa thithisiwa ha mbuelo dza madaka	**U sa wanala ha mbuelo dza madaka**	**U konda u wana mbuelo dza madaka**	**Zwi shumiswa ndi zwa thengo ya ntha**
Khuni	1	2	3	4
Malasha	1	2	3	4
Mibomo na u bveledzwa ha khuni	1	2	3	4

V33.1
V33.2
V33.3

34. U shanduka ha mutsho zwi shela mulenzhe hani kha ku shumisele kwa mbuelo dza madaka? **Kha vha swae**

Zwi shumiswa zwa madaka	**Masiandoitwa**			
	U sa thithisiwa ha mbuelo dza madaka	**Zwi shumiswa zwia konda na usa wanala**	**Zwi shumiswa ndi zwa thengo ya ntha**	**Zwi shumiswa zwo fambanaho a zwi tsha wanala**
Ngowa	1	2	3	4

V34.1
V34.2
V34.3
V34.4

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Miri ya mishonga	1	2	3	4
Mahatsi a u fulela	1	2	3	4
Mitshelo na zwiliwa zwa daka	1	2	3	4

Ndila dzine vha dzi shumisa u kona u tshila

35. Vhone na mudi wavho vha kona hani u tshila kha mvula i songo lavheleliwaho? **Kha vha swae**

Vha kona hani	**Kha vha swae**	**Vha kona hani**	**Kha vha swae**
U shanduka ha tshifhinga tsha u lima	1	U saya u lima tsimuni	2
Vha di tika nga u shumisa kana u rengisa zwiliwa zwa daka	3	U tavha tshini na milambo	4
Vha shumisa madindi u sheledza	5	U tavha ha mitshelo na zwi limiwa zwo kondelela gomelelo	6
U vhulunga madi nga tzhifhinga tsha mvula	7	Ndila dzinwe dzine vha dzi shumisa	8

V35.1 V35.2 V35.3 V35.4 V35.5 V35.6 V35.7 V35.8

36. Vha kona hani u tshila kha mufhiso wa ntha? **Kha vha swae**

Vha kona hani	**Vha kona hani**	**Vha kona hani**	**Vha kona hani**
U tavha miri ine ya tsireledza zwi limiwa	1	U tavha miri tshini na midi u itela murunzi	2
U dzula nduni(u fungudza tshifhinga tsho dzula vha tsimuni)	3	U rhenga zwi shumisiwa zwo fhungudza mufhiso, sa tsumbo fene	4

V36.1 V36.2 V36.3 V36.4

37. Vha kona u tshila hani kha gomelelo?**kha vha swae**

Vha kona hani	**Vha kona hani**	**Vha kona hani**	**Vha kona hani**
U engedza uvhulunga kwa madi,sa tsumbo u rhenga thannga	1	U dovholola u shumisa madi, sa tsumbo madi a u tanzwa a dovha a shumisiwa u sheledza	2
U ditika nga u shumisa kana u rengisa zwiliwa zwa daka	3	U shavhela mushumoni	4

V37.1 V37.2 V37.3 V37.4 V37.5 V37.6 V37.7 V37.8 V37.9 V37.10

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U engedza ku wanelo kwa madi, sa tsumbo madi a fhasi	5	U tshentsha ku shumiselo kwa madi. Sa tsumbo u shumisa madi zwa vhudi	6
Uzwala zwimedzwa zwino kondelela gomelelo	7	U tavha tshini na mulambo	8
U sheledza nga madi a mulamboni	9	Ndila dzinwe dzine vha dzi shumisa	10

38. Vha kona u tshila hani kha midalo ya vhuhali?**kha vha swae**

Vha kona hani	**Vha kona hani**	**Vha kona hani**	**Vha kona hani**
U shumisa ha thekinolodzhi sa whatsapp na facebook?	1	U pfuluwela kha vhunwe vhupo	2
U ditika nga u shumisa kana u rengisa zwiliwa zwa daka	3	U shavhela mushumoni	4
U rengisa zwi shumiswa zwa nduni kana thundu	5	U wana tikedzo kha mashaka na dzi khonani	6
U wana thuso ya zwiliwa	7	U tavha ha miri u itela u langa midalo	8
U fhata dzi mbondo dzau tshireledza midalo	9	Ndila dzinwe dzine vha dzi shumisa	10

V38.1
V38.2
V38.3
V38.4
V38.5
V38.6
V38.7
V38.8
V38.9
V38.10

39. Ndi khaedu dzi fhio dzine vhatangana nadzo vha tshi tshila kha tshifhinga tshau tshentsha ha mutsho. **Kha vha swae(Q?)**

khaedu	**Vha kona hani**
A huna khaedu	1
u sa vha na ndivhadzo ngaha u tshentsha ha mutsho	2
U sa vha na vhutali ngaha ndila dzine ndzinga shumisiwa u tshila na khaedu	3
U savha na tshelede	4
Zwishumisiwa zwa madaka zwine vha zwi takalela a zwi tsha wanala	5
U sa vha hone ha mimakete	6
U tshentsha ha ndila dzau tavha	7
U shota ha zwi shumisiwa aw ma imo zwa u tavha	8
Usa vha na ndivho nga vhaswa kha zwa vhulimo	9
U kwashekana ha mupo kha tshitshavha	10
Zwinwe, kha vha sumbedze	11

V39.1
V39.2
V39.3
V39.4
V39.5
V39.6
V39.7
V39.8
V39.9
V39.10

V40.1
V40.2
V40.3

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40. Ndi zwi fhio zwo vha thusaho u tshila kha u tshentsha ha mutsho**? (Kha vha swae kha tshibogisi)?**

Zwiimiswa	**Kha vha swae**	**zwiimiswa**	**Kha vha swae**
Mashaka	1	Zwiimiswa zwa mbulungano	2
Vhadzula tshini	3	Zwiimiswa zwa matsheleni	4
Zwiimiswa zwa zwino wanala vhuponi havho	5	Zwiimiswa zwa muvhuso	6
Zwiimiswa zwi si zwa muvhuso(NGO)	7	Masipala	8
Zwiiimiswa zwa mashango davha (sa tsumbo. WFP, FAO)	9	Zwiimiswa zwa vhundu	10

V40.4	
V40.5	
V40.6	
V40.7	
V40.8	
V40.9	
V40.10	

41. Vho tangana na zwi fhio khau tshentsha ha mutsho**? Vho wana tshivhudzo?**

Mutsho na khombo	**Kha vha swae**	
	ee	**Hai**
Mvula i songo lavheleliwaho	1	2
Mufhiso wa ntha	1	2
U engedzea ha midalo	1	2
U engedzea ha gomelelo	1	2
U engedzea ha mimuya mihulwane	1	2
U engedzea ha tshifhango	1	2

V41.1	
V41.2	
V41.3	
V41.4	
V41.5	
V41.6	

42. Tshiko tsha tshivhudzo nga ha u tshentsha ha mutsho? **Kha vha swae**

zwiko zwa mutsho	**Kha vha swea**	**Zwiko zwa mutsho**	**Kha vha swae**
Guranda	1	U dalela vha ra saintsi vha mutsho	2
Radio	3	Vhamusanda	4

V42.1	
V42.2	
V42.3	

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Vha divhi vha mutsho	5	Mashaka na dzi khonani	6
Thelevishini	7	U zwi wana kha muvhuso	8
Inthenete	9	Zwiimiswa hu si zwa muvhuso(NGO)	10
Zwikolo na vha gudisi	11	Huna zwinwe kha vha sumbedzise	12

V42.4	
V42.5	
V42.6	
V42.7	
V42.8	
V42.9	
V42.10	
V42.11	
V42.12	

43. Madzangano ateaho u jia vhudifhinduleli khau tshanduko ya mutsho:

Madzangano	**U sa tenda nga mannda**	**U sa tenda**	**U tenda kana u sa tenda**	**U tenda**	**U tenda nga manda**
Zwigwada zwa vhadzulapo	1	2	3	4	5
Vha dzulapo na mashaka	1	2	3	4	5
Khamphani	1	2	3	4	5
Vhamusanda	1	2	3	4	5
Vha langa vhupo	1	2	3	4	5
Vha langa shango	1	2	3	4	5
Vha mashango davha	1	2	3	4	5

V43.1	
V43.2	
V43.3	
V43.4	
V43.5	
V43.6	
V43.7	

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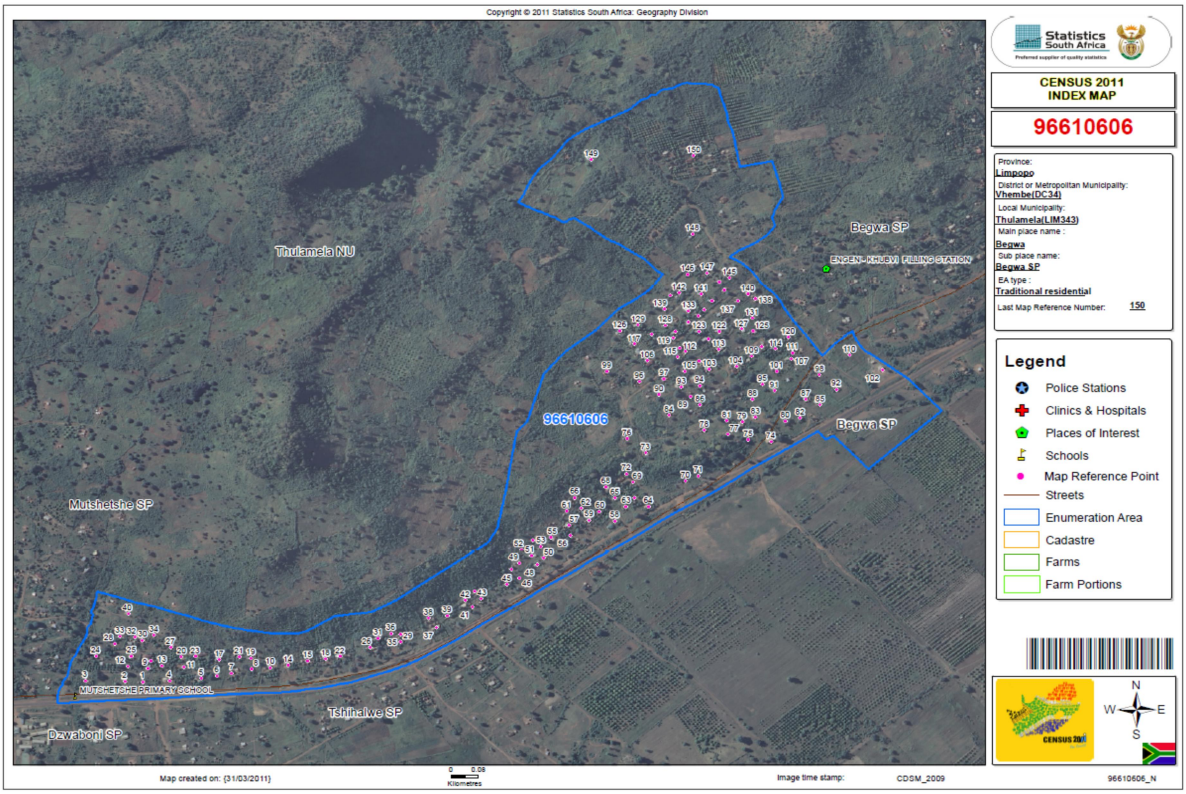
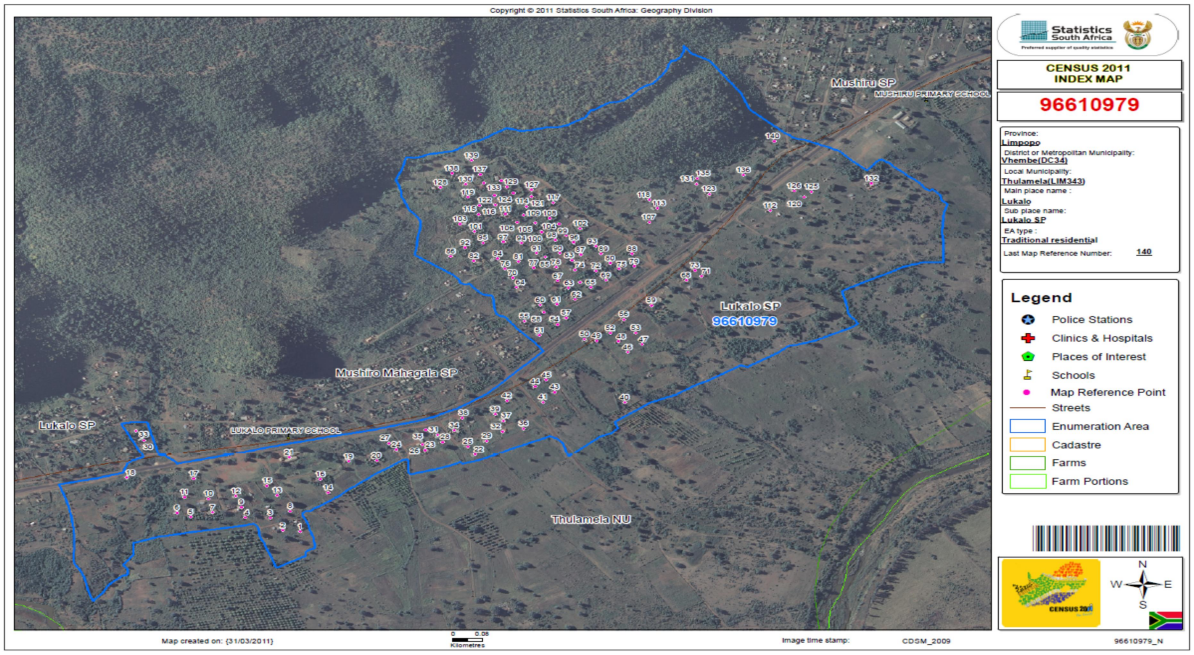
APPENDIX 3: THE ENUMERATION AREA (EA) MAP OF SURVEYED VILLAGES



The EA of Begwa Rural Community



The EA of Lukalo Rural Community

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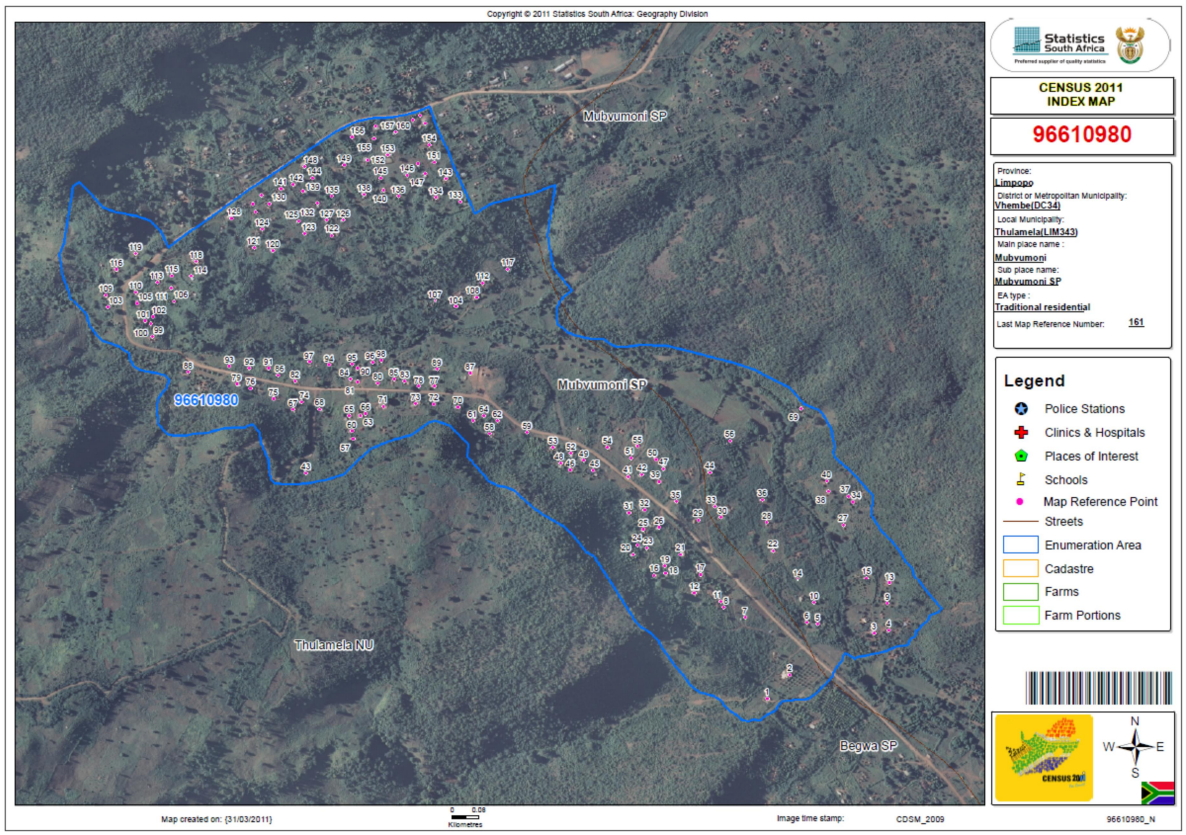
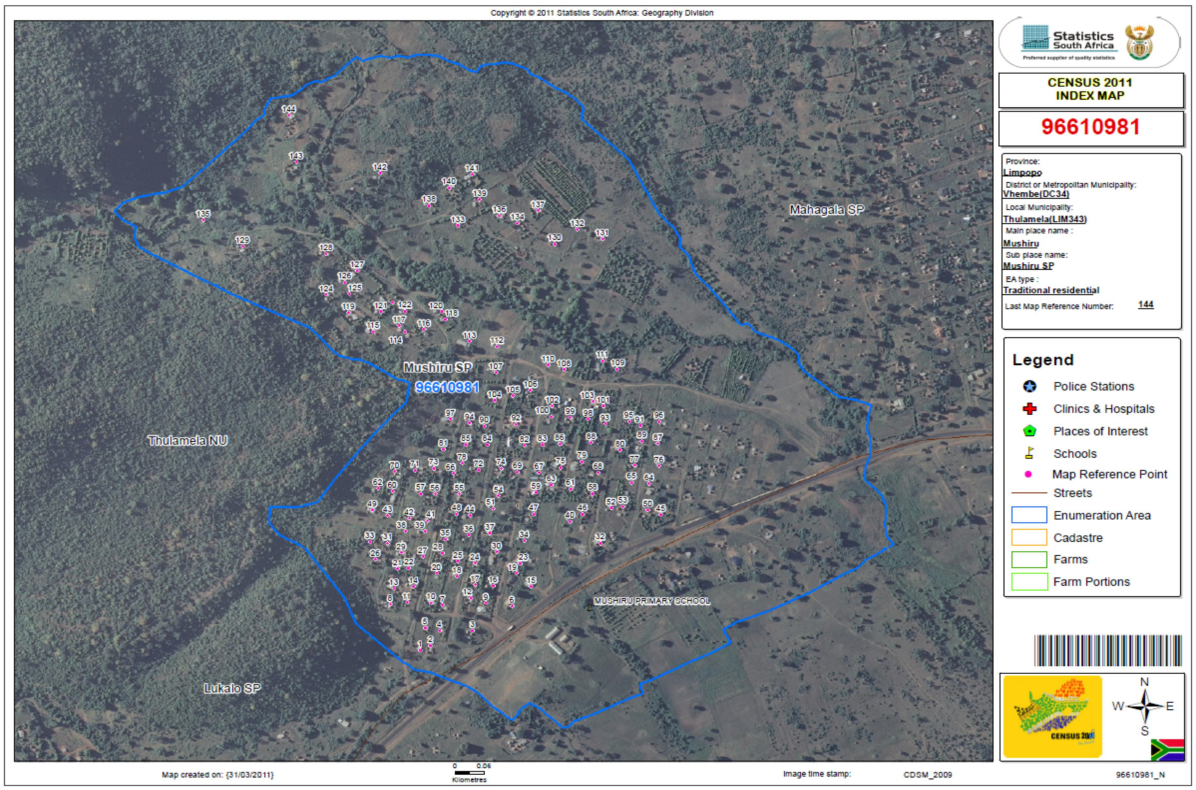


The EA of Mubvumoni Rural Community



The EA of Mushiru Rural Community

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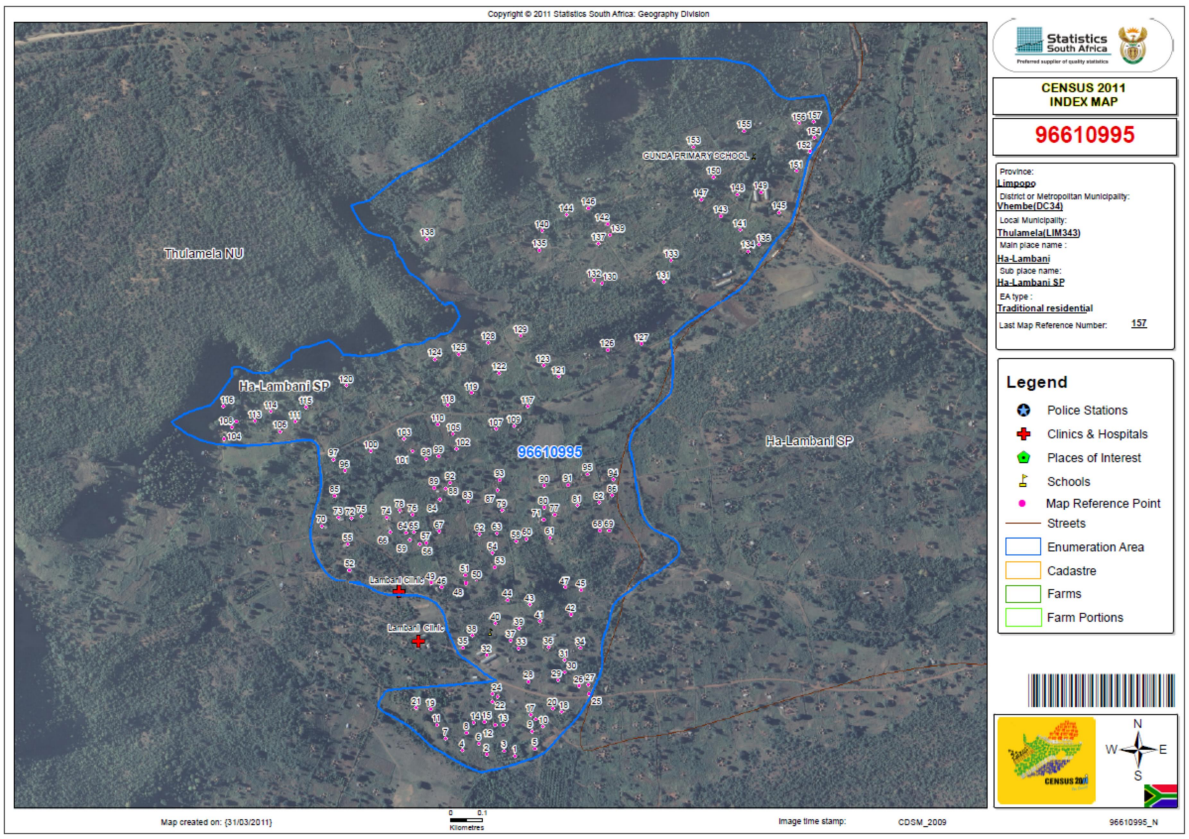
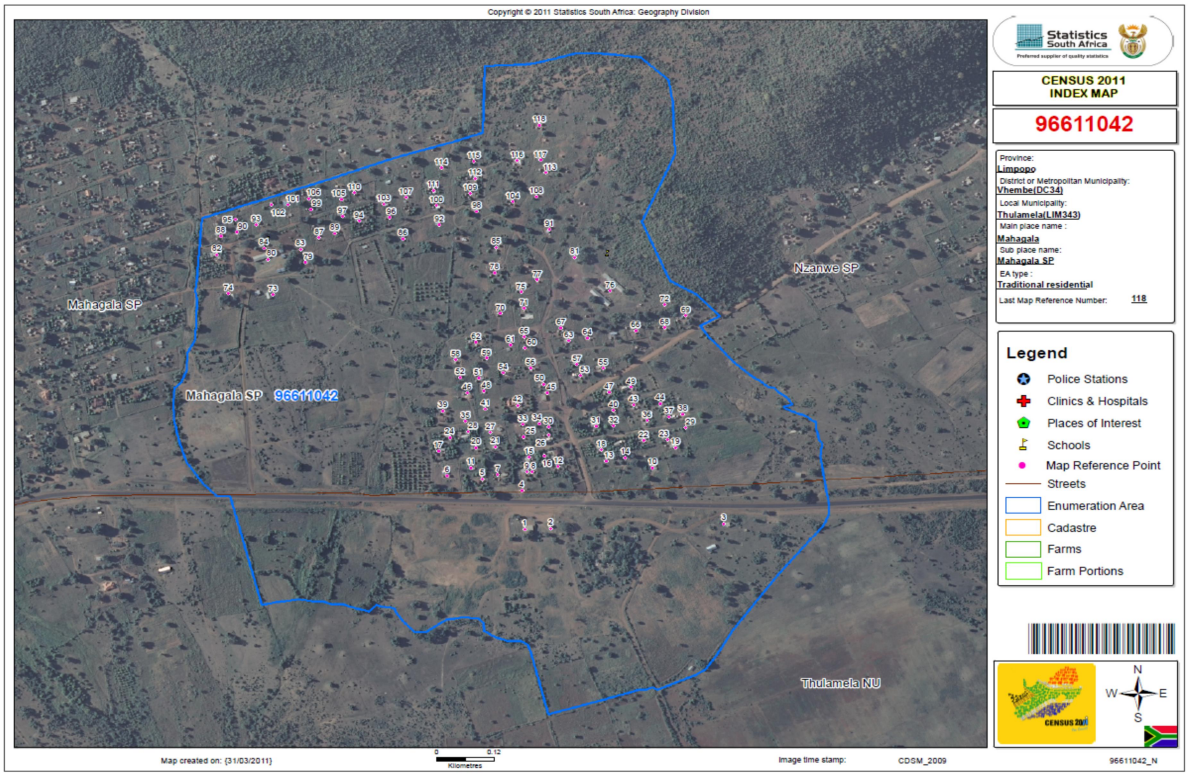


The EA of Gunda Rural Community



The EA of Mahagala Rural Community

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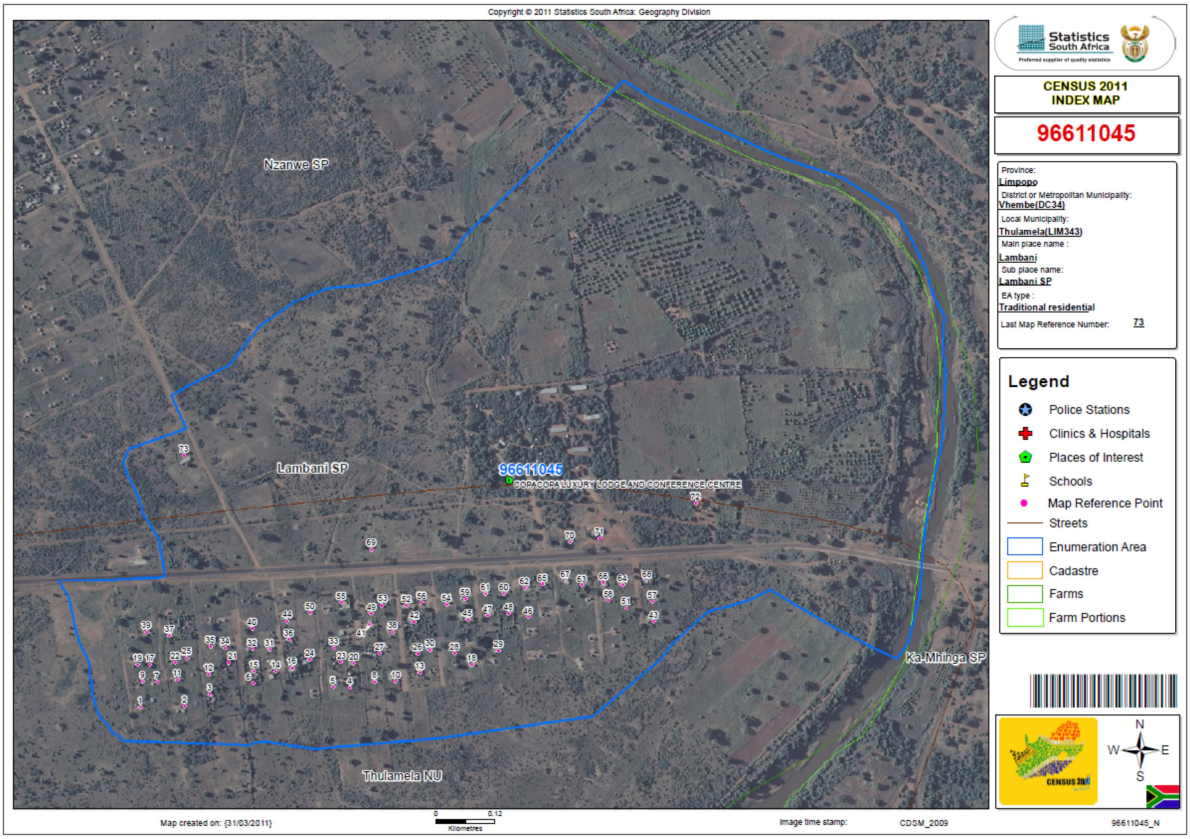

The EA of Lambani Rural Community

The EA of Majosi Rural Community

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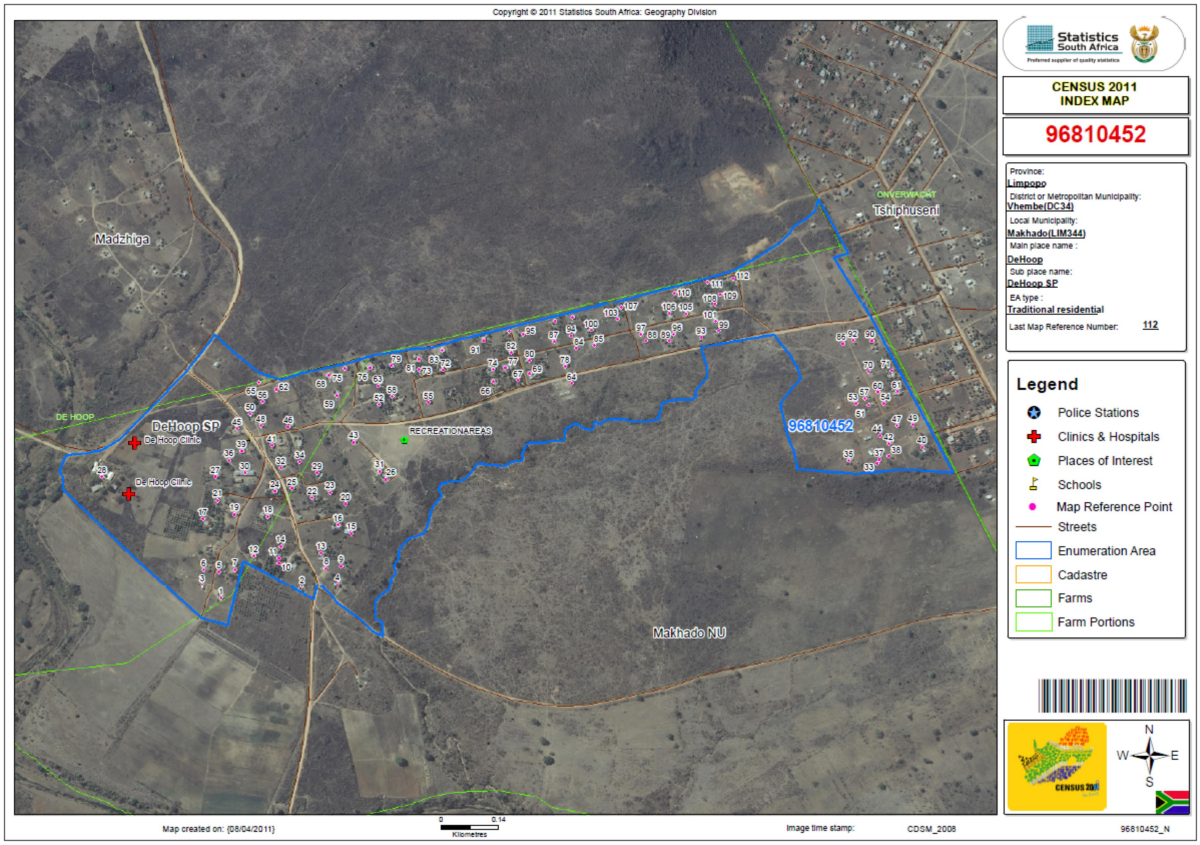

The EA of Dehoop Rural Community

The EA of Masia/Tshikwarani Rural Community

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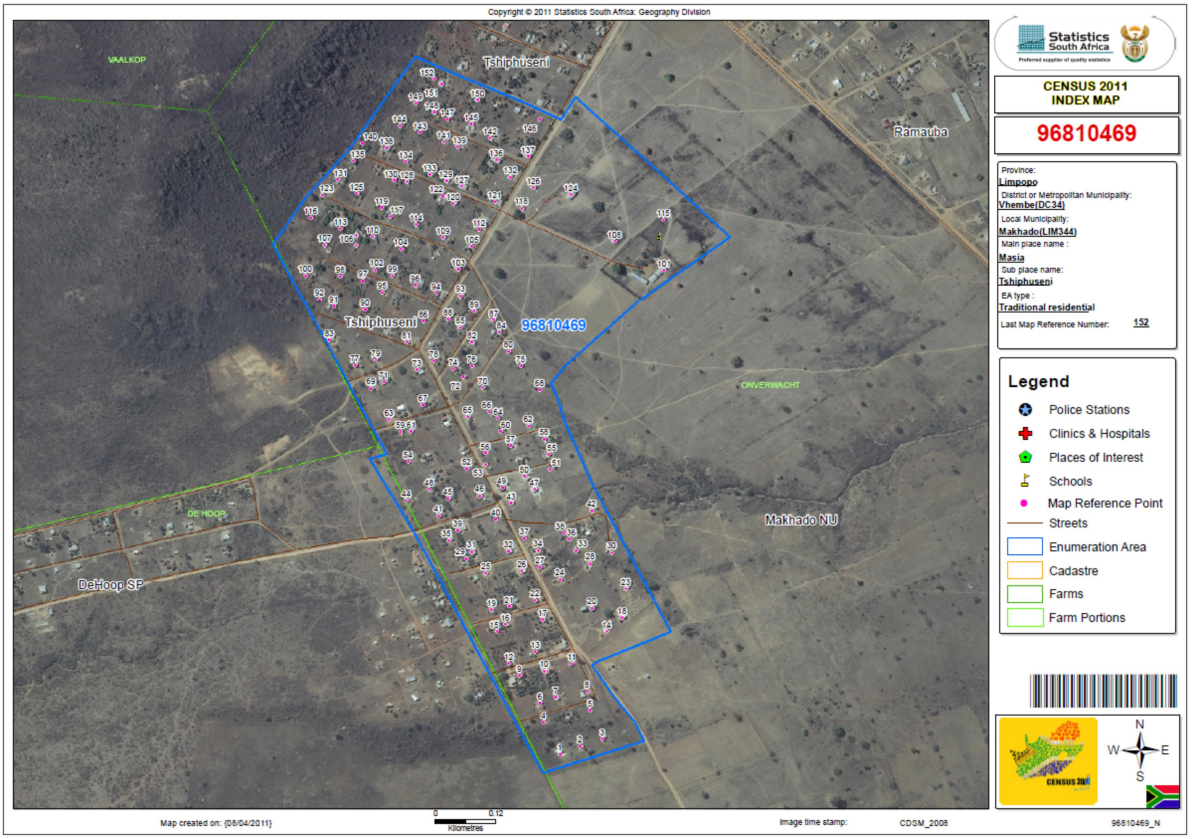

The EA of Tshipuseni Rural Community

The EA of Ramauba Rural Community

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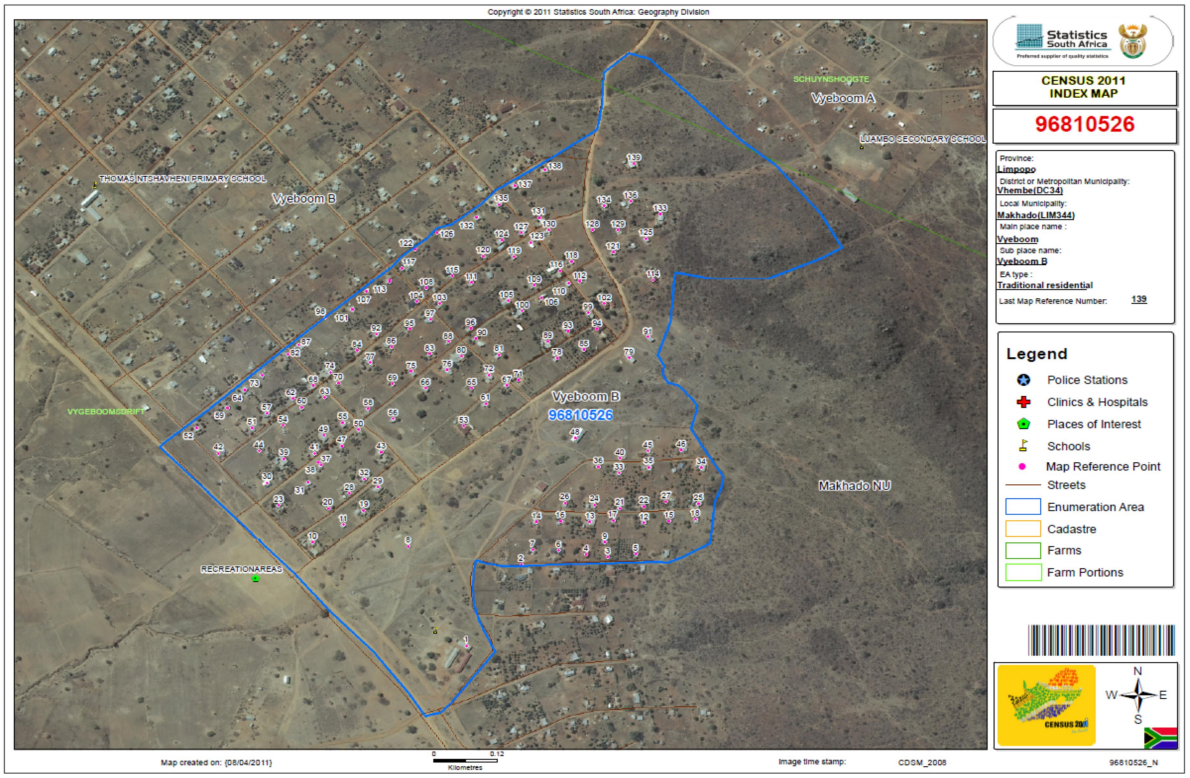
The EA of Thondoni Rural Community



The EA of Vyeboom Rural Community

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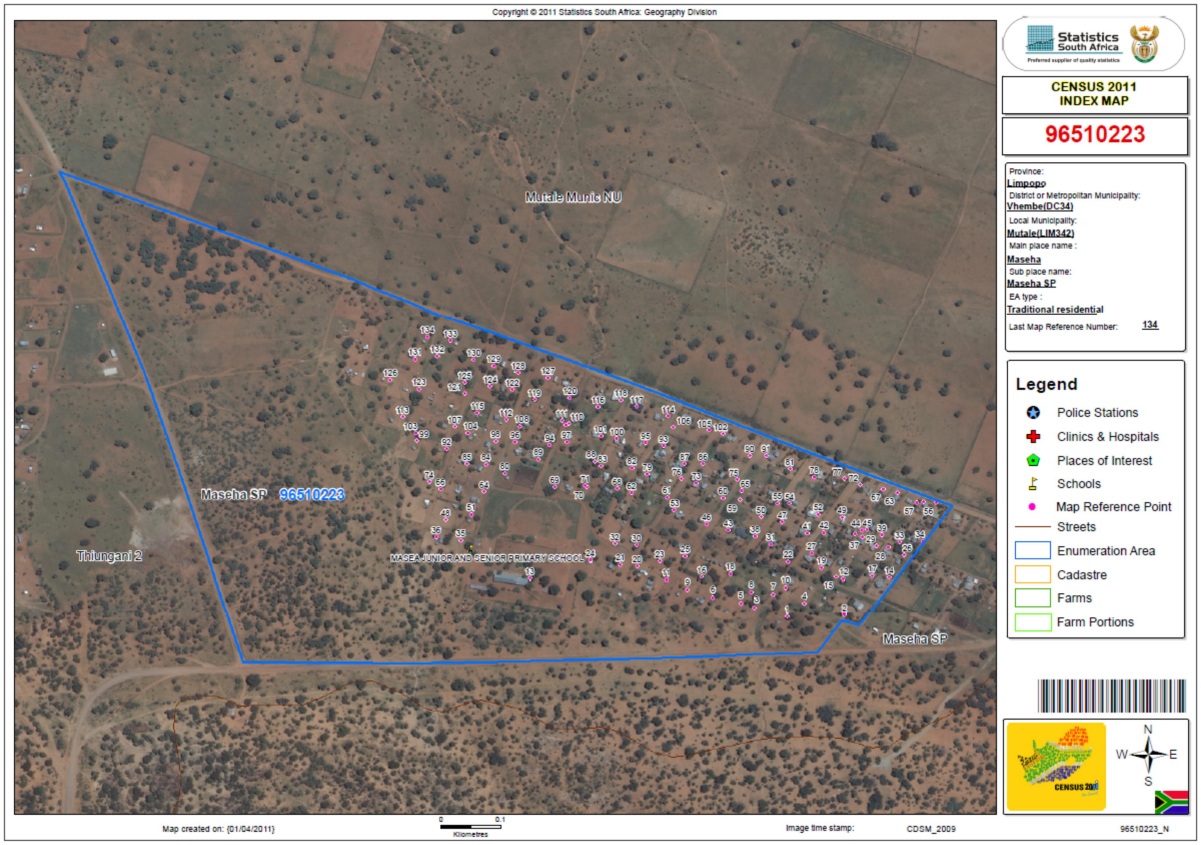

The EA of Maseha Rural Community

The EA of Sigonde Rural Community

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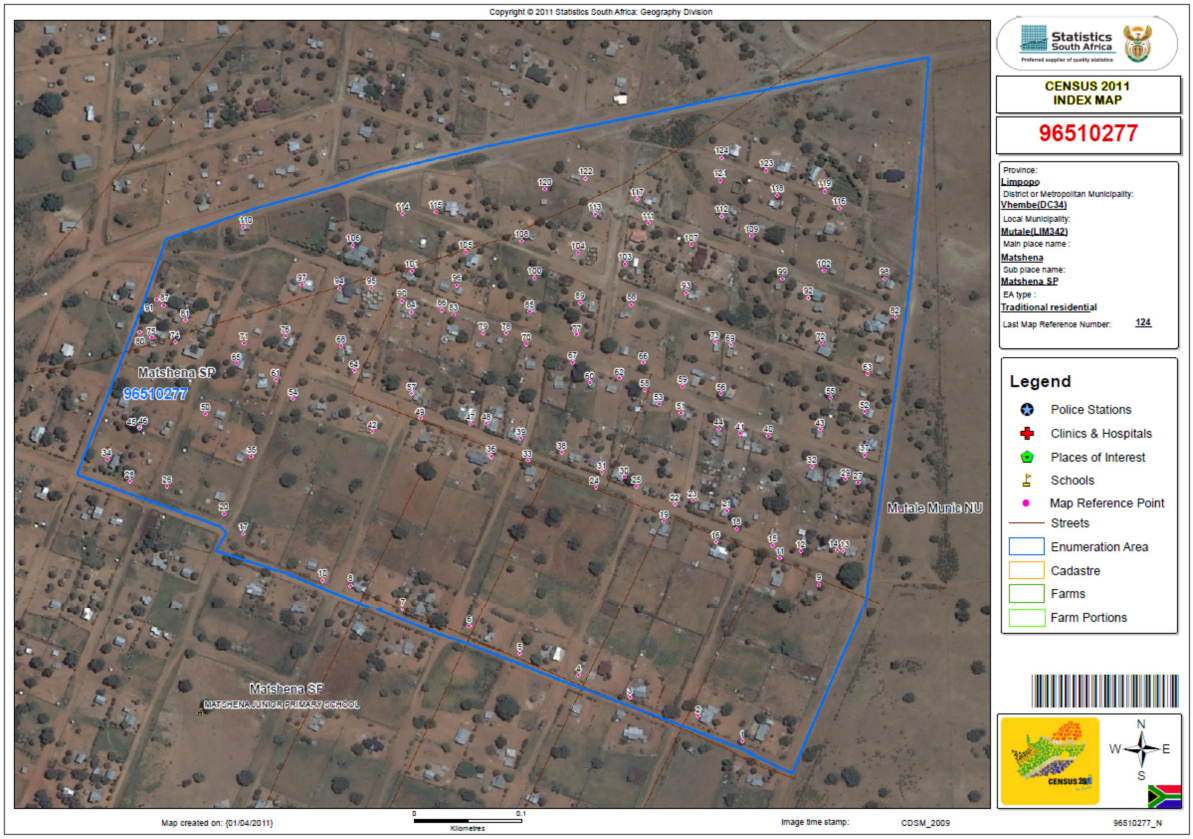

The EA of Matshena Rural Community

The EA of Manenzhe Rural Community

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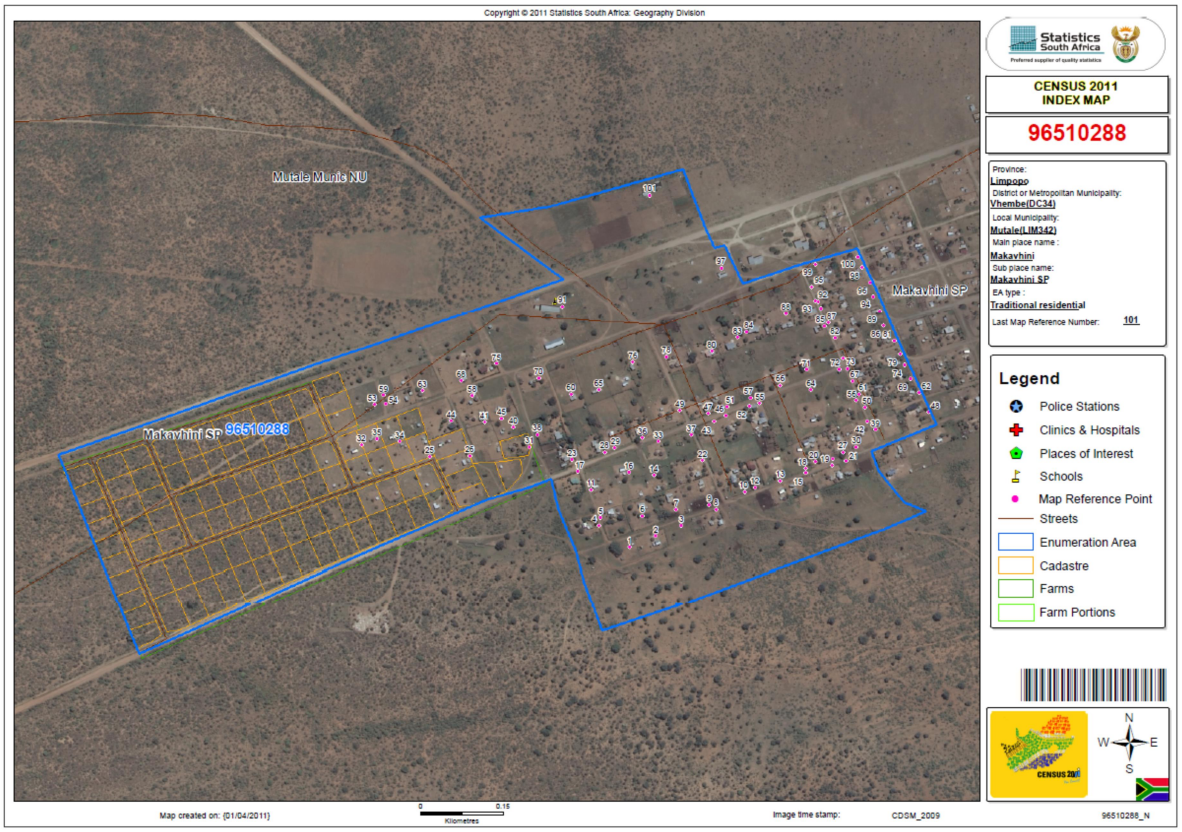

The EA of Makavhini Rural Community

The EA of Mapakoni Rural Community

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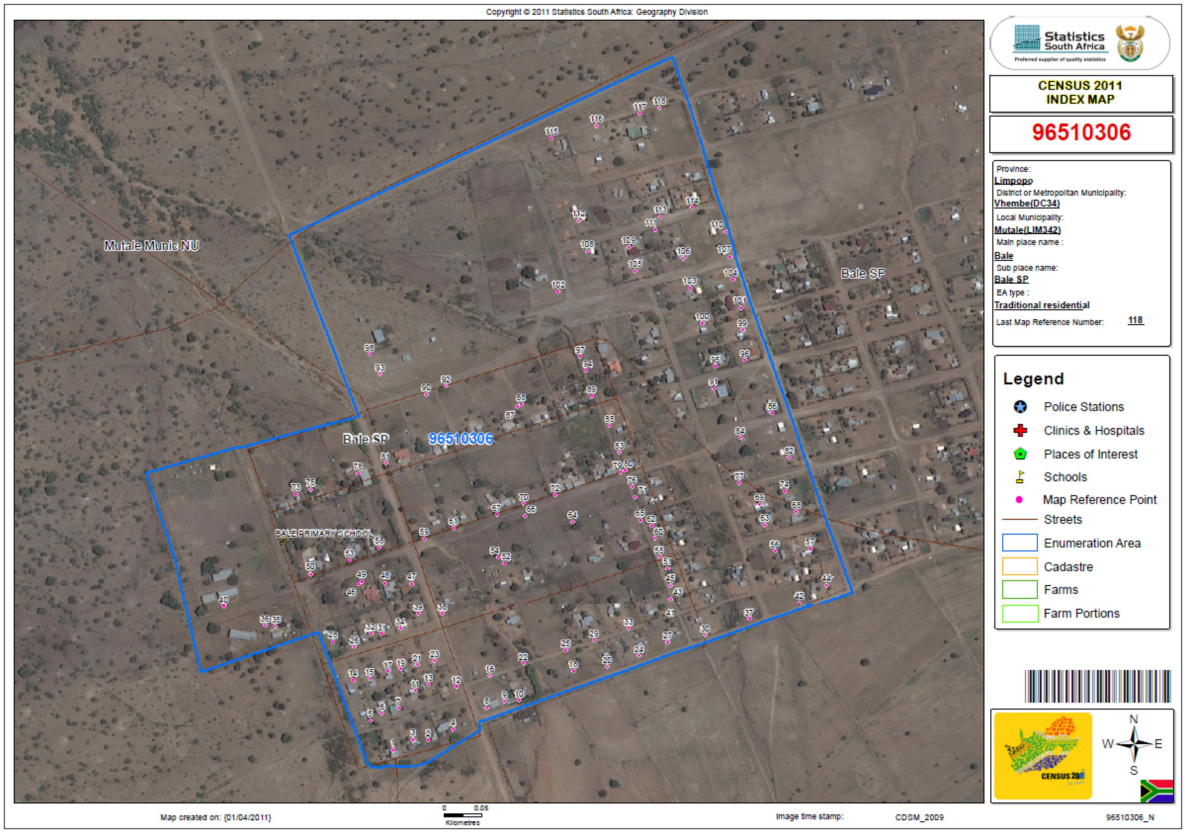

The EA of Bale Rural Community

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