

https://dspace.org/

Climate variability, asset adapttation and rural livelihoods in Mtubatuba, Kwazulu-Natal, South Africa

Sibiya, Nomfundo Patricia

2019

https://hdl.handle.net/10539/28810

Sibiya, Nomfundo Patricia (2019) Climate variability, asset adaptation and rural livelihoods in Mtubatuba, Kwazulu-Natal, South Africa, University of the Witwatersrand, Johannesburg, <http://hdl.handle.net/10539/28810>

Downloaded from a DSpace repository. https://dspace.org/



CLIMATE VARIABILITY, ASSET ADAPTATION AND RURAL LIVELIHOODS IN MTUBATUBA, KWAZULU-NATAL, SOUTH AFRICA

Nomfundo Patricia Sibiya

Student number: 573380

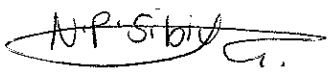
A dissertation submitted to the Faculty of Science, University of the Witwatersrand, Johannesburg, in fulfilment of the requirements for the degree of Master of Science

Supervised by: Professor Mulala Danny Simatele

Signed on 14 May 2019 in Johannesburg

DECLARATION

I, Nomfundo Sibiya declare that this Dissertation entitled "Climate Variability, Asset Adaptation and Rural Livelihoods in Mtubatuba, Kwazulu-Natal, South Africa" is my own, unaided work. It is being submitted for the Degree of Master of Science at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other University.



Signed on 14 May 2019 in Johannesburg

ABSTRACT

Climate variability and change are real and are happening now. In fact, if climate variability and change are not addressed urgently, it will affect most if not all the subsectors of the country. The aim of this study was to investigate the ways in which poor rural people of Nkombose, Ebaswazini, and Ogengele in Mtubatuba are affected by climate variability, and to understand the ways in which these communities are adapting to climate variability using the asset-based adaptation framework. The study utilised questionnaires to gather the various weather perceptions from the communities. Parallel to the human perceptions, the study reviewed meteorological data particularly to examine whether any climate variations have taken place in Mtubatuba. Furthermore, focus group discussions, listing and ranking matrices, and mind maps were used to determine the implications of climate variability on rural livelihoods. Lastly, semi-structured interviews were conducted with local authorities from the Mtubatuba Local Municipality to understand the municipality's role in building the communities adaptive capacity and in responding to the impacts of climate variability.

The research findings indicate that Mtubatuba like everywhere else in the world has been subjected to climate variability. Climate variability has presented itself in the form of droughts and severe thunderstorms. The empirical evidence suggests that the major implication of climate variability was the lack of water, which was attributed to inadequate rainfall amounts. The findings of this study indicate that droughts have resulted in reduced agricultural practices, increased livestock losses, reduced business and work opportunities. Therefore, this study demonstrates that rural communities depend highly on rain-fed agriculture to sustain their livelihoods.

However, the study also established that the three rural communities are not passive actors as they are actively involved in developing ways of adapting to the impacts of climate variability. As such, the finding of this study suggest that the three rural communities depend more on adaptation strategies which are linked to financial, human, and social asset portfolios. Therefore, the local municipality and the government need to engage with the communities and make use of local knowledge as entry points in developing climate variability and change policy frameworks.

Keywords: Climate variability and change, climate impacts, rural livelihoods, asset adaptation, adaptive capacity.

DEDICATION

To my Mother, Mrs Jabulile Sibiya, who turns 60 years on 4 August 2019. I am constantly in awe of your strength and resilience. Your support and belief in God's purpose and abilities for my life is incredible. You are a true Proverbs 31 Women. Thank you for always pushing me to reach greater heights. I love you dearly.

ACKNOWLEDGEMENTS

I would like to express my sincere gratitude to the following individuals and institutions:

Firstly, to God be the glory for always being my light and strength. *"It is of the Lord's mercies that we are not consumed, because his compassions never fail. They are new every morning: great is thy faithfulness."* - Lamentations 3:22-23

To the University of the Witwatersrand, thank you for the Staff Bursary, which made it possible for me to undertake and complete my studies.

To my supervisor, Professor Mulala Danny Simatele, thank you very much for your invaluable mentoring. Your guidance and support has been remarkable. I learned a lot from you. Thank you also, for your patience and time. God bless you.

To the South African Weather Service, thank you for providing the meteorological data.

To all the research participants from Nkombose, Ebaswazini, and Ogengele, thank you for opening your doors and for letting me into your lives. To the three local authorities from the Disaster Management Centre at the Mtubatuba Local Municipality, thank you for participating in this study and for providing me with the information.

To my parents, Mr. Fundakubona and Mrs. Jabulile Sibiya, thank you for your continued guidance and support. Thank you also, for playing a major role in raising my son, and for loving him relentlessly particularly in times when I have fallen short of fulfilling my role as a Mother. I will always be indebted to you. God bless you abundantly.

To my son, Luthando Nzuza, I thank God every day for you. Just like your name, you are a true epitome of love. Thank you for your unconditional love. To my siblings, Sibusiso, Nomkhosi, and Kwanele Sibiya, thank you for being my biggest cheerleaders and for always supporting my dreams and aspirations. To Simphiwe Mbiko, and Angeline Zwane, and Shae Lazarus, thank you for your support and for lending me an ear particularly when the going got tough.

Lastly, to my family, friends, and colleagues at the Wits Health Sciences Research Office, thank you for supporting me throughout this journey. I am extremely lucky to have you all in my life.

God bless you all.

TABLE OF CONTENTS

DECLARATION i

ABSTRACT ii

DEDICATION iii

ACKNOWLEDGEMENTS iv

LIST OF FIGURES viii

LIST OF TABLES ix

LIST OF APPENDICES x

CHAPTER ONE - FRAMES OF REFERENCE

1.1 Introduction 1

1.2 Problem statement 2

1.3 Research Questions 4

1.4 Research Aims and Objectives 5

1.5 Theoretical Considerations and Literature Review 5

1.6 Research Methodology 7

1.7 Research Design 7

1.8 Data Analysis 8

1.9 Ethical Consideration 8

1.10 Organisation of the Dissertation 9

CHAPTER TWO - THEORETICAL CONSIDERATIONS AND LITERATURE REVIEW

2.1 Introduction 10

2.2 Definition of Key Concepts 10

2.3 Perspectives on Climate Variability and Change in a Global Context 14

2.4 Perspectives on Climate Variability and Change in sub-Saharan Africa 16

2.5 Perspectives on Climate Variability and Change in South Africa 19

2.6 Climate Change Adaptation and the Effect of Climate Change on Rural Livelihoods 21

2.7 Gaps in the Existing Literature 26

CHAPTER THREE - METHODOLOGICAL CONSIDERATIONS

3.1 Introduction 29

3.2 Recapping of the Research Aims and Objectives 29

3.3 Research Philosophy 30

3.4 Research Design 32

3.4.1 Description of the research site 32

3.4.2 Study population and sampling procedure 35

3.4.3 Data collection tools 38

3.5 Data Analysis 44

3.6 Methodological Reflections 45

CHAPTER FOUR - EMPIRICAL EVIDENCE

4.1 Introduction 47

4.2 Perceptions on how climate variability has manifested itself in Mtubatuba 47

4.3 Perceived impacts of climate variability on rural livelihoods in Mtubatuba 54

4.4 Adaptation strategies adopted by the rural communities in Mtubatuba 59

4.4.1 Communities adaptation strategies against the impacts of droughts 61

4.4.2 Communities adaptation strategies against the impacts of

Severe thunderstorms 73

4.4.3 Adaptation strategies offered to the three research sites by the Mtubatuba Local Municipality 74

CHAPTER FIVE –DISCUSSION

5.1 Introduction 77

5.2 Climate change: an existing and persistent phenomenon in Mtubatuba 77

5.3 The adverse impacts of climate variability on rural communities in Mtubatuba 79

5.4 Assets for climate variability adaptation in Mtubatuba 84

5.5 The wider implications of the findings of this study 88

CHAPTER SIX – CONCLUSION AND RECOMMENDATIONS

6.1 Introduction 91

6.2 Summary of key findings of the research and the conclusion 91

6.3 Recommendations for building an adaptive capacity towards climate variability 93

6.4 Study Limitations and Recommendations for future research 95

PERSONAL COMMUNICATION 96

REFERENCES 98

APPENDICES 136

LIST OF FIGURES

Figure 3.1:	Location of the three research sites in Mtubatuba	34
Figure 4.1:	Extreme weather events observed in three research sites	49
Figure 4.2:	Extreme weather events observed in Mtubatuba	50
Figure 4.3:	Average rainfall amounts in Mtubatuba	52
Figure 4.4:	Average minimum and maximum temperatures in Mtubatuba	53
Figure 4.5:	The effects of lack of water attributed to droughts	56
Figure 4.6:	The effects of lack of water attributed to droughts	57
Figure 4.7:	Mealies and sugarcane field	58
Figure 4.8:	Assets identified by communities	60
Figure 4.9:	Water resources in the three research sites	61
Figure 4.10:	Household assets for adaptation	69
Figure 4.11:	Percentage use of each asset portfolio	70
Figure 4.12:	Chickens kept for selling purposes in Nkombose	71
Figure 4.13:	Research participants using human resources to adapt	72
Figure 5.1:	Article published in the Daily Sun	80
Figure 5.2:	The effects of droughts on farming and planting	81
Figure 5.3:	The effects of droughts on livestock production	83
Figure 5.4:	Adaptive capacity of individuals with and without capital	85

LIST OF TABLES

Table 2.1:	The five fundamental assets	12
Table 3.1:	Sample size calculation for each research site	37
Table 3.2:	Sampling fraction for the three research sites	38
Table 4.1:	Household responses on observed weather changes	48
Table 4.2:	Listing and ranking matrices data	54
Table 4.3:	Climate variability associated impacts and adaptation in Nkombose	62
Table 4.4:	Climate variability associated impacts and adaptation in Ebaswazini	64
Table 4.5:	Climate variability associated impacts and adaptation in Ogengele	66

LIST OF APPENDICES

Appendix A: Human Research Ethics Clearance Certificate 136

Appendix B: Participant Information Sheet (Questionnaire respondents) 137

Appendix C: Participant Information Sheet (Interview respondents) 138

Appendix D: Participant Information Sheet (Focus Group participants) 139

Appendix E: Consent form (Interview respondents) 140

Appendix F: Consent form (Focus Group participants) 141

Appendix G: Questionnaire 142

Appendix H: Interview Schedule 147

Appendix I: Focus Group Discussion Questions 150

Appendix J: Response rate for Extreme weather events observed 152

Appendix K: Meteorological data trends for Mtubatuba 153

Appendix L: Response rate for effects of lack of water 154

Appendix M: Response rate for household assets for adaptation 155

CHAPTER ONE

FRAMES OF REFERENCE

1.1 Introduction

It is now widely acknowledged that climate variability presents different challenges globally (Simatele *et al.*, 2012; Fisher *et al.*, 2010; Dube and Phiri, 2013). Climate variability challenges are predicted to emerge in various forms; these include changes in rainfall patterns, and in the severity and occurrence of extreme weather events such as droughts and floods (Davis, 2011). Climate variability affects the lives and livelihoods of millions of poor people globally because the slightest change in rainfall amount and extreme temperatures can have negative impacts on livelihoods (Bele *et al.*, 2013; Bryan *et al.*, 2013; IPCC, 2012; Midgley and Thuiller, 2011; Ostfeld, 2009; Douglas *et al.*, 2008). In Bangladesh, for example, Brouwer *et al.* (2007) found that poor households who were affected by floods in 2004 lost more than twice as much of their total income compared to well-off households. This concretises previous findings, which suggest that poor people are more vulnerable to disaster events (Rabbani *et al.*, 2013; Carter *et al.*, 2007). In 2011, there were reported cases of severe floods in South Africa, Mozambique, Uganda, and Namibia in Africa; Mexico, Brazil, and Colombia in America; and India, Korea, Pakistan, China, Cambodia, Thailand, and the Philippines in Asia, where fatalities in each of the floods were more than 50 and property was severely damaged (Kundzewicz *et al.*, 2012).

While it is acknowledged that climate variability has devastating impacts globally, it is argued that developing countries are the most affected (Madzwamuse, 2010; UNFCCC, 2007). It has also been argued that several factors aggravate the susceptibility (to climate variability and change) of poor people in sub-Saharan Africa. These factors include rapid population growth, high rates of poverty, low levels of education, weak institutions and policy frameworks, lack of social safety nets, and limited technological advancement (Perez *et al.*, 2015; IPCC, 2014; Binns *et al.*, 2012; Roudier *et al.*, 2011). Given that many people in sub-Saharan Africa depend on farming, climate variability and change prevent the poor from engaging in practices which contribute to effective and efficient food production. As a result, climate variability significantly affects rural livelihoods and contributes to increased levels of poverty (Madzwamuse, 2010; UNFCCC, 2007).

South Africa as a country has experienced numerous impacts of climate variability. Turpie and Visser (2013) are of the view that in South Africa, climate variability is projected to result in irregular rainfall patterns and frequent droughts. In the year 2000, the northern region of South Africa was greatly affected by severe floods; this resulted in damaged infrastructure and multiple deaths (David *et al.*, 2007). In 2016 and 2017, there were reported cases of localised flooding in a number of provinces across South Africa. The extent of destruction ranged from cars being washed away, homes being flooded and numerous fatalities being recorded (Floodlist, 2017).

In light of the above, it is evident that the impacts of climate variability in South Africa are widespread. However, it is documented that nowhere else will the impact of climate variability be more severe than in the agriculture and water sectors (Yilmaz and Yazicigil, 2011). CEMEX UK Operations Ltd (2004), for example, projected that by the year 2025, water availability will be less than 1000 m^3/person/year in nine countries in Africa, particularly in the eastern and southern Africa (South Africa included), bearing in mind that the projections made by CEMEX UK Operations Ltd (2004) were only based on population growth and do not take into account the distinction in water resources attributed to climate variability. In fact, the above projections are already evident. For instance, in 2018 the Western Cape Province experienced increased water scarcity due to climate variability. This resulted in a restricted use of 50 litres of water for each person on each day, given that 50 litres is the absolute minimum required to survive (Gleick, 1996).

Apata *et al* (2009) suggest that it is important to consider the local communities' understanding of climate variability, particularly if one wants to approach climate variability in an appropriate manner. For South Africa, in general, existing literature suggests that there is a need for more research to investigate the impacts of climate variability on water resources and agriculture, particularly in terms of how communities respond and build adaptive capacity and resilience (Ziervogel *et al.*, 2014).

1.2 Problem statement

It is argued that KwaZulu-Natal is one of the provinces that is expected to be greatly affected by climate variability (Reid and Vogel, 2006). Although this province has developed over the years, it is still home to many rural communities, where the majority of these communities depend on rain-fed agriculture to sustain their livelihoods (Turpie and Visser, 2013). The combination of extreme weather conditions has negative impacts on food security and the region's agricultural productivity. The extreme weather event that has contributed significantly towards food insecurity in KwaZulu-

Natal is droughts. Reid and Vogel (2006) argue that the rural areas of northern KwaZulu-Natal are in a hydrological crisis as they have been the most affected by droughts.

UMkhanyakude District Municipality, as documented by Mabuza (2016), is one of the worst areas to live in South Africa because the majority of the rural communities in that district lack running water, flush toilets and has high poverty levels. The worst areas to live in South Africa list was largely dominated by KwaZulu-Natal and Eastern Cape District Municipalities. Mabuza (2016) observed that climate variability has devastating impacts within the KwaZulu-Natal province. These impacts include socio-economic impacts and environmental impacts. According to Reid and Vogel (2006) other episodes of droughts and impacts in KwaZulu-Natal, recorded in the press and other sources include:

(i) Drought drives KwaZulu-Natal farmers out (Pietermaritzburg News, 14/08/1979)
(ii) The economic impact value of the KwaZulu-Natal drought in 1980 was 507 540,00[1] USD (Star, 21/08/1980)
(iii) Cash crops failed KwaZulu-Natal (Star, 29/03/1983)
(iv) In 1992–1993 drought, boreholes drilled and water supplied (Gilham, 1997).

Mtubatuba in the uMkhanyakude District Municipality, as documented by Rondganger (2016), was one of the areas in KwaZulu-Natal where people were without water after springs, taps, and rivers dried up. Rondganger (2016) found that these areas were left with no water for weeks due to a drought. In the article the KwaZulu-Natal Department of Co-operative Governance and Traditional Affairs spokesperson, Lennox Mabaso expressed that "The drought situation has deepened to the extent that not only have some of our reservoirs dried up, but the groundwater is getting exhausted. Even the boreholes are running dry. In some areas where we drill, nothing comes out", (Rondganger, 2016, para. 19).

Following the floods that occurred in KwaZulu-Natal in 2017, KwaZulu-Natal Premier Willies Mchunu expressed that "clearly, the natural forces are threatening the future of our province and global warming effects are realities facing us today", (Zietsman, 2017, para. 5).

Within this context, it is obvious that climate variability has devastating impacts seen through increased droughts, which have compromised agricultural activities. Despite these impacts, the poor rural people are not passive actors. In fact, Moser and Satterthwaite (2008) are of the view that rural poor people are constantly involved in protecting and adjusting their asset portfolios against the impacts of extreme weather events. Assets are defined as "stock of financial, physical, human, natural or social resource that can be acquired, developed, improved and transferred across

generations. A stock endures; it is not entirely consumed. It generates flow or consumption, as well as additional stock." (Ford Foundation 2004 cited in Moser 2006, p.5).

The researcher found that there is very limited literature, which focusses on how the rural communities in KwaZulu-Natal cope with and adapt to climate variability. In addition, it is evident that many studies have struggled with examining the significance of climate as a driver of change (Nielsen and Reenberg, 2010; Mertz et al., 2009; Nielsen, 2009; Tschakert, 2007). As such, this study was developed to address these gaps.

In view of this observation, this study was interested in investigating the ways in which rural poor households in the three research sites use the different asset portfolios and a combination of assets to build their adaptive capacity and resilience against climate variability. The study was also interested in understanding the extent to which communities, particularly rural communities of the three research sites, adapt to climate variability.

1.3 Research Questions

In view of the above, the following questions guided the research process:

(i) How has climate variability manifested itself in the three research sites in Mtubatuba?

(ii) What are the impacts of climate variability on rural livelihoods in the three research sites in Mtubatuba?

(iii) How do the rural poor communities in the three research sites in Mtubatuba build adaptive capacity and resilience against climate variability?

(iv) How does the asset-based adaptation framework provide a framework through which to investigate and analyse the adaptation responses of poor communities in the three research sites in Mtubatuba?

(v) What is the impact or the implication of the findings of this study in a wider context, particularly in the sub-Saharan African context?

1.4 Research Aim and Objectives

The aim of this study was two-fold. *Firstly*, the study aimed to investigate the ways in which poor rural people are affected by climate variability and *secondly*, to understand the ways in which these communities are adapting to climate variability using the asset-based adaptation framework.

The above aims were supported by the following objectives:

(i) To determine the impact of climate variability on poor rural people in the three research sites.

(ii) To identify the different asset portfolios which each of these communities use to adapt to climate variability.

(iii) To understand which asset portfolios play a very important role in the adaptation process in order to identify appropriate intervention measures.

(iv) To contribute to the body of knowledge on the combination of assets of climate variability adaptation.

1.5 Theoretical Considerations and Literature Review

The establishment of the Intergovernmental Panel on Climate Change (IPCC) in 1988 and the United Nations Framework Convention on Climate Change (UNFCCC) in 1992 were two essential milestones for scientists and policymakers in understanding climate variability and striving to address the causes and effects of climate variability. Research conducted by several researchers suggests that the greenhouse gas emissions have contributed to climate variability in the sub-Saharan region and the world at large (Reason, 2007; Warburton *et al.*, 2005; Reason and Keibel, 2004; Mirza, 2003; Rosenzweig *et al.*, 2001). Furthermore, Stocker *et al.* (2013) argue that climate scientists have over the years built an increasingly clear picture of how the earth's climate is being altered by greenhouse gas emissions arising from the burning of fossil fuels. Turpie and Visser (2013) and Fairbanks and Scholes (1999), argue that climate variability presents social, economic, and environmental challenges for South African societies, particularly rural communities, because they depend highly on natural resources. Although we are still faced with climate variability challenges, Füssel and Klein (2006) are of the view that scientific knowledge has, over almost three decades, played a significant role in the formulation and implementation of policies to curb climate variability impacts. Ziervogel *et al.* (2014) observed that in South Africa for example, academics

and policymakers have worked together meticulously on climate variability. This was evident in 2005 where science and policy plenary sessions were intertwined at the National Climate Change Summit, 'Climate Action Now'. The key policies that resulted from the Summit include South Africa's Second National Communication under the United Nations Framework Convention on Climate Change (Department of Environmental Affairs, 2011), and the National Climate Change Response White Paper (Republic of South Africa, 2011).

According to Hellmuth *et al.* (2007), climate variability presents challenges to the lives and livelihoods of individuals and to the infrastructure and economy at the regional and national levels. Arnall (2012) and Lemos *et al.* (2013) emphasise that, at rural community-level in South Africa, it is a major challenge to respond to climate variability, particularly because it is considered in the context of wider development pressures. These pressures include sustainable management of forest and land resources and poverty.

In the sub-Saharan African region, agricultural production is vulnerable to the effects of climate variability, with rain-fed agriculture contributing to almost 96 % of the total crop production (World Bank 2015). This finding reinforces the studies conducted by Kumssa and Jones (2010) and Mendelsohn and Tiwani (2000), which indicate that climate variability affects agricultural productions and aggravates food insecurity in Africa. According to the Food and Agriculture (2003), more than 60% of Africans depend on agricultural activities to sustain their livelihoods. Sokona and Denton (2001) argue that although livelihoods have continually adapted to change, the impacts of climate variability may push people beyond their ability to deal with these impacts and to adapt.

Literature on climate variability and rural livelihoods documents how livelihoods are affected by multiple stressors and how households adapt to stressors (Reid and Vogel, 2006; Tschakert, 2007; Paavola, 2008; Osbahr *et al.*, 2008; Bryan *et al.*, 2009). However, Eakin (2005) and Belliveau *et al.* (2006) identify connections between multiple stressors and adaptation, particularly environmental change and economic globalisation. Bryant *et al.* (2000) reaffirms that adaptation to climate variability is a multifaceted and a multiscale process. In the climate change and variability literature, Smit *et al.* (2000, p.225) defines adaptation as "the adjustment of socio-ecological systems to a climate stressor in order to moderate harm or take advantage of the opportunity".

Several studies have revealed the significant adaptation strategies, which the rural poor can use to cope with climate variability (Adger *et al.*, 2003; Hulme and Shepherd, 2003; IPCC, 2001b). Bryan and Behrman (2013) argue that, although the literature on climate variability adaptation is quite broad, most of it focuses on policy responses to climate variability (at either national or

international level) and independent adaptation at the individual or household level (often excluding the adaptation efforts made at community-level).

However, a small number of papers draws on rural development and collective adaptation efforts of community members for the greater advantage of a bigger group (Dodman and Mitlin, 2013; Ayers and Forsyth, 2009; Adger, 2003). In addition, it is evident that the UNFCCC and IPCC agendas and procedures have influenced the way of thinking and policy on climate variability and change adaptation (IPCC, 1988 and UNFCCC, 1992).

1.6 Research Methodology

This section provides a brief description of the methodology which was used in this study. The data which were used in this study were collected from the rural communities of Nkombose, Ebaswazini, and Ogengele in Mtubatuba, northern KwaZulu-Natal. This study used both the qualitative and quantitative research methods. The qualitative research method was selected for this study as it allowed the researcher an opportunity to answer the research questions from different angles and also to obtain as much information as possible for this study, whereas, the quantitative research method was used to compare and support the qualitative data. The detailed research methodology utilised in this study is comprehensively discussed under Chapter three of this dissertation.

1.7 Research Design

To facilitate the gathering of qualitative and quantitative data for analysis, the study used descriptive and exploratory research designs. The purpose of a descriptive research design was to obtain the respondents' views on the impacts of climate variability as well as the adaptive measures and assets which they use to survive the effects of climate variability on their rural livelihoods. The exploratory research design provided further insight into the impacts of climate variability on rural livelihoods.

For this study, the researcher sampled households, rather than individuals. This was because sampling households gave a better overview of each household's adaptive capacity. A probability sample was used as it allowed for every household of the wider population to have an equal chance of being included in the sample. The systematic sampling method was used to select the sample of

households for each research site. Using the sampling fraction, the frequency interval was determined. In this process, the first respondent was purposely selected.

The researcher used a multi-faceted approach to collect data. A number of instruments were used to gather information which contributed to answering the research questions and objectives of this study. The study made use of Questionnaires, Observations, Focus group discussions, Participatory research methods (mind maps, listing and ranking matrix), existing Meteorological data, and Interviews to collect data. The detailed research design used in this study is comprehensively discussed under Chapter three of this dissertation.

1.8 Data Analysis

The data obtained from the mind maps, listing and ranking matrix, interviews, questionnaires, focus groups, observations, and temperature and rainfall data were analysed. Data obtained from the questionnaires were captured on REDCap and were subsequently exported to STATA. Frequency tables and figures were drawn from the data obtained from the questionnaires. Qualitative data obtained from open ended questions from the questionnaires were coded into different themes. Information obtained from focus group discussions, interviews, mind maps, listing and ranking matrix was discussed extensively. Climate data which included minimum and maximum temperature in ºC and rainfall amounts data in mm were averaged per year and included on a Microsoft excel spreadsheet. Thereafter, graphs were drawn demonstrating the variations over the years.

1.9 Ethical Consideration

Ethics is defined as "a branch of philosophy that deals with the conduct of people and guides the norms or standards of behaviour of people and relationships with each other" (Blumberg *et al.*, 2005 and Kovacs, 1985 cited in Akaranga and Ongong'a, 2013, p.1). It refers to a "way of life, the social norms for conduct that distinguishes between acceptable and unacceptable behaviour" (Akaranga and Ongong'a, 2013, p.8; Shah, 2011, p.205).

The following ethical considerations were observed when conducting this study:

(i) The study was approved by the Human Research Ethics Committee (Non-Medical) of the University of the Witwatersrand (clearance number: R14/49, protocol number: H18/07/25) (see Appendix A)

(ii) Informed consent was obtained from the participants (see Appendix E).

(iii) The right to confidentiality and anonymity and the right to withdraw from the study were observed.

(iv) The respondents were also given an opportunity to ask questions and request clarification whenever they needed to.

1.10 Organisation of the Dissertation

The dissertation consists of six chapters. **Chapter one** comprises the frames of references, which includes the problem statement, research questions, research aims and objectives. In **Chapter two**, a comprehensive literature review on climate variability, asset adaptation, and rural livelihoods is provided. The methodological considerations are discussed in **Chapter three**. The empirical evidence of the study is reported in **Chapter four**. A detailed discussion and the implications of the findings of this study in a wider context are presented in **Chapter five**. Lastly, **Chapter six** consists of the conclusion, recommendations, and limitations of the study.

CHAPTER TWO

THEORETICAL CONSIDERATIONS AND LITERATURE REVIEW

2.1 Introduction

This Chapter is dedicated to discussing the existing body of knowledge of the impacts of climate variability on rural livelihoods and the various assets rural communities use to adapt and build resilience against climate variability.

In view of this, it is essential to note that research literature provides strong evidence that the climate is changing (Fussel, 2009; Smith *et al.*, 2009). Climate variability and change have contributed to the instability of rainfall patterns and temperatures in many parts of the world and also to the frequency of extreme weather events (Yamashita *et al.*, 2016; Muis *et al.*, 2015; Minville *et al.*, 2008).

In light of the above, this Chapter is divided into three subsections. The first subsection is dedicated to defining the key concepts used in this chapter. It is important to define these concepts in order to provide a common understanding of the words I refer to in this chapter. Secondly, the literature is contextualised and various perspectives and synergies are discussed. The third subsection is dedicated to discussing the gaps in the existing literature. It is important to engage with some of the views of various scholars in order to establish the existing gaps in knowledge.

2.2 Definition of Key Concepts

As mentioned above, this subsection is dedicated to defining key concepts, which include the following:

(i) **Climate variability and climate change** - Climate variability can be complex to define because it is often used interchangeably with climate change. It is important to note that these two terms are different. The World Meteorological Organization (2017) and the Intergovernmental Panel on Climate Change (2014) defines **climate variability** as the variations in the mean state and other statistics (such as standard

deviations, the occurrence of extremes etc.) of the climate on all temporal and spatial scales beyond that of individual weather events.

Climate change is defined by the United Nations Framework Convention on Climate Change (1992) as a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods. The Intergovernmental Panel on Climate Change (2014) defines climate change as a change in the state of the climate that can be identified by changes in the mean (and/or the variability), and that persists for an extended period, typically decades or longer. Both of these definitions provide clarity on what one could perceive as climate change.

However, for the purpose of this study, I refer to climate variability as changes in the average weather patterns (e.g. temperature, rainfall) over the periods ranging from months to 30 years, whilst climate change refers to any long-term change in the average weather patterns (ranging from over 30 years to decades to millennia) in a particular area.

(ii) **Assets** - Ford Foundation (2004) cited in Moser (2006, p.5) defines assets as "stock of financial, physical, human, natural or social resource that can be acquired, developed, improved and transferred across generations". In addition, the Ford Foundation (2004) is of the view that these resources generate flows of consumption as well as additional stock. On the other hand, Sen (1997) regards assets as the basis of agents' power to act to reproduce, challenge or change the rules that govern the control, use, and transformation of resources. Bebbington (1999) is of the view that assets are not only just resources that people use to build resilience and support livelihoods, but that assets are also resources that provide households capacity to act.

However, for the purpose of this study, I take assets as any tangible (physical resources such as land, infrastructure, house, and vehicle) and intangible (investments) resources that people use to build resilience against climate variability. Table 2.1 indicates the five fundamental assets defined by Moser and Dani (2008).

Table 2.1: The five fundamental assets.

Assets	Characterisations	Examples
Physical assets	Item of economic, commercial or exchange value that has a material existence. Physical assets are also known as tangible assets.	Buildings, plant, tools, Land, vehicles, machinery, equipment, silver, gold, or any other form of tangible resources.
Financial assets	These are intangible resources. They cannot be seen or touched and may not have a physical presence except for the existence of a document that presents the ownership interest held on the asset.	Stocks, bond, funds in the bank, investments, accounts receivable.
Human assets	Investments in nutrition, health, and education of individuals. A collection of skills, knowledge or other intangible assets that an individual has that can be used to create economic value for an individual, their community, and employers.	Investments.
Natural assets	These are assets of the natural environment. These consist of land and water areas with their ecosystems, biological assets (produced or wild), air, and subsoil assets. Natural assets are the foundation not only of production but of life itself.	
Social assets	There are institutions that assist people in maintaining and developing human capital in partnership with others.	Families, schools, businesses, voluntary organisations communities, and trade unions.

Source: Moser and Dani (2008).

(iii) **Adaptation** - Different scholars have different notions of what adaptation is. Burton (1992) for example, defines adaptation to climate variability and change as the process through which people reduce the adverse effects of climate change on their health and well-being, whereas Watson *et al.* (1996) are of the view that adaptation refers to the degree to which adjustments are possible in practice, processes or structures of systems to projected or actual changes of climate. The International Panel on Climate Change (2014, p.5) defines adaptation as "an adjustment in natural and human systems in response to actual and expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities".

All these definitions provide us with some understanding of what one could regard as adaptation. However, for the purpose of this study, I regarded adaptation as a way in which people and communities respond to the effects of climate variability and change.

(iv) **Adaptive Capacity** - Nelson *et al.* (2007) define adaptive capacity as the set of resources, and the ability to employ those resources, that are prerequisites to adaptation, whilst, Adger *et al.* (2007) are of the view that adaptive capacity is the ability or potential of a system to respond successfully to climate variability and change. In turn, Smit *et al.* (1999) describe adaptive capacity as the potential or capability of a system to adapt to (to alter to better suit) climatic stimuli or their effects or impacts. The IPCC (2007a) defines adaptive capacity as the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences. For the purpose of this study, I take adaptive capacity as the ability of a system or people to adjust, cope and survive the negative impacts of climate variability and change.

(v) **Livelihoods** - Chambers and Conway (1992) describe livelihoods as a system consisting of activities, capabilities, and assets for a means of living, whilst, Carney (1998) defines sustainable livelihoods as those which have the ability to cope and recuperate from stresses and shocks, maintain and enhance local and global assets on which livelihoods depend, also allowing future generations to benefit from them.

Babulo *et al.* (2008) agree with the definition given by Carney (1998). In addition, Babulo *et al.* (2008) view livelihoods as the capabilities, assets (including both material

and social resources), activities essential for a means of living and considered to be sustainable when they can survive and recuperate from stress and shocks and maintain or boost their capabilities and assets both now and in the future, while not undermining the natural resource base. According to the livelihoods framework described by the UK Department for International Development (DFID), five types of capital support livelihoods (Carney, 1998): Natural capital (such as lands, water, forests and fisheries); human capital (such as knowledge and skills); financial capital (such as income opportunities); physical capital (such as infrastructures), and social capital (such as social networks).

Therefore, for the purpose of this study, I used Carney (1998) definition of livelihoods.

2.3 Contextualizing the Literature: Perspectives on Climate Variability and Change in a Global Context

It is now widely acknowledged that climate change can be attributed to both natural and anthropogenic (human-induced) factors (IPCC, 2009; IPCC, 2001a). According to Burroughs (2007), although climate patterns naturally change over time, scientists have attributed the anthropogenic factor of greenhouse gas emissions to be the main cause of climate variability and change. Robledo and Forner (2005), who argue that the increased concentration of greenhouse gas emissions in the atmosphere causes uncertainties in the climate system, also support this view. The uncertainties include changes in the rainfall patterns and the frequency and severity of extreme events (for example flooding, hurricanes, typhoons, etc.) and changes in the intensity and measure of the phenomena such as El Niño (or ENSO). These views have been summarised by the IPCC (2013), who are of the view that it is highly possible that more than half of the rise in global average temperature observed from 1951 to 2010 could have been instigated by an anthropogenic increase in greenhouse gas emissions and possibly other anthropogenic factors.

In addition, the IPCC (2007b) observed that there is growing evidence that suggests that the climate is changing; this is directly visible through changes in precipitation patterns, rising ocean temperatures and global average air temperatures and changes in the frequency and severity of storms. Furthermore, the IPCC (2007b) is of the view that the rise of global atmospheric carbon dioxide levels has been accompanied by a rapid rise in the global surface temperature over the last 100 years. The IPCC (2001a) also argues that the global climate is now warming at an extraordinary rate and therefore is unavoidably modifying weather patterns all over the world.

Research suggests that international initiatives have been developed to address the challenges posed by climate change, particularly in reducing and avoiding greenhouse gas emissions (United Nations, 1998 and IPCC, 2010). The establishment of the key outcomes at the United Nations Conference on Environment and Development, also known as the Earth Summit, for instance, demonstrates some of the developments that have been made. Furthermore, the establishment of the United Nations Framework Convention on Climate Change (UNFCCC) as an international treaty, which nearly 200 governments agreed to in 1992, demonstrates that efforts are being made to prevent and reduce climate change. This treaty brought about the Kyoto Protocol, which is the treaty which required some industrialised countries to reduce their greenhouse gases emissions. The preamble of the UNFCCC recognises that a change in the Earth's climate and its adverse effects are a common concern of humankind (UNFCCC, 2007). The Kyoto Protocol was adopted in 1997 in Kyoto, Japan and became effective in 2005; the agreement bound industrialised countries to reduce greenhouse gas emissions over a five-year period (United Nations, 1998 and IPCC, 2010).

The Intergovernmental Panel on Climate Change (IPCC) was established in 1998, as a scientific body whose role was to evaluate the risk of climate change caused by human activity, as well as the impacts of human-induced climate change, and options for climate change mitigation and adaptation (IPCC, 2010; United Nations, 1998). The IPCC has over the years published numerous documents, which have contributed to the climate change literature. The Third Assessment published in 2001 (IPCC, 2001a) evaluated the ability of the world to cope and adapt to the unavoidable impacts that will be caused by climate change. Smit *et al.* (2001) observed that the IPCC's Third Assessment found that the impacts of climate change are not equally distributed; in fact, the ones least able to cope with climate change will be the ones who will be most affected. In 2002, the UNFCCC originated the National Adaptation Programmes of Action (NAPA) in the least developed countries to assist prioritise adaptation actions. The objective of the NAPA was to serve as a simplified and direct way of communicating information related to the urgent and immediate adaptation needs of the least developed countries. The research summarised above demonstrates that scientists across the globe have developed systems and procedures to make countries accountable for their greenhouse gas emissions and established ways to mitigate and adapt to the impacts of changing climates.

2.4 Contextualizing the Literature: Perspectives on Climate Variability and Change in sub-Saharan Africa

It is now widely recognised that the climate is changing at an alarming rate and it is impacting the lives of many people in all parts of the world (International Panel on Climate Change (IPCC, 2007a: 2012; Karl and Trenberth, 2003). Although climate change is a global concern, the UNFCCC (2007) and Madzwamuse (2010) argue that developing countries are the most affected by climate change. Research conducted by several researchers suggests that the sub-Saharan African region is more at risk and vulnerable to climate variability and change than anywhere else in the world (Hummel, 2015; Barr *et al.*, 2010). This is also supported by Bewket (2012), Beg *et al.* (2011), and Huq *et al.* (2004) who argue that although Africa emits the least greenhouse gas emissions (due to least levels of industrial development), it is the most at risk to the impacts of climate change.

According to Bwalya (2013), Africa is considered the most vulnerable continent to climate change. This is also supported by several other studies (World Bank, 2016; IPCC, 2007a; Vogel, 2005; Liliana, 2005) which also projected that Africa is highly susceptible to climate change. Studies by De Cock (2012) and Knueppel *et al.* (2009) established that South Africans living in rural households are extremely affected by climate change. Several other studies found that rural poor people residing in coastal areas are largely susceptible to natural disasters, such as floods, tsunamis, hurricanes, and other extreme coastal events (Hallegatte *et al.* 2017; Barbier 2008, 2015; Laso Bayas *et al.* 2011; Das and Vincent 2009; Carter *et al.* 2007; McSweeney 2005; Badola and Hussein 2005).

Hulme *et al.* (2001) are of the view that temperatures across the African continent are projected to increase by 2 - 6°C over the next 40 years. Whilst, the IPCC report on Regional Climate Projections (2007) projects that by 2050 the average temperatures in Africa are expected to increase by 1.5 - 3°C and the warming of the African continent is expected to be greater than anywhere else in the world. Buckland *et al.* (2000) found that droughts are the most detrimental natural disaster in southern Africa in environmental, social, and economic terms. In fact, Niang *et al.* (2014), Tschakert *et al.* (2010), New *et al.* (2006), Fauchereau *et al.* (2003), and Richard *et al.* (2001) argue that the incidence of extreme events such as floods and droughts have intensified in the sub-Saharan African region. In addition, Reich *et al.* (2001) are of the view that there have been increases in desertification in the sub-Saharan African region. Furthermore, Chen *et al.* (2006) and Hay *et al.* (2002) argue that there have been changes in certain disease vectors which have caused variations in the temporal and spatial transmission of infectious diseases. Whereas, Songok *et al.* (2011a) and Thomas *et al.* (2007) argue that beyond rise in temperatures, climate change in sub-

Saharan Africa is predicted to cause variations in the intensity of rainfall. According to Janowiak (1988), the variability of inter-annual rainfall over most of Africa is high. Hulme *et al.* (2001) also observed that substantial multi-decadal rainfall variability is prominent in the Sahel region. In addition, research conducted by several researchers suggests that there has been a decline in rainfall amounts in the Sahel region over the course of the 20th century (Biasutti, 2013; Ackerley *et al.*, 2011; Mohamed, 2011; Lebel and Ali, 2009; Nicholson *et al.*, 2000).

The IPCC (2007b) projects that by 2020, up to 250 million African people are likely to suffer from food insecurity because of lack of water, loss of livestock, and climate-driven crop failure. Furthermore, the IPCC (2007) projects that by 2020, between 75 and 250 million people in Africa could be exposed to water stress because of climate change, in some countries, water stress will reduce the yields of rain-fed agriculture by up to 50%. Hope (2009), who argues that climate change affects water availability, food security, productivity, and biodiversity in Africa, also supports this finding. Angula (2010) estimates that by 2025 the majority of southern African countries will experience water scarcity and stress due to climate change. Several studies suggest that African countries are most impacted by climate change because they rely highly on agricultural practices and they have very low technical, financial, and institutional capacity to adapt (Rose, 2015; Signgh and Purohit, 2014; Nordhaus, 2006; and Huq *et al.*, 2004). In comparison to other continents, AmjathBabu *et al.* (2016) are of the view that the expected impacts of climate change on agriculture are much greater in sub-Saharan Africa.

Studies on the impacts of climate change provide strong evidence of negative impacts on crop yields (e.g. Nelson *et al.*, 2014) and livelihood outcomes for people in the sub-Saharan Africa region (IPCC, 2014). Research by Schlenker and Lobell (2010) argues that food production and related livelihood practices will be exceptionally affected by climate variability and change in sub-Saharan Africa. Shah *et al.* (2008) estimate that more than 80% of the population in the sub-Saharan African region live in rural areas, with approximately 85% of the population depending on rain-fed agriculture (this includes livestock and crop production), and biodiversity and agriculture-based rural livelihoods activities. In view of this, climate change negatively impacts agricultural productions and intensifies the challenge of food security in Africa (Kumssa and Jones, 2010; Mendelsohn and Tiwani, 2000). According to the Food and Agriculture Organization (FAO, 2003), over 60% of Africans rely on agricultural activities to sustain their livelihoods. The IPCC (2007b) argues that in sub-Saharan Africa, agricultural output will decrease from 21% to 9% by 2080 because of climate change. Hendriks (2005) established that in South Africa, a great number of households in rural areas are susceptible to incidents of food insecurity. Kurukulasuriya and Mandelsohn (2006) and Smit and Skinner (2002) provide strong evidence that in the absence of

adaptation, climate change is harmful to the agriculture sector, but with adaptation, the susceptibility can be decreased substantially.

According to Kebede *et al.* (2011) and Songok *et al.* (2011b), in sub-Saharan Africa, extreme droughts are already impeding people's ability to rear livestock and grow food, and pastoralists and agro-pastoralists will need to adapt to changes in water systems in order to sustain their well-being and food security. Angelsen and Dokken (2015), who found that in sub-Saharan Africa, poor rural households situated in less-favoured regions are already subjected to decreasing income because of extreme climate conditions, support this view. Further projections by the IPCC (2007b) suggest that because of drought, by 2100, arid and semi-arid areas of Africa are predicted to increase by 5-8%, or 60-90 million hectares, causing agricultural production losses of between 0.4-7% of the gross domestic product (GDP) in northern, western central, and southern Africa.

Bunce *et al.* (2010a) argue that climate variability significantly worsens people's lives in Tanzania and Mozambique, whereas, Tschakert (2007) found that in Senegal, climate change provides added stress to the lives of people who are already vulnerable to poor health, rural unemployment, and inadequate infrastructure. In an analysis of climate vulnerability, poverty, and environmental dependence of more than 7,300 households in forest-adjacent communities in twenty-four developing countries, Angelsen and Dokken (2015) found that the poor have a tendency to live in the less favourable areas. In addition, these communities make 29 percent of their revenue from environmental resources and therefore, are more vulnerable to extreme climate conditions. Therefore, Niang *et al.* (2014) argue that often the world's poor are considered the most vulnerable to climate change, and therefore they are the most in need of adaptation, to decrease the impacts and challenges posed by climate change on their lives and livelihoods.

Research conducted by several researchers suggests that sub-Saharan Africa is susceptible to climate change, as multiple socioeconomic, political, and biophysical pressures interact to intensify the region's vulnerability and limit its adaptive capacity (IPCC 2007a; Reid and Vogel 2006; Davidson *et al.* 2003). According to Adger *et al.* (2003), climate change does not only disturb the livelihoods of people but also reduce the national development of developing countries around the world. Furthermore, Adger *et al.* (2003) are of the view that although climate change is a global concern, the need for adaptation is greater for developing countries because they are more vulnerable.

In view of the above literature, some researchers have argued that climate change is more than just an environmental concern. O'Brien *et al.* (2010), for example, are of the view that climate change has been mostly demonstrated as an environmental concern that can be solved by decreasing

greenhouse gas emissions, with little regard for its cultural, social, ethical, and political dimensions. Adger (2001) states that understanding how natural resource-dependent people cope with climate change in the context of wider livelihood influences is critical to formulating a valid theory and adaptation frameworks, which are able to contribute to policy delivery, governance and development instruments in Africa. Alam (2016) is of the view that climate change impacts communities, countries, and regions differently and therefore the adaptation strategies used by various groups will be different. Lastly, Agrawal *et al.* (2008) argue that because climate impacts are generally experienced locally, responses must be personalised to match the needs of those affected at that particular time instead of designing a 'one size fits all' response.

2.5 Contextualizing the Literature: Perspectives on Climate Variability and Change in South Africa

While it is acknowledged that climate variability and change are a global concern, it is argued that South Africa is highly vulnerable to the impacts of climate change (Republic of South Africa, 2011). The South African Climate Change Response Strategy (Department of Environmental Affairs and Tourism, 2004) states that the rainfall patterns of South Africa are variable in spatial distribution and are irregular, both within and between years. This is also supported by the Department of Environmental Affairs and Tourism (2005), who is of the view that South Africa is largely arid and is at great risk of experiencing droughts and floods in any given year. Hannah *et al.* (2005) argue that in South Africa climate change is projected to greatly impact temperatures, rainfall patterns, and water availability, with the western regions expected to have a 30% reduction in water availability by the year 2050. Similarly, Midgley *et al.* (2007) argue that climate change is predicted to result in increased average temperatures of between 1°C and 3°C across South Africa by 2050. Engelbrecht *et al.* (2013) is of the view that intense thunderstorms may occur more frequently over South Africa in warmer climate. The Department of Environmental Affairs and Tourism (2013) and Boko *et al.* (2007) argue that in South Africa, climate change projections up to the year 2050 show significant warming (5-8°C) over the interior, a risk of drier conditions to the west and south of the country and a risk of wetter conditions along the eastern portion of the country. Furthermore, Engelbrecht *et al.* (2015) reported that temperatures within most of the southern African region are projected to increase between 4 °C and 6 °C by the end of the century under the A2 (a low mitigation) scenario of the Special Report on Emission Scenarios.

According to the Department of Environmental Affairs (2017), studies of historical temperature trends indicate that South Africa has been warming considerably over the period 1931-2015. The findings demonstrate that the strongest warming patterns have been detected in the northeast (Limpopo and Mpumalanga, extending southwards to the east coast of KwaZulu-Natal) and in the drier western parts of the country (North Cape and Western Cape). The detected rate of warming has been 2 °C per century and possibly greater, this is more than double the global rate of temperature rise.

According to the UNFCCC (2011), South Africa is susceptible to climate change because a great percentage of the population is resilient to extreme climate events (e.g. high disease burden; poverty; location; and inadequate housing infrastructure). In South Africa, rural poverty and chronic deficiency are partly attributed to the poor endowments in natural resources of former homeland areas (Fraser *et al*., 2003; Mukherjee and Benson, 2003).

According to Carmin *et al.* (2012); Farrell (2010); and the Republic of South Africa (2004), in 2004, South Africa produced a National Climate Change Response Strategy (NCCRP) intended to integrate climate change response programmes across national and regional boundaries. The Republic of South Africa (2012) is of the view that the NCCRP is South Africa's vision to an effective climate change response and a framework for a long-term, just transition to a climate resilient and lower carbon economy and society. It presents for the first time in South Africa a comprehensive policy framework for responding to climate change, including a detailed approach to mitigation and adaptation. The National Climate Change Response Policy was launched officially in 2012 (Republic of South Africa 2012).

In South Africa, the National Climate Change Response Green Paper, 2010, published in Government Notice 1083 of 2010, serves as "the South African Government's vision for an effective climate change response and the long-term transition to a climate resilient and low-carbon economy and society" (Department of Environmental Affairs, 2011, p.5).

In KwaZulu-Natal, Reid and Vogel (2006) established that the numerous day-to-day stresses and weak organisational support intensify people's vulnerability to future climate change. The city of Durban in the KwaZulu-Natal province developed the Durban Climate Change Strategy (DCCS) in 2014. The establishment of the DCCS was initiated by the Environmental Planning and Climate Protection Department and the Energy Office of eThekwini Municipality as a first step in aligning and ensuring collaboration between the adaptation and mitigation work being undertaken in Durban. The literature presented above demonstrates that various actions have been undertaken in South Africa and KwaZulu-Natal to mitigate and adapt to climate variability and change.

2.6 Climate Change Adaptation and the Effect of Climate Change on Rural Livelihoods

Pielke *et al.* (2007) are of the view that the recognition of the inevitable impacts of climate change has encouraged adaptation research over the years. Research suggests that adaptation to climate change has attained prominence on the international development agenda (UNFCCC 2007; Stern 2007; OECD 2006; Commission for Africa, 2005). Within the climate variability discourse, researchers have different views on what adaption is. Nightingale (2009) for example views adaptation as a political process that involves social capital and power relations, whereas Deressa (2007) and Deressa *et al.* (2005) view adaptation to climate change as a two-step process: the household must perceive that the climate is changing and then respond to changes through adaptation. On the other hand, Adger *et al.* (2005, p.78) view adaptation as "an adjustment in ecological, social or economic systems in response to observed or expected changes in climatic stimuli and their effects and impacts in order to alleviate adverse impacts of change or take advantage of new opportunities".

Studies by Nunn *et al.* (2014), Barnett and Campbell (2010), Kelman and West (2009) and Mortreux and Barnett (2009) provide strong evidence that researchers are gradually recognising that to better understand what climate change means for communities (especially for the purposes of facilitating adaptation) there is a need for knowledge of how people experience and respond to changing climatic conditions that are particularly relevant to them. Adger *et al.* (2012) support these studies; it is argued that climate adaptation should not be carried out in a stand-alone fashion but rather within the prevailing societal norms and cultural practices. Similarly, Asfaw (2010) is of the view that adaptation strategies need to be diverse and specific to a particular location based on traditional roots and should benefit from modern science.

From an asset adaptation perspective, however, Prowse and Scott (2008) argue that more understanding is required on the multifaceted asset-based relationship between adaptation and multiple stressors in rural areas. In addition, Prowse and Scott (2008) are of the view that asset adaptation, in the context of climate variability, establishes the degree to which a household will be food secure or will be exposed to food insecurity. Burton and van Aalst (2004) observed that scientists, researchers, and policymakers come across and report on numerous difficulties that impede adaptation planning and implementation. Ekstrom and Moser (2014), for example, established that political support and insufficient financial resources are the common difficulties encountered by local people in adapting to climate variability. Similarly, Benebere *et al.* (2017) also found that if the respondents had resources to enable them to build dams in the communities to

store water for domestic and agricultural purposes, it would reduce the hindrance to adaptation to climate variability. However, Benebere *et al.* (2017) argue that the communities' inability to raise money together with the poor interest of the government to commit resources towards the building of water reservoirs were some of the causes for the respondents' inability to adapt to climate variability. A study conducted by Ribot *et al.* (1996) found that most times individuals are forced to carry out adaptation strategies as a response to climate stresses, particularly after an occurrence of an extreme weather event. Tambo and Abdoulaye (2013), Trærup and Mertz (2011) and Bryan *et al.* (2009), observed that in some instances, households do not undertake any adaptation measures towards the impacts of climate variability. According to Patt and Schroter (2008), this can be attributed to a view that the stressor is not that severe, whilst Trærup and Mertz (2011) suggest that households may undertake no adaptation because they are unable to adapt (generally due to financial reasons).

Moreover, several researchers found that the lack of protection infrastructure in rural areas, such as embankments, seawalls, and storm shelters means that poor rural households often depend on natural barriers such as mangroves for protection (Dasgupta *et al.,* 2016; Das and Vincent 2009; Barbier 2008; Badola and Hussain 2005). Lyimo and Kangalawe, (2010) emphasised that climate change is making life more challenging for rural people because they rely highly on natural resources to sustain their livelihoods. In fact, Akudugu *et al.* (2012), Gyampoh *et al.* (2009) and Mertz *et al.* (2009) argue that climate change has become a major burden to many rural communities as it impacts their livelihoods.

A recent study by Wunder *et al.* (2018) found that rural households in developing countries rely heavily on forest extraction, a combination of crops and other revenue sources for their livelihoods and that the composition and magnitude of these livelihood outcomes are vulnerable to climate change. Lately, there have been a number of studies that demonstrate diversification of rural livelihoods in almost all parts of the world, in fact, people are now moving away from on-farm activities (Lei *et al.*, 2016; Dumenu and Obeng, 2016; Van Aelst and Holvoet, 2016; Shisanya and Mafongoya, 2016). This is a feasible option of supporting rural livelihoods, impelling general development and decreasing poverty in rural areas. Livelihoods research has assisted in clarifying the different responses used by individuals and households, and understandings of endowments, entitlements and capabilities within an organisational hierarchy and power principles (Pretty and Ward, 2001; Feldham and Assaf, 1999; Scoones, 1998; Chambers, 1989; Sen, 1981; Giddens, 1979). Previous studies on sustainable livelihoods prove that livelihoods are made up of a combination of assets (or also referred to as capitals) which allow people to follow a number of strategies to achieve better livelihood outcomes (Carney *et al.*, 1999; Scoones, 1998). A study by Graham *et al.*

(2018) explored how understanding the lived values of local community members could enlighten the improvement of impartial local climate change adaptation plans. As such, Graham *et al.* (2018) suggest that decision-makers need to consider the lived values of those who are mostly affected by and susceptible to climate change in order for adaptation planning and policy to be successful.

Hulme (2009) is of the view that although the need for adaptation is evident, implementing adaptation in reality is complicated as there are distinctions on where, how and when to act as the incident differs in the local context. Tompkins *et al.* (2010) are of the view that execution of adaptation is not keeping up with the growing need, they further argue that the 'adaptation deficit' is getting wider. Numerous researchers are of the view that effective adaptation strategies for rural livelihoods need to be sturdy, particularly in the time of extensive and often immeasurable uncertainties (Neufeldt, *et al.*, 2011; Hulme 2009; Fraser, 2007).

However, it is important to note that literature suggests that not all climate change strategies are constructive as some worsen the livelihood situation of the people. Adomako and Ampadu (2015), for example, suggests that this is clear in strategies such as intensification of anti-environmental practices including bushfires and deforestation, and other agricultural practices such as slash and burn, ever-changing cultivation and chemical usage in many parts of the world. Adomako and Ampadu (2015) are of the view that these practices continue to impede and aggravate the condition of the environment, and further undermines sustainability; hence disturbing the security of rural livelihoods. Furthermore, Adomako and Ampadu (2015) and Akudugu *et. al.* (2012) are of the view that acceptance of unpleasant practices aggravates the situation as it adds to factors which bring about climate change and therefore further threaten the livelihood situation of rural people.

Several researchers have discussed vulnerability and adaptive capacity as important notions for understanding how developing countries deal with climate variability (Mimura *et al.*, 2007; Challinor *et al.*, 2007; Smit and Wandel 2006; Eakin and Luers 2006; Adger 2006; Schroter *et al.*, 2005). Similarly, several researchers have documented a number of significant adaptation strategies which rural people can use to deal with climate change (Hulme and Shepard, 2003; Adger *et al.*, 2003; IPCC, 2001b). While these scholars believe that adaptation to climate change is important, some have differing views. Adger *et al.* (2005) for example, believe that there are a number of issues concerning the measurement of the efficiency of adaptation, these include: the effectiveness of an adaptation option introduced by an organisation may depend on actions taken by others; the effectiveness of an adaptation action may rely on the future unknown-state of the world; uncertainty over how a certain adaptation option will work even under clear conditions. Whilst an adaptation measure may be successful at decreasing the impacts of climate change or increasing

opportunities in one place or time, it may intensify stresses downstream, or decrease the abilities of others to adapt to climate change.

However, Moser and Ekstrom (2010) and Adger *et al.* (2009) found that the promise of building adaptive capacity to reduce climate variability impacts and vulnerability has been weakened, in large part, by social barriers to adaptation. Several researchers have argued that the susceptibility of rural households depends on access to and use of livelihood capital, namely: human, financial, natural, social, and physical capital (DFIF, 1999; Carney, 1998; Chamber and Conway, 1992). Literature provides substantial evidence that adaptation strategies draw on human, financial, natural, and social assets, with actions limited by a lack of these assets (Ostrom *et al.*, 2007; Adger, 2003; Nel *et al.*, 2001; Lipton *et al.*, 1996).

According to Bebbington (1999) to increase adaptive capacity, a household must enlarge its asset base; this involves both the tangible resources (such as natural and productive resources) and the abilities to do so (this includes social, financial and human assets). Moser (1998: 3) observed that the more assets people have the least susceptible they are, and the bigger the erosion of people's assets, the more insecure they are. Bryant *et al.* (2000) and Reilly and Schimmelpfennig (2000) argue that the adaptive capacity and asset base for adaptation is determined by human and social capital as well as peoples assets in the community in which they reside, the ecological resilience (or sensitivity) of the natural capital and the presence or absence of rights, institutions and laws.

A study by the UNFCCC (2007) argues that adaptive capacity is normally limited by gender inequality, weak institutions, lack of education and information, marginalisation from decision-making processes and planning procedures, poverty, lack of infrastructure and services, environmental degradation, poor public and environmental health, natural disasters, insecure tenure, and reliance on rain-fed agriculture and climate-sensitive resources. In addition, several other scholars are of the view that adaptive capacity is affected by many factors such as access to appropriate technology, knowledge of and perceptions about climate change, and policies and institutions (Alam *et al.*, 2016; Haden *et al.*, 2012; Brulle *et al.*, 2012; Hisali, 2011; Mertz *et al.*, 2009; Adger *et al.*, 2003). Ribot (2010) established that adaptive capacity is unevenly distributed and the variation is influenced by socio-economic status; ethnicity, inequality and social exclusion based on gender.

Alam (2016), Brulle *et al.* (2012), Fraser *et al.* (2011), Adger *et al.* (2009) and Berry *et al.* (2006) are of the view that the factors liable for the variation in adaptive responses across regions include socio-economics, the agro-ecological system, existing infrastructure and capacity and climatic impact. Turner *et al.* (2003); Smit and Pilifosova (2003); Handmer *et al.* (1999) widely recognise that

the exposure and sensitivity of the adaptive capacity are not fixed, but change extensively over time, space, and subpopulations, as do the challenges and impacts experienced. Conway (2009) views the concept of resilience as being at the centre of adaptation and adaptive capacity, this comprises of the abilities of an individual, households, communities, and countries to survive the impacts of climate change.

Research demonstrates that prior studies have identified a number of frameworks that are able to guide adaptation for poor urban and rural people to extreme weather events. The establishment of the asset-based adaptation framework by Moser and Satterthwaite (2008) for example, gave clear guidance as to why there is a need to include rural poor people when dealing with adaptation to climate variability. According to Moser and Satterthwaite (2008), the establishment of the asset-based adaptation framework has provided a tool that assists in identifying asset adaptation or resilience strategies that communities use when faced with extreme weather events. Furthermore, Moser and Satterthwaite (2008) indicate that the asset-based adaptation framework observed that rural poor people are not passive actors but they are rather active actors who are actively involved in developing ways of adapting to climate variability by constantly modifying their asset portfolios against the impacts of extreme weather events.

A prior study conducted by Roncoli *et al.* (2002) observed that rural households in dryland farming systems in Africa used their local knowledge to create adaptation strategies to safeguard against changing climatic conditions. This finding corroborates Moser and Satterthwaite's (2008) argument that rural communities are not passive actors. The Participatory Climate Change Asset Adaptation Appraisal (PCCAA) framework developed by the Global Urban Research Centre and the University of Manchester, builds on the accumulation of assets. The PCCAA uses the principles and practices of participatory research (Moser and Satterthwaite, 2008). The PCCAA is an extension of the asset-based vulnerability and adaptation framework, developed by Moser and Satterthwaite (2008). The PCCAA comprises of two key components; asset vulnerability analytical and the asset-based adaptation operational frameworks. The IPCC (1988) and UNFCCC (1992) procedures and agendas have also greatly influenced policy on adaptation to climate variability and change.

On the contrary, Ribot (2010, 2011) criticised the notion of adaptation for accusing the victim, by placing the burden on the susceptible household or group to adjust, rather than on those institutions or groups who contributed to climate variability and hence caused vulnerability. Adger *et al.* (2006) argue that adaptation to climate variability is not a choice given to vulnerable groups, but an obligation and these same groups are frequently overlooked in adaptation policy decisions.

Brooks and Adger (2003) argue that human adaptation practices are quite evident in developing and developed countries. Nuorteva *et al.* (2010) and Ellis (1999) are of the view that the majority of the adaptation strategies implemented by rural communities are intended to respond to short-term shock events, instead of planned strategies. Bates *et al.* (2008), Smit *et al.* (2000), and Sohngen and Mendelsohn (1998), argue that most adaptation strategies are independent rather than strategic, and are usually applied in socio-economic sectors where capital investment (e.g. money and technology) is low. According to Adger (2001) realising that action is needed to heighten the adaptive capacity of the most susceptible societies and groups, a research agenda needed to be established. The research agenda is dedicated to discovering common determinants of resilience. These determinants include the groups faced with the impacts of climate change, the private sector to grasp opportunities associated with climate change, the flexibility, and the social capital of societies, and innovation in the institutions of government, and the underlying health status and well-being of individuals (Adger, 2001).

It now accepted that climate change affects the livelihood strategies all over the world. Ateeq-Ur-Rehman *et al.* (2018) found that in rural areas of developing countries livelihoods are most affected because of the low agricultural productivity, decreasing natural resources and unawareness of climate which lead to increase poverty. According to David *et al.* (2007), the majority of the rural communities have limited access to credit opportunities, markets, limited access to quality social services, limited formal education, and limited resources. Consequently, when natural and anthropogenic events occur, they become the most vulnerable. According to Lemos *et al.* (2013) and Arnall (2012), responding to climate change at the rural community level in South Africa is a challenge, which includes sustainable management of forest and land resources as well as poverty. However, Arnall (2012) found that rural households seem to use several coping strategies to respond to environmental challenges which are caused by climate change. This is supported by Paavola (2008) and Smit and Pilifosova (2003) who observed that rural communities, regardless of their restricted capacities, usually endeavour to have secured and sustainable livelihoods by embracing numerous means to adapt. However, as reported by Arnall (2012), the traditional coping mechanisms for rural communities may possibly be insufficient when dealing with the new challenges brought about by climate change.

2.7 Gaps in the Existing Literature

From the literature reviewed above, it is evident that research on climate variability and rural livelihoods has been undertaken in South Africa and across the world (Ebhuoma and Simatele,

2017; Simatele and Simatele, 2015; Li *et al.*, 2013; Ziervogel and Calder, 2003). This review has highlighted the various research literatures on the impacts of climate change on rural livelihoods at a global, regional and national scale. The literature has provided strong evidence that climate variability is already occurring and is affecting human settlements causing loss of life, social disruptions, and economic hardships. These hardships are most felt by the rural poor in most of the sub-Saharan African region. This is attributed to the limited resources that most rural communities have access to, therefore when extreme weather events occur, it is difficult for these communities to adapt or cope.

However, there remain gaps in the literature. There is substantial amount of research on climate change adaptation at a global level, for example in Europe, Australia, Canada, and The United States (Barnett *et al.*, 2013; Matasci *et al.*, 2013; McNeeley, 2012; Gero *et al.*, 2012; Biesbroek *et al.*, 2011; Jantarasami *et al.*, 2010), however, there is limited empirical evidence on climate change adaptation and barriers thereof in the sub-Saharan African region (e.g. Boyd *et al.*, 2013; Sietz *et al.*, 2011; Nielsen and Reenberg, 2010). This was also recognised by England *et al.* (2018), Klausbruckner *et al.* (2016) and Novellie *et al.* (2016), who are of the view that most of the existing literature on Africa focuses on the more developed southern African sub-continent. In fact, Nkhonjera (2017) found that there is limited scientific work that focuses on how African cities are affected and how they adapt to climate variability and change. Therefore, it is evident that there are a relatively small number of studies which focus primarily on the vulnerable and less developed African countries. A number of researchers are of the view that existing empirical evidence on barriers to climate adaptation in sub-Saharan Africa is extremely disjointed and context-specific (Boyd *et al.*, 2013; Sietz *et al.*, 2011; Nielsen and Reenberg, 2010). In fact, Cabral *et al.* (2017) and Nkhonjera (2017) are of the view that despite being highly vulnerable, African cities are under-represented in climate change research. Henderson *et al.* (2017), Moyo and Nangombe (2015) and Simon and Leck (2015) are of the view that this is to some extent because local climate change challenges, priorities, vulnerabilities, and magnitude are different and vary across countries.

McCord *et al.* (2018) argue that the literature on smallholder adaptation has focused on how household characteristics influence adaptation actions, while disregarding community-level factors that enable adaptation actions, especially in cases where individual and community level incentives are diverse. As reported by Faling *et al.* (2012), there is recognition of climate variability by many smaller municipalities in South Africa, but there is limited evidence on action undertaken by municipalities. Ziervogel and Parnell (2012) argue that one of the difficulties that local government encounter in mainstreaming adaptation to climate variability is the lack of authority held by environmental departments to address climate variability.

There is a dire need for studies which will examine how losses caused by extreme weather events are distributed among households and to analyse climate variability adaptation abilities of smaller households (Karfakis *et al.*, 2012). In addition, some authors highlight the need for more studies which will focus on local responses and local knowledge to reduce climate vulnerability (Valdivia *et al.*, 2010), and therefore evidence that demonstrates an integration of local knowledge into climate policies is needed (Brugger and Crimmins, 2012; Nyong *et al.*, 2007;).

O'Brien *et al.* (2007) and Adepetu and Berthe (2007) are of the view that in some instances, existing coping strategies may intensify vulnerability to future climate variability, by prioritising temporary resource availability. According to Tschakert and Dietrich (2010), Belliveau *et al.* (2006) and Bryant *et al.* (2000), the process of adaptation to numerous stressors remains poorly understood. Prowse and Scott (2008) argue that more research is required into the link between multiple stressors, assets, and adaptation. In addition, Hellmuth *et al.* (2007) argue that it is important to strengthen local and national capacities in order to manage climate risks in the future. A study conducted by the IPCC (2007b) suggests that emerging evidence shows that coping and adaptation strategies used by the poor people in developing countries are extremely diverse and therefore there is a need for local level studies which will inform effective and efficient policy development.

Reckien *et al.* (2017) argue that climate change, mitigation, and adaptation bring about equity and justice concerns. There are however researchers who choose to focus entirely on technical and infrastructural alternatives in their analysis of climate change adaptation in different African communities (for example, Eguavoen and McCartney 2013), without including any arguments on concerns for sustainability. Although research on climate variability, asset adaptation, and rural livelihoods has been conducted globally and nationally, limited research has been done in KwaZulu-Natal. The researcher believes that capacity building is very important in curbing the negative impacts of climate change. The more people are involved in building a knowledge base and contributing to climate variability and change adaptation, the better the world will be.

Thus, it is crucial that research in the field of climate variability and change is intensified. This will assist in finding new and more effective ways in which the rural poor communities can build resilience against climate variability and change. As more research is undertaken, there is hope that valuable knowledge is uncovered and imparted to the rural poor communities and all vulnerable individuals greatly affected by climate change, to help these individuals and communities prepare for and respond to extreme weather events.

CHAPTER THREE

METHODOLOGICAL CONSIDERATIONS

3.1 Introduction

This chapter discusses the methodological principles used in this study. Polit and Hungler (2004) define methodology as the ways of obtaining, organising and analysing data. Burns and Grove (2003) are of the view that a methodology should include the sample, setting, design, the data collection and analysis techniques, and the methodological limitations of the study, whilst, Henning *et al.* (2004, p.36) describe methodology as "a coherent group of methods that complement one another and that have the ability to fit to deliver data and findings that will reflect the research question and suit the researcher's purpose". For the purpose of this study, we take methodology as the ways in which the sample size was established; the sampling methods that were used to determine the sample size; the tools used to collect data; how the data was organised and analysed.

In view of this, the chapter is divided into the five subsections. In the first section, the research aims and objectives are reiterated. Secondly, the research philosophy used in the study is discussed. The research design used in the study is indicated in the third section. The fourth and the fifth subsections are dedicated to data analysis and methodological reflections respectively.

3.2 Recapping of the Research Aims and Objectives

As discussed in *section 1.4* of this dissertation, the aim of this study was two-fold. *Firstly*, the study aimed to investigate the ways in which poor rural people are affected by climate variability. *Secondly*, to understand the ways in which the communities from the three research sites are adapting to climate variability using the asset-based adaptation framework.

In order to achieve the abovementioned aims, four research objectives were formulated. The first objective was to determine the impact of climate variability on poor rural people in the three research sites, followed by identifying the different asset portfolios which each of these communities uses to adapt to climate variability. In addition, it was of great significance to understand which asset portfolios play a very important role in the adaptation process in order to

identify appropriate intervention measures. The final objective of the study was to contribute to the body of knowledge on the combination of assets of climate variability adaptation.

In view of this, the aims and objectives of the study informed the research philosophy which was used in this study.

3.3 Research Philosophy

A research philosophy is a specific way of developing knowledge that defines the philosophical paradigm (Saunders *et al.*, 2009; Holden and Lynch, 2004). This development and understanding of knowledge depends on particular assumptions based on our perspective of the world (Saunders *et al.*, 2009; Holden and Lynch, 2004). Saunders *et al.* (2009) argue that the assumptions in research philosophy explain the researchers view regarding the world. These assumptions determine the research strategy and the methods of the chosen strategy. Guba and Lincoln (1982) argue that philosophical paradigm within research is very important, as it is the basic belief system or worldview that guides the investigation. This is also supported by Mertens (2010) who is of the view that basic philosophical assumptions guide and direct the thinking and action of the researcher. Maree and van Westhuizen (2007) argue that research is about understanding the world, one's understanding is informed by how you view the world, what you view understanding to be and what you see as the purpose of understanding.

According to Saunders *et al.* (1996), basic paradigm beliefs not only guide the investigation (in terms of the choice of design and method) but also its ontology (nature of reality and being) and epistemology (nature and scope of knowledge). Sikes (2004) is of the view that the way in which we each view the world is associated with our past experiences in life. This concerns the nature of knowledge (epistemological assumptions), the nature of social reality (ontological assumptions), the ways and the extent to which your own values influence your research process (axiological assumptions). Furthermore, Sikes (2004) recognises that it is imperative that all researchers devote some time to think about how they are philosophically and paradigmatically positioned and for them to be conscious of how their position might influence their research. Sikes (2004) argues that, irrespective of how each researcher is positioned in terms of their individual epistemological assumptions, it is essential that researchers are clear in their minds of the repercussions of their position, that they state their position clearly.

Crotty (2003, p.42) defines epistemology as "a way of understanding and explaining how we know what we know". Therefore, epistemology defines how we think. Epistemology is necessary as it

allows one to be able to establish the truth from the false, by formulating an appropriate way of evaluation. It is also important for obtaining knowledge of the world around us. Crotty (2003) argues that without epistemology, it would be a challenge to think. In fact, we would have no reason to be certain that our thinking was useful or true, but instead we would only just have casual pictures rushing before our mind. There are two types of epistemological assumptions, namely Objectivism (or positivism) and Subjectivism (or constructivism or interpretivism). Lakoff (1987) argues that objectivism is 'one version of basic realism' according to which reality exists independent of humans, while subjectivism is an assumption, that social reality is made from the perceptions and consequent actions of social actors (people).

The epistemological standpoint of this study was constructivism, mostly because the study aimed at obtaining answers to the research aims and objectives stated in section 3.2. The most important concept of constructivism is that knowledge is created which cannot take place independent of the learner. Constructivism is a school of thought that argues that humans construct knowledge and that the only reality we know is expressed by human thought and interaction (Dawson, 2013; Wisker, 2008; and O'Leary, 2004). In addition, individual constructions are only produced through interaction between and among the researcher and the respondents. This philosophy was of great value to this study because the aim of this study was to understand how rural communities built their adaptive capacity when extreme weather events occurred. In conducting the research, the researcher was able to get various views and concerns from the communities regarding how the changing climate has affected their lives and livelihoods and also what they did to survive and cope.

Crotty (2003, p.3) describes a research methodology as "the strategy, plan of action, process or design underlying the choice and use of particular methods and linking the choice and use of the methods to the desired outcomes". O'Leary (2004) argues that there is no best type of research methodology but simply one that is perceived by the researcher to be the best fit for answering the research questions. The methodological approaches used in this study were qualitative and quantitative methods. These approaches were used simultaneously. Weinreich (2009) argues that the purpose of qualitative research is to offer the researcher a perspective through direct interactions with the people under study. The qualitative methodological approach was concerned with developing a detailed and in-depth understanding of human behaviour towards climate variability. The qualitative data, which was obtained from questionnaires, interviews and focus groups, afforded the study the rich description of individual experiences needed to achieve a deep analysis of their adaptive capacity and resilience against climate variability, whilst, the quantitative methodological approach was used to compare and support the qualitative data.

3.4 Research Design

McMillan and Schumacher (2001) define a research design as a plan for selecting subjects, research sites, and data collection procedures to answer the research question(s). Burns and Grove (2003, p.195) define a research design as "a blueprint for conducting a study with maximum control over factors that may interfere with the validity of the findings". This section describes at length the research sites, study population and the data collection tools which were used in this study.

3.4.1 Description of the research site

Mtubatuba is situated approximately 55km north of Richards Bay and Empangeni and 200km north of Durban in the KwaZulu-Natal province (28°25'S 32°11'E). The town is perfectly situated as a place from which to explore the culture of the Zulu Nation. The town is also home to the well-known iSimangaliso Wetland Park. Mtubatuba falls under the uMkhanyakude District Municipality, which is the second largest District in KwaZulu-Natal.

The climate of Mtubatuba is humid and has an annual average temperature of approximately 21.5 ºC (uMkhanyakude District Municipality, 2018). Summers generally range from humid to hot, while winters are mostly cool to mild. The annual rainfall varies between 600mm and 700mm in the western areas, which are primarily rural and between 1201mm and 1250mm on the eastern side, along the coastal sea belt (uMkhanyakude District Municipality, 2018). In addition, Mtubatuba is highly dominated by Gum trees (Eucalyptus Grandis (*Myrtaceae*)), which is considered an invasive species in South Africa.

The Mtubatuba Local Municipality Final IDP Review Plan (2016/2017) stipulates that water availability is one of the key challenges experienced by the Mtubatuba Local Municipality, together with the other local municipalities under uMkhanyakude District Municipality. In addition, the document argues that the people of Mtubatuba do not have access to clean water, in accordance with the National Department of Water Affairs standards.

Three research sites in Mtubatuba were selected for this study. These are Nkombose, Ebaswazini, and Ogengele areas (Figure 3.1).

(i) **Nkombose** - Nkombose is located ±10km from Mtubatuba town. This rural area covers ±14.24km² with a population of approximately 9768 (685.75 per km²). The number of households is 1905 (133.74 per km²) (Statistics South Africa Census, 2011a).

(ii) **Ebaswazini** - Ebaswazini is a rural area in Mtubatuba and is located ±18,7 km from Mtubatuba town. This rural area covers ±19.62km² with a population of approximately 2936 (149.68km²). The number of households is 485 (24.73 per km²) (Statistics South Africa Census, 2011b).

(iii) **Ogengele** - Ogengele is a small rural area located under the Mtubatuba Local Municipality. The area covers ±19.70km² with a population of approximately 4263 (216.37km²). The number of households is 681 (34.56 per km²) (Statistics South Africa Census, 2011c).

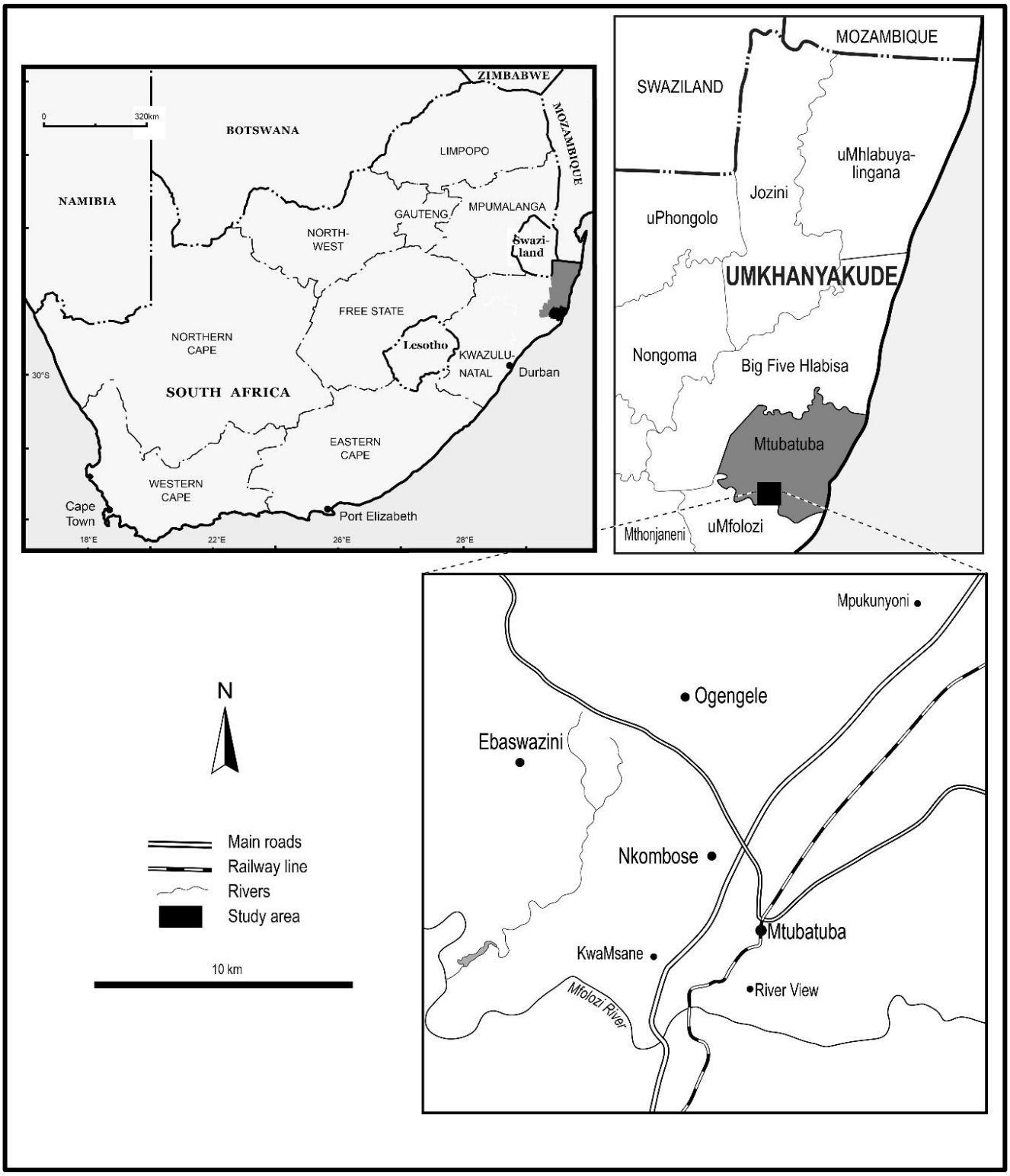


Figure 3.1: Location of the three research sites in Mtubatuba.

Source: Cartography Unit, University of the Witwatersrand (2018).

3.4.2 Study population and sampling procedure

Polit and Hungler (1999, p.37) refer to the population as "an aggregate or totality of all the objects, subjects or members that conform to a set of specifications". A population consists of individuals, groups, organizations, human products, and events, or the conditions to which they are exposed (Welman, *et al.*, 2009). For this study, the study population consisted of women and men from all three research sites. This included the general members of the communities. The majority of the population were black and Zulu speaking.

The process of choosing a share of the population to represent the whole population is known as sampling (Polit and Hungler 1999, p.95; LoBiondo-Wood and Haber 1998, p.250). According to Morrison (1993), the quality of the research is not only reliant on the suitability of the methodology and instruments used but also on the appropriateness of the strategy used to sample the study population. It was therefore important that a correct sampling method was chosen for this study.

According to Alvi (2016), in an investigation, it is impossible to assess every single element of a population so a group of people (smaller in number than the population) is selected for the assessment. There are two main methods of sampling, namely: probability and non-probability (Schofield, 1996; Cohen and Holliday, 1996; 1982; 1979). According to Leedy and Ormorod (2005), the sampling method one chooses to use for a study is always dependent on the study's research questions and sample population to be researched.

As mentioned in *section 3.4.1,* the total number of households for Nkombose was 1905, Ebaswazini was 485 and 681 for Ogengele. Therefore, the total number of households for the entire study population between all three-research sites was 681 + 485 + 1905 = 3071 households. Given that 3071 households is a large number, the researcher was required to select a sample of households from the total study population, which was used to represent the entire target group.

In order to calculate the sample size for each research site, the researcher had to select a confidence level and margin of error. This study used a 95% confidence level with ±5% precision/marginal error, which falls within the limits of a z-score of ±1.96.

The Cochran's formula for calculating sample size (infinite population) in estimating the mean was used. Therefore, the total sample size for all three-research sites was calculated as follows (Cochran, 1963, p.75):

$$\mathbf{n}_{\circ} = (z^2pq)/e^2$$

Where:

$\mathbf{n}_o$ is the total sample size required

z is the standard normal deviation, which is 1.96 for 0.05 margin of error

p is the proportion in the target population, which is recommended to be 50% or 0.5 if there is no estimate available of the proportion in the target population

q is the proportion not having the characteristic, which is (1-p) = 1-0.5=0.5

e is the margin of error that was set at 5% or 0.05 for this study

$$\mathbf{n}_o = (1.96^2 \times 0.5 \times 0.5) / (0.05^2) = \mathbf{384}$$

For this study, a total sample size of 384 was considered sufficient. In order to determine the sample size for each research site, the following equation was used (Cochran, 1963, p.75):

$$\frac{\text{The total sample size of each research site}}{\text{The total target study population}} \quad X \quad \mathbf{n}_o$$

Where the total target study population or households between the three research sites are 3071; and total $\mathbf{n}_o$ is 384.

Thus, the sample size for Nkombose was: (1905/3071) X 384 = 238.

The sample size for Ebaswazini was: (485/3071) X 384 = 61;

The sample size for Ogengele was: (681/3071) X 384 = 85;

The table below illustrates the percentage contributions of each research site to the total study population. As demonstrated by the percentages, Ebaswazini contributed 16% of the total study population, as it was the research site with the least number of households. Ogengele contributed 22% to the total study population, whereas, Nkombose contributed the most with 62%. This was attributed to Nkombose having a higher number of households when compared to the other research sites. Therefore, Nkombose needed to have a much bigger contribution (in terms of the number of sampled households) to the total sample population. It was of great significance that the three research sites were equally represented in the total sampled study population.

Table 3.1: Sample size calculation for each research site

	Total number of households	**Sample per research site (using a 5% margin of error)**	**Percentage contribution of each sampled households in the three research sites**
Nkombose	1905	(1905/3071) X 384= 238	(238/384) X 100 = 62%
Ebaswazini	485	(485/3071) X 384= 61	(61/384) X 100 = 16%
Ogengele	681	(681/3071) X 384= 85	(85/384) X 100 = 22%
Total	**3071 target study population/households**	**384 total sampled population/households**	**Total percentage of the entire sampled population/households 100%**

For this study, a probability sample was used. The ***probability sample*** was selected because it allowed for every household of the wider population to have an equal chance of being included or being randomly selected for the sample. In order to select the required sample size, a systematic sampling method was used, which is one of a number of probability methods. The ***systematic sampling method*** is a random sampling method which entails choosing samples using a system of intervals in a numbered population. As a result, a list of households for each research site was created. The list was used in randomly selecting the households to be sampled. In this process, the first respondent was selected purposely.

In order to determine the interval at which each household would have been selected, the sampling fraction was used. The ***sampling fraction*** is the fraction of the sample size to the population size. In view of that, using the sampling fraction, the frequency interval at which each household was to be selected for all three research sites was determined to be eight (8) (Table 3.2). Therefore, every eighth household from the list of households was chosen until the required sample size was reached for each research site. This process was conducted for all three research sites. The equation that was used is as follows (Cochran, 1963, p.75):

$$f = N/sn$$

f = frequency interval

N = the total number of the wider population

sn = the required sample size

Table 3.2: Sampling fraction for the three research sites

	Nkombose	**Ebaswazini**	**Ogengele**
Frequency interval (f)	1905/238 = 8 (every 8th household, 1 household was selected)	485/61 = 8 (every 8th household, 1 household was selected)	681/85 = 8 (every 8th household, 1 household was selected)

3.4.3 Data collection tools

Creswell (2009, p.161) describes a data collection instrument as a research instrument which is used to compute, examine or report data. Data collection is an important part of any research study. Thus, it was significant that appropriate data collection tools were used to collect data for this study. The section below discusses the tools that were used to collect data for this study.

(i) Questionnaires

Polit and Hungler (1999) define a questionnaire as a method of data collection, which is completed by the respondent in written format. Wisker (2008, p.187) suggests that questionnaires are often used to gather information directly by asking people questions about facts, attitudes, activities, behaviours, and responses to events and usually consist of a list of questions. Sapsford (1999) and Oppenheim (1992) argue that questionnaires present an unprejudiced way of gathering data about people's attitudes, beliefs, behaviour, and knowledge.

According to Williams (2003), with careful planning, questionnaires can yield high quality usable data, achieve good response rates, provide anonymity and reduce bias. Thus in defining the main aim of a questionnaire, Bradburn (2004) states that one basic rule exists, which is 'Ask what you want to know, not something else'. This is also supported by numerous authors (McGuirk and O'Neill, 2005; Parfitt, 2005; Bulmer, 2004; Creswell, 2003; de Vaus, 2002; Oppenheim, 1992 and Patton, 2000) who are of the view that a good questionnaire design is vital in order to generate valuable data, which is in line with the goals of the research.

In view of the above, a questionnaire containing open-ended and closed-ended questionnaires was generated for this study (see Appendix G). A questionnaire was used as it provided a cost effective way of collecting data, especially because the sample size for this study was large.

In accordance with Oppenheim (1992), who suggested that a questionnaire could contain a further introductory paragraph, the questionnaire designed for this study consisted of a short introductory paragraph. The aim of the short introductory paragraph was to formally introduce the researcher to the research participants and to guide the participants on how to complete the questionnaire.

The questionnaire distributed to all three-research sites for this study was exactly the same format and all questions were asked precisely the same way. As Ceci´c and Musson (2004, p.41) highlighted "The point of having a questionnaire is primarily to have all the data in more or less the same format, which means that all the questions are asked of the whole population of observers in precisely the same way. It makes the collected data comparable within the data set as well as between different events (for which the same type of form was used)".

For this study, the questionnaire collected the following information: background information of respondents (how many years have they lived in the community), their perceptions on climate whether it has changed or not, their experiences on climate variability and associated impacts, and their response measures. The research participants were given a list from which to choose from the various weather events they had experienced over the years. The questionnaire also included general information such as age and gender of the respondent, household size, and level of education.

Questions were simple and phrased in a manner that all respondents understood as suggested by Jack and Clarke (1998) who argue that questions should be asked in simple words. Questionnaires were designed in both English and isiZulu to accommodate the respondents' preferences. Each respondent was asked in which language they wished to complete the questionnaire. This allowed all respondents to be able to express their views in a free and fair manner.

(ii) **Observation**

Marshall and Rossman (1989, p.79) define observation as "the systematic description of events, behaviours, and artifacts in the social setting chosen for study". Geertz (1973) is of the view that the overall aim of observation is to develop a 'thick description' of a situation – in order to explain both what is going on and why it makes sense to people in a particular socio-cultural setting. Similarly, Erlandson *et al.* (1993) argue that observations allow the researcher to examine existing

conditions using the five senses and to provide a 'written photograph' of the conditions of the study areas. Observation methods are valuable to researchers in a number of ways. Schmuck (1997) indicates that observations offer researchers an idea of how the research participants communicate with one another, ways of examining non-verbal expression of feelings, how much time is spent on the different activities, and observe who interacts with whom.

There are numerous types of observations, such as participant, non-participant, covert, overt, structured and unstructured. For the purpose of this study, participant observations were carried out. DeMunck and Sobo (1998) describe participant observation as the primary method used by anthropologists doing fieldwork. Schensul *et al.* (1999, p.91) defines participant observation as "the process of learning through exposure to or involvement in the day-to-day or routine activities of participants in the researcher setting". DeWalt and DeWalt (2002) define a participant observation as the process enabling researchers to learn about the activities of the people under study in the natural setting through observing and participating in those activities. As such, it offers the perspective for the development of interview guides and sampling guidelines.

DeWalt and DeWalt (1998) are of the view that a participant observation is categorised by wanting to learn more about others, having an open, non-judgemental approach, being aware of the tendency for feeling culture shock and for making mistakes, most of which can be overcome by being a vigilant observer and a good listener, and being open to the unpredictable.

Participant observation allows researchers to authenticate meanings of terms that participants use in interviews, questionnaires, and focus groups. In addition, participant observation enables the researcher to observe events that informants may be incapable or reluctant to share when doing so would be insensitive, impolite, and inappropriate (Marshall and Rossman, 1995).

Participant observations allowed the researcher to observe the resources available in each community and to observe the various coping strategies communities use when extreme weather events took place.

(iii) **Focus groups**

Focus group discussion is a method where a researcher gathers a group of individuals to discuss a specific topic, with the main aim being to draw from the multifaceted perceptions, beliefs, attitudes, and personal experiences of the participants through a moderated dialogue (Hayward *et al.*, 2004; Israel *et al.*, 1998; Morgan, 1996; Cornwall and Jewkes, 1995; Kitzinger, 1994). Similarly, Krueger and Casey (2000) describe a focus group as a discussion among a small number of target

population members guided by a moderator. According to Ritchie (2003), focus groups offer a social setting for research, and thus an opportunity to discover how people think and talk about a certain subject. Focus group discussions are perfect for creative thinking and verifying concepts and terms used by the research participants. According to American Statistical Association (1997), focus group discussions provide a wealth of information; this includes what the respondents think and why they think that way.

A focus group discussion was selected as one of the methods of collecting data for this study, as it offered a platform to uncover perceptions, values and differing worldviews from the participants. Key individuals from each of the research sites were identified and requested to participate in the focus group discussions. The key individuals were individuals who have lived in each of the three research sites for over 25 years. These individuals were believed to have experienced the various change in weather patterns and therefore were able to provide in-depth knowledge on the subject matter. Locally perceived adaptation and coping strategies in the three research sites were discussed in the three focus groups. Additional questions were discussed (see Appendix I), such as if there was any potential support provided to communities by the Mtubatuba Local Municipality. The focus group discussions were conducted in isiZulu because this was the preferred language for all the participants. The researcher was comfortable with facilitating the discussions in isiZulu, as it is her official home language and she could converse quite fluently in this language.

Stewart *et al.* (2007) suggest that it is always an advantage to over-recruit for a focus group and possibly manage a fairly larger group, than to under-recruit and risk having to call off the meeting or having an unsatisfactory discussion.

Mattar (1994), Krueger (1994), Oppenhein (1992) and Morgan (1988) are of the view that when setting the size of the focus group, the researcher must consider that the group be small enough that all the participants have an opportunity to share their thoughts, and big enough to offer diverse perceptions. This view is also supported by Krueger and Casey (2000) who suggest that usually six to eight participants are adequate, while some studies have reported as few as four and as many as fifteen participants are sufficient (e.g. Fern, 1982 and Mendes de Almeida, 1980). The size of the three focus groups for this study varied between five to nine participants.

Furthermore, evidence suggests that mixed gender groups are likely to increase the quality of discussions and potentially its outcomes (Freitas *et al.*, 1998). Therefore, it was paramount to have both male and female representation within the three focus groups conducted in the three study sites.

(iv) **Participatory research methods (mind maps and listing and ranking matrix)**

Participatory research has become quite popular as a research strategy within the qualitative research methods (Bergold and Thomas 2010; Bergold 2007). Chambers (1986) describes participatory research approach as a coherent and mutually supportive pattern of concepts, values, methods and action amenable to wide application. Participatory research can be viewed as a methodology that argues in support of the importance, the possibility, and the effectiveness of involving research partners in the process of producing knowledge (Bergold, 2007).

The participatory research method was selected for this study, as it allowed research to be conducted directly with the immediately affected persons. According to Fals-Borda and Rahman (1991) the aim of using participatory research methods should be to reconstruct knowledge and for understanding and empowerment. Key individuals from the three research sites were identified to participate in the participatory research methods. The key individuals were individuals who have lived in each of the three research sites for over 25 years. These individuals were believed to have experienced the various change in weather patterns and therefore were able to provide in-depth knowledge on the subject matter. Three participatory research methods were used for this study, namely: Mind maps, Listing and rankings matrix.

According to Farrand *et al.* (2002) and Williams *et al.* (1997), mind maps assist people in learning concepts; it is argued that this is better than note taking and traditional linear formats. Mind maps are done in a free-form way instead of a step-by-step process, therefore mind maps are meant to be self-sufficient interpretations of the idea they represent (Buzan and Abbott 2005). Mind maps allowed the participants to document the various resources available in their communities.

Ager and Sparling (2013) define a Participatory Ranking Methodology (PRM) as a 'mixed methods approach to collecting data, where a group of well-informed participants generates responses to a specific question or set of questions. Furthermore, this methodology promotes an engaged and participatory process, drawing upon local knowledge and perceptions (Ager and Sparling, 2013). A listing and ranking matrix was conducted with the participants. The listing and ranking matrices provided a simple and effective way for participants to prioritise, compare, score and subsequently discuss the effects of climate variability on their livelihoods and the potential solutions. The problems were listed as the participants were randomly calling them out. Subsequently, the researcher asked the participants to rank the problems they had previously listed, where ten (10) represented the most detrimental to their livelihoods and one (1) being the least detrimental.

(v) **Interviews**

According to Kvale (1996, p.174) an interview is "a conversation, which its purpose is to gather descriptions of the [life-world] of the interviewee with respect to interpretation of the meanings of the described phenomena". Schostak, (2006) argues that an interview is an extendable dialogue between people whose aim is to have an 'in-depth understanding' of a particular subject, and through which a phenomenon could be understood in terms of the meanings interviewees bring to it. Boyce and Neale (2006, p.3) define interviews as "a qualitative research technique, which involves conducting intensive individual interviews with a small number of respondents to explore their perspectives on a particular idea, programme or situation".

The use of interviews in research demonstrates a shift from observing humans as merely manipulative and data being somehow exterior to individuals and rather towards viewing knowledge as being generated by humans, often through dialogues (Kvale, 1996). According to Rubin and Rubin (1995, p.17), interviewing requires "a respect for and curiosity about what people say, and a systematic effort to really hear and understand what people tell you". Connaway and Powell (2010) advise that when conducting an interview, the interviewer should make an effort to create a friendly, non-threatening environment. Similarly as one would do with a cover letter, the interviewer should provide a brief, informal introduction to the study; emphasise the importance of the person's participation, and guarantee confidentiality and anonymity. Similarly Dörnyei (2007, p.140) argues that a great qualitative interview has two fundamental features: "(a) it flows naturally, and (b) it is rich in detail".

Similarly, there are different types of interviews, such as unstructured, semi-structured and structured interviews. For the purpose of this study, semi-structured interviews were conducted with three local authorities from the Mtubatuba Local Municipality. Semi-structured interviews consist of various key questions which assist in defining the key areas which will be explored (see Appendix H). It also allows the interviewer or interviewee to dig deep in order to follow an idea or reply in more detail (Britten, 1999). Kvale and Brinkmann (2009) are of the view that semi-structured interviews are often the most effective and convenient way of gathering information.

Pontin (2000) suggests that all interviews must be recorded in terms of note taking as well as digitally recorded, as this safeguard against prejudice and provides an everlasting record of what was and was not said. Therefore, the interviews were recorded and transcribed. Similarly, Pontin (2000) and May (1991) suggest that it is helpful to make field notes about observations, thoughts, and ideas about the interview during and immediately after each interview, as this can help when one analyses the data. In the data collection process, notes were taken.

(vi) **Documentary review of existing data**

In a time where researchers all over the world are frequently collecting a vast amount of data, the feasibility of using existing data for research is becoming more acceptable (Andrews, *et al.* 2012; Smith *et al.*, 2011; Smith, 2008). Furthermore, Andrews *et al.* (2012) and Smith *et al.* (2011) suggest that it is essential to define secondary data analysis as a systematic research method.

Most research starts with an inquiry to learn what is already known and what gaps exist about a certain subject (Creswell, 2009). This includes related and corroborating literature; in addition, one must also consider previously collected data on the subject (Doolan and Froelicher, 2009; Dale *et al.*, 1988). Novak (1996) argues that secondary data are useful in designing succeeding primary research as it can offer a starting point with which to compare the results of the primary data you have collected. Therefore, Novak (1996) argues that it is always sensible to review secondary data before starting any research activity (Novak, 1996).

Thus, this study utilised and reviewed existing data such as meteorological data and existing policies around climate variability and adaptation to further understand the phenomenon under investigation. Temperature and rainfall data were requested from the South African Weather Service (from 1997-2017). The purpose of requesting the data was to examine the climate information, which was recorded by the South African Weather Service in Mtubatuba over the years (1997-2017). The role of the data was to determine whether the various extreme weather events mentioned by the participants correlated with the temperature and rainfall data recorded over the years.

A google search was conducted to discover the various policies that exist in South Africa and KwaZulu-Natal pertaining to climate variability, its impacts on rural livelihoods and the various adaptation strategies that may be adopted by those affected.

3.5 Data Analysis

Shamoo and Resnik (2003) define data analysis as the process of systematically applying statistical and/or logical techniques to describe and illustrate, condense and recap, and evaluate data. According to Shamoo and Resnik (2003), various analytic procedures offer a way of drawing inductive interpretations from data and differentiating the signal (the phenomenon of interest) from the noise (statistical fluctuations) present in the data.

Firstly, data obtained in isiZulu were translated into English. Thereafter the data obtained from questionnaires were captured on the REDCap database. REDCap is a tool that allows one to create research databases, capture and manage data and export directly to a statistical programme of choice. Subsequently, the data were exported to STATA. STATA was one of a few statistical software that was compatible with REDCap. Using the STATA software, frequency tables and figures were compiled for the different variables.

Qualitative data obtained from open-ended questions from the questionnaires were coded and the researcher searched for similar themes in the responses received. Coding was carried out utilising the Microsoft Excel spreadsheet package. Data obtained from the focus group discussions and participatory research methods (mind maps, listing and ranking matrix) were translated from isiZulu to English. Furthermore, this information was transcribed and quotes were extracted and discussed extensively. Climate data obtained from the South African Weather Service were captured on a Microsoft Excel spreadsheet and the average temperature and rainfall were calculated for each year. Thereafter the data were analysed on the Excel spreadsheet and line graphs were drawn.

3.6 Methodological Reflections

The first step that the researcher undertook before engaging with the communities was to meet with the Induna for each of the three research sites. Meeting with the Indunas was very crucial for this study as the researcher needed to observe the protocol of the rural areas. This also allowed the researcher the opportunity to first introduce herself to those that govern the various areas and to request for their permission before engaging with the communities. Once the permission was granted from the Indunas, then only did the researcher start engaging with the sampled households.

Taking into consideration that the three research sites were positioned in the heart of the northern KwaZulu-Natal province and were rural in nature the researcher found it befitting to compile the data collection tools and the participation information sheet in both isiZulu and English. This was done to accommodate every participant and to remove boundaries that could have been potentially created by the language used to collect the data. This was not a difficult task for the researcher to do as she was an isiZulu speaking individual herself and even engaging in the language was easy to do. Therefore, when the participation information sheet and the questionnaires were distributed, the head of the sampled household was given an opportunity to choose between an isiZulu and

an English questionnaire. The questionnaires were distributed to the sampled households and the respondents were given two days (or more upon request) to complete the questionnaire. Although this technique assisted, not all of the questionnaires were returned when the researcher went back to collect them.

In most cases, respondents requested that the researcher read and writes the respondents answers, as some respondents were elderly and some illiterate. This gave the researcher time to interact more with the respondents. It is important to note that there were cases where the head of the sampled household refused to participate in the study as they felt that 'people always come to ask questions and never return to give solutions and assistance to the vulnerable communities'. In those instances, the researcher left the household peacefully and respected the household head's rights. Additionally, in some cases, the questionnaire respondents could not complete all the questions as they were either in a hurry somewhere or just irritated by the endless questions. In those cases, no one was forced to complete or respond against their will.

The researcher had wished to have at least eight or more individuals participate in each of the three focus group discussions but unfortunately, in some cases, the number of participants was lower than the anticipated number. Nonetheless, those that participated in the discussions were willing to share their experiences and insights. Even though the researcher had initially planned on doing transect walks, it became clear that using participatory methods would allow the community members the opportunity to participate in this study more effectively. Therefore, the researcher opted to use a mind map so that the participants could map out the various resources, which are available in their communities. In addition, a listing and ranking matrix was used to document the impact of climate variability.

CHAPTER FOUR

EMPIRICAL EVIDENCE

4.1 Introduction

This chapter is dedicated to presenting the findings of this study, which were obtained from the data collection phase. It is important to present and discuss the views obtained from the research participants. The views and perceptions presented in this chapter were gathered from the sampled research participants from Nkombose, Ebaswazini, and Ogengele in Mtubatuba. As outlined in chapter three of this dissertation, 384 households were sampled (of which 355 households participated, making the response rate 92%). In addition, three focus group discussions and three participatory research groups were conducted. Furthermore, three individual interviews were conducted with three local authorities from the Disaster Management Centre at the Mtubatuba Local Municipality.

In view of the above, this chapter is structured around the research questions, which were asked in *section 1.3* of this dissertation. The first section is dedicated to presenting the perceptions on how climate variability has manifested itself in Mtubatuba. Thereafter, the perceived impacts of climate variability on rural livelihoods in Mtubatuba are presented. Lastly, I reflect on the key adaptation strategies and asset portfolios used by the rural communities in the three research sites to adapt to the impacts of climate variability.

4.2 Perceptions on how climate variability has manifested itself in Mtubatuba

One of the issues that this study was interested in was understanding how rural communities in Mtubatuba are adapting to the impacts of climate variability. In order to establish this fact, it was important to first determine the level of extent to which the communities understood their weather or observed changes in weather patterns. Therefore, it was of great significance to understand whether the participants in the three research sites had experienced any changes in climatic conditions over the last 20 years. Table 4.1 below outlines their responses.

Table 4.1: Household responses on whether changes have been observed in the weather patterns (n= number of responses, N= total number of responses)

Observed changes in the weather patterns	Nkombose (n)	Ebaswazini (n)	Ogengele (n)	Total (N)	Percentage (%)
Yes	220	57	77	354	99, 7%
No	1	0	0	1	0, 3%
Total	221	57	77	355	100%

N = 355; Percentage = (n/N) x 100%

Source: Based on fieldwork data, 2018

Based on the data presented in table 4.1, it is suggestive that the majority 354 (99, 7%) of the research participants in the three research sites have observed changes in the weather patterns in the last 20 years. Notably, 100% of the research participants from Ebaswazini and Ogengele seem to have observed changes in climatic conditions over the last 20 years, whereas one research participant (which is equivalent to 0.3%) from Nkombose expressed that they had not seen any changes in the weather patterns.

Furthermore, in acquiring more information, the focus group discussion participants were asked to detail the climate of the three research sites in order for the researcher to establish whether the participants were aware of any changes in the weather patterns in the last 20 years. Therefore, the question that the participants were asked was 'How would you best describe the climate of this area for the past 20 years (1997-2017)?' In answering this question, the respondents gave an account of how the climate had changed over the years, with one respondent from Ebaswazini expressing that:

> "It used to always rain in summer but now we are not guaranteed any rain in summer. Now the rain is never enough therefore we never have enough water" (Pers. Com 2018a)

One respondent from Ogengele stated:

> "There's not enough rain now we don't have enough water to sustain our livelihoods. It has also become extremely hotter over the years and this is affecting our health especially us with high blood pressure" (Pers. Com 2018b)

Whereas in Nkombose the participants expressed that:

"It now rains in winter something that never used to happen in the past" (Pers. Com 2018c)

Therefore, from the data presented in table 4.1 and the data collected from the focus group discussions, it is evident that all three research sites have experienced changes in climatic conditions over the last 20 years.

Having established that the research participants observed changes in the weather patterns, it was then important for the researcher to establish the changes in weather patterns that were observed by the participants. In view of this, the question that was asked required the participants to categorise the different extreme weather events, which the research participants had experienced over the last 20 years. These views are captured in figure 4.1.

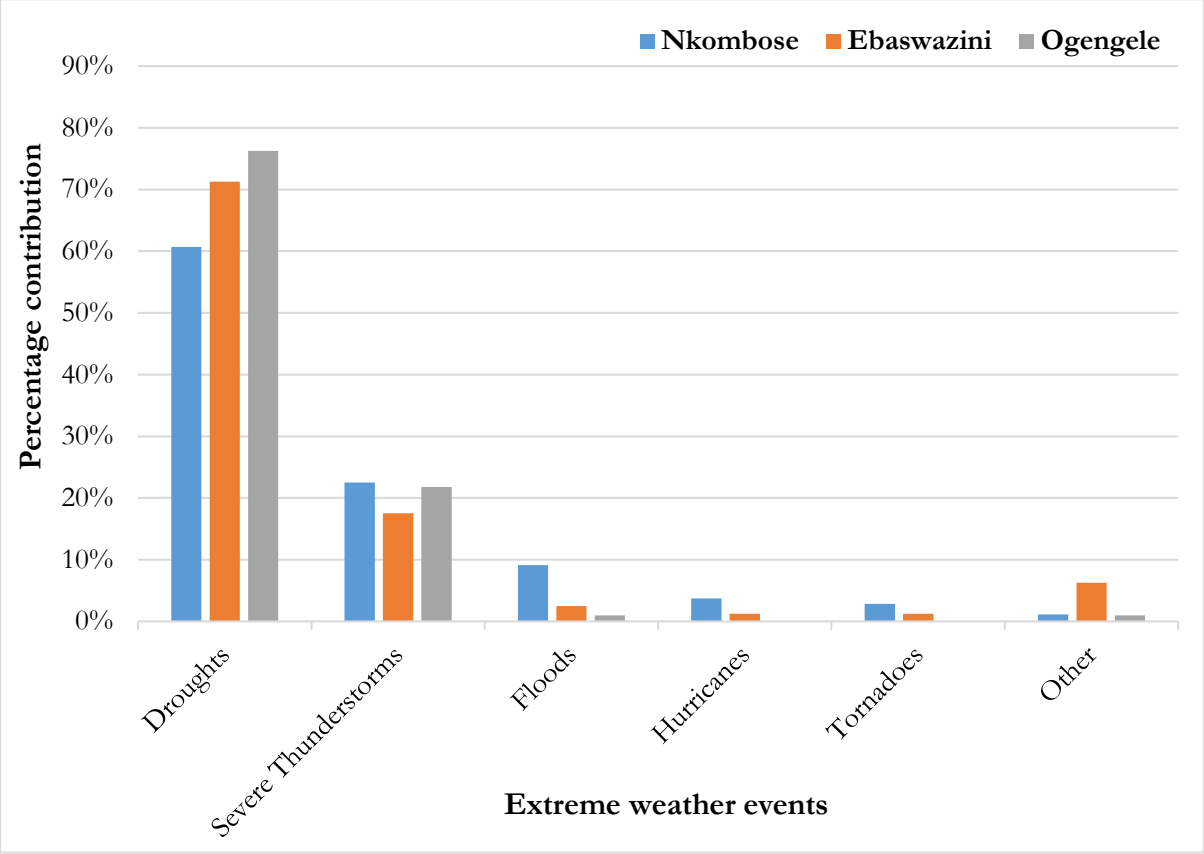


Figure 4.1: Extreme weather events observed by the research participants

Source: Based on fieldwork data, 2018 (see appendix J)

Figure 4.1 reveals that across the three research sites the research participants seem to have observed droughts as the most frequent extreme weather event in the last 20 years. In Nkombose (61%), Ebaswazini (71%), and Ogengele (76%), the research participants were of the view that droughts are one of the main ways in which the changes in weather patterns have presented

themselves in the three research sites. It is also evident from figure 4.1 that severe thunderstorms are the second way in which climate variability has presented itself in the three research sites in Mtubatuba. In Nkombose (23%), Ebaswazini (18%), and Ogengele (22%) of the research participants viewed severe thunderstorms as the second most occurring extreme weather event in Mtubatuba.

Having established the extreme weather events observed in each research site, the researcher found it fitting to analyse the overall perceptions throughout the three research sites, therefore an analysis of the overall perception was done. The overall perceptions of the ways in which climate variability has presented itself in Mtubatuba are presented in figure 4.2.

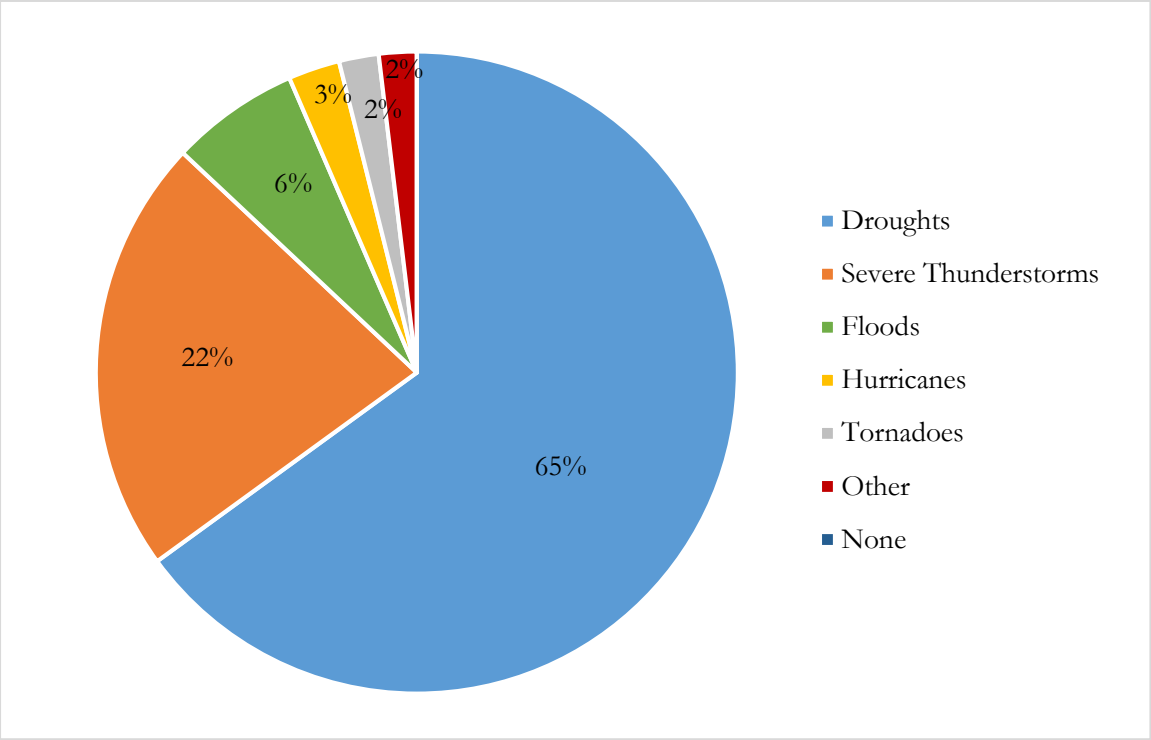


Figure 4.2: Extreme weather events observed by the research participants in Mtubatuba

Source: Based on fieldwork data, 2018 (see appendix J)

As illustrated in figure 4.2 it is evident that the majority 347 (65%) of the research participants from the three research sites observed droughts in their respective communities, whereas 115 (22%) of the research participants observed severe thunderstorms. The remaining 70 (13%) of the extreme weather events that the research participants had experienced were floods, tornadoes, hurricanes and other. The 'other' extreme weather events category included strong winds and extreme heat.

Furthermore, in gathering more information during a focus group discussion, participants were requested to identify extreme weather events they have experienced in their communities in the last 20 years. The focus group discussion participants were also of the view that droughts were the most occurring extreme weather events. One of the focus group respondents from Ogengele stated that:

> "We experience drought all the time. However, 2016 is still the most memorable year when it was bad. We used to wake up at 12h00am to go get water from the hand-operated lever pump because it used to be too full during the day." (Pers. Com 2018d)

In addition, in a series of interviews conducted with the three local authorities from the Disaster Management Centre in Mtubatuba Local Municipality, the authorities were asked to discuss issues around weather challenges that have been a concern for their department. One of the authorities stated that:

> "Shortage of rain and severe thunderstorms are amongst the many challenges faced by residents in Mtubatuba. Shortage of rain is because of droughts. Whereas, the occurrence of severe thunderstorms is attributed to Mtubatuba having a high lightning density." (Pers. Com 2018e)

While the data presented above provide strong evidence that droughts and severe thunderstorms are the two most occurring extreme weather events in the three research sites, it was important for the researcher to compare human perceptions to scientific data. Therefore, rainfall amount data calculated in millimetres (mm) obtained from the South African Weather Service were reviewed and the average rainfall amounts for each year were calculated. This weather data were recorded at the Riverview weather station, which is approximately nine kilometres from Nkombose, 20 kilometres from Ebaswazini and 19 kilometres from Ogengele. The average rainfall amount (mm) recorded in Mtubatuba from 1997-2017 is presented in figure 4.3.

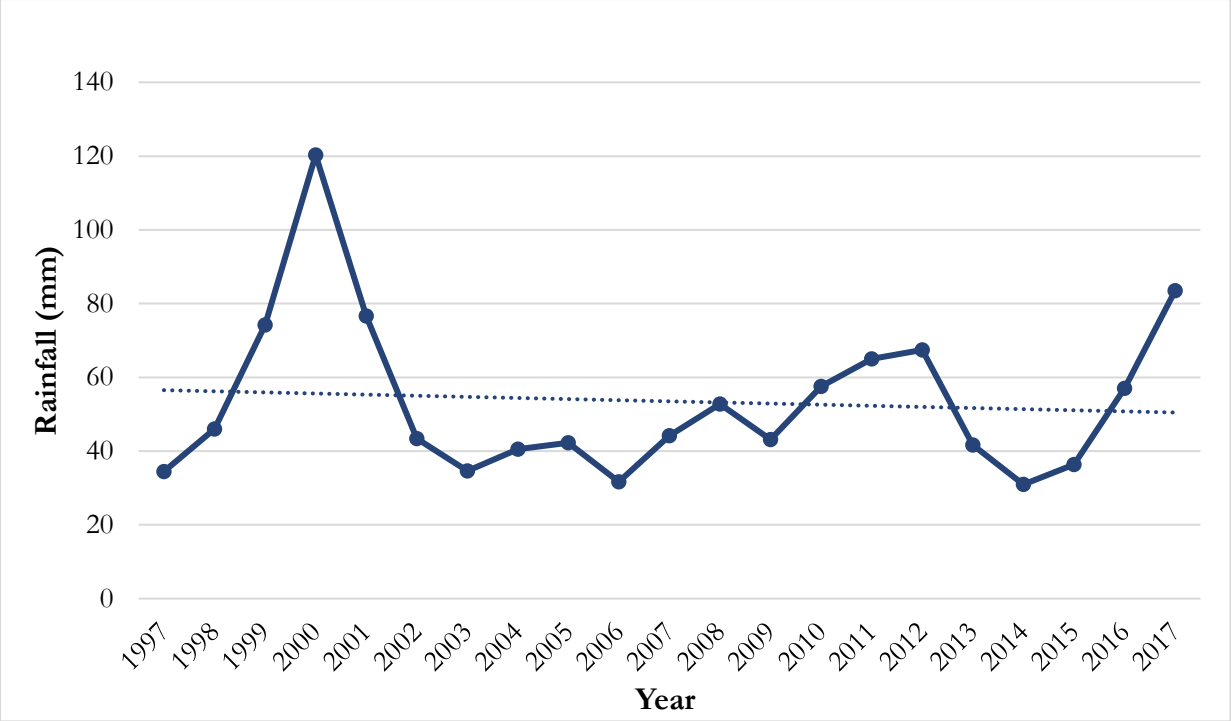


Figure 4.3: Average rainfall amount recorded in Mtubatuba from 1997-2017 with a Trendline demonstrating the general pattern over the years

Source: South African Weather Service, 2018 (see appendix K)

As illustrated in figure 4.3, it is evident that in Mtubatuba between 1997-2017 there have been more years of below average precipitation or rainfall (where the average is 53mm). This finding seems to suggest that the area of Mtubatuba has been receiving inadequate rainfall amounts, which have led to frequent drought episodes. In light of the above, the South African Weather Service (2016) defines a drought as a degree of dryness in comparison to normal or average amounts of rainfall for a particular area or place and the duration of the dry period. Therefore, in view of what a drought is, it is suggestive that the scientific data correlate with the finding from the human perceptions, which suggests that Mtubatuba has been experiencing more years of below average rainfall, which have subsequently resulted in drought episodes.

Furthermore, the researcher found it imperative to understand the relationship between human perceptions related to severe thunderstorms to that of scientific data. Therefore, temperature data calculated in degrees Celsius obtained from the South African Weather Service (2018) were reviewed and the average minimum and maximum temperatures for each year were calculated. The results of the temperature data are presented in figure 4.4 below.

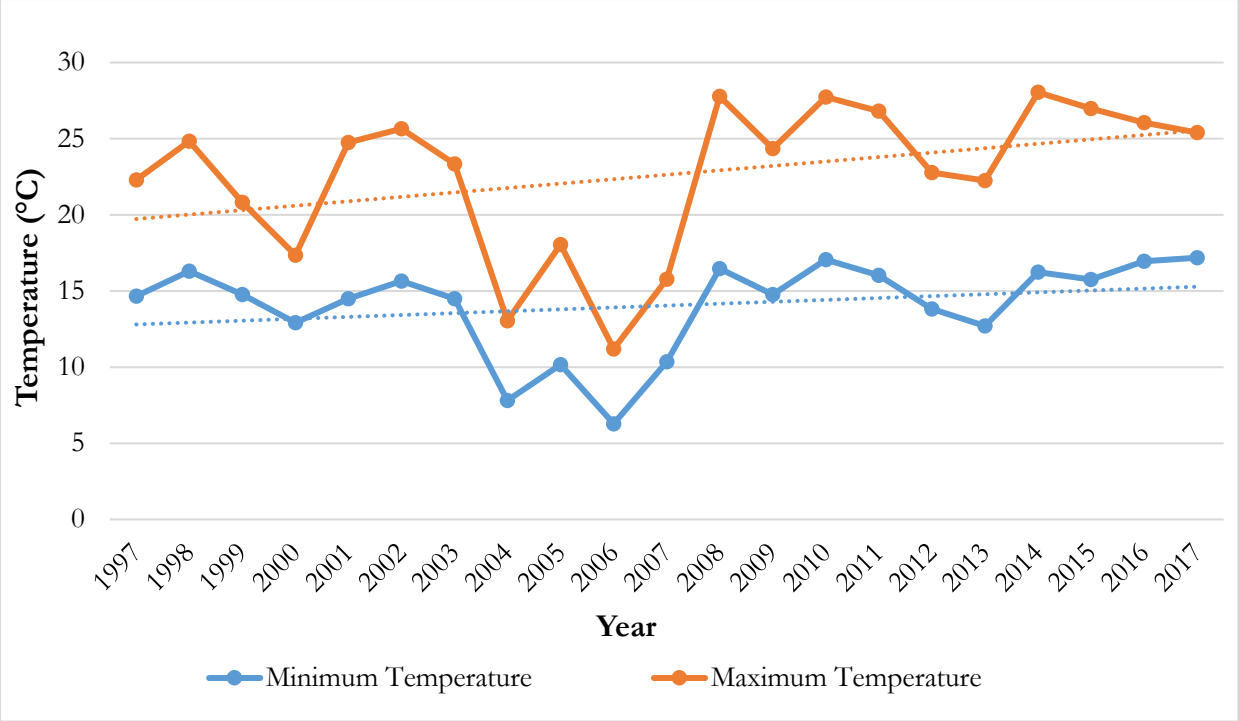


Figure 4.4: Average minimum and maximum temperatures recorded in Mtubatuba from 1997-2017 with a Trendline demonstrating the general pattern over the years

Source: South African Weather Service, 2018 (see appendix K)

In view of the findings presented in figure 4.4, it is evident that the temperatures (both minimum and maximum) have increased slightly, particularly in the last ten years (2008-2017). The average minimum temperature recorded was 14°C, while the average maximum temperature recorded was 23°C. It is evident that more than half of the temperatures recorded over the 21-year period are above average. The researcher was interested in understanding the relationship between high temperatures and the occurrence of severe thunderstorms. Therefore, documentary review of existing data was undertaken. Thus, given that the temperature data presented above show that the majority of the temperatures recorded were above average, it demonstrates that the area of Mtubatuba is humid and warm as it was previously indicated under the description of the research site. Consequently, this finding correlates with climate research data, which suggest that severe thunderstorms thrive in humid and warm areas. In view of this, it is suggestive that there could be a relationship between the high temperatures demonstrated in figure 4.4 and the occurrence of severe thunderstorms in Mtubatuba. The scientific data finding relates to that of human perception, which suggests that severe thunderstorms are one of the ways in which climate variability has manifested itself in Mtubatuba.

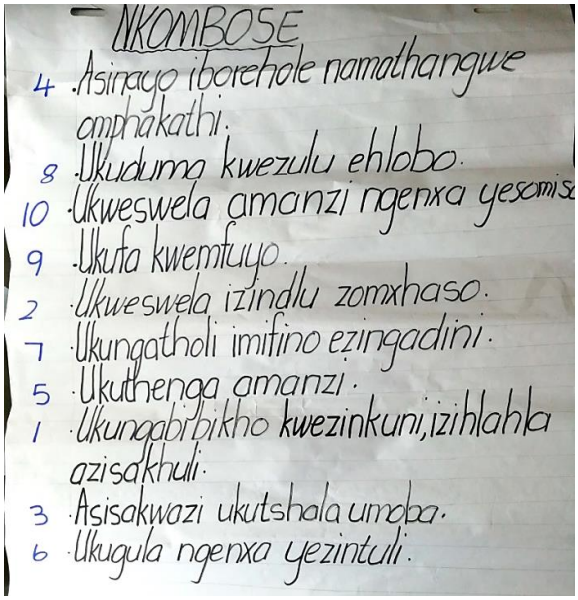
4.3 Perceived impacts of climate variability on rural livelihoods in Mtubatuba

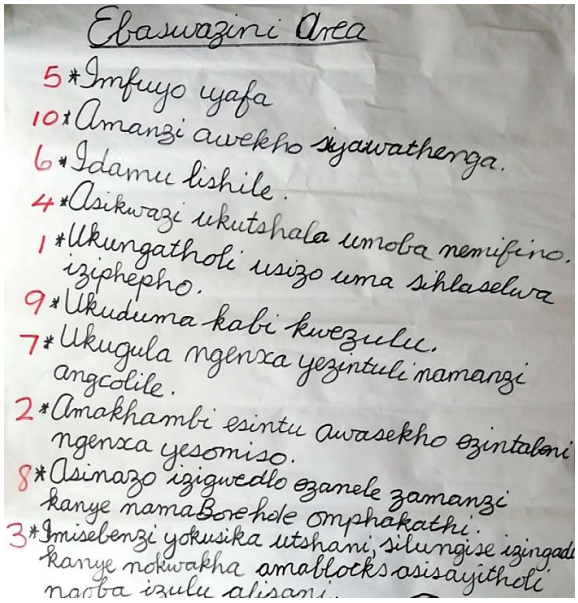
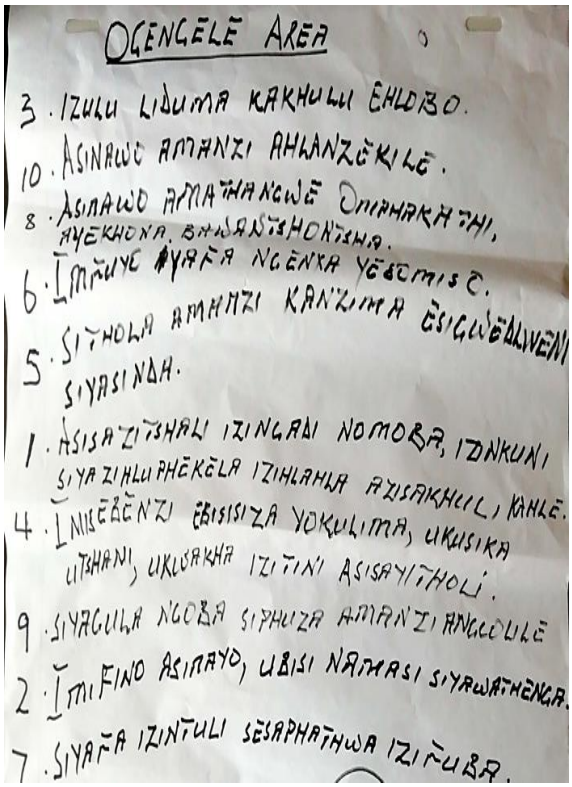
It was established that the research participants and the meteorological data suggest that droughts and severe thunderstorms are the two major ways in which climate variability has manifested itself in Mtubatuba. Therefore, drawing from the research participants' insights on climate variability in Mtubatuba, the study was also interested in understanding the impacts of climate variability on poor rural communities in Nkombose, Ebaswazini, and Ogengele.

In view of this, a number of questions were asked in order to gather information on the impacts of climate variability on rural livelihoods in Mtubatuba. Therefore, in trying to obtain information, a listing and ranking task was employed. The research participants were asked to randomly call out the various impacts of climate variability. Subsequently, the researcher asked the research participants to rank the impacts from the most severe to the least impactful. This task allowed the researcher an opportunity to determine the ways in which droughts and severe thunderstorms have affected the livelihoods of the rural communities in the three research sites. The views obtained from the listing and ranking tasks are shown in table 4.2 below.

Table 4.2: Listing and ranking matrices data of the impacts of droughts and severe thunderstorms on rural livelihoods in Mtubatuba

Key: One (1) means the least impactful and 10 the most impactful/severe

Listing and Ranking Matrices from the three research sites	**English translation and ranking according to the severity**
	**Legend** 10. Lack of water because of drought. 9. Livestock losses. 8. Frequent severe thunderstorms in summer. 7. Not getting spinach from the gardens. 6. Sick from the dust. 5. Buying water. 4. No community borehole and tanks. (Where water is free). 3. Can no longer plant sugarcane. 2. Not enough RDP houses. 1. Trees are not growing so there is no firewood.

	**Legend** 10. No water is available because of inadequate rainfall. Have to buy water. 9. Frequent severe thunderstorms. 8. Not enough hand-operated lever pump and community boreholes. 7. Sick from dust and dirty water. 6. The dam has no water. 5. Livestock is dying. 4. Can no longer plant sugarcane and spinach. 3. No more jobs for cutting grass, fixing gardens and building blocks. 2. No traditional medicine in the mountains because of drought. 1. Not getting help when hurricanes occur.
	**Legend** 10. No clean water because of inadequate rainfall. 9. Sick from drinking dirty water. 8. No community water tanks. Used to have some tanks but they were stolen. 7. Chest problems from being exposed to a lot of dust. 6. Livestock is dying due to drought. 5. Struggle to get water from the hand-operated lever pump, which requires power to operate. 4. No more jobs of working in the farms, cutting grass, building blocks. 3. Frequent severe thunderstorms. 2. Livestock losses. Now have to buy milk and maas. 1. Can no longer plant in the gardens. Trees no longer grow properly, therefore, struggling to get wood to make fire.

Source: Based on fieldwork data, 2018

From the data presented in table 4.2, it is suggestive that the communities identified lack of water attributed to droughts as the largest impact of climate variability in Nkombose, Ebaswazini, and Ogengele. Table 4.2 also provides information on how lack of water attributed to droughts has affected the rural livelihoods of the three communities. From the listing and ranking matrix, it is suggestive that in Nkombose the lack of water attributed to droughts has resulted in increased livestock losses, reduced farming and planting practices, and the communities having to buy water. Whereas in Ebaswazini, it appears that the lack of water attributed to droughts has resulted in people getting sick from drinking dirty water; increased livestock losses; communities partaking in far less farming and planting practices. Lastly, in Ogengele, it is suggestive that the lack of water attributed to droughts has resulted in people getting sick from drinking dirty water; increased livestock losses, job losses and the communities having to buy milk and Maas.

In addition, to the impacts identified through the listing and ranking tasks, the researcher found it important to examine the other ways in which climate variability has affected the lives of the communities in the three research sites. Therefore, in gathering information, the research participants were asked to identify how droughts have affected their rural livelihoods. The views of the research participants are captured in figures 4.5 and 4.6 below.

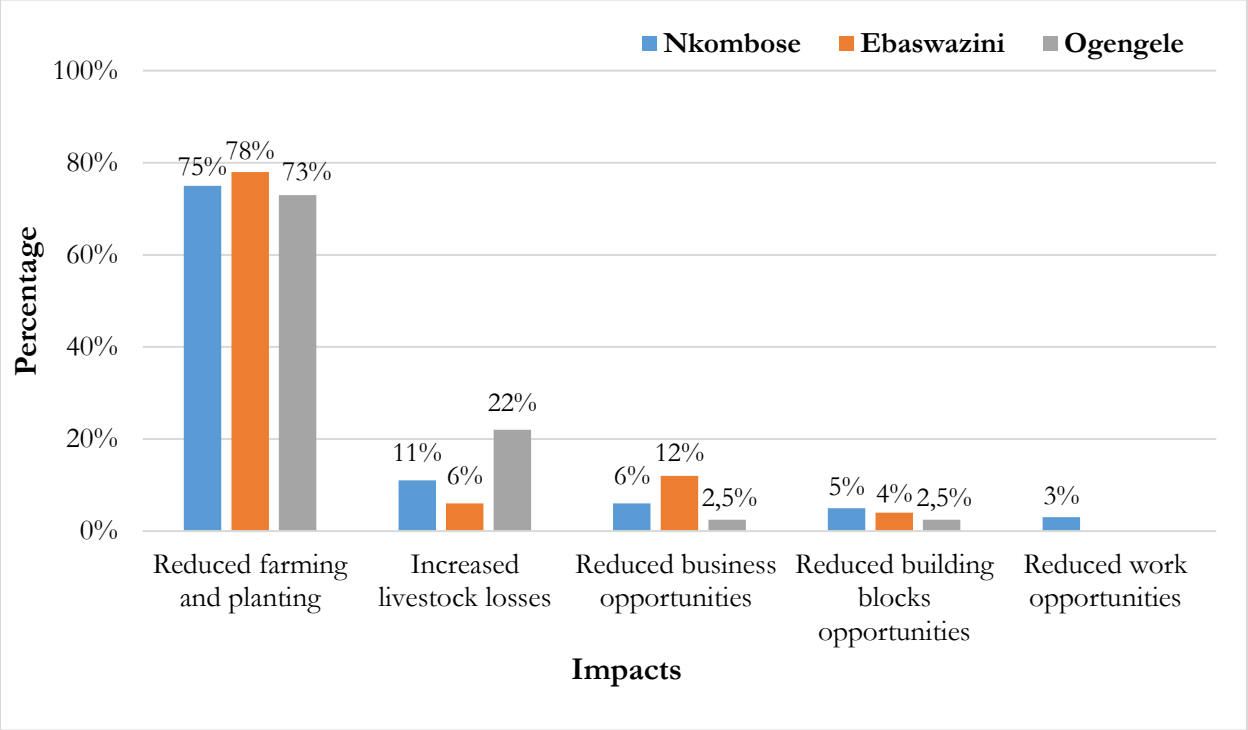


Figure 4.5: The effects of lack of water attributed to droughts on rural livelihoods in Mtubatuba

Source: Based on fieldwork data, 2018 (see appendix L)

The data presented in figure 4.5 seem to suggest that in all three research sites having insufficient water due to droughts has led to reduced farming and planting; increased livestock losses; reduced business opportunities; reduced building block opportunities; and reduced work opportunities. Undoubtedly, it is evident that in all three research sites, over 70% of the research participants identified reduced farming and planting as the greatest way in which the lack of water due to droughts has affected their rural livelihoods. Interestingly, in Nkombose (11%) and Ogengele (22%), the research participants identified increased livestock losses as the second greatest way in which droughts have affected their rural livelihoods. In Ebaswazini (12%) of the research participants identified reduced business opportunities as the second way in which droughts have affected their rural livelihoods. On the other hand, in Nkombose reduced work opportunities (3%) were identified as the least affected activity by lack of water, while in Ebaswazini and Ogengele reduced work opportunities was not identified at all by the research participants as an effect caused by droughts.

Having established the individual effects experienced by each community, it was important to examine the overall effects of droughts for the entire study population. Therefore, figure 4.6 below demonstrates the overall perception of how droughts have affected the communities in the three research sites.

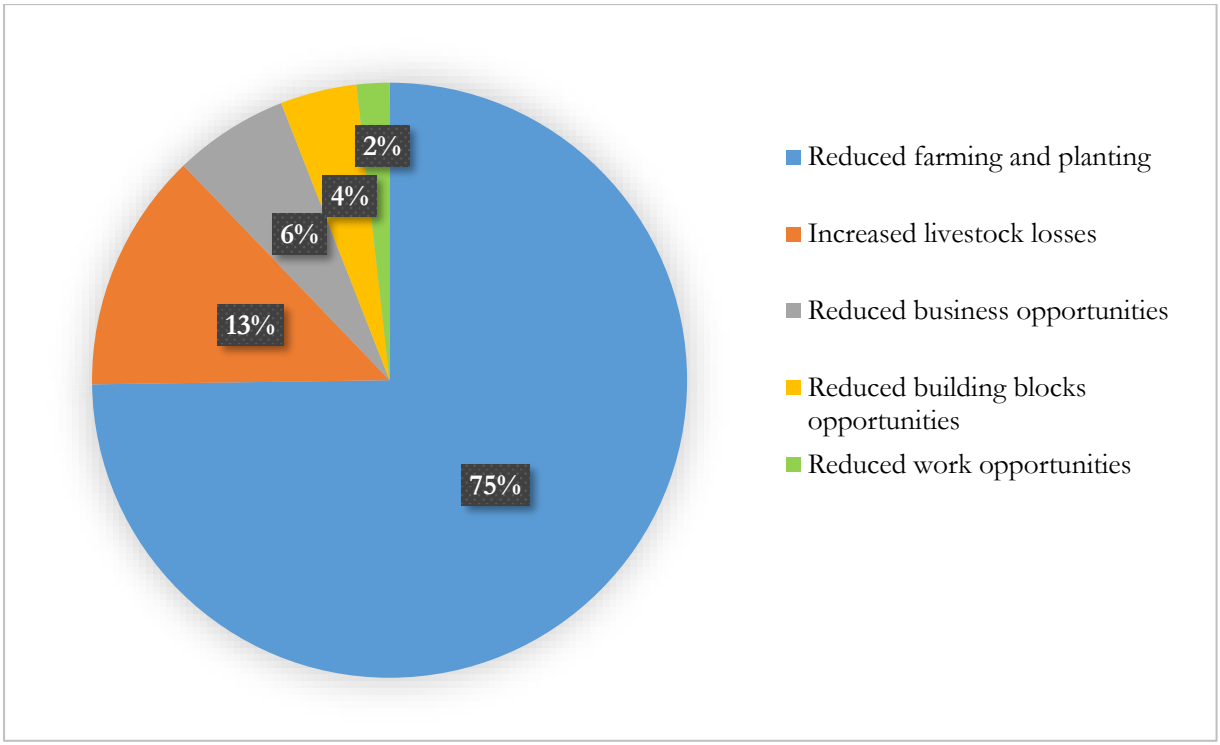


Figure 4.6: The effects of lack of water attributed to droughts on rural livelihoods in Mtubatuba

Source: Based on fieldwork data, 2018 (see appendix L)

As illustrated in figure 4.6 it is suggestive that across the three research sites three-quarters (75%) of the research participants identified reduced farming and planting (referred to by the participants as 'ukulima and ukutshala') as the largest effect caused by droughts on rural livelihoods. Evidently, farming and planting (particularly rain-fed agriculture) contribute largely to rural livelihoods in the three research sites and not having water to sustain this activity greatly affects these communities. Figure 4.7 below demonstrates crop failure, which the research participants attributed to the effects of droughts on rural livelihoods in Nkombose.



Figure 4.7 (left): Mealies in one of the research participant's yard in Nkombose **(right):** Sugarcane in one of the research participant's yard in Nkombose

Source: Based on fieldwork data, 2018

The negative effects of droughts on farming and planting practices are visible from figure 4.7. Subsequently, the overall contribution of increased livestock losses was 13%. This is seen as the second effect of lack of water attributed to droughts on rural livelihoods in Mtubatuba. In addition, 6% of the research participants expressed that droughts affected them through reduced business opportunities, whereas 4% of the research participants reported that due to inadequate rainfall amounts there have been reduced opportunities for building (houses, schools, and other facilities) and manufacturing building blocks. As building requires water, if this resource is scarce there are fewer opportunities available to continue to partake in it. One research participant from Nkombose stated that:

> "I used to work for someone who owned a building blocks business but I lost the job because the employer could no longer have too many people working for him as the work became less because there is no water to sustain the business." (Pers. Com 2018f)

Lastly, 2% of the research participants stated that because of the lack of water there has been reduced work opportunities for them, this included making mats from the grass (because the grass is burnt), cutting grass at people's houses and schools. These were all the effects of droughts identified by the participants from the three communities.

Furthermore, this study was also interested in determining the impacts of severe thunderstorms on rural livelihoods. Therefore, in gathering this information the research participants were asked to describe how severe thunderstorms affected their lives. Although not so many participants responded to this question, those who did expressed similar views. One research participant from Nkombose stated that:

> "Severe thunderstorms occur all the time. When the severe thunderstorms come, my family and I used to think maybe someone has sent it to us because it used to be very bad. Severe thunderstorms have really affected us because one of our family members got struck by lightning and died…We are scared." (Pers. Com 2018g)

Another respondent from Ebaswazini expressed similar views:

> "We are scared of severe thunderstorms" (Pers. Com 2018h)

Evidently, from the findings, it is suggestive that loss of life and fear are the two major impacts of severe thunderstorms on rural livelihoods in Mtubatuba.

4.4 Adaptation strategies adopted by the rural communities in Mtubatuba

This study was also interested in understanding the key adaptation strategies, which the communities of Nkombose, Ebaswazini, and Ogengele use to adapt to the impacts of climate variability. Therefore, it was important for this study to first establish what resources, referred to in this study as assets, were available in each of the three communities. Thus, in undertaking this task, the research participants were required to brainstorm and map out on a chart paper the various assets that were available in their respective communities. The exercise revealed the information as captured in figure 4.8.

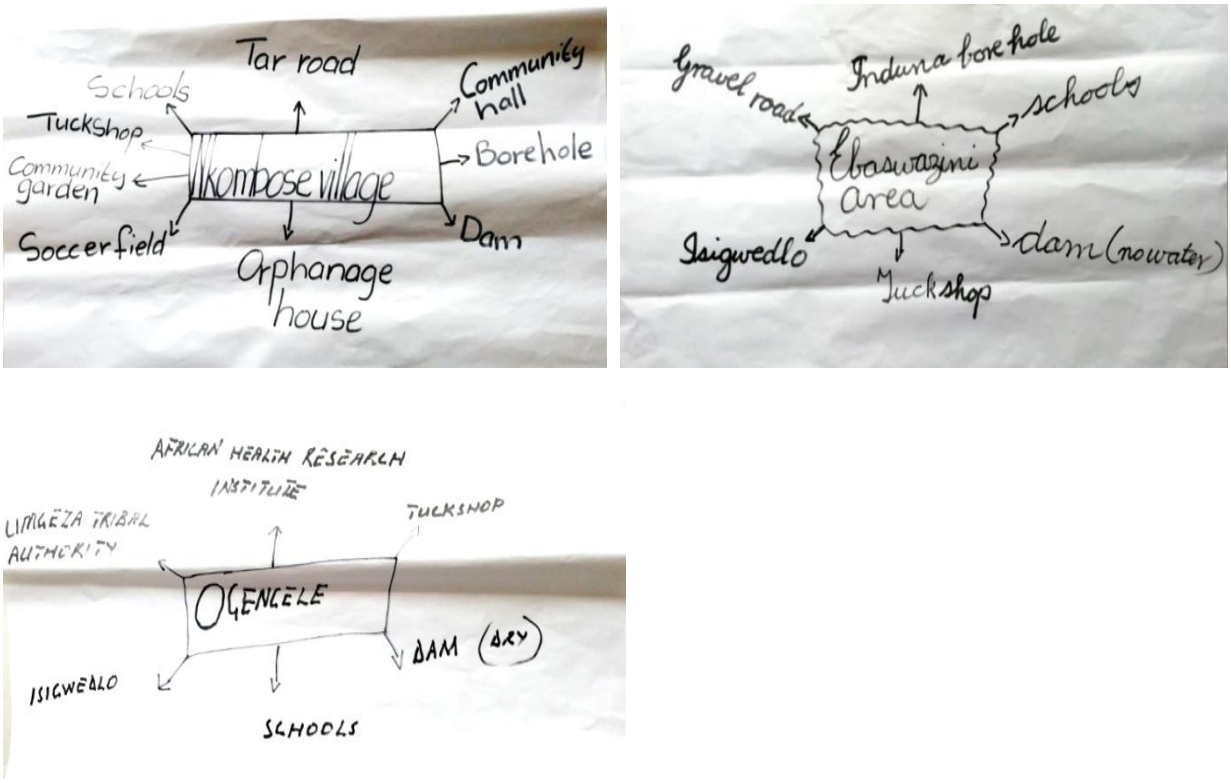


Figure 4:8: Assets identified by communities in Nkombose, Ebaswazini, and Ogengele

Source: Communities identification of the different assets in the three research sites

Based on the information presented in figure 4.8 it appears that the respondents were able to identify their sources of water when there is insufficient rainfall to sustain their lives. As seen in figure 4.8, the community of Nkombose was able to identify that there is a dam (see figure 4.9, bottom left) and a borehole which supplies water to the JoJo tanks (see figure 4.9, top left). In Ebaswazini the community has a dam with no water and a hand-operated lever pump (referred to by participants as Isigwedlo) (see figure 4.9, bottom right) and a borehole, which is located at the Induna's residence. In Ogengele the community depends on a hand-operated lever pump (see figure 4.9, top right) and a dry dam. It is evident that the three communities were able to identify the different resources, which they rely on in times of need.



Figure 4.9 (top left): JoJo water tanks where there is a borehole, which pumps the water to the tanks in Nkombose, **(top right):** A boy from the Ogengele community paddling the hand-operated lever pump for water, **(bottom left):** A small dam in Nkombose where some residents get water, **(bottom right):** A hand-operated lever pump in Ebaswazini.

Source: Based on fieldwork data, 2018

4.4.1 Communities adaptation strategies against the impacts of droughts

Having established the various assets available in Nkombose, Ebaswazini, and Ogengele, the study was now interested in understanding the key adaptation strategies that bring about adaptation. Therefore, in gathering this information, the researcher investigated the adaptation strategies and assets, which the communities of Nkombose, Ebaswazini, and Ogengele use to respond to the impacts of climate variability. In view of this, the communities were asked to identify the various adaptation strategies, which they use to adapt to the impacts of climate variability. Thereafter, each adaptation strategy was linked to an asset portfolio in order to fully understand which asset portfolios these communities regarded as the most important in adapting to the impacts of climate variability. The research participants views are captured in table 4.3, 4.4, and 4.5.

Table 4.3: Climate variability associated impacts and adaptation measures in Nkombose

(n= number of responses, N= total number of responses)

Climate variability impacts identified by communities	**Key adaptation strategies**	**Most important assets**	**Nkombose**	
			(n)	**(%)**
1. Lack of water attributed to droughts 2. Reduced farming and planting	Through social grants and investments (pension/social grant/ retirement annuity) able to obtain money to buy water and vegetables, etc.	**Financial Assets (income, savings)**	50	25%
1. Lack of water attributed to droughts 2. Reduced selling or business activities 3. Reduced building/building blocks activities	Through trade, able to sell (clothes, food etc.) and obtain money to buy water and vegetables, etc.		40	20%
1. Lack of water attributed to droughts 2. Reduced farming and planting 3. Increased livestock losses	Through procurement able to get what is needed to cope and survive the impacts (e.g. water, lightning conductor, black sand to fertilise the sand, medicine for the cows, fruits, and vegetables)		10	5%
1. Reduced work opportunities	Through education and skills can start small businesses and be self-employed or apply for full-time, part-time and piece jobs	**Human Assets (labour, education, skills)**	76	39%

Climate variability impacts identified by communities	Key adaptation strategies	Most important assets	Nkombose	
			(n)	(%)
1. Reduced farming and planting 2. Lack of water attributed to droughts	Can use human knowledge and skills to cope (e.g. plant in tyres to withhold water for longer; use bleach to purify the water)	**Human Assets (labour, education, skills)**	6	3%
1. Lack of water attributed to droughts 2. Reduced work opportunities 3. Reduced selling or business activities 4. Reduced building/building blocks activities	Through social relations, depend on children/husband/wife/Relatives for support	**Social Assets (social structures, social relations)**	6	3%
1. Lack of water attributed to droughts 2. Reduced work opportunities	Support from the Induna/ councillors/ municipality		3	2%
1. Lack of water attributed to droughts 2. Reduced farming and planting 3. Reduced work opportunities 4. Reduced selling or business activities 5. Reduced building/building blocks activities	No coping strategy	**No Asset**	6	3%
Total			**197**	**100%**

N = 197; Percentage = (n/N) x 100%

Source: Based on fieldwork data, 2018

Table 4.4: Climate variability associated impacts and adaptation measures in Ebaswazini

(n= number of responses, N= total number of responses)

Climate variability impacts identified by communities	**Key adaptation strategies**	**Most important assets**	**Ebaswazini**	
			(n)	**(%)**
1. Lack of water attributed to droughts 2. Reduced farming and planting	Through social grants and investments (pension/social grant/ retirement annuity) able to obtain money to buy water and vegetables, etc.	**Financial Assets (income, savings)**	17	32%
1. Lack of water attributed to droughts 2. Reduced selling or business activities 3. Reduced building/building blocks activities	Through trade, able to sell (clothes, food etc.) and obtain money to buy water and vegetables, etc.		6	11%
1. Lack of water attributed to droughts 2. Reduced farming and planting 3. Increased livestock losses	Through procurement able to get what is needed to cope and survive the impacts (e.g. water, lightning conductor, black sand to fertilise the sand, medicine for the cows, fruits, and vegetables)		0	0%
1. Reduced work opportunities	Through education and skills can start small businesses and be self-employed or apply for full-time, part-time and piece jobs	**Human Assets (labour, education, skills)**	22	42%

Climate variability impacts identified by communities	Key adaptation strategies	Most important assets	Ebaswazini	
			(n)	(%)
1. Reduced farming and planting 2. Lack of water attributed to droughts	Can use human knowledge and skills to cope (e.g. plant in tyres to withhold water for longer; use bleach to purify the water)	**Human Assets (labour, education, skills)**	0	0%
1. Lack of water attributed to droughts 2. Reduced work opportunities 3. Reduced selling or business activities 4. Reduced building/building blocks activities	Through social relations, depend on children/husband/wife/Relatives for support	**(social structures, social relations)**	3	6%
1. Lack of water attributed to droughts 2. Reduced work opportunities	Support from the Induna/ councillors/ municipality		0	0%
1. Lack of water attributed to droughts 2. Reduced farming and planting 3. Reduced work opportunities 4. Reduced selling or business activities 5. Reduced building/building blocks activities	No coping strategy	**No Asset**	5	9%
Total			**53**	**100%**

N = 53; Percentage = (n/N) x 100%

Source: Based on fieldwork data, 2018

Table 4.5: Climate variability associated impacts and adaptation measures in Ogengele

(n= number of responses, N= total number of responses)

Climate variability impacts identified by communities	**Key adaptation strategies**	**Most important assets**	**Ogengele**	
			(n)	**(%)**
1. Lack of water attributed to droughts 2. Reduced farming and planting	Through social grants and investments (pension/social grant/ retirement annuity) able to obtain money to buy water and vegetables, etc.	**Financial Assets (income, savings)**	28	36%
1. Lack of water attributed to droughts 2. Reduced selling or business activities 3. Reduced building/building blocks activities	Through trade, able to sell (clothes, food etc.) and obtain money to buy water and vegetables, etc.		6	7,8%
1. Lack of water attributed to droughts 2. Reduced farming and planting 3. Increased livestock losses	Through procurement able to get what is needed to cope and survive the impacts (e.g. water, lightning conductor, black sand to fertilise the sand, medicine for the cows, fruits, and vegetables)		6	7,8%
1. Reduced work opportunities	Through education and skills can start small businesses and be self-employed or apply for full-time, part-time and piece jobs	**Human Assets (labour, education, skills)**	26	34%

Climate variability impacts identified by communities	Key adaptation strategies	Most important assets	Ogengele	
			(n)	(%)
1. Reduced farming and planting 2. Lack of water attributed to droughts	Can use human knowledge and skills to cope (e.g. plant in tyres to withhold water for longer; use bleach to purify the water)	**Human Assets (labour, education, skills)**	0	0%
1. Lack of water attributed to droughts 2. Reduced work opportunities 3. Reduced selling or business activities 4. Reduced building/building blocks activities	Through social relations, depend on children/husband/wife/Relatives for support	**(social structures, social relations)**	5	6,5%
1. Lack of water attributed to droughts 2. Reduced work opportunities	Support from the Induna/ councillors/ municipality		0	0%
1. Lack of water attributed to droughts 2. Reduced farming and planting 3. Reduced work opportunities 4. Reduced selling or business activities 5. Reduced building/building blocks activities	No coping strategy	**No Asset**	6	8%
Total			**77**	**100%**

N = 77; Percentage = (n/N) x 100%

Source: Based on fieldwork data, 2018

Tables 4.3, 4.4 and 4.5 outlines the key adaptation strategies, which the communities of Nkombose, Ebaswazini, and Ogengele depend on when dealing with the impacts of climate variability. The data presented in table 4.3 reveals that half (50%) of the research participants from Nkombose identified adaptation strategies which were linked to financial asset portfolios, whereas, 42% of the research participants identified strategies which were aligned with human asset portfolios. Five percent of the research participants identified strategies, which were linked to social asset portfolios. Lastly, 3% of the research participants expressed that they had no coping mechanisms, therefore, were not coping.

Similarly, in Ebaswazini 43% of the research participants identified adaptation strategies, which were more aligned with financial asset portfolios, whereas, 42% of the research participants identified adaptation strategies linked to human asset portfolios. Just under one-tenth (9%) of the research participants in Ebaswazini stated that they were not coping, thus had no adaptation strategy in place.

In Ogengele, the majority (51.6%) of the research participants identified adaptation strategies which were linked to financial assets. In comparison to Nkombose and Ebaswazini, the data presented in table 4.5 suggest that in Ogengele fewer research participants (34%) depend on adaptation strategies which are linked to human asset portfolios, whereas 6.5% and 8% of the research participants identified adaptation strategies which were linked to social assets and no assets (no adaption strategy) respectively.

It is evident from the data presented in tables 4.3, 4.4, and 4.5 that the adaptation strategies which the majority of the research participants rely on to respond and to build an adaptive capacity towards the impacts of climate variability are linked to financial and human asset portfolios. The key adaptation strategies linked to financial asset portfolios included financial assistance in the form of social grants and investments; trade through selling which enables the research participants to obtain money which is used to purchase what is needed to adapt to the impacts of droughts and severe thunderstorms. The key adaptation strategies linked to human asset portfolios included labour, education, and skills.

Having established the key adaptation strategies which the communities of Nkombose, Ebaswazini, and Ogengele use, it was extremely important for this study to understand which assets play a very important role in adapting to the impacts of climate variability. Although the key adaptation strategies were linked to asset portfolios as seen in tables 4.3, 4.4, and 4.5 above, the study found it important to further investigate the key assets using the five fundamental assets defined by Moser and Dani (2008). Therefore, the study investigated the assets, which the three communities regard

as the most important in responding to the impacts of droughts. In gathering the information, the question that was asked required the research participants to categorise the assets which they use as well as describe how these assets help them in building an adaptive capacity towards the impacts of droughts. Financial assets were recognised as any financial resources available to people, such as investments, savings, and grants. Human assets were accepted as being a collection of skills, knowledge and other intangible assets, which individuals use to create economic value. Social assets were acknowledged as institutions that help people develop and maintain human capital in collaborating with others. Physical assets included land, buildings, machinery, plant, tools, equipment, vehicles, gold, silver or any other form of tangible economic resources. Natural assets were recognised as assets of the natural environment. The results from this investigation are presented in figure 4.10.

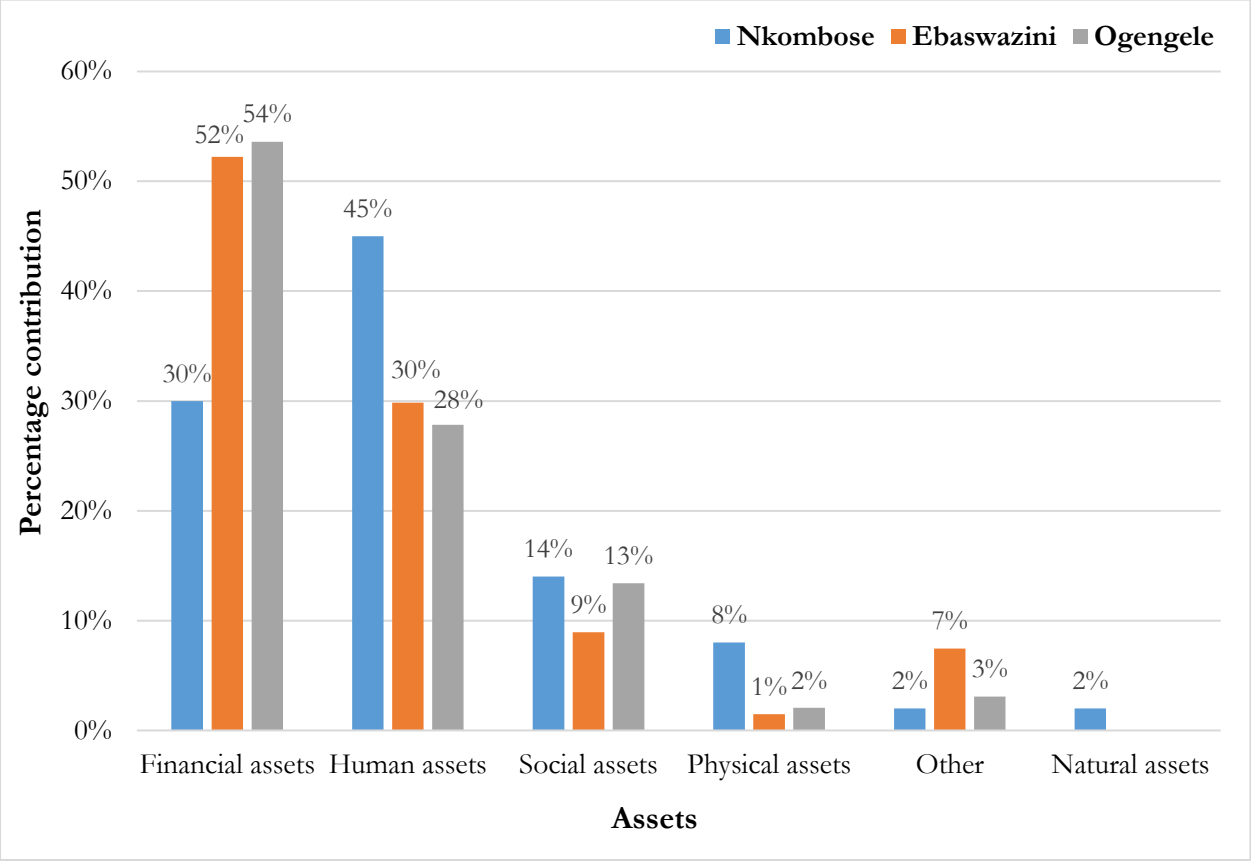


Figure 4.10: Household assets for adaptation (%) in Nkombose, Ebaswazini and Ogengele

Source: Based on fieldwork data, 2018 (see appendix M)

Figure 4.10 illustrates the research participants perceptions on the asset portfolios which contribute to the climate variability adaptation process in Nkombose, Ebaswazini, and Ogengele. Interestingly from Ebaswazini (52%) and Ogengele (54%) research participants regarded financial

assets as the most important asset used for adapting to the impacts of climate variability. In Nkombose, 30% the research participants identified financial assets as the second most important asset portfolio which contributes to adapting to the impacts of climate variability.

Notably, the majority of the research participants (45%) in Nkombose found human assets to be the most important asset portfolio used for adapting to the impacts of climate variability. In Ebaswazini (30%) and Ogengele (28%) human asset portfolios were identified as the second most important asset portfolio.

Figure 4.10 demonstrates that research participants from all three research sites identified social assets as the third asset portfolio, which contributes to adapting to climate variability. Interestingly, in Nkombose only 2% of the research participants identified natural assets, however in Ebaswazini and Ogengele no research participant identified this asset portfolio.

In view of the above data, the researcher found it important to examine the overall contribution of household asset portfolios used for adaptation across the three research sites. Figure 4.11 below demonstrates the general view across the three research sites on the household assets used for adaptation.

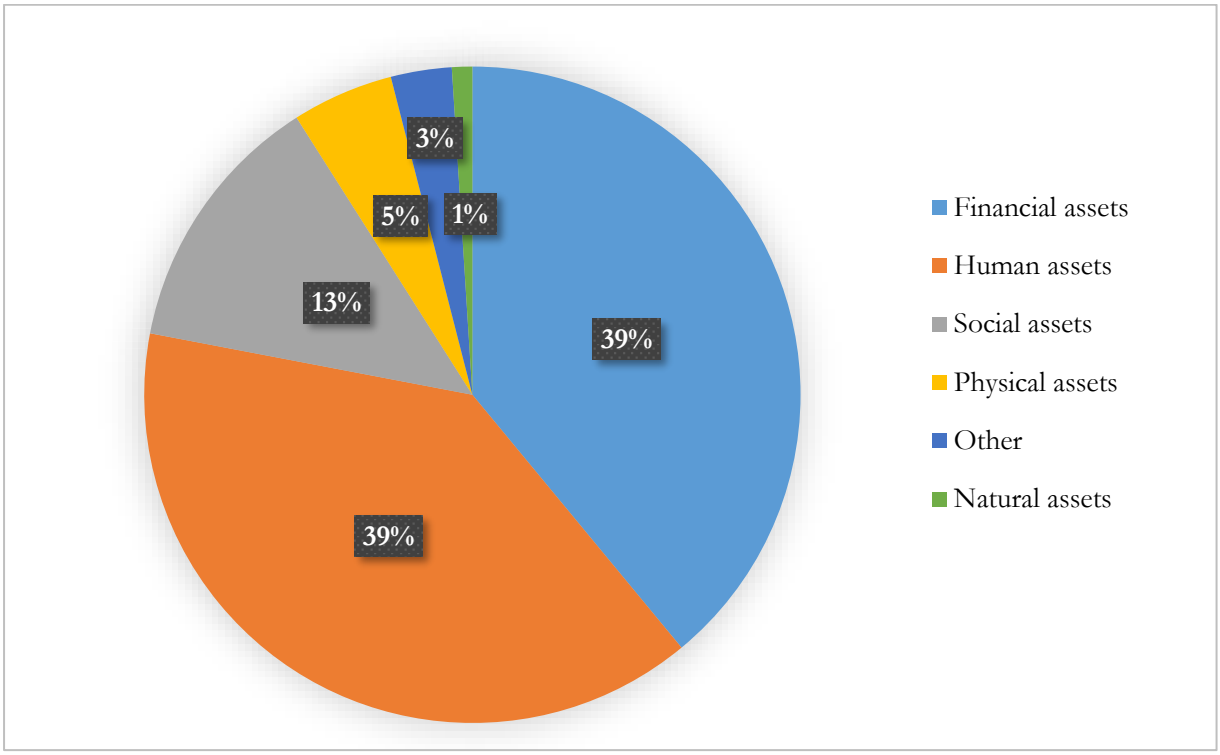


Figure 4.11: Percentage use of each household asset across the three research sites

Source: Based on fieldwork data, 2018 (see appendix M)

Notably, figure 4.11 reveals that financial (39%) and human asset (39%) portfolios are equally important in adapting to the impacts of climate variability. In view of this finding, it is important to note that it is similar to the finding previously reported in tables 4.3, 4.4, and 4.5 where the majority of the key adaptation strategies were aligned with financial and human asset portfolios. Furthermore, the three communities consider social asset portfolios (13%) as the third important asset portfolio used to adapt to the impacts of climate variability. In addition, figure 4.11 suggests that the communities view physical (5%) and natural (1%) asset portfolios as the least significant in adapting to the impacts of climate variability.

In light of the above findings, the data below highlight a wide range of views and exemplifies words of the participants regarding the adaptation strategies linked to financial and human asset portfolios as these were identified as the most important asset portfolios used for adaptation in Nkombose, Ebaswazini, and Ogengele. One focus group respondent from Ebaswazini expressed that:

> "The way the changing weather has affected us is that in order to get clean water we now need to use our pension money to buy water. We buy 5000 litres of water for R650, 200 litres for R50 and 20 litres for R5" (Pers. Com 2018i).

The above view demonstrates how financial assets in terms of pension funds are used to build an adaptive capacity towards the impact of droughts. Another research participant from Nkombose spoke about the ways in which they generate financial assets, which they use to adapt to the impacts of droughts:

> "I am struggling to get sugarcane produce from my garden because of the impacts of drought on farming. I have decided to sell chickens as this activity is more stable and sustainable to support me and my family." (Pers. Com 2018j)



Figure 4.12: Chickens kept for selling purposes by a research participant in Nkombose

Source: Based on fieldwork data, 2018

In contrast, other participants expressed that they had no financial assets, therefore they resorted to other ways of adapting to the impacts of droughts. One respondent from Nkombose stated that:

> "We get water from the same dam, where cows drink, as we cannot afford to buy water from the borehole." (Pers. Com 2018k)

Interestingly, it was noted that the participants that used water from the dam because they could not afford to buy water, they were however able to tap into other asset portfolios in order to adapt. One research participant stated that:

> "I use bleach to purify the water I get from the dam" (Pers. Com 2018l)

The above view demonstrates the use of local knowledge, which forms part of the human asset portfolio as a way of adapting to the impacts of droughts. Another research participant who used human asset portfolios expressed that:

> "We use nets to secure and black sand to fertilise where we plant our vegetables. We believe black sand can hold the water in the ground for longer." (Pers. Com 2018m)

As seen in figure 4.13 below, it is evident that human assets such as local knowledge are an important adaptation strategy for rural livelihoods in responding to the perceived impacts of climate variability in Mtubatuba.



Figure 4.13 (left): Research participant's using black sand to plant vegetables in a secured area in Nkombose, **(right):** A research participant's garden in Ebaswazini where black sand is used as a fertiliser.

Source: Based on fieldwork data, 2018

4.4.2 Communities adaptation strategies against the impacts of severe thunderstorms

As it was established in *section 4.2* of this dissertation, one of the other climate variability challenges that were identified by the communities was severe thunderstorms, therefore it was important for this study to understand how the communities of Nkombose, Ebaswazini, and Ogengele were adapting to the impacts of severe thunderstorms. In investigating the adaptation strategies used by these communities, the participants were requested to identify adaptation strategies and precautionary measures they put in place to respond to and prepare for severe thunderstorms. In view of this, a selection of quotes presented below illustrates the key adaptation strategies drawn from the discussions. One respondent expressed that:

> "We tell the municipality, for the disaster centre to install lightning conductors but we are still waiting, no help has been provided" (Pers. Com 2018n)

Another respondent from Ogengele expressed that:

> "When severe thunderstorms come we put water and double buy or umanyazini in a basin and leave it outside in the yard. This prevents the thunderstorm from striking anything and anyone in the yard" (Pers. Com 2018o)

Furthermore, during a focus group discussion at Ebaswazini, one respondent stated that:

> "We take empty cans and start banging them against each other to make a noise and we do this to prevent thunderstorms from striking anything or anyone in the yard" (Pers. Com 2018p)

Whereas another respondent indicated that:

> "When severe thunderstorms come we depend on Jeyes Fluid. We mix it with water and spill the mixture around the house to prevent the thunder from striking the house" (Pers. Com 2018q)

Another respondent expressed that they use what they have to adapt:

> "I use my voice…I pray loudly so the thunder can pass without striking in our yard" (Pers. Com 2018r)

The above view was supported by another respondent, who expressed that:

> "I scream *it is at home* so the thunder can pass without striking in our yard" (Pers. Com 2018s)

From all the adaptation strategies quoted above, it is suggestive that the majority of the participants from Nkombose, Ebaswazini, and Ogengele have adopted locally perceived knowledge which forms part of the human asset portfolios to adapt to the impacts of severe thunderstorms.

4.4.3 Adaptation strategies offered to the three research sites by the Mtubatuba Local Municipality

Although national and sectoral policies direct and guide how people can respond to climate change, local municipalities are the ones that should initiate and drive climate change mitigation and adaptation on the ground. Therefore, the study was interested in investigating the ways in which the Mtubatuba Local Municipality assists the communities in building an adaptive capacity towards the impacts of climate variability. Thus, in investigating the ways in which the Mtubatuba Local Municipality assists the communities, local authorities from the Disaster Management Centre were asked to identify and discuss the ways in which the municipality supports the three communities in times of need, particularly in times when a crisis arises from the impacts of climate variability.

In view of this, one of the questions that were asked required the local authorities to discuss issues around weather challenges that have been an area of concern for the rural communities in Mtubatuba and what assistance the Disaster Management Centre has provided to those in need. In answering this question, one of the authorities expressed that:

> "Shortage of rain is a real concern in Mtubatuba and this is a problem because we need water to extinguish fires for example. Also, the lightning density is too high in Mtubatuba; there are many family houses that have been struck by lightning." (Pers. Com 2018t)

Having established the area of concern, the study was interested in understanding the challenges that the Mtubatuba Disaster Management Centre face in addressing issues of climate variability and change. One authority stated that:

> "Shortage of lightning conductors because we depend on the Provincial Disaster Management Centre to provide these sometimes we have to wait 4-5 months before we receive them which delays our response to those who may have been negatively affected by severe thunderstorms." (Pers. Com 2018u)

In understanding the above statement, the authorities were asked if the Mtubatuba Local Municipality has a budget or resources which are specifically dedicated to addressing issues of

climate variability and change. The authorities expressed similar views, where one authority stated that:

> "Unfortunately we do not have a budget at the local municipal level. We depend on the UMkhanyakude District Municipality and the Provincial Disaster Management Centre to provide resources, which we use to help the communities." (Pers. Com 2018v)

Whereas another authority expressed that:

> "Some resources we use to respond to the impacts of climate variability are not strong enough, for example, we give tents to those affected by strong winds and fire which may have left them homeless. Although this is a temporary response, tents are not strong enough. We would like to provide better resources but we just do not have the funds." (Pers. Com 2018w)

In gathering more information on the subject matter, the local authorities were asked whether the local municipality has outreach programmes for the communities that sensitise people about climate variability and change. One local authority stated that:

> "The Disaster Management Centre conducts public awareness campaigns at schools and communities. At these campaigns, we teach the communities about the importance of not burning the veld, water conservation and what to do to prevent being struck by lightning." (Pers. Com 2018x)

Furthermore, another authority expressed that:

> We teach the communities things like *do not follow/herd cows when it is thundering* because cows are warm-blooded. *Open the windows in the house* when it is thundering so that the house is cooler. *Do not run,* walk instead. This basic knowledge can help them when severe thunderstorms occur." (Pers. Com 2018y)

Local authorities were also asked to identify the policy or policies (at the municipal level or provincial level) which they use to address issues of climate variability and change in Mtubatuba. The three authorities expressed similar views, where one expressed that:

> "We do not have a policy at the municipal level. We depend on the Provincial Disaster Management Policy, which addresses issues of climate change. However, the KwaZulu-Natal province is working on developing a Provincial Climate Change Policy. The UMkhanyakude District Municipality has sent its risk profile to be included in this policy document." (Pers. Com 2018z)

In light of the above insights, it is suggestive that the Mtubatuba Local Municipality through the Disaster Management Centre does not have a budget and a policy at the municipal level dedicated to addressing the issues of climate variability and change. However, from the views gathered from the local authorities, it seems like the Mtubatuba Local Municipality through the Disaster Management Centre provides the communities with basic knowledge and limited resources, which they use to respond to the impacts of climate variability. One can tentatively conclude that the basic knowledge and limited resources are considered to be contributing to the communities' human and social asset portfolios, which they use to adapt to the impacts of climate variability.

CHAPTER FIVE

DISCUSSION

5.1 Introduction

This chapter aims to present a discussion of the findings of this study. The aim of this study was to investigate the ways in which poor rural communities of Nkombose, Ebaswazini, and Ogengele in Mtubatuba are affected by climate variability and to understand the ways in which these communities are adapting to the impacts of climate variability.

In view of the above, this chapter is presented in a manner which engages the research objectives which were outlined in *section 1.4* of this dissertation. The first objective examines climate variability in Mtubatuba. Secondly, a discussion on the impacts of climate variability on poor rural people in Mtubatuba is presented. The third section is dedicated to discussing the adaptation strategies and asset portfolios used for climate variability adaptation in Mtubatuba. Lastly, the wider implications of the findings in South Africa and in sub-Saharan Africa are presented.

5.2 Climate variability: an existing and persistent phenomenon in Mtubatuba

As pointed out in Chapter one of this dissertation and later in the empirical evidence presented in Chapter four, one of the things that this study was interested in was to determine whether changes in the weather patterns are a factor that is observed by the rural communities of Mtubatuba. Therefore, based on the findings presented in table 4.1 in the previous chapter, it was established that 99.7% of the research participants indicated that they have observed varying climate conditions in Mtubatuba. It is evident that the variability in the weather patterns in Mtubatuba have not gone unnoticed by the communities. Therefore, one can argue that rural communities are aware of the varying weather patterns that have emerged over the years. In fact, a number of previous studies indicate that rural communities in sub-Saharan Africa and globally are aware of the varying climatic conditions (Nhemachena *et al.*, 2014 and Haque *et al.*, 2012). Thus, when the findings of this study are examined and compared to previous studies within the sub-region, it is noticeable that what is happening in other parts of Africa is occurring in Mtubatuba.

In fact, the weather perceptions were generally around the change in rainfall patterns. More so, it is clear that the weather perceptions are more tilted towards increased droughts and severe

thunderstorms. A study conducted by Reid and Vogel (2006) confirmed similar results that in northern KwaZulu-Natal majority of the rural communities have been significantly affected by droughts and therefore, are experiencing a water crisis. Dube and Phiri (2013) argue that in South Africa, the weather is changing rapidly and it is predicted to have major consequences for African people. In addition, a recent study conducted by Rankoana (2018) on human perception of climate change in Limpopo demonstrates that an increase in temperatures and irregular rainfall patterns has resulted in the local population perceiving that the climatic conditions are changing. Therefore, this study echoes similar sentiments and argues that the variations in climatic conditions have some serious implications on rural livelihoods. One can argue that the implications of varying weather patterns can have serious repercussions on the physical, biological and human systems; this includes water availability, food security, health, and economic livelihoods.

In view of the above, it is argued that the perceptions of the people in Mtubatuba are not far removed from what the scientific data are indicating. If one looks at the data from the South African Weather Service it is evident that the scientific data presented supports the occurrence of climate variability as seen in figure 4.3 and 4.4 in Chapter four. However, one must acknowledge that the individual's interpretations and perceptions of climate variability are driven by their values, personal experiences, beliefs, and cultural norms as suggested by Hulme (2009). Furthermore, a study by Shahi (2011) found that human perceptions of climate change are built on what people see in their local environments (for example sporadic rainfall amounts as seen in this study). Ejembi and Alfa (2012) and Slegers (2008) argue that human perceptions of the change in climatic conditions are determined by how the change in climate affects people's livelihoods.

Therefore, it is argued that people's perceptions and understanding of their climate are very important in the development of intervention measures. However, this study argues that all levels of society and Government should work together to integrate climate variability and change into the policy framework. It is important to understand that the Government needs to be aware of what people say so that resilience and people's adaptive capacity can be built accordingly. Therefore, it is important that when intervention measures are put in place, human perceptions are considered as they provide the right entry points into the nature and quality of the policies and strategies that are developed. In fact, a study by Slegers (2008) confirmed similar results, where it was argued that the knowledge obtained from examining the local populations' perceptions of climate change could be utilised to develop community-specific adaptation strategies. Buys *et al.* (2012) and Alexander *et al.* (2006) are also of the view that climate change beliefs are quite significant in developing adaptation policy and ensuring community's cooperation in adopting protective strategies.

However, although the findings of this study revealed that droughts episodes were attributed to reduced or sporadic rainfall amounts, it is important to recognise that other factors such as El Niño (or ENSO) and human influence could have been liable for the occurrence of droughts in Mtubatuba. This argument corroborates with Nicholson (2000) who demonstrated that although El Niño (or ENSO) is centered on the Pacific, it influences global atmospheric circulation and worldwide sea-surface temperatures which in turn affects rainfall patterns in Africa. In fact, a number of studies have demonstrated a correlation between rainfall and El Niño (or ENSO) in the southern and eastern Africa (Nicholson, 1996; Lindesay *et al.*, 1986; Janowiak, 1988; Farmer, 1988; van Heerden *et al.*, 1988). Therefore, it is argued that these factors could have also influenced the change in weather patterns in Mtubatuba, particularly rainfall patterns over the years.

In view of the above, it is argued that climate variability is taking place in Mtubatuba just like everywhere else in the world.

5.3 The adverse impacts of climate variability on rural communities in Mtubatuba

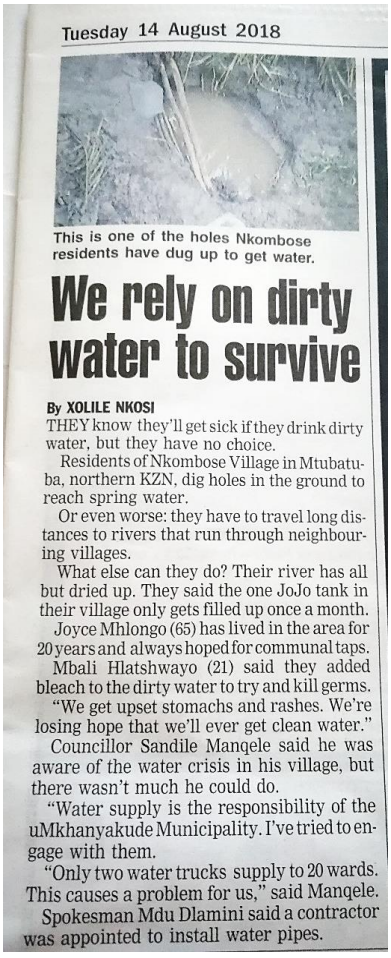
This study was particularly interested in determining the various impacts of climate variability on rural livelihoods in Mtubatuba. Based on the findings of this study it is evident that climate variability negatively affects rural communities in Mtubatuba just like in other developing countries in the sub-region and globally. However, Hummel (2015) and Barr *et al.* (2010) suggest that the sub-Saharan African region is the most at risk and susceptible to climate variability and change compared to anywhere else in the world. De Cock (2012) and Knueppel *et al.* (2009) found that rural South African communities are the most affected by climate variability. As such, the rural communities of Mtubatuba are not exempted from experiencing challenges caused by climate variability, particularly around sustaining their rural livelihoods. In fact, when we compare the findings of this study with other studies it is evident that the impacts of climate variability on rural livelihoods are similar.

Therefore, it is widely acknowledged that rural communities depend highly on natural resources to sustain their rural livelihoods. As such, when the climatic conditions vary over time the rural communities are the most affected. This argument is similar to an argument made by Lyimo and Kangalawe (2010) who emphasised that climate variability and change presents many challenges for rural communities because they depend highly on natural resource to sustain their livelihoods. In fact, Akudugu *et al.* (2012), Gyampoh *et al.* (2009) and Mertz (2009) argue that climate variability

has become a hindrance to the sustainability of many rural livelihoods. Nonetheless, one must realise that different communities are affected by climate variability differently. This is because the needs and wants of people generally differ.

In view of the above observations, the weather challenges experienced by the rural communities of Mtubatuba in KwaZulu-Natal include water scarcity as a result of droughts, which has implications on health, food production, livestock production and financial pressure. This demonstrates that climate variability will have adverse effects on almost all the subsectors of the country. This finding is similar to a finding by Simatele *et al.* (2012) who, working the context of Lusaka in Zambia, found that climate variability and change will affect food production, human health, and livelihood assets. In fact, Turpie and Visser (2013) argue that climate variability and change present social, economic, and environmental challenges for the rural communities of South Africa as they depend highly on natural resources. However, it is argued that the major impact of climate variability on rural communities in Mtubatuba is lack of water, which is attributed to inadequate rainfall amounts or droughts (as seen in table 4.2 and figure 4.5 in Chapter 4).

In fact, the researcher came across a newspaper article entitled 'We rely on dirty water to survive' (figure 5.1), which documents the daily struggle for water that the residents of Nkombose are subjected to because rivers have dried up as a result of inadequate rainfall amounts or droughts.



Tuesday 14 August 2018

This is one of the holes Nkombose residents have dug up to get water.

We rely on dirty water to survive

By XOLILE NKOSI

THEY know they'll get sick if they drink dirty water, but they have no choice.

Residents of Nkombose Village in Mtubatuba, northern KZN, dig holes in the ground to reach spring water.

Or even worse: they have to travel long distances to rivers that run through neighbouring villages.

What else can they do? Their river has all but dried up. They said the one JoJo tank in their village only gets filled up once a month.

Joyce Mhlongo (65) has lived in the area for 20 years and always hoped for communal taps.

Mbali Hlatshwayo (21) said they added bleach to the dirty water to try and kill germs.

"We get upset stomachs and rashes. We're losing hope that we'll ever get clean water."

Councillor Sandile Manqele said he was aware of the water crisis in his village, but there wasn't much he could do.

"Water supply is the responsibility of the uMkhanyakude Municipality. I've tried to engage with them.

"Only two water trucks supply to 20 wards. This causes a problem for us," said Manqele.

Spokesman Mdu Dlamini said a contractor was appointed to install water pipes.

Figure 5.1: Article published in the *Daily Sun*

Source: Daily Sun Newspaper, 14 August 2018

In view of this, it is evident that lack of water attributed to droughts has become a major hindrance for rural communities as it greatly affects their lives, which are highly dependent on this natural resource. One can argue that water is not only used for human consumption but communities, particularly rural communities, also need water for crop farming and livestock production. As such, everyone deserves to have access to this essential resource irrespective of one's financial status. In fact, Clause 27 of the South African Constitution and the South African National Water Amendment Act 27 of 2014 emphasises that everyone has the right to access to clean water and sufficient food.

Although it is recognised that the rural communities such as those of Mtubatuba do not pay for water, one can argue that these communities still deserve clean and adequate water supply, as it is their human right as stated in the constitution. Furthermore, it is argued that every person needs a minimum of 50 litres of water per day given that 50 litres is the absolute minimum required to survive (Gleick, 1996). In fact, Mumma (2008) found that inclusion of the requirements for a permit and the water charges for obtaining water resources in the Water Act (2002) in Kenya was criticised by many for being prejudicial to the rural poor. Hence, the current Water Act (2016) provides some sort of liberation to poor rural communities (Shurie *et al.*, 2017).

Therefore, the researcher is of the view that the Mtubatuba Local Municipality and the Government at large need to be aware of how climate variability negatively affects the livelihoods of rural communities and subsequently take action in providing aid. It is argued that the Government should intensify the effort in providing effective and sufficient aid to those who are less fortunate particularly in rural areas, as they are equally deserving of being assisted when climate conditions vary. In view of this, figure 5.2 below illustrates just one of the many impacts of climate variability on rural livelihoods. It is evident from the figure below that droughts have the potential to lead to reduced agricultural practices (as established in this study) which indirectly can result in food insecurity.

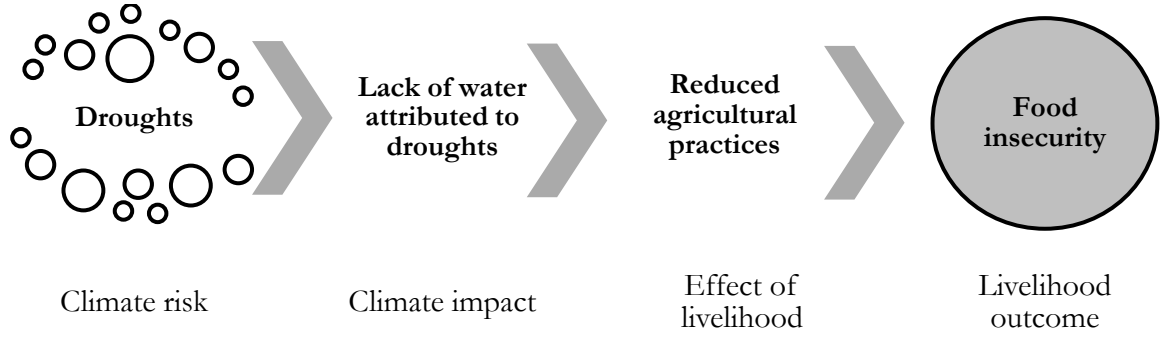


Figure 5.2: The effect of droughts on farming and planting in Mtubatuba

Source: Author's own work

Therefore, one can argue that although the research participants identified reduced farming and planting as an impact, the implications of this are vast and destructive. The implications have the ability to go beyond just people being unable to partake in activities but it can also affect human health and exacerbate poverty levels in some cases. In fact, research shows that climate variability significantly affects rural livelihoods and contributes to increased levels of poverty (Madzwamuse, 2010 and UNFCCC, 2007). This is supported by Perez *et al.* (2015), IPCC (2014), Binns *et al.* (2012) and Roudier *et al.* (2011) who argue that a number of factors aggravate the vulnerability of the poor

people in sub-Saharan Africa to climate variability and change. These factors include low levels of education, weak institutions and policy frameworks, limited technological advancement, high rates of poverty, rapid population growth, and lack of social safety nets.

In view of the above, when one examines previous studies it is evident that the findings of this study are similar to the findings of other previous studies. Wiid and Ziervogel (2012) for example, found that excessive dependence on rainfall explains the heightened exposure of farming communities in sub-Saharan Africa to irregular supply and dwindling availability of water for farming that emanates from declining rainfall, prolonged dry seasons, and droughts, higher than average levels of evaporation and earlier than normal rains. Evidently, studies on the impacts of climate change provide strong evidence of the negative impacts on crop yields (e.g. Nelson *et al.*, 2014) and livelihood outcomes for people in the sub-Saharan African region (IPCC, 2014). In fact, Kebede *et al.* (2011) and Songok *et al.* (2011b) argue that in sub-Saharan Africa, extreme droughts already hinder people's ability to produce food and livestock. Turpie and Visser (2013) demonstrate that in KwaZulu-Natal the majority of the rural communities are dependent on rain-fed agriculture for their livelihoods (as seen in this study). Wheeler and von Braun (2013) argue that climate variability and change can possibly disturb the developments of creating a world without hunger as the steadiness of the food systems may be in danger under the changing climatic conditions. More so, AmjathBabu *et al.* (2016) are of the view that the predicted effects of climate variability and change on agriculture are greater in the sub-Saharan African region. In fact, the IPCC (2007b) projected that by the year 2020, approximately 250 million people from Africa may suffer from food insecurity because of lack of water which is attributed to drought episodes, livestock losses, and climate-driven crop failure. Taking into account that the year 2020 is in less than a year's time, it is evident from this study that the projections made by the IPCC over a decade ago are now taking place in the rural communities of Mtubatuba.

This study also established that similar to farming, a great number of rural communities depend on livestock production for rural livelihoods. Therefore, one can argue that livestock contributes to one of the assets that rural communities depend on to sustain their rural livelihoods. In fact, IFAD (2010), Thornton *et al.* (2007), FAO (2007) and Easterling *et al.* (2007) argue that livestock is the one of a few assets that the rural poor people have, however, it is extremely susceptible to climate variability. However, this study is of the view that livestock is not considered the only asset for the rural poor as it was established that these communities have other assets. Nonetheless, research shows that there are limited studies, which explore the relationship between climate variability and livestock; however, figure 5.3 below attempts to show this relationship (using cows as an example as this is the common livestock in Mtubatuba).

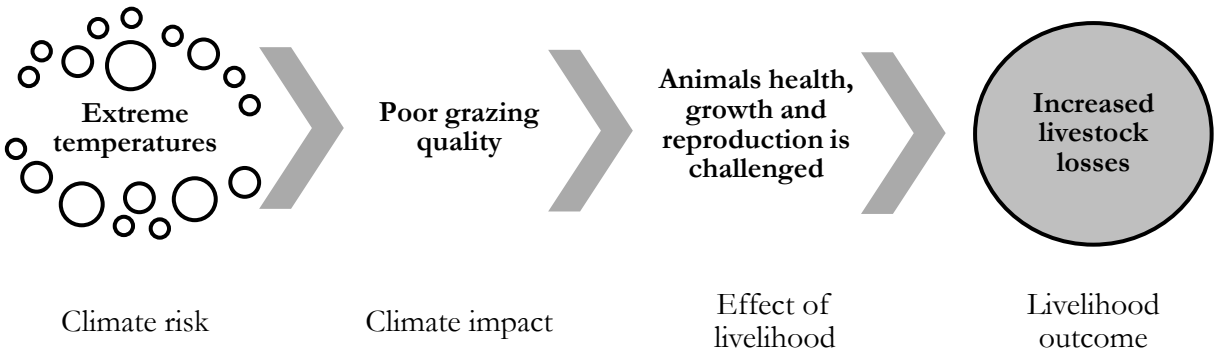


Figure 5.3: The effect of droughts on livestock production in Mtubatuba

Source: Author's own work

This finding argues that extreme temperatures affect livestock production as by negatively affecting livestock feed, health, and growth. This finding draws parallel to a number of previous studies such as that of Smith *et al.* (1996) who argues that there are four ways in which climate variability and change will affect animal production, this includes: impacts livestock feed-grain availability and price; impacts livestock pastures and forage crop production and quality; changes in livestock diseases and pests; and directly affects animal health, growth, and production. In addition, Seo and Mendelssohn (2006a) argued that climate variability and change has the potential of affecting livestock in Africa because small animals (e.g. sheep, goat) can withstand higher temperatures because they can tolerate heat, but by contrast, large animals (e.g. cattle) cannot tolerate heat. Lacetera (2019) further reiterates the impact of extreme temperatures by outlining how a hot environment affects farm animal health. Firstly, Lacetera (2019) is of the view that the direct effects of extreme heat are due to increased temperatures, frequency, and intensity of heat waves. These direct effects can affect livestock health by causing metabolic disruptions, oxidative stress, and immune suppression causing infections and death. Furthermore, Lacetera (2019) argues that the indirect effects are linked to alteration of the availability and the quality of animal feed and drinking water.

It was also established that lack of water due to droughts affects livestock in that animals just like all other living organisms require water for survival. Young *et al.* (2010) support this view, by arguing that a decreased in water supply adversely affects livestock production and therefore affects subsistence farmers because they depend greatly on surface water to support their farming practices. Furthermore, this study established that a small percentage of the research participants suffered job losses as an impact of climate variability. In view of this, it is argued that job losses contribute immensely to income insecurity. Numerous studies were of a similar view. Macchi

(2011), Kohler *et al.* (2010) and Marston (2008) for example found that climate variability and change resulted in water scarcity, which added to income insecurity in a rural area in Nepal. Whereas, Angelsen and Dokken (2015) found that the rural poor people obtain 29 percent of their earnings from environmental resources. A study by Angelsen and Dokken (2015) found that in sub-Saharan Africa, poor rural communities situated in arid regions are already experiencing decreasing revenues because of extreme climatic conditions.

Therefore, this study argues that varying climate conditions can intensify poverty levels in rural communities, particularly because rural communities depend on natural resources to sustain their rural livelihoods. In view of this, it is evident that when environmental resources are under threat from climate variability, the rural communities suffer the most as they undergo added stress in trying to earn a living. The Government needs to engage with rural communities in order to establish the various challenges that they face when dealing with climate variability. As stated previously, involving rural communities will provide the right entry points in preparing in advance and responding to climate variability.

5.4 Assets for climate variability adaptation in Mtubatuba

It was established that the rural communities in Mtubatuba are well aware of climate variability and its impact. Therefore, this study was further interested in determining how the communities of Mtubatuba are adapting to the impacts of climate variability, particularly in examining the different coping strategies that they have put in place. This study supports Moser and Satterthwaite (2008) who argues that poor rural people are not passive actors but they are actively involved in developing ways of adapting to climate variability. Zinyengere *et al.* (2013) and Ziervogel and Taylor (2008) further support this view, as their studies established that people are cognisant of the implications of climate variability on their lives and therefore have developed adaptation strategies which they use to survive the impacts of climate variability.

Moser and Satterthwaite (2008) argue that the degree to which the rural poor are able to adapt and enhance their resilience to climate change largely depends on the bundle of assets that they have and the extent to which these assets can be used to minimise the risks that they face in their environment. Similarly, Bebbington (1999, p.2029) argue that "when people have assets, they have the capability to be and to act". This is similar to a finding by Pelling and High (2005) which found that communities select and implement adaptation strategies according to the resources that they have, as well as their social relationships and beliefs. Reilly and Schimmelpfennig (2000) and Bryant

et al. (2000) argue that the ability of an individual to adapt to climate variability is greatly influenced by the human and social capital that an individual possesses and the assets which are available in the community where one lives. Furthermore, natural capital and the existence or lack of appropriate laws and institutions also play an important role in the adaptive capacity of an individual. In fact, the World Bank (2001) is of the view that natural, physical, and human assets are at the centre of whether a community, household, and an individual will live in poverty – or be able to escape it.

Based on the findings of this study, it is clear that financial, human and social asset portfolios form part of the three most important assets used by the communities of Nkombose, Ebaswazini, and Ogengele to adapt and cope with the impacts of climate variability. Interestingly, this finding correlates with Jabeen's (2015) study which found that financial, human and social assets are the three significant asset portfolios used to build a long-term capacity of individuals within low-income households and communities. If one considers financial assets, for example, it is argued that a person with financial assets is at an advantage over a person who has none. This is because a person with a financial asset is able to acquire the needed resources, which they can use to adapt to or build resilience against the impacts of climate variability. This argument is demonstrated in figure 5.4 below.

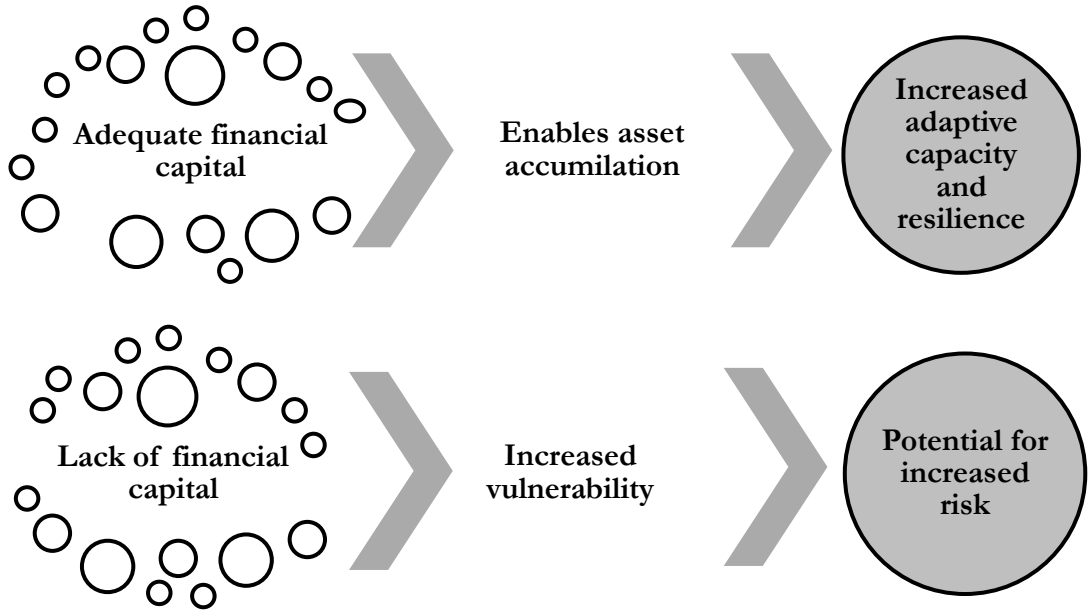


Figure 5.4: A comparison of the adaptive capacity of individuals with financial capital and those without out financial capital.

Source: Author's own work

In view of the above, this study argues that individuals who have financial capital through employment, businesses, and investments will always have increased adaptive capacity when compared to those who lack financial capital.

Nonetheless, the study confirmed that not everyone is able to adapt to the impacts of climate variability. This can be because of the lack of means for adaptation, which can subsequently result in increased vulnerability. In fact, Trærup and Mertz (2011) found that research participants might undertake no adaptation because they are unable to adapt (sometimes due to financial reasons). Similarly, Ekstrom and Moser (2014) observed that insufficient financial capital and political support are the most common difficulties that local people encounter when adapting to the impacts of climate variability. A study by Smit *et al.* (2001) found that vulnerability is strongly tied to wealth. Ellis (2000) and Scoones (1996) argue that the majority of the people pursue paid work and off-farm revenue sources in order to intensify their livelihood support base. It is evident that financial asset portfolios and human asset portfolios are connected because people's skills and knowledge influence their ability to seek employment which is not dependent on farming (for example, getting a full-time job, or selling clothes and chickens).

Therefore, one can argue that knowledge and skills (which forms part of the human asset portfolio) are highly regarded as an important household asset for adaptation. In fact, many studies state the great significance of local knowledge in formulating climate variability adaptation strategies and policies (Thomas *et al.*, 2007; Vogel and O'Brien, 2006; Roncoli *et al.*, 2002, 2001). Robinson and Herbert (2001) noted that in order to develop effective, efficient and sustainable adaptation strategies, local knowledge must be integrated into climate change policies. Roncoli *et al.* (2002) observed that the rural households in dryland farming systems in Africa utilised their local knowledge to come up with adaptation strategies which they used to cope with and adapt to varying weather patterns, whereas, a study by Allen (2006) argues that local knowledge should be the key priority when developing adaptation measures.

In view of this, it was established that the poor rural communities of Mtubatuba have developed ways of adapting to the impacts of climate variability. However, it is argued that the adaptation is weak. Therefore, the Mtubatuba Local Municipality and the Government need to start putting in place certain measures (in addition to improved policy frameworks and regulations). Some of the measures could be:

a) To supply the communities with free and clean water particularly when there are inadequate rainfall amounts (this can be in a form of community tanks or have water tank trucks in and around the communities at least twice a week). If financial constraints exist

then the Municipality could consider collaborating with public and private sectors. For example, partnering with 'Charity: Water' which is a non-profit organization which assists in bringing clean and safe drinking water to people in developing countries.

b) To provide the communities with skills development programmes and knowledge which they can use to adapt to climate variability,
c) To provide job opportunities so that the communities are able to support their families and to improve their financial situation,
d) To build RDP houses for those who cannot afford to build resilient houses,
e) To install lightning conductors as precautionary measures rather than as an after effect.

Although the above measures are not the only options available, it is however argued that these measures could be great starting points not only for climate variability adaptation but also for long-term climate change adaptation (particularly (b) to (e)). These measures can advance the quality of life and financial well-being of people living in these rural areas. In addition, these measures can enable the communities to be actively involved in agricultural productivity, which is one of the biggest activities, which rural livelihoods depend on. With these measures in place, the rural poor people of Mtubatuba and KwaZulu-Natal could be protected.

In addition, it is important to enable rural poor communities continuously to ensure long-standing adaptation instead of a once-off solution. This argument agrees with Hulme and Moore (2008) who argue that the rural poor people cannot benefit from one 'magic bullet' (such as, microcredit, and women's groups). They argue that the rural poor people require a structured set of support that offers livelihood security; confidence building and skill development; asset transfer; and support for the institutionalization of their improved position within the local economy and society (Hulme and Moore, 2008). Therefore, unless the rural communities obtain skills development and stable financial sources through employment opportunities, the current adaptation strategies will not be long-lasting ways of adapting to climate variability.

This study shows that the Mtubatuba Local Municipality recognises climate variability and its impacts on the rural livelihoods; however, the action is very limited. This correlates with Faling *et al.* (2012) who argues that many small municipalities in South Africa are aware of climate variability; however there is a limited indication of action. In view of this, it is worthwhile to note that municipalities in South Africa have been given legal provisions to establish proactive climate variability and change strategies (Faling *et al.*, 2012). These legal provisions are includes in the various Acts and guidelines. These include the Disaster Management Act (Republic of South Africa, 2002), the Disaster Management Regulations and the Disaster Management Guidelines

(Department of Provincial and Local Government, 2005). In fact, the Disaster Management Guidelines classify climate risks such as droughts and floods as extreme weather disasters that need a municipal response. Therefore, one can argue that within the context of South Africa, the Government and the municipalities need to actively involve and empower communities in developing ways of adapting to climate variability as this would also contribute to long-term climate change adaptation. Empowered communities are likely to be able to adapt to the impacts of climate variability. In view of this, the study suggests that in order to build long-term adaptation strategies, these must be home-grown from the communities.

5.5 The wider implications of the findings of this study in sub-Saharan Africa and the South African context

The first implication of this study derived from the finding that the communities of Nkombose, Ebaswazini, and Ogengele identified droughts and severe thunderstorms as the two ways in which climate variability has manifested itself in Mtubatuba. This finding was supported by scientific data, which was also presented under the empirical evidence of this study. Therefore, this finding provides much needed empirical data on climate variability in Mtubatuba. In addition, this finding adds to an existing body of knowledge, which suggests that droughts are common in southern Africa (Reason *et al.*, 2005; Mulenga *et al.*, 2003 and Rouault and Richard, 2005). In fact, droughts are not only a national or regional dilemma but there is substantial amount of literature that demonstrates that droughts are actually a global concern (Cheng *et al.,* 2016; Kiem *et al.*, 2016; Aghakouchak *et al.*, 2015; Zuo *et al.*, 2015; Masih *et al.*, 2014; Lyon, 2014; Van Dijk *et al.*, 2013; Qiu, 2010). Therefore, in view of this, this finding hopes to contribute to the Mtubatuba Local Municipality's future planning and intervention measures of addressing and preparing for extreme weather events in Mtubatuba.

The second implication of this study is around how the rural communities are most impacted by climate variability. This study has demonstrated how inadequate rainfall amounts or droughts have implications on farming and planting practices, livestock production, food security, health nutrition, and job opportunities. In fact, studies by Sheffield *et al.* (2012) and Wang *et al.* (2011) argue that droughts could negatively affect food production, water supply, and the whole environment. Therefore, this study demonstrates that if climate variability and change are not addressed, it will have implications on the subsectors of the country. Therefore, the findings of this study also add to the existing knowledge on how rural communities are highly dependent on

rain-fed agriculture to sustain their livelihoods. Studies on the impacts of climate variability provide strong evidence of the negative impacts of climate variability on crop yields (e.g. Nelson *et al.*, 2014) and livelihood outcomes for people in the sub-Saharan Africa region (IPCC, 2014). AmjathBabu *et al.* (2016) found that the estimated impacts of climate variability and change on agriculture are much greater in sub-Saharan Africa when compared to other regions in the world. Hendriks (2005) found that in South Africa, a large percentage of households in rural areas are at risk of food insecurity because of climate variability. It is evident that the negative impacts of climate variability on farming are a global concern, which needs to be addressed urgently. Therefore, studies such as this one hope to emphasise the need for Government and municipal intervention in addressing the impacts of climate variability.

The third implication of this study stems from our understanding that the people of Nkombose, Ebaswazini, and Ogengele are not passive actors but are actively involved in coming up with ways of adapting to the impacts of climate variability. In fact, previous studies (e.g. Nunn *et al.*, 2014 and Barnett and Campbell, 2010) provide strong evidence that researchers are gradually recognizing that to better understand what climate variability means for communities, there is a need for knowledge of how people experience and respond to varying climatic conditions that are particularly relevant to them. Therefore, this study provides needed knowledge of the numerous ways in which rural communities respond to climate variability.

In view of this, this study found that the rural communities of Nkombose, Ebaswazini, and Ogengele rely on adaptation strategies, which are mostly linked to financial, human, and social asset portfolios. Interestingly, this study is not the first to discover that financial, human, and social asset portfolios are the three important assets used for adaptation. In fact, Jabeen (2015) found that financial, human and social assets are the three significant asset portfolios used to build a long-term capacity of individuals within low-income households and communities. However, this study does provide adequate data to substantiate this finding. Therefore, this study adds to the existing body knowledge on the important asset portfolios used by rural communities in adapting to the impacts of climate variability. In view of this, this research suggests that if rural communities are equipped with adequate local knowledge on how to live under changing climates the communities will not only survive but they will thrive.

For South Africa and sub-Saharan Africa, existing literature suggests that there is a need for more research to investigate the impacts of climate variability on water resources and agriculture, particularly in terms of how communities respond and build adaptive capacity and resilience (Ziervogel *et al.*, 2014). In view of this, therefore, this study is of great importance as it is the first

study focussing on the impacts of climate variability on rural livelihoods in Mtubatuba, KwaZulu-Natal. The study hopes to contribute significantly to the discussion of how the Mtubatuba Local Municipality, as well as the country and the continent at large, can better equip and provide assistance to rural poor communities in preparing for and responding to the impacts of climate variability. This also involves nurturing and supporting the existing adaptation strategies, which the communities have put in place in order to make them long-lasting and efficient.

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

6.1 Introduction

This chapter is dedicated to presenting a summary of the findings of this study. Therefore, this chapter outlines the key findings, particularly the findings, which demonstrate that the research questions and objectives outlined in chapter one of this study have been answered. In addition, the chapter discusses the recommendations for the various stakeholder groups. These recommendations encourage social cohesion and collective efforts of build a long-lasting adaptive capacity towards the impacts of climate variability in rural communities. Lastly, I reflect on the limitations of the study as well as the research gaps, which could potentially inspire future research in climate variability adaptation in rural communities.

6.2 Summary of key findings of the research and the conclusion

Climate variability and change have become quite a topic in the 20th century, particularly in developing countries. This is because developing countries are the most affected by climate variability and change. Although more and more people have become aware of the negative impacts of climate variability, particularly on rural livelihoods (Turpie and Visser, 2013) there is very limited literature, which focusses on how the rural communities in KwaZulu-Natal cope with, and adapt to climate variability. Therefore, this study investigated the ways in which the rural poor households in Mtubatuba use the different asset portfolios and a combination of assets to build their adaptive capacity and resilience against climate variability.

In view of the above, the study established that the communities of Nkombose, Ebaswazini, and Ogengele in Mtubatuba like everywhere else in the sub-region and globally have been exposed to climate variability. The human perceptions revealed that the rural communities in Mtubatuba are aware of the varying climatic conditions. In fact, the human perceptions and the climate data obtained for this study demonstrates that the communities of Nkombose, Ebaswazini, and Ogengele have been greatly affected by droughts and severe thunderstorms. These two extreme weather events have had implications on the lives of the rural poor people in Mtubatuba.

The first objective of this study was achieved as the study determined that the major impact of climate variability linked to droughts was lack of water. This impact had implications on various activities (such as reduced farming and planting practices, increased livestock losses) which the rural communities undertake to sustain their rural livelihoods. In fact, lack of water attributed to droughts was seen as adding more pressure on the lives of the rural communities in Mtubatuba, particularly because water is the most fundamental resource, required in sustaining human and animal life. Thus, one can conclude that the implications of the lack of water attributed to droughts have the potential to not only affect the day-to-day activities of these communities but also to further aggravate their ability to sustain their rural livelihoods. Furthermore, reduced agricultural practices have the ability to contribute to food insecurity and increased poverty levels in rural communities of Mtubatuba.

The study demonstrates that the rural communities of Mtubatuba are passive actors as they are actively involved in developing ways of adapting to the impacts of climate variability. Therefore, the second and the third objectives were fulfilled as the study established the different asset portfolios which the rural communities in Mtubatuba use to adapt to climate variability and the assets which play a very important role in the adaptation process. The majority of the households in the rural communities of Mtubatuba were able to develop strategies, which they use to adapt to the impact of climate variability. These strategies were linked to the five fundamental assets as defined by Moser and Dani (2008). These measures included using social grants and investments to purchase water and agricultural produce that was required to sustain their lives. It was also established that some households were able to use their skills to sell in order to gain financial capital. In view of this, the study established that access to financial capital or assets contributes immensely to the person's ability to build resilience and adapt to climate change. In addition, the study established that a fair number of the research participants relied highly on local knowledge, skills, and education (which form part of the human asset portfolios) in adapting to the impacts of climate variability. In fact, financial and human assets were the two most important asset portfolios used by the rural communities in Mtubatuba in the adaptation process. Social asset portfolios were observed as the third asset portfolio which communities relied on in adapting to climate variability.

In view of the above, one can conclude that although the communities are adapting to the impacts of climate variability, the adaptation is weak. Therefore, the researcher is of the view that the Mtubatuba Local Municipality and the government need to get more involved in engaging and equipping these communities. This will enable the communities to develop long-lasting and efficient ways of adapting to the impacts of climate variability. This will also have policy

implications as when intervention measures are put in place, human perceptions will provide the right entry points into the nature and quality of the policies and strategies that are developed.

Lastly, the fourth objective was achieved as the data presented and discussed in this dissertation has theoretical implications and contributes to the body of knowledge on the combination of assets used in the climate variability adaptation process particularly by rural poor communities.

6.3 Recommendations for building an adaptive capacity on the impacts of climate variability in rural communities

Climate variability and change are one of the major global issues of our time. In fact, climate variability affects almost all (if not all) form of life. Unfortunately, rural communities, particularly in developing countries, are the most affected by climate variability and change. It is evident from the findings of this study that the rural communities of Mtubatuba are already experiencing the negative impacts of climate variability. Although these communities have managed to put in place measures of adapting to the impacts of climate variability, it is evident that these strategies are limited by the quality of assets that they have. Therefore, because building resilience and adapting to the impacts climate variability requires a collective effort, this study's recommendations have been divided according to the different stakeholder groups.

a) Recommendations for the rural communities of Mtubatuba:

It is widely acknowledged that rural communities are the most affected by climate variability, as a result, are most in need of adaptation. In view of this, this study recommends that rural people need to start interacting with each other within their various communities. These communities can start support groups such as climate variability and change support groups or focus groups, where they can meet as often as they can to discuss the various concerns that they are faced with and to come up with ways of addressing these concerns. Thereafter, the communities could use the views obtained from these discussions to encourage municipal and governmental support and intervention. This will not only show initiation but also prove that the communities are willing to participate in developing ways of dealing with the issues of climate change. This will also serve as a strong collective voice rather than separate voices.

Furthermore, the communities could use the support groups and focus groups to share the existing adaption measures which they use as these can also assist others community members. Sharing of local knowledge is very important.

b) Recommendations for the Mtubatuba Local Municipality:

One can argue that a community can never reach its full potential without the support of its municipality. Therefore, this study recommends action driven measures, which the Mtubatuba Local Municipality, as well as other municipalities, could embark on in order to enable the communities, particularly rural communities to reach their full potential in facing the changing climate conditions. Firstly, municipalities need to engage with rural communities and utilise local knowledge as entry points for developing local climate variability and change policies and frameworks. Additionally, the Mtubatuba Local Municipality needs to interact with the rural communities particularly on issues around the possible ways of supplying water when extreme weather events occur

Secondly, it is very important for municipalities to enable rural communities by providing skills and job opportunities. As established in this study, skills are very important, as these are intangible assets, which the communities can draw on particularly in times of need. In addition, the Mtubatuba Local Municipality needs to provide the communities with housing improvements as well as provide the rural communities with lightning conductors as a precautionary measure. This will assists communities with long-lasting resources, which will enable them to withstand climate variability. In fact, if these communities were to be provided with resilient basic services, they would not need to dig deep into their asset portfolios every time an extreme weather event occurs. These communities would be in a better position and better prepared for climate variability most of the times.

c) Recommendations for the Government:

One cannot overemphasise the importance of the Government's role in climate variability adaptation. Firstly, this study recommends that there is a need for the Government, local municipalities and rural communities to embark on a journey of discovering new and efficient ways of building an adaptive capacity towards the impacts of climate variability and change as well as to strengthen the existing adaptation strategies adopted by rural communities.

Secondly, this study recommends that the Government provide support to local and district municipalities so that they are able to drive climate variability adaptation on the ground. The support required includes providing the municipalities with the necessary resources required to carry out their duties, such as emotional support, financial support, and informational support. Thereafter, the Government should hold local and district municipalities accountable if they do not carry out their mandate.

6.4 Limitations of the study and Recommendations for future research

All studies have limitations. Therefore, this study may have had its own limitations. The first limitation was that the study was limited to three rural areas in Mtubatuba because of time constraints and financial resources. Therefore, the results may not be generalised for the entire Mtubatuba area, as there are many rural communities in this area. Future studies could consider incorporating more rural communities in Mtubatuba and thus a larger sample size.

Secondly, the study only examined the impacts and adaptation strategies related to climate variability. Therefore, based on the findings of this study, it is evident that there is a need for further studies which will explore a number of other elements, such as a study investigating the contribution of El Niño (or ENSO) and human influence on climate variability in Mtubatuba. It would be interesting to determine whether there is a connection between El Niño (or ENSO) and climate variability; as well as human influence and climate variability. In addition, as previously stated in *section 3.4.1* under the description of the research site, that Mtubatuba is highly dominated by Gum trees (Eucalyptus Grandis (Myrtaceae) there is a need for a study that will investigate the impact of Gum trees on water resources in Mtubatuba. Lastly, there is a dire need for a study, which will examine the impact of climate variability and change on food security as well as poverty levels in rural communities in South Africa.

ACKNOWLEDGEMENT OF PERSONAL COMMUNICATION

Pers. Com 2018a, Focus group respondent in Ebaswazini on 16 October 2018, Mtubatuba, KwaZulu-Natal.

Pers. Com 2018b, Focus group respondent in Ogengele on 23 October 2018, Mtubatuba, KwaZulu-Natal.

Pers. Com 2018c, Focus group respondent in Nkombose on 15 August 2018, Mtubatuba, KwaZulu-Natal.

Pers. Com 2018d, Focus group respondent in Ogengele on 23 October 2018, Mtubatuba, KwaZulu-Natal.

Pers. Com 2018e, Interview with a local authority from the Disaster Management Centre, Mtubatuba Local Municipality on 17 October 2018, Mtubatuba, KwaZulu-Natal.

Pers. Com 2018f, Questionnaire participant in Nkombose on 14 August 2018, Mtubatuba, KwaZulu-Natal.

Pers. Com 2018g, Questionnaire participant in Nkombose on 10 August 2018, Mtubatuba, KwaZulu-Natal.

Pers. Com 2018h, Questionnaire participant in Ebaswazini on 18 August 2018, Mtubatuba, KwaZulu-Natal.

Pers. Com 2018i, Focus group respondent in Ebaswazini on 16 October 2018, Mtubatuba, KwaZulu-Natal.

Pers. Com 2018j, Questionnaire participant in Nkombose on 11 August 2018, Mtubatuba, KwaZulu-Natal.

Pers. Com 2018k, Questionnaire participant in Nkombose on 16 August 2018, Mtubatuba, KwaZulu-Natal.

Pers. Com 2018l, Questionnaire participant in Nkombose on 13 August 2018, Mtubatuba, KwaZulu-Natal.

Pers. Com 2018m, Questionnaire participant in Nkombose on 16 August 2018, Mtubatuba, KwaZulu-Natal.

Pers. Com 2018n, Focus group respondent in Ebaswazini on 16 October 2018, Mtubatuba, KwaZulu-Natal.

Pers. Com 2018o, Focus group respondent in Ogengele on 23 October 2018, Mtubatuba, KwaZulu-Natal.

Pers. Com 2018p, Focus group respondent in Ebaswazini on 16 October 2018, Mtubatuba, KwaZulu-Natal.

Pers. Com 2018q, Focus group respondent in Nkombose on 15 August 2018, Mtubatuba, KwaZulu-Natal.

Pers. Com 2018r, Focus group respondent in Nkombose on 15 August 2018, Mtubatuba, KwaZulu-Natal.

Pers. Com 2018s, Focus group respondent in Nkombose on 15 August 2018, Mtubatuba, KwaZulu-Natal.

Pers. Com 2018t, Interview with a local authority from the Disaster Management Centre, Mtubatuba Local Municipality on 17 October 2018, Mtubatuba, KwaZulu-Natal.

Pers. Com 2018u, Interview with a local authority from the Disaster Management Centre, Mtubatuba Local Municipality on 17 October 2018, Mtubatuba, KwaZulu-Natal.

Pers. Com 2018v, Interview with a local authority from the Disaster Management Centre, Mtubatuba Local Municipality on 17 October 2018, Mtubatuba, KwaZulu-Natal.

Pers. Com 2018w, Interview with a local authority from the Disaster Management Centre, Mtubatuba Local Municipality on 17 October 2018, Mtubatuba, KwaZulu-Natal.

Pers. Com 2018x, Interview with a local authority from the Disaster Management Centre, Mtubatuba Local Municipality on 17 October 2018, Mtubatuba, KwaZulu-Natal.

Pers. Com 2018y, Interview with a local authority from the Disaster Management Centre, Mtubatuba Local Municipality on 17 October 2018, Mtubatuba, KwaZulu-Natal.

Pers. Com 2018z, Interview with a local authority from the Disaster Management Centre, Mtubatuba Local Municipality on 17 October 2018, Mtubatuba, KwaZulu-Natal.

REFERENCES

Ackerley, D., Booth, B.B.B., Knight, S.H.E., Highwood, E.J., Frame, D.J., Allen, M.R. and Rowell, D.P. (2011). Sensitivity of Twentieth-Century Sahel Rainfall to Sulfate Aerosol and CO2 Forcing. *American Meteorological Societ*, 24: 4999-5014.

Adepetu, A. and Berthe, A. (2007). Vulnerability of rural sahelian households to droughts: options for adaptation. *Assessments of impacts and adaptations to climate change (AIACC)*, Project No. AF 92, International START Secretariat, Washington.

Adger, W.N. (2001). Social capital and climate change. Working Paper 8, Tyndall Centre for Climate Change Research, University of East Anglia, Norwich.

Adger, W. N. (2003). Social capital, collective action, and adaptation to climate change. *Economic Geography*, 79(4): 387–404.

Adger, W.N., Huq, S., Brown, K., Conway, D., and Hulme, M. (2003). Adaptation to climate change in the developing world. *Progress in Development Studies*, 3(3): 179-195.

Adger, W.N., Huq, S., Mace, M.J. and Paavola, J. (Eds.). (2005). Justice in Vulnerability and Adaptation to Climate Change. Page 78. MIT Press, Cambridge.

Adger, W. (2006). Vulnerability. *Global Environmental Change*, 16 (3): 268-281.

Adger, W.N., Jouni P., Saleemul, H. and Mace, M.J. eds. (2006). *Fairness in Adaptation to Climate Change*. Cambridge, MA: MIT Press.

Adger, W.N., Agrawala, S., Mirza, M.M.Q., Conde, C., O'Brien, K., Pulhin, J., Pulwart, R., Smit, B. and Takahashi, K. (2007). Assessment of adaptation practices, options, constraints and capacity. In: *Climate Change 2007*: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the FourthAssessment Report of the Intergovernmental Panel on Climate Change [Parry, M.L., O.F. Canziani, J.P. Palutikof, P.J. van der Linden, and C.E. Hanson (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 717-743.

Adger, W.N., Dessai, S., Goulden, M., Hulme, M., Lorenzoni, I., Nelson, D.R., Naess, L.O., Wolf, J. and Wreford, A. (2009). Are there social limits to adaptation to climate change? *Climate Change*, 93: 335–354.

Adger, W.N., Barnett, J., Brown, K., Marshall, N.A. and O'Brien, K. (2012). Cultural dimensions of climate change impacts and adaptation. *Nature Climate Change*, 3: 112-117.

Adomako, T. and Ampadu, B. (2015). The Impact of Agricultural Practices on Environmental Sustainability in Ghana: A Review. *Journal of Sustainable Development*, 8(8): 70-85.

Ager, A. and Sparling, T. (2013). Participatory Ranking Methodology (PRM), *A Brief Guide, Version 3.1*. New York, USA: Program on Forced Migration and Health, Mailman School of Public Health, Columbia University.

Aghakouchat, A., Cheng L., Mazdiyasni, O., and Farahmand, A. (2015). Global warming and changes in risk of concurrent climate extremes: insights from the 2014 California drought. *Geophys. Res. Lett.*, 41: 8847–8852.

Agrawal, A., McSweeney, C., and Perrin, N. (2008). Local institutions and climate change adaptation. World Bank, Washington, DC.

Akaranga, S.I. and Ongong'a, J. (2013). Work Ethics for University Lecturers: An Example of Nairobi and Kenyatta. *International Journal of Arts and Commerce*, 2 (8): 8-22.

Akudugu, M. A., Dittoh, S. and Mahama, E.S. (2012). The Implications of Climate Change on Food Security and Rural Livelihoods: Experiences from Northern Ghana. *Journal of Environment and Earth Science*, 2(3): 21-29.

Alam, G.M.M. (2016). An assessment of the livelihood vulnerability of the riverbank erosion hazard and its impact on food security for rural households in Bangladesh. PhD thesis, School of Commerce, University of Southern Queensland, Australia.

Alexander, L. V., Zhang, X., Peterson, T.C., Caesar, J., Gleason, B., Klein Tank, A.M.G., Haylock, M., Collins, D., Trewin, B., Rahimzadeh, F., Tagipour, A., Rupa Kumar, K., Revadekar, J., Griffiths, G., Vincent, L., Stephenson, D. B., Burn, J., Aguilar, E., Brunet, M., Taylor, M., New, M., Zhai, P., Rusticucci, M., Vazquez-Aguirre, J. L. (2006). Global observed changes in daily climate extremes of temperature and precipitation. *J. Geophys. Res.*, 111, D05109, doi: 10.1029/2005JD006290

Allen, M., *et al.* (2006). Quantifying anthropogenic influence on recent near-surface temperature change. *Surv. Geophysics*, 27, 491–544, doi: 10.1007/s10712-006-9011-6.

Alvi, M.H. (2016). A Manual for Selecting Sampling Techniques in Research

Amjath-Babu, T.S., Krupnik, T.J., Aravindakshan, S., Arshad, M. and Kaechele, H. (2016). Climate change and indicators of probable shifts in the consumption portfolios of dryland farmers in sub-Saharan Africa: implications for policy. *Ecol. Indic*, 67: 830–838.

Andrews, L., Higgins, A., Andrews, M.W. and Lalor, J. G. (2012). Classic grounded theory to analyse secondary data: Reality and reflections. *The Grounded Theory Review*, 11(1): 12-26.

Angelsen, A. and Dokken, T. (2015). Environmental reliance, climate exposure, and vulnerability: a cross-sectional analysis of structural and stochastic poverty. Policy Research Working Paper 7474. Washington, DC: World Bank.

Angula, M. (2010). Gender and climate change: Namibia case study. Heinrich Boell Foundation, Cape Town, 45.

Apata, T.G., Samuel, K.D., Adeola, A.O. (2009). Analysis of climate change perception and adaptation among arable food crop farmers in South Western Nigeria. Paper presented at the *International Association of Agricultural Economists' 2009 Conference*, Beijing, China, 16–22.

Arnall, A.H. (2012). Understanding adaptive capacity at local level in Mozambique. *Mozambique Synthesis Report*, Africa Climate Change Resilience Alliance (ACCRA), Maputo.

American Statistical Association. (1997). How to Conduct Pretesting. American Statistical Association series: What is a Survey? Alexandria.

Asfaw, Z. (2010). Homegardens and traditional agroforestry systems in climate adaptation: hopes for climate homegardens and agroforestry in Ethiopia. In: Assefa, F. and Girmay, W. (eds.), *Proceedings of a National Workshop on Climate Change: Challenges and opportunities for adaptation in Ethiopia*. The Biological Society of Ethiopia, Addis Ababa University, Addis Ababa. Pp. 41-53.

Ateeq-Ur-Rehman, M., Siddiqui, B.N., Hashmi, N., Masud, K., Adeel, M., Khan, M.R.A., Dawood, K.M., Shah, S.A.A. and Karim, M. (2018). Climate Change Impact on Rural Livelihoods of Small Landholder: A Case of Rajanpur, Pakistan. *International Journal of Applied Agricultural Sciences*, 4(2): 28-34. doi: 10.11648/j.ijaas.20180402.11

Ayers, J. and Forsyth, T. (2009). Community–based adaptation to climate change: Strengthening resilience through development. *Environment: Science and Policy for Sustainable Development*, 51 (4):22–31.

Babulo, B., Muys, B., Nega, F., Tollens, E., Nyssen, J., Deckers, J. and Mathijs, E. (2008). Household livelihood strategies and forest dependence in the highlands of Tigray, Northern Ethiopia. *Agricultural Systems,* 98:147–155.

Badola, R., and Hussain, S.A. (2005). Valuing ecosystems functions: an empirical study on the storm protection function of Bhitarkanika mangrove ecosystem, India. *Environmental Conservation*, 32(1):85–92.

Barbier, E. B. (2008). In the wake of the tsunami: lessons learned from the household decision to replant mangroves in Thailand. *Resource and Energy Economics*, 30(2):229–49.

Barbier, E. B. (2015). Climate change impacts on rural poverty in low-elevation coastal zones. *Estuarine, Coastal and Shelf Science*, 165:A1–13

Barnett, J. and Campbell, J. (2010). Climate change and small island states: Power, knowledge and the South Pacific. London, UK: Earthscan.

Barnett, J., Waters, E., Pendergast, S. and Puleston, A. (2013). Barriers to adaptation to sealevel rise. National Climate Change Adaptation Research Facility, Gold Coast: University of Melbourne.

Barr, R., Fankhauser, S. and Hamilton, K. (2010). Adaptation investment: A resource allocation framework. *Mitig. Adapt. Strateg. Glob. Change*, 15(8):843-858.

Bates, B., Kundzewicz, Z. W., Wu, S., and Palutikof, J. (2008). *Climate change and water*. Cambridge: Intergovernmental Panel on Climate Change (IPCC).

Bebbington, A. (1999). Capitals and the Capabilities: A Framework for Analysing Peasant Viability Rural Livelihoods and Poverty. *World Development*, 27 (12): 2021-44.

Beg, N., Morlot, J.C., Davidson, O., Afrane-Okesse, Y., Tyani, L., Denton, F., Sokona, Y., Thomas, J.P., La Rovere, E., Parikh, J.K., Parikh, K. and Rahman, A.A. (2011). Linkages between Climate Change and Sustainable Development. *Clim. Policy,* 2(2-3):129-144.

Bele, M.Y., Tiani, A.M., Somorin, O.A. and Sonwa, D.J. (2013). Exploring vulnerability and adaptation to climate change of communities in the forest zone of Cameroon. *Climatic Change*, 119(3-4): 1-15.

Belliveau, S., Smit, B. and Bradshaw, B. (2006). Multiple exposures and dynamic vulnerability: Evidence from the grape industry in the Okanagan Valley, Canada. *Global Environmental Change*, 16: 364-378.

Benebere, P., Asante, F. and Appiah, D.O. (2017). Hindrances to adaptation to water insecurity under climate variability in peri-urban Ghana. *Cogent Social Sciences*, 3 (1394786): 1-17.

Bergold, J. (2007). Participatory strategies in community psychology research—a short survey. In A. Bokszczanin (Ed.), *Poland welcomes community psychology: Proceedings from the 6th European Conference on Community Psychology*, pp.57-66. Opole: Opole University Press.

Bergold, J. and Thomas, S. (2010). Partizipative Forschung. In Günter Mey and Katja Mruck (Eds.), *Handbuch Qualitative Forschung in der Psychologie*, pp.333-344. Wiesbaden: VS Verlag.

Berry, P.M., Rounsevell, M.D.A., Harrison, P.A. and Audsley, E. (2006). Assessing the vulnerability of agricultural land use and species to climate change and the role of policy in facilitating adaptation. *Environ. Sci. Policy,* 9: 189–204.

Bewket, W. (2012). Climate change perceptions and adaptive responses of smallholder farmers in Central Highlands of Ethiopia. *Int. J. Environ. Stud.*, 69(3):507-523.

Biasutti, M. (2013). Forced Sahel rainfall trends in the CMIP5 archive. *Journal of Geophysical Research D: Atmospheres*, 118(4): 1613-1623.

Biesbroek, R., Klostermann, J., Termeer, C. and Kabat, P. (2011). Barriers to climate change adaptation in the Netherlands. *Climate Law*, 2(2): 181-199. Doi: 10.3233/CL-2011-033.

Binns, T., Dixon, A. and Nel, E. (2012). *Africa: Diversity and Development*. Routledge, London, New York.

Blumberg, B., Cooper, D.R. and Schindler, P.S. (2005). *Business Research Methods*. Mc Graw Hill: Berkshire.

Boko, M., Niang, I., Nyong, A., Vogel, C., Githeko, A., Medany, M., Osman-Elasha, B., Tabo, R. and Yanda, P. (2007). *Africa: Climate Change 2007: Impacts, Adaptation and Vulnerability*. In Parry, M.L., Canziani, O.F., Palutikof, J.P., van der Linden, P.J. and Hanson, C.E. Eds. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge UK, 433-467.

Boyce, C. and Neale, P. (2006). *Conducting in-depth Interviews: A Guide for Designing and Conducting In-Depth Interviews*. Pathfinder International Tool Series.

Boyd, E., Cornforth, R.J., Lamb, P.J., Tarhule, A., Lélé, M.I. and Brouder, A. (2013). Building resilience to face recurring environmental crisis in African Sahel. *Nature Climate Change*, 3: 631–637. Doi:10.1038/nclimate1856.

Bradburn, N.M. (2004). Understanding the question-answer process. *Survey Methodology*, 30 (1): 5-15.

Britten, N. (1999). Qualitative interviews in healthcare. In Pope C, Mays N (eds) *Qualitative research in health care*. 2nd ed. pp 11–19. London: BMJ Books.

Brooks, N. and Adger, W.N. (2003). Country level risk measures of climate-related natural disasters and implications for adaptation to climate change. *Tyndall Centre Working Paper 26*.

Brouwer, R., Akter, S., Brander, L. and Haque, E. (2007). Socioeconomic vulnerability and adaptation to environmental risk: a case study of climate change and flooding in Bangladesh. *Risk Analysis*, 27(2): 313-326.

Brugger, J. and Crimmins, M.A. (2012). *Weather, Climate and Rural Arizona: Insights and Assessment Strategies*. A Technical Input to the U.S National Climate Assessment, University of Arizona, Tucson, AZ, USA, 80.

Brulle, R., Carmichael, J. and Jenkins, J. (2012). Shifting public opinion on climate change: an empirical assessment of factors influencing concern over climate change in the U.S., 2002–2010. *Clim. Change*, 114: 169–188.

Bryan, E., Deressa, T.T, Gbetibouo, G.A. and Ringler, C. (2009). Adaptation to climate change in Ethiopia and South Africa: options and constraints. *Environmental Science and Policy*, 12: 413-426.

Bryan, E., and Behrman, J. (2013). Community–based adaptation to climate change: A theoretical framework, overview of key issues and discussion of gender differentiated priorities and participation. *CAPRi Working Paper No. 109*. Washington, D.C.: International Food Policy Research Institute.

Bryan, E., Ringler, C., Okoba, B., Roncoli, C., Silvestri, S. and Herrero, M. (2013). Adapting agriculture to climate change in Kenya: household strategies and determinants. *Journal of Environmental Management*, 114: 26-35.

Bryant, R.C., Smit, B., Brklacich, M., Johnston, R., Smithers, J., Chiotti, Q., Singh, B. (2000). Adaptation in Canadian agriculture to climate variability and change. *Climate Change*, 45: 181–201.

Buckland, R., Eele, G., Mugwara, R. (2000). Humanitarian crises and natural disasters: a SADC perspective. In: Clay, E. and Stokke, O. (eds) *Food and human security*. Frank Cass Publishers, London, p 181–195.

Bulmer, M. (2004). Questionnaires, 1st edition, *Sage Benchmarks in Social Science Research Methods*, edited by: Bulmer, M., Sage Publications, London, 354 pp.

Bunce, M., Brown, K. and Rosendo, S. (2010a). Policy misfits, climate change and crossscale vulnerability in coastal Africa: how development projects undermine resilience. *Environmental Science and Policy*, 13(6): 485-497.

Burns, S.N. and Grove, S.K. (2003). Understanding nursing research. 3rd edition. Philadelphia: Saunders.

Burroughs, W.J. (2007). Climate Change: A Multidisciplinary Approach (2nd ed.), Cambridge: Cambridge University Press.

Burton, I. (1992). Adapt and Thrive. Canadian Climate Centre unpublished manuscript, Downsview, Ontario.

Burton, I. and van Aalst, M. (2004). *Look before you leap: A risk management approach for incorporating climate change adaptation into World Bank operation*. Washington, DC: The World Bank.

Buys, L., Miller, E. and van Megen, K. (2012). Conceptualising climate change in rural Australia: community perceptions, attitudes and (in) actions. *Regional Environmental Change*, 12(1): 237-48.

Buzan, T. and Abbott, S. (2005). The ultimate book of mind maps: unlock your creativity, boost your memory, change your life. Thorsons, London.

Bwalya, M. (2013). Comprehensive Africa Agriculture Development Programme (CAADP) to reduce food security emergencies in Africa, NEPAD Planning and Coordinating Agency, Johannesburg.

Cabral, P., Augusto, G., Akande, A., Costa, A., Amade, N., Niquisse, S., Atumane, A., Cuna, A., Kazemi, K., Mlucasse, R. and Santha, R. (2017). Assessing Mozambique's exposure to coastal climate hazards and erosion. *Int. J. Disaster Risk Reduct*, 23: 45–52.

Carmin, J., Anguelovski, I. and Roberts, D. (2012). Urban Climate Adaptation in the Global South: Planning in an Emerging Policy Domain. *Journal of Planning Education and Research*, 32 (1): 18–32.

Carney, D. (Ed.). (1998). Sustainable Rural Livelihoods: What Contribution Can We Make? Department for International Development, London.

Carney, D., Drinkwater, M., Rusinów, T., Neefjes, K., Wanmali, S. and Singh, N. (1999). Implementing the Sustainable Livelihoods Approach. Sustainable Rural Livelihoods: What Contribution Can We Make?, DFID, London.

Carter, T.R., Jones, R.N., Lu, X., Bhadwal, S., Conde, C., Mearns, L.O., O'Neill, B.C., Rounsevell, M.D.A. and Zurek, M.B. (2007). New assessment methods and the characterisation of future conditions. In: Parry M.L., Canziani, O.F., Palutikof, J.P., van der Linden, P.J., Hanson, C.E. (Eds) *Climate change 2007: Impacts adaptation and vulnerability*. Contribution of working group II to the fourth assessment report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, 133-171.

Ceci´c, I. and Musson, R. (2004). Macroseismic surveys in theory and practice, *Nat. Hazards*, 31: 39–61.

CEMEX UK Operations Ltd. (2004). *Groundwater and climate change*.

Challinor, A., Wheeler, T., Garforth, C., Craufurd, P. and Kassam, A. (2007). Assessing the vulnerability of food crop systems in Africa to climate change. *Climate Change*, 83 (3): 381–399.

Chambers, R. (1986). Normal Professionalism, New Paradigms and Developments. *Institute of Development Studies*. Discussion Paper 227. University of Sussex, Brighton. P.1.

Chambers, R. (1989). Editorial Introduction: Vulnerability, Coping and Policy. IDS Bulletin 20.2: 1–7.

Chambers, R. and Conway, G.R. (1992). Sustainable Rural Livelihoods: Practical Concepts for the 21st Century. Institute of Development Studies, University of Sussex, UK.

Chen, Y.H., Aires, F., Francis, J.A. and Miller, J.R (2006). Observed relationships between Arctic longwave cloud forcing and cloud parameters using a neural network. *J. Climate*, 19: 4087-4104, doi:10.1175/JCLI3839.1.

Cheng, L., Hoerling, M., Aghakouchak, A., Livneh, B., Quan, X. W., and Eischeid, J. (2016). How has human-induced climate change affected California drought risk? *J. Climate*, 29: 111–120.

Cochran, W.G. (1963). Sampling Techniques. 2nd Ed. New York: John Wiley and Sons, Inc.

Cohen, L. and Holliday, M. (1979). Statistics for Education and Physical Education. London: Harper and Row.

Cohen, L. and Holliday, M. (1982). Statistics for Social Scientists. London: Harper and Row.

Cohen, L. and Holliday, M. (1996). Practical Statistics for Students. London: Paul Chapman.

Commission for Africa. (2005). Our common interest: the report of the Africa Commission. London, UK. Commission for Africa.

Connaway, L.S. and Powell, R.P. (2010). *Basic Research Methods for Librarians*. ABC-CLIO Corporate.

Constitution of the Republic of South Africa Act 108 of 1996.

Cornwall, A. and Jewkes, R. (1995). What is participatory research? *Social Science and Medicine*, 14: 1667–1676.

Conway, G. (2009). The Science of Climate Change in South Africa: Impacts and Adaptation, Grantham Institute for Climate Change Discussion Paper No. 1.

Creswell, J. W. (2003). Research Design: Qualitative, Quantitative and Mixed Methods Approaches, 2nd edition, Sage Publications, Inc, California, 246 pp.

Creswell, J. W. (2009). Research Design: Qualitative, Quantitative, and Mixed Methods Approaches. (3rd Ed.). Thousand Okas, CA: Sage.

Crotty, M. (2003). *The Foundations of Social Research: Meaning and Perspectives in the Research Process*. London: Sage Publications, 3rd edition, 10.

Dale, A., Arbor, S. and Procter, M. (1988). Doing secondary analysis. London, UK: Unwin Hyman.

Das, S. and Vincent, J.R. (2009). Mangroves protected villages and reduced death toll during Indian super cyclone. *Proceedings of the National Academy of Sciences of the United States of America,* 106(18):7357–60.

Dasgupta, S., Sobhan, I. and Wheeler, D. (2016). Impact of climate change and aquatic salinization on mangrove species and poor communities in the Bangladesh Sundarbans. Policy Research Working Paper 7736. Washington, DC: World Bank.

David, S.G.T., Twyman, C., Osbahr, H. and Hewitson, B. (2007). Adaptation to climate change and variability: farmer responses to intra-seasonal precipitation trends in South Africa. Climatic Change, 83 (3): 301-322.

Davidson, D.J., Williamson, T.B. and Parkins, J.R. (2003). Understanding climate change risk and vulnerability in northern forest-based communities. *Can. J. For. Res.* 33(11): 2252–2261. doi:10.1139/x03-138.

Davis, C.L. 2011. *Climate Risk and Vulnerability: A Handbook for southern Africa*. Council for Scientific and Industrial Research, Pretoria.

Dawson, C. (2013). Advanced Research Methods: A Practical Guide for Social Research Methods, Constable and Robinson, London.

De Cock, N. (2012). A comparative overview of commonly used food security indicators in Limpopo province, South Africa, Ghent University, Gent, Belgium, Netherlands.

deMunck, V.C. and Sobo, E.J. (Eds). (1998). Using methods in the field: a practical introduction and casebook. Walnut Creek, CA: AltaMira Press.

Department of Environmental Affairs and Tourism. (2004). Initial National Communication. South African Department of Environmental Affairs and Tourism, Pretoria.

Department of Environmental Affairs and Tourism. (2005). Annual Report. Accessed on 02 August 2018, from https://www.environment.gov.za/sites/default/files/reports/2015_16annual_report_environmentalaffairs.pdf

Department of Environmental Affairs. (2011). South Africa's Second National Communication under the United Nations Framework Convention on Climate Change. Pretoria, South Africa. [Online]. Available at: https://unfccc.int/resource/docs/natc/zafnc02.pdf [Accessed on 12 March 2018].

Department of Environmental Affairs. (2013). 'Long-term Adaption Scenarios Flagship Research Programme (LTAS) for South Africa', Climate change implications for agriculture and forestry, Government Printers, Pretoria.

Department of Environmental Affairs. (2017). National Climate Change Adaptation Strategy Republic of South Africa. Accessed on 13 July 2018, from https://www.environment.gov.za/sites/default/files/reports/nationalclimate_changeadaptation_strategyforcomment_nccas.pdf

Department of Provincial and Local Government. (2005). Robust & Inclusive Municipal Economies, Policy Guidelines for Implementing Local Economic Development in South Africa (Pretoria: Department of Provincial and Local Government).

Deressa, T., Hassan, R. and Poonyth, D. (2005). Measuring the economic impact of climate change on South Africa's sugarcane growing regions. *Agrekon*, 44(4): 524–542.

Deressa, T. (2007). Measuring the economic impact of climate change on Ethiopian agriculture: Ricardian approach. World Bank Policy Research Paper No. 4342. Washington D.C.: World Bank.

de Vaus, D. A. (2002). Surveys in Social Research, 5th edition, Allen and Unwin, Crows Nest, Australia, 379 pp.

DeWalt, K.M. and DeWalt, B.R. (1998). Participant observation. In H. Russell Bernard (Ed.), *Handbook of methods in cultural anthropology*. 259-300. Walnut Creek: AltaMira Press.

DeWalt, K.M. and DeWalt, B.R. (2002). *Participant observation: a guide for fieldworkers*. Walnut Creek, CA: AltaMira Press.

DFID. (1999). Sustainable Livelihoods Framework Guideline Sheets. Department of International Development, UK. EGIS, 2000. Riverine Chars in Bangladesh-environmental dynamics and management issues. Environment and GIS support project for Water sector Planning (EGIS), University Press Limited, Dhaka.

Dodman, D. and Mitlin, D. (2013). Challenges for community–based adaptation: Discovering the potential for transformation. *Journal of International Development*, 25(5): 640-659.

Doolan, D. M. and Froelicher, E. S. (2009). Using an existing data set to answer new research questions: A methodological review. *Research and Theory for Nursing Practice*: An International Journal, 23(3): 203-215. doi:10.1891/1541-6577.23.3.203

Dörnyei, Z. (2007). Research methods in applied linguistics: quantitative, qualitative, and mixed methodologies. Oxford: Oxford University Press.

Douglas, I., Alam, K., Maghenda, M.A., Mcdonnell, Y., McLean, L. and Campbell, J. (2008). Unjust waters: climate change, flooding and the urban poor in Africa. *Environment and Urbanization*, 20(1): 187-205.

Dube, T. and Phiri, K. (2013). Rural livelihoods under stress: The impact of climate change on livelihoods on in South Western Zimbabwe. *American International Journal of Contemporary Research*, 3(5): 11-25.

Dumenu, W.K and Obeng, E.A. (2016). Climate change and rural communities in Ghana: Social vulnerability, impacts, adaptations and policy implications. *Environmental Science & Policy,* 55: 208–217.

Eakin, H. (2005). Institutional change, climate risk, and rural vulnerability: Cases from Central Mexico. *World Development*, 33(11): 1923-1938.

Eakin, H. and Luers, A.L. (2006). Assessing the vulnerability of social–environmental systems. *Annual Review of Environment and Resources,* 31: 365–394.

Easterling, W.E. and Aggarwal, P.K. (2007). Food, Fibre and Forest Products. In: Climate change 2007: Impacts, adaptation and vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Eds: Parry, M.L., Canziani, O.F., Palutikof, J.P., Van der Linden, P.J. and Hanson, C.E., Cambridge University Press. Pp. 273 – 313.

Ebhuoma, E. and Simatele, D. (2017). Defying the odds: Climate variability, asset adaptation and food security nexus in the Delta State of Nigeria. *International Journal of Disaster Risk Reduction,* 21: 231–242.

Eguavoen, I. and McCartney, M. (2013). Water Storage: a Contribution to Climate Change Adaptation in Africa. *Rural 21*, 47 (1): 38 – 41.

Ejembi, E.P. and Alfa, G.B. (2012). Perceptions of climate change in Africa: regional agricultural perspectives. *Res. Humanit. Soc. Sci*, 2: 1–9.

Ekstrom, J. A. and Moser, S. C. (2014). Identifying and overcoming barriers in urban adaptation eforts to climate change: case study findings from the San Francisco Bay Area, California, USA. *Urban Clim*, 9: 54-74. http://dx.doi.org/10.1016/j.uclim.2014.06.002.

Ellis, F. (1999). Rural livelihood diversity in developing countries: Evidence and policy implications. *Natural Resource Perspectives*, 40(8): 1-10.

Ellis, F. (2000). Rural livelihoods and diversity in developing countries Oxford University Press, Oxford.

Engelbrecht, C.J., Engelbrecht, F.A and Dyson, L.L. (2013). High-resolution model projected changes in midtropospheric closed-lows and extreme rainfall events over southern Africa. *Int J Climatol,* 33: 173–187. doi:10.1002/joc.3420.

Engelbrecht, F., Adegoke, J., Bopape, M., Naidoo, M., Garland, R., Thatcher, M., McGregor, J., Katzfey, J., Werner, M., Ichoku, C. and Gatebe, C. (2015). Projections of rapidly rising surface temperatures over Africa under low mitigation. *Environmental Research Letters*, 10(8): 085004.

England, I.M., Stringer, L.C., Dougill, A.J. and Afionis, S. (2018). How do sectoral policies support climate compatible development? An empirical analysis focusing on southern. *Afr. Environ. Sci. Policy,* 79: 9–15.

Erlandson, D.A., Harris, E.L., Skipper, B.L. and Allen, S.D. (1993). *Doing naturalistic inquiry: a guide to methods*. Newbury Park, CA: Sage.

Faling, W., Tempelhoff, J.W.N. and van Niekerk D. (2012). Rhetoric or action: are South African municipalities planning for climate change? *Development southern Africa*, 29:241–257.

Fals-Borda, O. and Rahman, M.A. (Eds.) (1991). New York: Apex Press. *Canadian Journal for the Study of Adult Education*, 5(2): 66-71.

Fairbanks, D.H.K. and Scholes, R.J. (1999). South African Country Study on Climate Change: Vulnerability and Adaptation Assessment for Plantation Forestry. *National Research Facility*, Pretoria.

FAO. (2007). Adaptation to climate change in agriculture, forestry, and fisheries: perspectives, framework and priorities. FAO, Rome.

Farmer, G. (1988). Seasonal forecasting of the Kenya coast short rains, 1901–1984. *Journal of Climatology,* 8: 489–497.

Farrand, P., Hussain, F. and Hennessy, E. (2002). The efficacy of the "mind map" study technique. *Medical Education*, 36(5): 26–31.

Farrell, L.A. (2010). Mainstreaming Climate Change Adaptation into Urban Developement: Lessons from Two South African Cities, Masters Thesis, Stanford, CA: Stanford University

Fauchereau, N., Trzaska, S., Rouault, M. and Richard, Y. (2003). Rainfall Variability and Changes in southern Africa during the 20th Century in the Global Warming Context. Natural Hazards, 29(2): 139–154.

Feldman, T.R. and Assaf, S. (1999). Social Capital: Conceptual Frameworks and Empirical Evidence. An Annotated Bibliography. Washington: World Bank.

Fern, E. F. (1982). The use of focus groups for idea generation: The effects of group size, acquaintanceship and moderation on response quantity and quality. *Journal of Marketing Research*, 19: 1–13.

Few, R., Brown, K. and Tompkins, E.L. (2007). Public participation and climate change adaptation: Avoiding the illusion of inclusion. *Clim. Policy*, 7 (1): 46-59.

Fisher, M., Chaudhury, M. and McCusker, B. (2010). Do forests help rural households adapt to climate variability? Evidence from Southern Malawi. *World Development*, 38: 1241-1250.

Flood list. (2017). [Online]. Available at: http://floodlist.com/tag/south-africa [Accessed on 1 May 2018].

Food and Agriculture. (2003). *Responding to Agricultural and Food insecurity Challenges Mobilizing Africa to Implement NEPAD Programmes*. Conference of Ministers of Agriculture of the African Union, Maputo, Mozambique.

Food and Agriculture Organization (FAO). (2003). Food Security and HIV/AIDS: An Update Paper prepared for the 29th session of the Committee on World Food Security. Rome, Italy.

Ford Foundation. (2004). Building Assets to Reduce Poverty and Injustice, Ford Foundation, New York.

Fraser, N. (2007). Reframing justice in a globalizing world. *Global Inequality: Patterns and Explanations*, 252-272.

Fraser, E.D.G., Mabee, W. and Slaymaker, O. (2003). Mutual vulnerability, mutual dependence: The reflexive relation between human society and the environment. *Global Environmental Change*, 13(2): 137-144.

Fraser, E. D. G., Dougill, A.J., Hubacek, K., Quinn, C.H., Sendzimir, J. and Termansen, M. (2011). Assessing vulnerability to climate change in dryland livelihood systems: conceptual challenges and interdisciplinary solutions. *Ecology and Society,* 16(3): 3. http://dx.doi.org/10.5751/ES-03402-160303

Freitas, H., Oliveira, M., Jenkins, M. and Popjoy, O. (1998). The focus group, a qualitative research method: reviewing the theory, and providing guidelines to its planning. 1–22.

Füssel, H.M. and Klein, R.J.T. (2006). Climate change vulnerability assessments: An evolution of conceptual thinking. *Climate Change*, 75(3): 301-329.

Fussel, H.M. (2009). An updated assessment of the risks from climate change based on research published since the IPCC Fourth Assessment Report. *Clim. Change,* 97: 469–482.

Geertz, C. (1973). Thick Description: Towards an Interpretive Theory of Culture. In The Interpretation of Cultures. Basic Books.

Gero, A., Kuruppu, N. and Mukheibir, P. (2012). Cross-scale barriers to climate change adaptation in local government, Australia. University of Technology, Sydney.

Giddens, A. (1979). Central Problems in Social Theory: Action, Structure and Contradiction in Social Analysis, London: MacMillan.

Gilham, S.W. (1997). Drought relief in rural KwaZulu-Natal. In: Twenty third WEDC Conference, Durban, South Africa, pp. 415–417.

Gleick, P.H. (1996). Basic water requirements for human activities: meeting basic needs. *Water International*, 21: 83-92.

Graham, S., Barnett, J., Mortreux, C., Hurlimann, A., and Fincher, R. (2018). Local values and fairness in climate change adaptation: Insights from marginal rural Australian communities. *World Development*, 108: 332–343.

Guba, E. G. and Lincoln, Y. S. (1982). Establishing dependability and confirmability in naturalistic inquiry through an Audit. Paper presented at the Annual Meeting of the American Educational Research Association, New York, NY.

Gyampoh, B.A., Amisah, S., Idinoba, M. and Nkem, J. (2009). Using traditional knowledge to cope with climate change in rural Ghana. *Unasylva,* Vol 60, No. 231/232. FAO ftp://ftp.fao.org/docrep/fao/011/i0670e/i0670e14.pdf

Haden, V.R., Niles, M.T., Lubell, M., Perlman, J. and Jackson, L. (2012). Global and local concerns: what attitudes motivate farmers to mitigate and adapt to climate change. *PLoS One*, 7: 52882.

Hallegatte, S., Vogt-Schilb, A., Bangalore, M. and Rozenberg, J. (2017). Unbreakable: Building the Resilience of the Poor in the Face of Natural Disasters. Climate change and development series. Accessed on 03 August 2018, from file:///C:/Users/a0023599/Downloads/97814648100391.pdf

Handmer, J.W., Dovers, S. and Downing, T.E. (1999). Societal Vulnerability to Climate Change and Variability. *Mitigation and Adaptation Strategies for Global Change*, 4: 267–281.

Hannah, L., Midgley, G.F., Hughes, G. and Bomhard, B. (2005). The view from the Cape: exinction risk, protected areas and climate change. *BioScience*, 55: 231–42.

Haque, M.M., Chin, H.C. and Debnath, A.K. (2012). An investigation on multi-vehicle motorcycle crashes using log-linear models. *Safety Science*, 50(2): 352-62.

Hay, S.I., Rogers, D.J., Randolph, S.E., Stern, D.I., Cox, J., *et al.* (2002). Hot topic or hot air? Climate change and malaria resurgence in East African highlands. *Trends Parasitol*, 18: 530–534.

Hayward, C., Simpson, L. and Wood, L. (2004). Still left out in the cold: Problematising participatory research and development. *Sociologia Ruralis*, 44: 95–108.

Hellmuth, M.E., Moorhead, A., Thomson, M.C., Williams, J., eds. (2007). *Climate Risk Management in Africa: Learning from Practice*. International Research Institute for Climate and Society (IRI). New York: Columbia University.

Henderson, J.V., Storeygard, A. and Deichmann, U. (2017). Has climate change driven urbanization in Africa? *J. Dev. Econ.*, 124: 60–82.

Hendriks, S.L. (2005). The challenges facing empirical estimation of food (in) security in South Africa. *Development southern Africa*, 22(1): 103–123. https://doi.org/10.1080/03768350500044651

Henning, E., Van Rensburg, W. and Smit, B. (2004). Finding your way in qualitative research. Pretoria: Van Schaik. ISBN 0-627-02545-5 pbk. Pages 179.

Hisali, E., Birungi, P. and Buyinza, F. (2011). Adaptation to climate change in Uganda: evidence from micro level data. *Glob. Environ. Change*, 21 (4): 1245–1261.

Holden, M.T. and Lynch, P. (2004). Choosing the Appropriate Methodology: Understanding Research Philosophy (RIKON Group). *The Marketing Review*, 4: 397-409.

Hope, K.R. (2009). Climate change and poverty in Africa. *Int. J. Sust. Dev. World Ecol.*, 16(6):451-461.

Hulme, M., Doherty, R., Ngara, T., New, M. and Lister, D. (2001). African climate change: 1900–2100. *Climate Research,* 17: 145–68.

Hulme, D. and Shepherd, A. (2003). Conceptualizing chronic poverty. *World Development*, 31(3): 403-423.

Hulme, D. and Moore, K. (2008). Assisting the Poorest in Bangladesh: Learning from BRAC's 'Targeting the Ultra Poor Programme'. In Barrientos, A. and Hulme, D. (Eds.) Social Protection for the Poor and Poorest: Risk, Needs and Rights. Basingstoke, UK: Palgrave MacMillan. 194-210.

Hulme, D. (2009). Global Poverty Reduction and the Millennium Development Goals: A Short History of the World's Biggest Promise. Brooks World Poverty Institute Working Paper 100. Brooks World Poverty Institute, Manchester: University of Manchester.

Hummel, D. (2015). Climate Change, Land Degradation and Migration in Mali and Senegal-some Policy Implications, Migration and Development. Institute of Social-Ecological Research, Hamburger Allee 45, 60486 Frankfurt/Main, German.

Huq, S., Reid, H., Konate, M., Rahman, A., Sokona, Y. and Crick, F. (2004). Mainstreaming adaptation to climate change in LDCs. *Clim. Policy*, 4(1):25-43.

IFAD. (2010). Livestock and climate change. Livestock Thematic Papers. Tools for project design. Heidelberg, Berlin.

IPCC. (1988). [Online]. Available at: http://www.environment.gov.au/climate-change/publications/fact-sheet-ipcc [Accessed on 3 April 2018].

IPCC. (2001a). *Climate change: Impacts, adaptation and vulnerability*. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change, edited by McCarthy, J.J., Canziani, O.F., Leary, N.A., Dokken, D.J. and White, K.S. (eds). Cambridge University Press, Cambridge, UK, and New York, USA, 2001.

IPCC. (2001b). *Climate Change 2001: Synthesis Report*. A Contribution of Working Groups I, II, and III to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge.

IPCC. (2007a). *Climate Change 2007: Impacts, Adaptation and Vulnerability*. Working Group II Contribution to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, UK: Cambridge University Press

IPCC. (2007b). Summary for Policymakers. In: *Climate Change 2007: The Physical Science Basis*. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M.Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

IPCC. (2010). available at http://www.ipcc.ch/organization/organization_history.htm.

IPCC. (2012). *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation*. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change [Field, C.B., Barros, V., Stocker, T.F., Qin, D., Dokken, D.J.,Ebi, K.L., Mastrandrea, M.D.,Mach, K.J., Plattner, G.-K., Allen, S.K., Tignor, M. and Midgley, P.M (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, 582.

IPCC. (2013). The Physical Science Basis: Working Group I Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, New York, 1, 535-1.

IPCC. (2014). Summary for Policymakers in: *Climate Change 2014: Impacts, Adaptation and Vulnerability*. Part A: Global and Sectoral Aspects, Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, pp 1-32. Cambridge, UK and New York, NY, USA: Cambridge University Press.

Israel, B. A., Schulz, A. J., Parker, E. A. and Becker, A. B. (1998). Review of community-based research: Assessing partnership approaches to improve public health. *Annual Review of Public Health*, 19: 173–202.

Jabeen, H. (2015). Adapting the assets of urban low-income households with climate extremes: experience from Dhaka. *International Journal of Urban Sustainable Development*, 7(1): 72-88, DOI: 10.1080/19463138.2014.977293

Jack, B. and Clarke, A. (1998). The purpose and use of questionnaires in research. *Professional Nurse*, 14: 176–179.

Janowiak, J.E. (1988). An Investigation of Interannual Rainfall Variability in Africa. *Journal of Climate*, 1: 240-255. https://doi.org/10.1175/1520-0442(1988)001<0240:AIOIRV>2.0.CO;2

Jantarasami, L.C., Lawler, J.J. and Thomas, C.W. (2010). Institutional barriers to climate change adaptation in US national parks and forests. *Ecology and Society*, 15(4): 33.

Karfakis, P., Lipper, L. and Smulders, M. (2012). The assessment of the socio-economic impacts of climate change at household level and policy implications. *Food and Agriculture Organization of the United Nations*. Rome.

Karl, T. R. and Trenberth, K.E. (2003). Modern global climate change. *Science*, 302: 1719–1723.

Kebede, T., Gutu, T. and Tadesse, E. (2011). Performance and economic efficiency of browsing ArsiBale goats supplemented with sweet potato (Ipomoea batatas L.) vines as replacement for concentrate. *Int. J. Livestock Production*, 2 (7): 92-99.

Kelman, I. and West, J. (2009). Climate change and Small Island Developing States: a critical review. *Ecological and Environmental Anthropology*, 5(1): 1–16.

Kiem, A. S., Johnson, F., Westra, S., van Dijk, A., Evans, J. P., O'Donnell, A., Rouillard, A., Barr, C., Tyler, J., Thyer, M., Jakob, D., Woldemeskel, F., Sivakumar, B., and Mehrotra, R. (2016). Nature harzards in Australia: drought. *Climatic Change*, 139: 37–54.

Kitzinger, J. (1994). The methodology of focus groups: the importance of interaction between research participants. *Sociology of Health and Illness*, 16: 103–121.

Klausbruckner, C., Annegarn, H., Henneman, L.R.F. and Rafaj, P. (2016). A policy review of synergies and trade-offs in South African climate change mitigation and air pollution control strategies. *Environ. Sci. Policy,* 57: 70–78.

Knueppel, D., Demment, M. and Kaisser, L. (2009). Validation of household food insecurity access scale in rural Tanzania. *Public Health Nutrition,* 13(3): 360–367. https://doi.org/10.1017/S1368980009991121

Kohler, T., Giger, M., Hurni, H., Ott, C., Wiesmann, U., Wymann von Dach, S. and Maselli, D. (2010). Mountains and climate change: A global concern. *Mountains Research and Development*, 30: 53-55.

Kovacs, A. (1985). *The Research process: Essentials of skill development*. F.A Davis Company: Philadelphia, USA.

Krueger, R. A. (1994). Focus groups: A practical guide for applied research. Thousand Oaks, CA: Sage Publications Inc.

Krueger, R. A. and Casey, M. A. (2000). Focus groups: A practical guide for applied research, 4th ed. Thousand Oaks, CA: Sage Publications Inc.

Kumssa, A. and Jones, J.F. (2010). Climate change and human security in Africa. *International Journal of Sustainable Development and World Ecology*, 17(6): 453–461.

Kundzewicz, Z.W., *et al.* (2012). Flood risk in Europe – setting the stage. In: Kundzewicz, Z.W. ed. *Changes in flood risk in Europe, Wallingford*: IAHS Press, 11-26.

Kurukulasuriya, P. and Mendelsohn, R. (2006). A Ricardian analysis of the impact of climate change on African cropland. CEEPA Discussion Paper No. 8, Centre for Environmental Economics and Policy in Africa, University of Pretoria.

Kvale, S. (1996). *Interviews*. London: Sage

Kvale, S. and Brinkmann, S. (2009). Interviews. Learning the Craft of Qualitative Research Interviewing. (2nd Ed.). Thousand Okas, CA: Sage.

Lacetera, N. (2019). Impact of heat stress on animal health and welfare. *Anim. Front.* 9(1):26–31.

Lakoff, G. (1987). *Women, fire, and dangerous things*. Chicago: University of Chicago Press.

Laso Bayas, J. C., Marohn, C., Dercon, G., Dewi, S., Piepho, H.P., Joshi, L., van Noordwijk, M. and Cadisch, G. (2011). Influence of coastal vegetation on the 2004 tsunami wave impact Aceh. *Proceedings of the National Academy of Sciences of the United States of America*, 108(46):18612–17.

Lebel, T. and Ali, A. (2009). Recent trends in the Central and Western Sahel rainfall regime (1990-2007). *Journal of Hydrology*, 375(1-2): 52-64.

Leedy, P. D. and Ormrod, J. E. (2005). *Practical research: Planning and design* (8th ed.). Upper Saddle River, NJ: Prentice Hall.

Lei, Y., Liu, C., Zhang, L., and Luo, S. (2016). How smallholder farmers adapt to agricultural drought in a changing climate: A case study in southern China. *Land Use Policy*, 55: 300-308.

Lemos, M.C., Eakin, H., Nelson, D. and Engle, N. (2013). Building Adaptive Capacity to Climate Change in Less Developed Countries. School of Natural Resources and Environment, *University of Michigan*, Michigan.

Li, C., Tang, Y., Luo, H., Di, B. and Zhang, L. (2013). Local farmers' perceptions of climate change and local adaptive strategies: a case study from the middle Yarlung Zangbo River Valley, Tibet, China. *Environmental management*, 52(4): 894-906.

Liliana, H. (2005). The food gaps: The impacts of climate change on food production: A 2020 perspective, Universal Ecological Fund, Alexandria, VA, USA.

Lindesay, J.A., Harrison, M.S.J. and Haffner, M.P. (1986). The Southern Oscillation and South African rainfall. *South African Journal of Science*, 82: 196–198.

Lipton, M., Ellis, F. and Lipton, M. editors. (1996). Land, labour and livelihoods in rural South Africa. Vol 2: KwaZulu-Natal and Northern Province. Indicator Press, Durban, South Africa.

LoBiondo-Wood, G. and Haber, J. (1998). Nursing research: Methods and critical appraisal for evidence-based practice. *Elsevier Health Sciences*, page 250.

Lyimo, J.G. and Kangalawe, R.Y.M. (2010). Vulnerability and adaptive strategies to the impact of climate change and variability. The case of rural households in semi-arid Tanzania. *Environmental Economics*, 1(2): 88-96

Lyon, B. (2014). Seasonal drought in the Greater Horn of Africa and its recent increase during the march-may long rains. *J. Climate*, 27: 7953–7975.

Mabuza, E. (2016). The worst areas to live in South Africa are…Herald Live. [Online]. Available at: www.heraldlive.co.za/news/2016/06/07/worst-areas-live-south-africa/ [Accessed on 10 March 2018].

Macchi, M. (2011). Framework for Community-based Climate Vulnerability and Capacity Assessment in Mountain Areas. ICIMOD: Kathmandu

Madzwamuse, M. (2010). *Climate Governance in Africa: Adaptation Strategies and Institutions*. Heinrich Böll Stiftung (HBS).

Maree, K. and Van der Westhuizen, C. (2007). Planning a research proposal. In: K Maree (ed.). *First steps in research*. Pretoria: Van Schaik.

Marshall, C. and Rossman, G.B. (1989). *Designing qualitative research*. Newbury Park, CA: Sage.

Marshall, C. and Rossman, G.B. (1995). *Designing qualitative research*. Newbury Park, CA: Sage.

Marston, R. (2008). Land, Life and Environmental Change in Mountains. *Annals of the Association of American Geographers,* 98: 507–520.

Masih, I., Maskey, S., Mussá, F. E. F., and Trambauer, P. (2014). A review of droughts on the African continent: a geospatial and long-term perspective. *Hydrol. Earth Syst. Sci.*, 18: 3635–3649.

Matasci, C., Kruse, S., Barawid, N. and Thalmann, P. (2013). Exploring barriers to climate change adaptation in the Swiss tourism sector. *Mitigation and Adaptation Strategies for Global Change*, 1-16. Doi:10.1007/s11027-013-9471-1.

Mattar, F.N. (1994). Pesquisa de Marketing. São Paulo: Atlas, 1: 171-174.

May, K.M. (1991). Interview techniques in qualitative research: concerns and challenges. In Morse J M (ed) *Qualitative nursing research*. 187–201. Newbury Park: Sage Publications.

McCord, P., Waldman, K., Baldwin, E., Dell'Angelo, J., and Evans, T. (2018). Assessing multi-level drivers of adaptation to climate variability and water insecurity in smallholder irrigation systems. *World Development*, 108: 296–308.

McDaniels, T.L., Axelrod, L. and Slovic, P. (1996). Perceived ecological risks of global change. *Global Environ Change*, 6(2):159–171.

McGuirk, P. M. and O'Neill, P. (2005). Using questionnaires in qualitative human geography. In I. Hay (Eds.), *Qualitative Research Methods in Human Geography*, 147-162. South Melbourne, Australia: Oxford University Press.

McMillan, J. H. and Schumacher, S. (2001). Research in Education. A Conceptual Introduction (5th ed.). New York: Longman.

Mcneeley, S.M. (2012). Examining barriers and opportunities for sustainable adaptation to climate change in Interior Alaska. *Climatic Change*, 111(3-4): 835-857. Dio:10.1007/s10584-011-0158-x.

McSweeney, K. (2005) Natural insurance, forest access, and compounded misfortune: Forest resources in smallholder coping strategies before and after Hurricane Mitch, eastern Honduras. *World Dev,* 33:1453–1471.

Mendelsohn, R. and Tiwari, D. (2000). Two Essays on Climate Change and Agriculture: A Developing Countries Perspective. *FAO Economic and Social Development Paper 145*. Rome, Italy.

Mendes de Almeida, P. F. (1980). A review of group discussion methodology. *European Research*, 8: 114–120.

Mertens, D. M. (2010). Research and Evaluation in Education and Psychology: Integrating Diversity with Quantitative, Qualitative, and Mixed Methods (3rd ed.). Thousand Oaks: Sage.

Mertz, O., Mbow, C., Reenberg, A., and Diouf, A. (2009). Farmers' perceptions of climate change and agricultural adaptation strategies in rural Sahel. *Environmental management*, 43(5): 804-816.

Midgley, G.F., Chapman, R.A., Mukheibir, P., Tadross, M., Hewitson, B., Wand, S., Schulze, R.E., Lumsden, T., Horan, M., Warburton, M., *et al.* (2007). Assessing Impacts, Vulnerability and Adaptation in Key South African Sectors: A Background Study for the Long Term Mitigation Scenarios assessment. Cape Town, South Africa: Energy Research Centre, University of Cape Town.

Midgley, G.F. and Thuiller, W. (2011). Potential responses of terrestrial biodiversity in southern Africa to anthropogenic climate change. *Regional Environmental Change*, 11: 127-135.

Mimura, N., Nurse R., McLean J., *et al.* (2007). Small islands. In Parry *et al* (eds) *Climate change 2007: impacts, adaptation and vulnerability*. Contributions of working group II to the fourth assessment report of the IPCC. Cambridge University Press: Cambridge.

Minville, M., Brissette, F. and Leconte, R. (2008) Uncertainty of the impact of climate change on the hydrology of a Nordic watershed. *Journal of Hydrology*, 358(1-2): 70-83

Mirza, M.M.Q. (2003). Climate change and extreme weather events: can developing countries adapt? *Climate Policy*. 3:3. Taylor and Francis.

Mohamed, A.B. (2011). Climate change risks in Sahelian Africa. *Regional Environmental Change*, 11(Suppl. 1): 109-117.

Morgan, D. L. (1996). Focus Groups. *Annual Review of Sociology*, 22: 129–152.

Morgan, D L. (1998). *The focus group guide book*. London: Sage Publications.

Morrison, K.R.B. (1993). *Planning and Accomplishing School-centred Evaluation*. Norfolk: Peter Francis Publishers.

Mortreux, C. and Barnett, J. (2009). Climate change, migration and adaptation in Funafuti, Tuvalu. *Global Environmental Change-Human and Policy Dimensions*, 19 (1): 105 – 112.

Moser, C. (1998). The Asset Vulnerability Framework: Reassessing Urban Poverty Reduction Strategies. *World Development*, 26(1):1-19.

Moser, C. (2006). Asset-based approaches to poverty reduction in a globalized context: an introduction to asset accumulation policy and summary of workshop findings. Page 5. Global Economy and Development Working Paper, The Brookings Institution, Washington DC.

Moser, C. and Dani, A. (2008). Assets, Livelihoods, and Social Policy. New Frontiers of Social Policy. Washington, DC: World Bank. World Bank. License: CC BY 3.0 IGO. [Online]. Available at: https://openknowledge.worldbank.org/handle/10986/6542 [Accessed on 10 March 2018].

Moser, C. and Satterthwaite, D. (2008). Towards pro-poor adaptation to climate change in the urban centres of low- and middle-income countries. GURC and IIED Discussion paper series, *Climate change and cities 3*.

Moser, C. (2008). Assets and Livelihoods: A framework for asset-based social policy. In Moser C and A. Dani (eds), *Assets, Livelihoods and Social Policy*. World Bank, Washington D.C.

Moser, S. C. and Ekstrom, J.A. (2010). A framework to diagnose barriers to climate change adaptation. *Proceedings of the National Academy of Sciences of the United States of America*, 107: 22026-22031.

Moyo, E.N. and Nangombe, S.S. (2015). Southern Africa's 2012–13 violent storms: role of climate change. *Procedia IUTAM*, 17: 69–78.

Muis, S., Güneralp, B., Jongman, B., Aerts, J.C. and Ward, P.J. (2015). Flood risk and adaptation strategies under climate change and urban expansion: a probabilistic analysis using global data. *Sci Total Environ*, 538: 445-457

Mukherjee, S. and Benson, T. (2003). The determinants of poverty in Malawi, 1998. *World Development*, 31(2): 339–358.

Mulenga, H.M., Rouault, M. and Reason, C.J.C. (2003). Dry summers over NE South Africa and associated circulation anomalies. *Climate Research*, 25: 29-41.

Mumma, A. (2008). 'Kenya's New Water Law: An analysis of the implications for the rural poor' in Giordano, M., Koppen, B.V. and Butterworth, J. eds, Community-Based Water Law and Water Resource Management Reform in Developing Countries (Wallingford: CABI).

Mtubatuba Local Municipality Final IDP Review Plan 2016/2017. (2018). [Online]. Available at: http://mtubatuba.org.za/wp-content/uploads/2016/08/Mtubatuba-final-IDP-16-17.pdf [Accessed on 12 January 2018].

National Climate Change Response Green Paper. (2010). Accessed on 12 July 2018, from https://www.gov.za/sites/default/files/33801_1083_2.pdf

National Water Amendment Act 27 of 2014. Government Gazette. Republic of South Africa. https://www.gov.za/sites/default/files/gcis_document/201409/377152-6act27of2014natwateramenda.pdf

Nel, E., Binns, T. and Motteux, N. (2001). Community-based development, non-governmental organisations and social capital in post-apartheid South Africa. *Geografiska Annaler*, 83B (1):3-13.

Nelson, D.R., Adger, W.N. and Brown, K. (2007). Adaptation to environmental change: contributions of a resilience framework. *Annual Review of Environment and Resources*, 32: 395–419.

Nelson, G.C., Valin, H., Sands, R.D., Havlík, P., Ahammad, H., Deryng, D., Elliott, J., Fujimori, S., Hasegawa, T., Heyhoe, E., Kyle, P., Von Lampe, M., Lotze-Campen, H., Mason d'Croz, D., van Meijl, H., van der Mensbrugghe, D., Müller, C., Popp, A., Robertson, R., Robinson, S., Schmid, E., Schmitz, C., Tabeau, A. and Willenbockelo, D. (2014). Climate change effects on agriculture: Economic responses to biophysical shocks. *Proc. Natl. Acad. Sci.*, 111(9): 3274-3279, doi:10.1073/pnas.1222465110.

Neufeldt, H., Kristjanson, P., Thorlakson, T., Gassner, A., Norton-Griffiths, M., Place, F., Langford, K. (2011). ICRAF Policy Brief 12: Making Climate-Smart Agriculture Work for the

Poor. World Agroforestry Centre (ICRAF), Nairobi. Available online at www.worldagroforestry.org/downloads/publications/PDFs/BR11267.PDF.

New, M., Hewitson, B., Stephenson, D.B., Tsiga, A., Kruger, A., Manhique, A., Gomez, B., Coelho, C.A.S., Masisi, D.N., Kululanga, E., Mbambalala, E., Adesina, F., Saleh, H., Kanyanga, J., Adosi, J., Bulane, L., Fortunata, L., Mdoka, M.L. and Lajoie, R. (2006). Evidence of trends in daily climate extremes over southern and west Africa. *Journal of Geophysical Research D: Atmospheres*, 111(D14), D14102, doi:10.1029/2005JD006289.

Nhemachena, C., Hassan, R. and Chakwizira, J. (2014), Analysis of determinants of farm-level adaptation measures to climate change in Sothern Africa. *Journal of Development and Agricultural Economics*, 6(5): 232-241.

Niang, I., Ruppel, O.C., Abdrabo, M.A., Essel, A., Lennard, C., Padgham, J. and Urquhart, P. (2014). Africa. In V. R. Barros, C. B. Field, D. J. Dokken, M. D. Mastrandrea, K. J. Mach, & T. E. Bilir (Eds.) *Climate change 2014: Impacts, adaptation, and vulnerability*. Part B: Regional aspects. Contribution of working group II to the fifth assessment report of the intergovernmental panel on climate change (pp. 1199–1265). Cambridge, U.K.: Cambridge University Press.

Nicholson, S.E. (1996). A review of climate dynamics and climate variability in eastern Africa. In The Limnology, Climatology and Paleoclimatology of the East African Lakes, Johnson TC, Odada E (eds). Gordon and Breach: Amsterdam; 25–56.

Nicholson, S.E., Some, B. and Kone, B. (2000). An analysis of recent rainfall conditions in West Africa, including the rainy seasons of the 1997 El Niño and the 1998 La Nina years. *Journal of Climate*, 13(14): 2628-2640.

Nielsen, J.O. (2009). Drought and marriage. Exploring the interconnection between climate variability and social change through a livelihood perspective. In The Question of Resilience. Social Responses to Climate Change, Hastrup K (ed). *The Royal Danish Academy of Sciences and Letters: Copenhagen*, 159-177.

Nielsen, J.Ø. and Reenberg, A. (2010a). Temporality and the problem with singling out climate as a current driver of change in a small West African village. *Journal of Arid Environments*, 74: 464–474.

Nightingale, A.J. (2009). Warming up the Climate Change Debate: A Challenge to Policy based on Adaptation. *Journal of Forest and Livelihood*, 8(1): 84-90.

Nkhonjera, G.K. (2017). Understanding the impact of climate change on the dwindling water resources of South Africa, focusing mainly on Olifants River basin: a review. *Environ. Sci. Policy,* 71: 19–29.

Nordhaus, W. (2006). Geography and Macroeconomics: New Data and Findings. *Proc. Nat. Acad. Sci.,* 103:3510-3517.

Novellie, P., Biggs, H. and Roux, D. (2016). National laws and policies can enable or confound adaptive governance: examples from South African national parks. *Environ. Sci. Policy,* 66: 40–46.

Nunn, P. D., Aalbersberg, W., Lata, S., and Gwilliam, M. (2014). Beyond the core: Community governance for climate change adaptation in peripheral parts of Pacific Island Countries. *Regional Environmental Change*, 14(1): 221–235.

Nuorteva, P., Keskinen, M. and Varis, O. (2010). Water, livelihoods and climate change adaptation in the Tonle Sap lake area, Cambodia: Learning from the past to understand the future. *Journal of Water and Climate Change*, 1(1): 87-101.

Nyong, A., Adesina, F. and Elasha, B. (2007). The value of indigenous knowledge in climate change mitigation and adaptation strategies in the African Sahel. *Mitigation and Adaptation Strategies for Global Change*, 12: 787-797.

O'Brien, K., Eriksen, S., Nygaard, L.P. and Schjolden, A. (2007). Why different interpretations of vulnerability matter in climate change discourses. *Climate Policy*, 7: 73-88.

O'Brien, K.L., St. Clair, A. and Kristoffersen, B. (2010). Climate change, ethics and human security. Cambridge: Cambridge University Press.

OECD. (2006). OECD Development Cooperation Report 2006. Accessed on 02 August 2018 from www.oecd.org/document/9/0,3343,en_2649_201185_38132297_1_1_1_1,00.html

O'Leary, A. (2004). The Essential Guide to Doing Research. London: SAGE Publications.

Oppenheim, A.N. (1992). Questionnaire design, interviewing and attitude measurement. New York: St. Martin's Press, 79-80.

Osbahr, H., Twyman, C., Thomas, D.S.G. and Adger, W.N. (2008). Effective livelihood adaptation to climate change disturbance: scale dimensions of practice in Mozambique. *Geoforum*, 39(6):1799-2132.

Ostfeld, R.S. (2009). Climate change and the distribution and intensity of infectious diseases. *Ecology*, 90(4): 903-905.

Ostrom, E., Janssen, M.A. and Anderies, J.M. (2007). Going beyond panaceas. *Proc. Natl. Acad. Sci.*, 104: 15176-15178.

Paavola, J. (2008). Livelihoods, vulnerability and adaptation to climate change in Morogoro, Tanzania. *Environmental Science and Policy*, 11(7): 642-654.

Parfitt, J. (2005). Questionnaire design and sampling, in: *Methods in Human Geography*, edited by Flowerdew, R. and Martin, D., Pearson Education Limited, England, 78–109.

Patt, A.G. and Schröter, D. (2008). Perceptions of climate risk in Mozambique: implications for the success of adaptation strategies. *Global Environmental Change*, 18(3): 458-467.

Patton, M. Q. (2000). Qualitative Research and Evaluation Method. London: SAGE Publications.

Pelling, M. and High, C. (2005). Understanding adaptation: What can social capital offer assessments of adaptive capacity? *Global Environmental Change*, 15: 308-319.

Perez, C., Jones, E., Kristjanson, P., Cramer, L., Thornton, P., Förch, W. and Barahona, C. (2015). How resilient are farming households and communities to a changing climate in Africa? A Gender-Based Perspective. *Global Environment Change*, 34: 95–107.

Pielke, R., Prins, G., Rayner, S. and Sarewitz, D. (2007). Climate change 2007: lifting the taboo on adaptation. *Nature*, 445: 597-598.

Polit, D. F. and Hungler, B. P. (1999). *Nursing research: principles and methods*. Phildelphia: JB Lippincott Company. Pages 37 and 95.

Polit, D.F. and Hungler, B.P. (2004) Nursing research-principle and methods. Lippincott Williams and Wilkins, Philadelphia.

Pontin, D. (2000). Interviews. In Cormack D F S (ed) *The research process in nursing*. 4th ed. 289–298. Oxford: Blackwell Science.

Pretty, J. and Ward, H. (2001). Social capital and the environment. *World Development,* 29 (2): 209–227.

Prowse, M. and Scott, L. (2008). Assets and Adaptation: An Emerging Debate. *IDS Bulletin*, 39 (4): 42 -52.

Qiu, J. (2010). China drought highlights future climate threats. *Nature*, 465: 142–143.

Rabbani, G., Rahman, S.H. and Faulkner, L. (2013). Impacts of Climatic Hazards on the Small Wetland Ecosystems (ponds): Evidence from Some Selected Areas of Coastal Bangladesh. *Sustainability*, 5: 1510–1521.

Rankoana, S.A. (2018). Human perception of climate change. Weather, 73(11): 367-370.

Reason, C.J.C. and Keibel, A. (2004). Tropical Cyclone Eline and its Unusual Penetration over the southern African Mainland. *Weather and Forecasting*, 19: 789-805.

Reason, C.J., Hachigonta, S. and Phaladi, R.F. (2005). Interannual variability in rainy season characteristics over the Limpopo region of southern Africa. International Journal of Climatology, 25: 1835-1853.

Reason, C.J.C. (2007). Tropical cyclone Dera, the unusual 2000 01 tropical cyclone season in the South West Indian Ocean and associated rainfall anomalies over southern Africa. *Meteorology and Atmospheric Physics*, 97: 181–188.

Reich, P. F., Numbem, S. T., Almaraz, R.A. and Eswaran, H. (2001). Land resource stresses and desertification in Africa. Pp. 101-114 In Bridges, E. M., Hannam, I. D., Oldeman L. R., Penning de Vries, F.W.T., Scherr, S.J. and Sombatpanit, S. 2001. *Response to Land Degradation. Enfield*, New Hampshire, USA: Science Publishers.

Reilly, J. and Schimmelpfennig, D. (2000). Irreversibility, uncertainty, and learning: portraits of adaptation to long-term climate change. *Climatic Change*, 45: 253-378 (http://dx.doi.org/10.1023/A:1005669807945)

Reckien, D., Creutzig, F., Fernandez, B., Lwasa, S., Tovar-Restrepo, M., Mcevoy, D. and Satterthwaite, D. (2017). Climate change, equity and the Sustainable Development Goals: an urban perspective. *Environment and Urbanization*, 29(1): 159-182. https://doi.org/10.1177/0956247816677778

Reid, P and Vogel, C. (2006). Living and responding to multiple stressors in South Africa – glimpses from KwaZulu-Natal. *Global Environmental Change*, 16: 195-206.

Republic of South Africa. (2004). South African National Climate Change Response Strategy, Pretoria, South Africa: Government of South Africa.

Republic of South Africa (RSA). (2011). National Climate Change Response White Paper. Pretoria Government Printer. 38. [Online]. Available at: http://pmg-assets.s3-website-eu-west-1.amazonaws.com/docs/111012nccr-whitepaper.pdf [Accessed on 12 March 2018].

Republic of South Africa. (2012). South Africa National Climate Change Response Policy White Paper, Pretoria, South Africa: Government of South Africa.

Reynolds, T. W., Bostrom, A., Read, D. and Morgan, M. G. (2010). Now what do people know about Global Climate Change? Survey Studies of Educated Laypeople. *Risk Analysis,* 30: 1520–1538. doi: 10.1111/j.1539-6924.2010.01448.x, ISSN: 1539-6924.

Ribot, J.C. (2010). 'Vulnerability does not just Fall from the Sky: Toward Multi-scale Pro-poor Climate Policy,' in Robin Mearns and Andrew Norton (eds.), Social Dimensions of Climate Change: Equity and Vulnerability in a Warming World. Washington, DC: The World Bank.

Ribot, J.C., Magalhães, A.R. and Panagides, S.S., editors. (1996). Climate variability, climate change and social vulnerability in the semi-arid Tropics. Cambridge: Cambridge University Press.

Ribot, J. (2011). Vulnerability before adaptation: Toward transformative climate action. *Global Environmental Change*, 21(4): 1160-1162.

Richard, Y., Fauchereau, N., Poccard, I., Rouault, M. and Trzaska, S. (2001). 20th century droughts in southern Africa: spatial and temporal variability, teleconnections with oceanic and atmospheric conditions. *Int J Climatol,* 21(7): 873–885. doi:10.1002/joc.656

Ritchie, J. (2003). The Applications of Qualitative Methods to Social Research. In *Qualitative Research Practice.* A Guide for Social Science Students and Researchers, eds. Ritchie, J and Lewis, J. London: Sage.

Robinson, J.B. and Herbert, D. (2001). Integrating climate change and sustainable development. *Int. J. Global Environmental Issues*, 1(2): 130–149.

Robledo, C. and Forner, C. (2005). Adaptation of forest ecosystems and the forest sector to climate change. Forest and Climate Change Working Paper 2. FAO. Rome.

Roncoli, C., Ingram, K. and Kirshen, P. (2001). The costs and risks of coping with drought: livelihood impacts and farmers' responses in Burkina Faso. *Climate Research*, 19: 119–132.

Roncoli, C., Ingram, K. and Kirshen, P. (2002). Reading the rains: local knowledge and rainfall forecasting among farmers of Burkina Faso. *Society and Natural Resources*, 15: 411-430. Doi:10.1080/08941920252866774.

Rondganger, L. (2016). Vast parts of KZN run dry. Independent Online (IOL). 14 January 2016. [Online]. Available at: https://www.iol.co.za/news/south-africa/kwazulu-natal/vast-parts-of-kzn-run-dry-1971048 [Accessed 10 March 2018].

Rose, R.M. (2015). The Impact of Climate Change on Human Security in the Sahel Region of Africa. *Donnish Journal of African Studies and Dev*., 1(2):009-014.

Rosenzweig, C., Iglesias, A., Yang, X.B., Epstein, P.R. and Chivian, E. (2001). Climate Change and Extreme Weather Events: Implications for Food Production, Plant Diseases, and Pests. *Global Change and Human Health*, 2:2. Springer Netherlands.

Rouault, M. and Richard, Y. (2005). Intensity and spatial extent of droughts in southern Africa. *Geophysical Research Letters,* 32: L15702, DOI: 10.1029/2005GL022436.

Roudier, P., Sultan, B., Quirion, P. and Berg, A. (2011). The impact of future climate change on West African crop yields: What does the recent literature say? *Global. Environmental Change*, 21 (3): 1073–1083.

Rubin, H.J. and Rubin, I.S. (1995). Qualitative Interviewing: The Art of Hearing Data. Sage, Thousand Oaks, CA.

Sapsford, R. (1999). Survey research. London: Sage.

Sarantakos, S. (2005). Social Research. 2nd edition, Palgrave Macmillan Hampshire, 464 pp., 2005.

Saunders, M., Lewis, P. and Thornhill, A. (2009). Research methods for business students: Prentice Hall.

Saunders, M.N.K., Lewis, P and Thornhill, A. (1996). Research Methods for Business Students, (3rd Ed), Rotolito Lombarda, Italy.

Schlenker, W. and Lobell, D.B. (2010). Robust negative impacts of climate change on African agriculture. *Environmental Research Letters*, 5, 014010. Doi:10.1088/1748-9326/5/1/014010.

Schmuck, R. A. (1997). Practical Action Research for Change. *Arlington Heights*, IL: IRI SkyLight Training and Publishing, Inc.

Schofield, W. (1996) Survey sampling. In Sapsford, R. and Jupp, V. (1996). (eds). Data Collection and Analysis. London: Sage and the Open University Press, 25–55.

Schostak, J. (2006). Interviewing and Representation in Qualitative Research. Maidenhead: Open University Press.

Schroter, D., Polsky, C. and Patt, A.G. (2005). Assessing vulnerabilities to the effects of global change: an eight-step approach. *Mitigation and Adaptation Strategies for Global Change*, 10(4): 573–595.

Scoones, I. (1996). Hazards and opportunities: farming livelihoods in dryland Africa, lessons from Zimbabwe Zed Books, London.

Scoones, I. (1998). Sustainable Rural Livelihoods: A Framework for Analysis IDS Working Paper 72. Institute of Development Studies, Brighton.

Sen, A.K. (1981). Poverty and famines: an essay on entitlement and deprivation. Oxford: Clarendon.

Sen, A. (1997). Editorial: human capital and human capability. *World Development*, 25(12): 1959-1961.

Seo, S.N. and Mendelsohn, R. (2006a). Climate change impacts on animal husbandry in Africa: A Ricardian analysis. CEEPA Discussion Paper No. 9, Centre for Environmental Economics and Policy in Africa, University of Pretoria, South Africa.

Shah, M.M., Fischer, G. and van Velthuizen, H. (2008). Food Security and Sustainable Agriculture. The Challenges of Climate Change in sub-Saharan Africa. International Institute for Applied Systems Analysis, Laxenburg, Austria.

Shah, N. (2011). Ethical Issues in biomedical Research publication. *Journal of Conservative Dentistry*, 14(3): 205-207.

Shahi, P. (2011). Upper Mustang's rain spell has weather experts scratching their heads. The Kathmandu Post, 28 July 2011. http://kathmandupost.ekantipur.com/printedition/news/2011-07-27/uppermustangs-rain-spell-has-weather-expertsscratching-their-heads.html (accessed 25 January 2019).

Shamoo, A.E. and Resnik, B.R. (2003). *Responsible Conduct of Research*. Oxford University Press.

Sheffield, J., Wood, E. F., and Roderick, M. L. (2012). Little change in global drought over the past 60 years. *Nature*, 491: 435–439.

Shensul, S.L., Schensul, J.J. and LeCompte, M.D. (1999). Essential Ethnographic Methods 2: Observations, Interviews and Questionnaires, Altamira Press, Walnut Creek, CA.

Shisanya, S. and Mafongoya, P.L. (2016). Adaptation to climate change and the impacts on household food security among rural farmers in uMzinyathi District of KwaZulu-Natal, South Africa. *Food Security*, 8: 597-608.

Shurie, M.M., Mwaniki, B. and Kameri-Mbote, P. (2017). Water permit systems, policy reforms and implications for equity in Kenya. Project Country Report. Output from the REACH programme.

Sietz, D., Boschütz, M. and Klein, R.J. (2011). Mainstreaming climate adaptation into development assistance: rationale, institutional barriers and opportunities in Mozambique. *Environmental Science and Policy*, 14(4): 493-502. Doi: org/10.1016/j.envsci.2011.01.001.

Signgh, A. and Purohit, B. (2014). Public Health Impacts of Global Warming and Climate Change. *Peace Rev. J. Soc. Justice*, 26(1): 112-120.

Sikes, P. (2004). *Methodology, procedures and ethical concerns*. Doing Educational Research: a Guide for first time researchers. C. Opie. London, UK, Sage Publications, 15-33.

Simatele, D., Binns, T. and Simatele, M. (2012). Sustaining livelihoods under a changing climate: the case of urban agriculture in Lusaka, Zambia. *Journal of Environmental Planning and Management*, 55(9): 1175-1191.

Simatele, D. and Simatele, M. (2015). Migration as an adaptive strategy to climate variability: a study of the Tonga-speaking people of Southern Zambia. *Disasters,* 39(4): 762–781.

Simon, D. and Leck, H. (2015). Understanding climate adaptation and transformation challenges in African cities. *Curr. Opin. Environ. Sustain*., 13: 109–116.

Slegers, M.F.W. (2008). If only it would rain: Farmers' perceptions of rainfall and drought in semi-arid central Tanzania. *J. Arid Environ*. 72: 2106–2123.

Smit, B., Burton, I., Klein, R.J.T., Street, R. (1999). The science of adaptation: a framework for assessment. *Mitigation and Adaptation Strategies for Global Change*, 4 (3): 199–213.

Smit, B., Burton, I., Klein, R. J. T. and Wandel, J. (2000). An anatomy of adaptation to climate change and variability. *Climatic Change*, 45(1): 223-251.

Smit, B., Pilifosova, O., Burton, I., Challenger, B., Huq, S., Klein, R.J.T., Yohe, G., Adaptation and Vulnerability, Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change. (2001). Adaptation to climate change in the context of sustainable development and equity. In: McCarthy, J.J., Canziano, O.F., Leary, N. (Eds.), *Climate Change* 2001—*Impacts*. Cambridge University Press, Cambridge, UK, 877–912.

Smit, B. and Skinner, M.K. (2002). Adaptation options in agriculture to climate change: a typology. *Mitigation and Adaptation Strategies for Global Change,* 7: 85–114.

Smit, B. and Pilifosova, O. (2003). From adaptation to adaptive capacity and vulnerability reduction. Climate Change, Adaptive Capacity and Development, J. B. Smith, R. J. T. Klein and S. Huq (eds). Imperial College Press, London, UK. 9–28.

Smit, B. and Wandel, J. (2006). Adaptation, adaptive capacity and vulnerability. *Global Environmental Change*, 16: 282-292.

Smith, B., McNabb, D. and Smithers, J. (1996). Agricultural adaptation to climatic variation. *Climate change*, 43: 7-29.

Smith, E. (2008). Using secondary data in educational and social research. New York, NY: McGraw-Hill Education.

Smith, J.B., Vogel, J.M. and Cromwell III, J.E. (2009). An Architecture for Government Action on Adaptation to Climate Change: An Editorial Comment. *Climatic Change*, 95 (1–2): 53–61.

Smith, A. K., Ayanian, J. Z., Covinsky, K. E., Landon, B. E., McCarthy, E. P., Wee, C. C. and Steinman, M. A. (2011). Conducting high-value secondary dataset analysis: An introductory guide and resources. *Journal of General Internal Medicine*, 28(8): 920-929. doi:10.1007/s11606-010-1621-5

Sohngen, B. and Mendelsohn, R. (1998). Valuing the impact of large-scale ecological change in a market: The effect of climate change on U.S. timber. *The American Economic Review*, 88(4): 686-714.

Sokona Y and Denton F. (2001). Climate Change Impacts: can Africa cope with the challenges? *Climate Policy,* 1: 117-123.

Songok, C.K., Kipkorir, E.C., Mugalavai, E.M. (2011a). Integration of indigenous knowledge systems into climate change adaptation and enhancing food security in Nandi and Keiyo districts, Kenya. In: Filho, WL (ed) *Experiences of climate change adaptation in Africa*. Springer, Hamburg, 69–95.

Songok, C.K., Kipkorir, E.C., Mugalavai, E.M., Kwonyike, A.C., Ngweno, C. (2011b). Improving the participation of agro-pastoralists in climate change adaptation and disaster risk reduction policy formulation: a case study from Keiyo district, Kenya. In: Filho WL (ed) *Experiences of climate change adaptation in Africa*. Springer, Hamburg, 55–68.

South African Weather Service. (2016). What is a drought? [Online]. Accessed on 30 November 2018 from http://www.weathersa.co.za/Home/ClimateQues

Statistics South Africa. (2011a). Census: Ebaswazini. [Online]. Accessed on 11 March 2018 from http://www.statssa.gov.za/?page_id=4286&id=9479.

Statistics South Africa. (2011b). Census: Nkombose: [Online]. Accessed on 11 March 2018 from http://www.statssa.gov.za/?page_id=4286&id=9482.

Statistics South Africa. (2011c). Census: Ogengele. [Online]. Accessed on 11 March 2018 from http://www.statssa.gov.za/?page_id=4286&id=9471.

Stern, N. (2007). The Economics of Climate Change: The Stern Review, Cambridge University Press, Cambridge.

Stewart, D. W., Shamdasani, P. N. and Rook, D. W. (2007). *Focus groups: Theory and practice* (2nd ed.). Thousand Oaks, CA: Sage.

Stocker, T., Qin, D. and Plattner, G., Tignor, M., Allen, S.K., Boschung, J., Nauels, A., Xia, Y., Bex V. and Midgley, P.M. (Eds.). (2013). *Climate Change 2013: The Physical Science Basis. Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Summary for Policymakers, Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Tambo, J.A. and Abdoulaye, T. (2013). Smallholder farmers' perceptions of and adaptations to climate change in the Nigerian savanna. *Reg Env Chang,* 13(2):375–388. doi: 10.1007/s10113-012-0351-0.

Thomas, D.S.G., Twyman, C., Osbahr, H. and Hewitson, B. (2007). Adaptation to climate change and variability: farmer responses to intraseasonal precipitation trends in South Africa. *Clim Chang,* 83(3): 301–322. doi: 10.1007/s10584-006-9205-4.

Thornton, P., Herrero, M., Freeman, A., Mwai, O., Rege, E., Jones, P. and McDermott, J. (2007). Vulnerability, climate change and livestock – Research opportunities and challenges for poverty alleviation. *SAT eJournal* 4(1): 1 – 23.

Tompkins, E. L., Adger, W.N., Boyd, E., Nicholson-Cole, S., Weatherhead, K. and Arnell, N. (2010). Observed adaptation to climate change: UK evidence of transition to a well-adapting society. *Global Environmental Change,* 20(4):627–635.

Trærup, S.L.M. and Mertz, O. (2011). Rainfall variability and household coping strategies in northern Tanzania: a motivation for district level strategies. *Reg Environ Chang*, 11(3):471–481. doi:10.1007/s10113-010-0156-y.

Tschakert, P. (2007). Views from the vulnerable: understanding climatic and other stressors in the Sahel. *Global Environmental Change*, 17(3-4), 381-396.

Tschakert, P., Sagoe, R., Ofori-Darko, G. and Codjoe, S.N. (2010). Floods in the Sahel: an analysis of anomalies, memory, and anticipatory learning. *Clim Chang*, 103:1–32. doi:10.1007/s10584-009-9776-y

Tschakert, P. and Dietrich, K.A. (2010). Anticipatory Learning for Climate Change Adaptation and Resilience. *Ecology and Society*, 15(2): 11.

Turner, B.,Kasperson,R.,Matson, P., McCarthy, J.,Corell,R.,Christensen, L., Eckley, N.,Kasperson, J. X., Luers, A., Martello, M.L., Polsky, C., Pulsiphe, A. and Schiller, A. (2003). A framework for vulnerability analysis in sustainability science. *Proceedings of the National Academy of Sciences of the United States of America*, 100(14): 8074-8079.

Turpie, J. and Visser, M. (2013). The impact of climate change on South Africa's rural areas, Submission for the 2013/14 Division of Revenue, *Financial and Fiscal Commission*, Cape Town, 100-162.

UMkhanyakude District Municipality. (2018). [Online]. Accessed on 12 January 2018 from http://www.ukdm.gov.za/.

UNFCCC. (1992). United Nations Framework Convention on Climate Change (UNFCCC) FCCC-84. Geneva: United Nations.

UNFCCC. (2007). *Climate Change: Impacts, Vulnerabilities and Adaptation in Developing Countries*. Climate Change Secretariat (UNFCCC), Bonn, Germany. [Online]. Accessed 10 March 2018 from http://unfccc.int/files/essential_background/background_publications_htmlpdf/application/txt/pub_07_impacts.pdf.

UNFCCC. (2011). The Cancun Agreements: Outcome of the work of the Ad Hoc Working Group on Long-term Cooperative Action under the Convention. Report of the Conference of the Parties, Sixteenth session, Cancun, Mexico 29 November – 10 December 2010, Addendum: Part Two: Action taken by the Conference of the Parties at its sixteenth session, Contents: Decisions adopted by the Conference of the Parties, FCCC/CP/2010/7/Add.1, United Nations Framework Convention on Climate Change (UNFCCC), UNFCCC Secretariat, Bonn, Germany, 31 pp.

United Nations. (1998). Kyoto Protocol to the United Nations Framework Convention on Climate Change. Accessed on 10 July 2018 from http://unfccc.int/resource/docs/convkp/kpeng.pdf.

Valdivia, C., Seth, A., Gilles, J.L., Garcia, M., Jimenez, E., Cusicanqui, J., Navia, F. and Yucra, E. (2010). Adapting to climate change in Andean ecosystems; landscapes, capitals, and perceptions shaping rural livelihood strategies and linking knowledge systems. *Annals of the Association of American Geographers*, 100(4): 818-834.

Van Aelst, K., and Holvoet, N. (2016). Intersections of Gender and Marital Status in Accessing Climate Change Adaptation: Evidence from Rural Tanzania. *World Development*, 79: 40-50, 52.

Van Dijk, A. I. J. M., Beck, H. E., Crosbie, R. S., de Jeu, A. M., Liu, Y. Y., Podger, G. M., Timbal, B. and Viney, N. R. (2013). The Millennium Drought in southeast Australia (2001–2009): Natural and human causes and implications for water resources, ecosystems, economy, and society. *Water Resour. Res.*, 49: 1040–1057.

Van Heerden, J., Terblanche, D.E. and Schulze, G.C. (1988). The Southern Oscillation and South African summer rainfall. *J Climatol*, 8:577–597.

Vogel, C. (2005). 'Usable Science: An assessment of long-term seasonal forecasts among farmers in rural areas of South Africa'. *South African Geographical Journal*, 82(2): 107–116. https://doi.org/10.1080/03736245.2000.9713700

Vogel, C.H. and O'Brien, K. (2006). Who can Eat Information? Examining the Effectiveness of Seasonal Climate Forecasts and Regional Climate-risk Management Strategies. *Climate Research,* 33: 111-122.

Wang, A. H., Lettenmaier, D. P., and Sheffield, J. (2011). Soil moisture drought in China, 1950–2006. *J. Climate*, 24: 3257–3271.

Warburton, M.L., Schulze, R.E. and Maharaj, M. (2005). Chapter 16: Is South Africa's Temperature Changing? An Analysis of Trends from Daily Records, 1950 – 2000. pp275 295. [In: Schulze, R.E., (ed) *Climate Change and Water Resources in southern Africa: Studies on Scenarios, Impacts, Vulnerabilities and Adaptation*. Water Research Commission, Pretoria, RSA, WRC Report 1430/1/05].

Water Act. (2002). Republic of Kenya. Chapter 372. National Council for Law Reporting with the Authority of the Attorney-General. www.kenyalaw.org.

Water Act. (2016). Republic of Kenya. No. 43. www.kenyalaw.org.

Watson, R.T., Zinyowera, M.C. and Moss, R.H. (1996). Climate Change 1995: Impacts, Adaptations and Mitigation of Climate Change: Scientific-Technical Analysis. Contribution of

Working Group II to the Second Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge.

Weinreich, N.K. (2009). Integrating Quantitative and Qualitative Methods in Social Marketing Research.

Welman, C., Kruger, F. and Mitchell, B. (2009). Research Methodology. 3rd ed. Cape Town: Oxford.

Wheeler, T. and von Braun, J. (2013). Climate Change Impacts on Global Food Security. Science 341: 508-513.

Wiid, N. and Ziervogel, G. (2012). Adapting to climate change in South Africa: commercial farmers' perception of and response to changing climate. *South African Geographical Journal*, 94(2).

Williams, C., Williams, S., Appleton, K. (1997). Mind maps: an aid to effective formulation. *Behav. Cogn. Psychother*, 25(3): 261–267. doi:10.1017/s1352465800018555

Williams, A. (2003). How to write and analyse a questionnaire. *J Orthod*; 3: 245e52.

Wisker, G. (2008). *The postgraduate research handbook*. London: Palgrave Macmillan. P. 187.

World Bank. (2001). World Development report 2000/2001: Attacking poverty, Washington, D.C.

World Bank. (2015a). *World Bank Country Classifications*. Washington, DC: World Bank. [Online]. Available at: http://data.worldbank.org/about/country-and-lending-groups [Accessed on 11 March 2018].

World Bank. (2016). Arable land (hectares per person), World Bank, Accessed on 31 July 2018, from http://data.worldbank.org/indicator/AG.LND.ARBL.HA.PC

World Meteorological Organization Statement on the State of the Global Climate. (2017). Issued on 23 March 2018. Accessed on 15 July 2018, from https://library.wmo.int/doc_num.php?explnum_id=4453

Wunder, S., Noack, F. and Angelsen, A. (2018). Climate, crops, and forests: a pan-tropical analysis of household income generation. *Environment and Development Economics,* 23(3): 279-297.

Yamashita, H., Grewe, V., Jöckel, P., Linke, F., Schaefer, M. and Sasaki, D. (2016). Air traffic simulation in chemistry-climate model EMAC 2.41: AirTraf 1.0 Geosci. *Model Dev,* 9: 3363–92.

Yilmaz, K.K., Yazicigil, H., *et al.* (2011). Potential impacts of climate change on Turkish water resources: a review. In: Baba, A. (Ed.), *Climate Change and Its Effects on Water Resources*, 105 NATO

Science for Peace and Security Series C: Environmental Security 3. Springer Science + Business Media B.V., Ankara, Turkey, pp. 105–114.

Young, B., Byers, E., Gravuer, K., Hammerson, G. and Redder, A. (2010). Guidelines for Using the NatureServe Climate Change Vulnerability Index. *NatureServe*, Arlington, VA.

Ziervogel, G. and Calder, R. (2003). Climate variability and rural livelihoods: assessing the impact of seasonal climate forecasts in Lesotho. *Area*, 35(4): 403-417.

Ziervogel, G. and Taylor, A. (2008). Feeling stressed integrating climate adaptation with other priorities in South Africa. *Environment Science and Policy for Sustainable Development*, 50(2): 32 – 41.

Ziervogel, G., Parnell, S. (2012). South African coastal cities: governance responses to climate change adaptation. In: Cartwright, A., Parnell, S., Oelofse, G., Ward, S. (Eds.). *Climate Change at the City Scale: Impacts, Mitigation and Adaptation in Cape Town*. Routledge, London, New York, 223–243.

Ziervogel, G., New, M., van Garderen, E.M., Midgley, G., Taylor, A., Hamann, R., Stuart-Hill, S., Myers, J. and Warburton, M. (2014). Climate change impacts and adaptation in South Africa. *WIREs Climate Change*, 5:605–620.

Zietsman, G. (2017). 'Global warming effects are realities' - KZN Premier points to climate change as cause of storm. [Online]. Available at: https://www.traveller24.com/Explore/Green/global-warming-effects-are-realities-kzn-premier-points-to-climate-change-as-cause-of-storm-20171013 [Accessed on 11 March 2018].

Zinyengere, N., Crespo, O. and Hachigonta, S. (2013). Crop response to climate change in southern Africa: a comprehensive review. *Global and Planetary Change,* 111: 118–126.

Zuo, D. D., Hou, W., and Wang, W. X. (2015). Sensitivity analysis of sample number of the drought descriptive model built by Copula function in southwest China. *Acta Phys. Sin.*, 64: 100203

APPENDIX A

Research Office

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

CLEARANCE CERTIFICATE	**PROTOCOL NUMBER: H18/07/25**
PROJECT TITLE	Climate variability, asset adaptation and rural livelihoods in Mtubatuba Kwazulu-Natal, South Africa
INVESTIGATOR(S)	Miss N Sibiya
SCHOOL/DEPARTMENT	Geography, Archaeology and Environmental Studies/
DATE CONSIDERED	20 July 2018
DECISION OF THE COMMITTEE	Approved
EXPIRY DATE	07 August 2021

DATE 08 August 2018 **CHAIRPERSON** _____
(Professor J Knight)

cc: Supervisor : Professor D Simatele

DECLARATION OF INVESTIGATOR(S)

To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10004, 10th Floor, Senate House, University. Unreported changes to the application may invalidate the clearance given by the HREC (Non-Medical)

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

_____ _____/_____/_____
Signature **Date**

PLEASE QUOTE THE PROTOCOL NUMBER ON ALL ENQUIRIES

APPENDIX B



PARTICIPATION INFORMATION SHEET

(QUESTIONNAIRE RESPONDENTS)

Date: **Place:**

RE: Invitation to participate in a research study entitled "Climate variability, asset adaptation and rural livelihoods in Mtubatuba, Kwazulu-Natal, South Africa"

Dear Sir/Madam,

My name is Nomfundo Sibiya and I am a Masters student in the School of Geography, Archaeology and Environmental Studies at the University of the Witwatersrand in Johannesburg. As part of my studies, I am required to do a research project which fits into the overall degree. In view of the above, I am investigating the ways in which rural households in Mtubatuba use different resources to respond to challenges of climate change.

Therefore, I am writing to invite you to take part in answering a questionnaire. As I have brought the form to your household, I will give you time (a day or two days) to complete the form. Therefore, I will come and collect the form from you on the second day from today. Should you require more time please feel free to let me know. You will not receive any direct benefits for participating in this study, and there are no disadvantages or penalties for not participating. Kindly note that there is neither cost nor payment to be made to the participants. The answering of the questionnaire will be completely confidential and anonymous as I will not be asking for your name or any identifying information, and the information you will provide on the questionnaire will be held securely and not disclosed to anyone else. I will be using a false name to represent your participation, in my final research report. If at any point you are uncomfortable with any question, you do not need to answer it.

If you have any questions afterwards about this research, please feel free to contact me or my supervisor on the details listed below. This study will be written up as a research report which will be available online through the university library website. If you wish to receive a summary of this report, I will be happy to send it to you upon request. If you have any queries, concerns or complaints regarding the ethical procedures of this study, you are welcome to contact the University Human Research Ethics Committee (non-medical), telephone + 27(0)11 717 1408, email Shaun.Schoeman@wits.ac.za.

Yours sincerely,

Study Investigator

Nomfundo Sibiya

573380@students.wits.ac.za

+27(0)73 731 2862

Supervisor

Professor Danny Simatele

Danny.simatele@wits.ac.za

+27(0)11 717 6516

APPENDIX C



PARTICIPATION INFORMATION SHEET

(INTERVIEW RESPONDENTS – LOCAL AUTHORITY OFFICIALS)

Date: **Place:**

RE: Invitation to participate in a research study entitled "Climate variability, asset adaptation and rural livelihoods in Mtubatuba, Kwazulu-Natal, South Africa"

Dear Sir/Madam,

My name is Nomfundo Sibiya and I am a Masters student in the School of Geography, Archaeology and Environmental Studies at the University of the Witwatersrand in Johannesburg. As part of my studies I am required to do a research project which fits into the overall degree. In view of the above, I am investigating the ways in which rural households in Mtubatuba use different resources to respond to challenges of climate change.

Therefore, I am writing to invite you to take part in an interview. This activity will take approximately 20 minutes. With your permission, I would also like to record the interview using a recorder. You will not receive any direct benefits for participating in this study, and there are no disadvantages or penalties for not participating. Kindly note that there is neither cost nor payment to be made to the participants. The interview will be completely confidential and anonymous as I will not be asking for your name or any identifying information, and the information you give to me will be held securely and not disclosed to anyone else. I will be using a false name to represent your participation, in my final research report. If at any point you are uncomfortable with any question, you do not need to answer it and if you want to stop the interview we can stop at any time.

If you have any questions afterwards about this research, please feel free to contact me or my supervisor on the details listed below. This study will be written up as a research report which will be available online through the university library website. If you wish to receive a summary of this report, I will be happy to send it to you upon request. If you have any queries, concerns or complaints regarding the ethical procedures of this study, you are welcome to contact the University Human Research Ethics Committee (non-medical), telephone + 27(0)11 717 1408, email Shaun.Schoeman@wits.ac.za.

Yours sincerely,

Study Investigator

Nomfundo Sibiya

573380@students.wits.ac.za

+27(0)73 731 2862

Supervisor

Professor Danny Simatele

Danny.simatele@wits.ac.za

+27(0)11 717 6516

APPENDIX D



PARTICIPATION INFORMATION SHEET

(FOCUS GROUP DISCUSSION PARTICIPANTS)

Date: **Place:**

RE: Invitation to participate in a research study entitled "Climate variability, asset adaptation and rural livelihoods in Mtubatuba, Kwazulu-Natal, South Africa"

Dear Sir/Madam,

My name is Nomfundo Sibiya and I am a Masters student in the School of Geography, Archaeology and Environmental Studies at the University of the Witwatersrand in Johannesburg. As part of my studies I am required to do a research project which fits into the overall degree. In view of the above, I am investigating the ways in which rural households in Mtubatuba use different resources to respond to challenges of climate change.

Therefore, I am writing to invite you to take part in a focus group discussion. This activity will take approximately 30 minutes. With your permission, I would also like to record the discussion using a recorder. You will not receive any direct benefits for participating in this study, and there are no disadvantages or penalties for not participating. Kindly note that there is neither cost nor payment to be made to the participants. As the focus group discussion will be held at a central place in the community there will be no transport reimbursements made to those who will attend the discussion. Because of the nature of a focus group I cannot guarantee confidentiality and anonymity. However, I will ask every individual who will be participating in the focus group to keep the information which will be discussed confidential. The focus group discussion will have approximately 8-10 participants. I will be using a false name to represent your participation, in my final research report. If at any point you are uncomfortable with any question, you do not need to answer it and if you want to stop the discussion we can stop at any time.

If you have any questions afterwards about this research, please feel free to contact me or my supervisor on the details listed below. This study will be written up as a research report which will be available online through the university library website. If you wish to receive a summary of this report, I will be happy to send it to you upon request. If you have any queries, concerns or complaints regarding the ethical procedures of this study, you are welcome to contact the University Human Research Ethics Committee (non-medical), telephone + 27(0)11 717 1408, email Shaun.Schoeman@wits.ac.za.

Yours sincerely,

Study Investigator

Nomfundo Sibiya

573380@students.wits.ac.za

+27(0)73 731 2862

Supervisor

Professor Danny Simatele

Danny.simatele@wits.ac.za

+27(0)11 717 6516

APPENDIX E

CONSENT FORM

(INTERVIEW RESPONDENTS)

Invitation to participate in a research study entitled "Climate variability, asset adaptation and rural livelihoods in Mtubatuba, Kwazulu-Natal, South Africa"

I..... agree to participate in this research project. Miss Nomfundo Sibiya has informed me about the nature and conduct of this study and I understand what my participation will involve. I have also received, read and understood the participant information sheet for this study. I have been notified about my rights to withdraw at any time and my right to anonymity and confidentiality.

	Please tick one
I agree that my participation will remain anonymous	YES ☐ NO ☐
I agree that the researcher may use anonymous quotes in her research report	YES ☐ NO ☐
I agree that the interview may be audio recorded	YES ☐ NO ☐
I agree that the information I provide may be used anonymously by other researchers following this study provided that these researchers get ethics clearance from the Human Research Ethics Committee	YES ☐ NO ☐

....

Participant's Signature **Date**

I, Nomfundo Sibiya, confirm that the above participant has been fully informed about the nature and conduct of the abovementioned study.

Study Investigator
Nomfundo Sibiya

....

Investigator's Signature **Date**

APPENDIX F

CONSENT FORM

(FOCUS GROUP DISCUSSION PARTICIPANTS)

Invitation to participate in a research study entitled "Climate variability, asset adaptation and rural livelihoods in Mtubatuba, Kwazulu-Natal, South Africa"

I..... agree to participate in this research project. Miss Nomfundo Sibiya has informed me about the nature and conduct of this study and I understand what my participation will involve. I have also received, read and understood the participant information sheet for this study. I have been notified about my rights to withdraw at any time. I have been informed that because of the nature of a focus group confidentiality and anonymity is not guaranteed.

	Please tick one
I agree that the researcher may use anonymous quotes in her research report	YES ☐ NO ☐
I agree that the interview may be audio recorded	YES ☐ NO ☐
I agree that the information I provide may be used anonymously by other researchers following this study provided that these researchers get ethics clearance from the Human Research Ethics Committee	YES ☐ NO ☐

....

Participant's Signature **Date**

I, Nomfundo Sibiya, confirm that the above participant has been fully informed about the nature and conduct of the abovementioned study.

Study Investigator
Nomfundo Sibiya

....

Investigator's Signature **Date**

APPENDIX G

Questionnaire on Climate variability, asset adaptation and rural livelihoods in Mtubatuba, KwaZulu-Natal, South Africa

---

Instructions:

Please fill out the form below to the best of your knowledge by ticking boxes. You are also welcomed to elaborate on each answer should you wish to do so. All answers are relevant to this research even when the answer is "I don't know." If you are unable to answer a question, you are allowed to leave it blank.

SECTION A: GENERAL

A1. What gender are you?

a) Male ☐ b) Female ☐

A2. What is your age?

a) 25 to 35 ☐ b) 36 to 45 ☐

c) 46 to 55 ☐ d) 56 to 65 ☐

e) over 65 ☐

A3. What is your ethnic background?

a) Black ☐ b) White ☐

c) Colored ☐ d) Indian ☐

e) Other (please specify) ☐

A4. What is your employment status?

a) Full-time employed ☐ b) Part-time employed ☐

c) Self-employed ☐ d) Unemployed ☐

e) Retired ☐ f) Other (please specify) ☐

A5. What is your highest level of education?

a) Less than High school ☐ b) High School ☐

c) Diploma/Degree ☐ d) Postgraduate degree ☐

A6. How long have you lived in this area?

a) 0 to 5 years ☐ b) 6 to 10 years ☐

c) 11 to 19 years ☐ d) 20 years or more ☐

A7. Are you the head of this household?

a) Yes ☐ b) No ☐

A8. What is the number of people residing in your household? (Including yourself)

a) 1 to 3 people ☐ b) 4-6 people ☐

c) 7 to 9 people ☐ d) 10 people or more ☐

SECTION B: CLIMATE VARIABILITY, ASSET ADAPTATION AND RURAL LIVELIHOODS INFORMATION

B1. During the time that you have lived in this area, have you observed any changes in the weather patterns?

a) Yes ☐ b) No ☐

B2. If yes, please explain what are the changes that you have seen

……

……

……

……

B3. If the weather has changed over the past number of years, has it prevented you from doing any activity/activities, which use to contribute to sustaining your life/livelihood?

a) Yes ☐ b) No ☐

B4. If yes, what are those activities?

……

……

……

……

……

B5. Have you ever experienced any of the following extreme weather events in the past number of years? (You can tick more than 1 if you have experienced more than 1 extreme weather ev ☐ ☐

a) Floods b) Droughts

c) Severe thunderstorms ☐ d) Tornadoes ☐

e) Hurricanes ☐ f) Other (Please specify) ☐

g) None ☐

B6. How often has the event(s) that you have selected above happened?

……

……

……

B7. How did the weather event(s) that you have selected above affect your life/livelihood?

……

……

……

……

B8. How have you coped with sustaining your life/livelihood over the years?

……

……

……

……

B9. Which resources have helped you in dealing with the changing weather patterns? (You can select all the relevant resources that have helped you to cope with changing climates).

a) Physical resources ☐
(e.g. infrastructure, house, vehicle etc.)

b) Financial resources ☐
(e.g. money in the bank, investments)

c) Human resources ☐
(e.g. labour, health, education, skills)

d) Natural resources ☐
(e.g. land, water, biodiversity)

e) Social resources ☐
(e.g., trust, relationships, social networks and connections)

f) Other (please specify) ☐

B10. In what ways have these resources helped you? (Please provide an explanation for each resource you have selected).

……

……

……

……

……

……

……

……

……

B11. How easy is it for you to access these resources?

……

……

……

……

Thank you for your time, participation and valuable contribution.

APPENDIX H

INTERVIEW SCHEDULE

(LOCAL AUTHORITY OFFICIALS: MTUBATUBA LOCAL MUNICIPALITY)

1. Are you able to share what your job function is within the Mtubatuba Local Municipality?

……

……

……

……

2. How long have you been in this position?

……

……

……

……

……

3. During the time you have been in this position, has any issues around weather challenges been an area of concern?

……

……

……

……

……

4. Is there a policy at municipal level or provincial level that you use to address issues of climate change?

a) Yes ☐ b) No ☐

5. If yes, how is this issue addressed within the policies?

……

……

……

6. As the local municipality, do you have a budget or resources that are specifically dedicated to addressing issues of climate change?

……

……

……

……

7. As the local municipality, do you have outreach programmes in the communities that sensitises people about climate change and to assist the communities to build resistance against climate change?

……

……

……

8. What are the challenges that you face in addressing issues of climate change? In addition, what do you consider as the way forward?

……

……

……

9. From what we have discussed, is there any other thing that you would like to add?

……

……

……

Thank you for your time, participation and valuable contribution.

APPENDIX I

Focus Group Discussion Questions

Good day and welcome to our focus group discussion session. Thank you for taking the time to join us to talk about climate variability, asset adaptation and rural livelihoods in this area.

My name is Nomfundo Sibiya and I am a Masters student in the School of Geography, Archaeology and Environmental Studies at the University of the Witwatersrand in Johannesburg. As part of my studies, I am required to do a research project, which fits into the overall degree. In view of the above, I am investigating the ways in which rural households in Mtubatuba use different resources to respond to challenges of climate change.

Therefore, you are invited to join this focus group discussion. During the discussion, please feel free to voice your various opinions, as there are no right or wrong answers so you are allowed to have differing points of view. As you may have noticed the recorder, I will tape record the discussion session because I do not want to miss any of your comments. People often say very helpful things in these discussions and sometimes the researcher may not be able to write fast enough. Although we may refer to one another by name, these names will not be included in the final report. You may be assured of complete confidentiality.

Let us begin. I have placed name cards on the table in front of you to help us remember each other's names. Let us introduce one another, please tell us your name and in which side of the village you are from.

Questions

1. How would you best describe the climate of this area for the past 20 years (1997-2017)?

2. Thinking back over the past 20 years that you have lived in this area, have you ever experienced any extreme weather events?

3. If so, what are these extreme weather conditions?

4. In which year(s) did these extreme weather conditions occur?

5. How has the changing climate impacted your lives?

6. In the past, how have you coped with the effects of climate variability?

7. What measures if any, do you put in place when extreme weather events occur?

8. Does the Mtubatuba Local Municipality provide the community with any assistance after an extreme weather event occur? If yes, what assistance have they provided in the past? In addition, was it helpful?

9. Of all the things we have discussed what has been your most important resources you have used that helped you in adapting to the impacts of climate variability?

In closing, have we missed anything? If anyone would like to add anything please feel free to do so now.

Thank you for your time, participation and valuable contribution.

APPENDIX J

Table 1: Extreme weather events observed by the household participants

(n= number of responses, N= total number of responses)

Extreme weather events	**Nkombose**		**Ebaswazini**		**Ogengele**		**Total**	
	(n)	**(%)**	**(n)**	**(%)**	**(n)**	**(%)**	**(n)**	**(%)**
Droughts	213	61%	57	71%	77	76%	347	65%
Severe Thunderstorms	79	23%	14	18%	22	22%	115	22%
Floods	32	9%	2	3%	1	1%	35	6,50%
Hurricanes	13	4%	1	1%	0	0%	14	2,60%
Tornadoes	10	3%	1	1%	0	0%	11	2%
Other	4	1%	5	6%	1	1%	10	1,90%
Total	351	100%	80	100%	101	100%	532	100%

N= 532; Percentage = (n/N) x 100%

Source: Based on fieldwork data, 2018

APPENDIX K

Table 2: Meteorological data trends in Mtubatuba (1997-2017)

Year	Minimum temperature (°C)	Maximum temperature (°C)	Rainfall amount (mm)
1997	14,7 °C	22,3 °C	34,4 mm
1998	16,3 °C	24,8 °C	46,0 mm
1999	14,8 °C	20,8 °C	74,2 mm
2000	12,9 °C	17,3 °C	120,3 mm
2001	14,5 °C	24,8 °C	76,7 mm
2002	15,7 °C	25,7 °C	43,4 mm
2003	14,5 °C	23,3 °C	34,6 mm
2004	7,8 °C	13,0 °C	40,6 mm
2005	10,2 °C	18,1 °C	42,3 mm
2006	6,3 °C	11,2 °C	31,7 mm
2007	10,4 °C	15,8 °C	44,2 mm
2008	16,5 °C	27,8 °C	52,8 mm
2009	14,8 °C	24,4 °C	43,1 mm
2010	17,1 °C	27,7 °C	57,5 mm
2011	16,0 °C	26,8 °C	65,0 mm
2012	13,8 °C	22,8 °C	67,4 mm
2013	12,7 °C	22,2 °C	41,6 mm
2014	16,2 °C	28,0 °C	31,0 mm
2015	15,8 °C	27,0 °C	36,4 mm
2016	16,9 °C	26,1 °C	57,0 mm
2017	17,2 °C	25,4 °C	83,5 mm

Source: South African Weather Service (2018)

APPENDIX L

Table 3: Effects of lack of water attributed to droughts on rural livelihoods in Mtubatuba

(n= number of responses, N= total number of responses)

Impacts	**Nkombose**		**Ebaswazini**		**Ogengele**		**Total**	
	(n)	**(%)**	**(n)**	**(%)**	**(n)**	**(%)**	**(n)**	**(%)**
Reduced farming/planting/gardening/ploughing	157	75%	39	78%	56	73%	252	74,8%
Increased livestock losses	24	11%	3	6%	17	22%	44	13,1%
Reduced selling or business activities	13	6%	6	12%	2	2,5%	21	6,2%
Reduced building/manufacturing building blocks activities	10	5%	2	4%	2	2,5%	14	4,2%
Reduced work opportunities	6	3%	0	0%	0	0%	6	1,8%
Total	210	100%	50	100%	77	100%	337	100%

N= 337; Percentage = (n/N) x 100%

Source: Based on fieldwork data, 2018

APPENDIX M

Table 4: Household assets for adaptation (%)

(n= number of responses, N= total number of responses)

Assets	**Nkombose**		**Ebaswazini**		**Ogengele**		**Total (%)**	
	(n)	**(%)**	**(n)**	**(%)**	**(n)**	**(%)**	**(n)**	**(%)**
Financial assets	79	30%	35	52%	52	54%	166	39%
Human assets	119	45%	20	30%	27	28%	166	39%
Social assets	37	14%	6	9%	13	13%	56	13%
Physical assets	20	8%	1	1%	2	2%	23	5%
Other assets	5	2%	5	7%	3	3%	13	3%
Natural assets	5	2%	0	0%	0	0%	5	1%
Total	265	100%	67	100%	97	100%	429	100%

N= 429; Percentage = (n/N) x 100%

Source: Based on fieldwork data, 2018