

**An exploration of the role of indigenous weather
and climate knowledge in crop production: the
case of Lepelle Nkumpi municipality in Limpopo
Province**

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Thesis accepted in fulfilment of the requirements for the
degree

Doctor of Philosophy in Indigenous Knowledge Systems
at the North-West University

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Graduation ceremony: July 2020

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ABSTRACT

Weather and climate have potential in contributing to the livelihood of the communities. Knowledge about weather and climate contribution to crop production is critically vital. The relative research on weather and climate predictions is often conducted at a macro level. However, failure to address micro level weather and climate prediction information may contribute to food insecurity. Detailed studies have not been conducted to address indigenous weather and climate prediction knowledge at micro level in Lepelle Nkumpi Municipality. The aim of this study was to explore the potential role that indigenous weather and climate knowledge can play in supporting crop production in Lepelle Nkumpi Municipality, Capricorn District Limpopo Province. In order to achieve the aim of the study, specific objectives were considered and explored. Furthermore, the documentation of indigenous weather and climate predictions was considered in order to bring much needed alignment in preparedness strategies, and close uncertain, unreliable weather and climate prediction information provided. In terms of alignment, the research addresses the issues on how indigenous weather and climate knowledge should be integrated with western knowledge to come up with more accurate and usable weather and climate predictions for smallholder farmers in the study area. The objectives of the study were to investigate and describe the nature and types of indigenous weather and climate knowledge, assess the knowledge, attitudes and perceptions of smallholder farmers, review and assess the impact of existing national and local policies on weather and climate on the utilization of indigenous knowledge, establish the link between indigenous and western weather and climate knowledge systems and develop a model for integrating indigenous and western weather and climate knowledge systems for improving crop production in Lepelle Nkumpi municipality of Limpopo province.

In approaching the challenges of weather and climate variability which affect food security within the communities, it was important to consider in the study participation of smallholder farmers and Traditional Council members to elicit their knowledge and wisdom on the phenomenon under study. Prior data collection, a literature review on the phenomenon was conducted with an emphasis on weather and climate, its role,

impact and contributions towards improving crop production and livelihood of the communities. However, western weather and climate prediction contribution to the livelihoods of communities is also presented and discussed. The persisting weather and climate prediction at a macro level is noted since it affect smallholder farmers in making informed decisions on crop production while knowledge of smallholders and Traditional councils' members are overlooked.

This research employed decolonising approaches for the researcher to understand and respect the traditional protocols prior interviewing smallholder farmers and traditional council members. The African ways of viewing the world was also explored in conferring the smallholder farmers and Traditional councils the sense of belonging and existence. The focus was on African indigenous worldviews, cosmology, conceptual and theoretical frames of the study and indigenous research paradigms and designs. More emphasis in the study is on the application of decolonising research methodologies for indigenous research. Furthermore, indigenous theories that support indigenous research undertaking were discussed.

The thesis explores the nature and types of indigenous knowledge available for use in decision making by the smallholder farmers and Traditional councils in Lepelle Nkumpi municipality, Limpopo Province. Indigenous weather predictions was examined based on plant phenology, astronomic, atmospheric and biological indicators. The recollection of smallholder farmers and Traditional councils revealed the prevalent of indigenous weather and climate indicators within their localities. Furthermore, the cultural and spiritual issues of importance in weather predictions were examined.

The use of a questionnaire to assess the attitude and perceptions of the respondents towards weather and climate knowledge is key and based on an individual self-esteem. A Knowledge, Perception and Attitude (KAP) survey conducted to assess the attitude and perceptions of smallholder farmers towards indigenous weather and climate are presented in details. About 61 % of respondents who participated during the survey were females and 39% males. The survey has revealed that about 52% of

respondents strongly agree with perceptions statements towards indigenous knowledge while 3.3 strongly disagree with the statements. It was also revealed in the study that gender influence on perception tend to be significant (P-value <0.05). The study inferred that female respondents tend to agree more than male counterparts. However, the age mean scores for group between 50-60 and 60 above are not significantly different from each other at 5% level of significance.

It was examined in the study that 55.9% of respondents very often consider attitude statements towards indigenous weather and climate while 3.5% are not at all consider indigenous weather and climate. Gender and attitudes of respondents have revealed that gender has an influence on attitudes and is significant at (P-value <0.05) in all five attitude statements. The results from the study shows that female respondents very often consider indigenous weather and climate than male counterparts with a mean score of 3.4 and above while mean score for males is 3.1. It was also revealed that age groups of 35-50 that are not significantly different (P value <0.05) from the mean score for age group of 60 and above. Therefore, smallholder farmers in Lepelle Nlumpi municipality consider indigenous weather and climate knowledge as important in making decisions on crop production systems.

The study further explored on analysing national and local policies on weather and climate which considers indigenous knowledge in agriculture. It is reported in the thesis that different government institutions less considered indigenous weather knowledge in their policies. In considering policy status, almost all institutions identified and documents reviewed, indigenous knowledge system (IKS) elements are not in place. Only Department of Science and Technology reported on IKS elements as partially in place while Department of Environmental Affairs reported the inclusion of IKS elements in their policies. Furthermore, reviewed policy documents lacks issues on indigenous weather and climate considerations. It is concluded that policy formulation and implementation should be inclusive with contributions from local rural communities.

In aligning indigenous and western weather knowledge on predictions, the focus was to achieve accepted and reliable weather and climate information for end-users. It was revealed in this thesis that the traditional councils/ knowledge-holders from the municipality recollection of the past extreme weather and climate events are well defined but not comparable with the information collected from three weather stations in the municipality. Knowledge-holders' experience and wisdom about the phenomenon under study is explored. Furthermore, a participatory approach to integrate indigenous and western knowledge system is described with more emphasis to participants concerns and challenges listed during validation research workshop. The thesis provide a general discussion, conclusions and recommendations from the study pertaining to generated knowledge, findings and limitation realised. The study reflected more on decolonising approaches to indigenous research which assisted the researcher in involving participants and respondents from the beginning of the research to the end. The involvement of the participants as co-researchers enhanced the whole research process whereby every individual raised his/her voice and it was examined in the entire study. Above all these considerations, smallholder farmers and traditional council members' use of their ancient wisdom can contribute greatly to the development of weather and climate mitigation strategies while documentation of indigenous weather and climate knowledge becomes critical and require special attention from government and policy makers.

KEY TERMS

Weather and climate, indigenous, epistemology, Knowledge, Attitudes and Perceptions, African indigenous worldview, decolonising approaches, Lepelle Nkumpi Municipality, Smallholder farmers, Traditional council, Limpopo Province.

DECLARATION BY STUDENT

I, undersigned, hereby declare that the work contained in this thesis is my own original work and that I have not, previously, in its entirety or in part, submitted it at any university for a degree.

Signature: _____

Date: _____

DEDICATION

I would like to dedicate this study to my wife Lehlokwa Veronica Magoro (Modipadi) and my daughters Mothekgi Eugenia (Mahlako), Tetelo (Mangakane), Thami (Hunadi) and my son Modisha Phasoane (Ngwato) for being so supportive and understanding. Special dedication goes to my late daughter Khutšišo (Hunadi), who motivated me to pursue my studies. To them I would like to say “*Modimo le badimo ba ba hlahle maphelong a bona* – May God and Ancestors guide them through their lives”.

ACKNOWLEDGEMENTS

I wish express my sincere gratitude to the heavenly father and my ancestors for giving a strength, emotional stability and guidance in undertaking the study.

My special thanks goes to Limpopo Department of Agriculture and Rural Development (LDARD) for their support and encouragement when I needed their approvals to attend to my activities related to my study. Many thanks goes to Mr Mathebula C, Director LDARD: Sekhukhune District Municipality and Mrs Kekane E, Director: LDARD Capricorn District Municipality for their encouragement and support. My special appreciation and assertion goes to Prof. P. Iya who motivated me to register my PhD in indigenous Knowledge Systems and affording himself time to explain how the programme will be conducted once approved. It was in 2012 when I inquired about the postgraduate studies in indigenous knowledge systems through him. I am very thankful and grateful to Ms Lerato Palesa who handled my inquiries with excellence during her tenure in the IKS unit. I would like to acknowledge Prof. Materechera S.A and Prof. Kabanda T.A for their initial assistance during the study.

Supervisory

I wish to sincerely salute, appreciate and thank Prof. Modise D, Prof Masoga M and Dr Koitsiwe M who tirelessly guided, persuaded, supported and encouraged me to correct and complete my research. My special thanks goes to Prof. Modise D who guided me in restructuring my work and provided support where required. I would like to thank Ms Lesedi Makapela from Indigenous Knowledge Systems (IKS) centre for her openness and administrative support. My appreciation to Dr Saurombe T for his encouragement and support afforded me during research process.

- Financial support

My special appreciation goes to the National Research Foundation (NRF) for their financial support that enabled me to undertake this study.

- Individuals representing different stakeholders

I would like to express my sincere gratitude and appreciation to the following individuals who participated on my study:

- Information

Mrs Mmaserame Majudjwa from Department of Agriculture, Forestry and Fisheries - Plant Production for completing the GAP Analysis checklist and reflecting on policy prescripts which are related to crop production, Mr Tom Suchanandan from Department of Science and Technology – IKS unit who provided insights on IKS policy within the Department, Mr Gilbert Morake Mosupje from Environmental Affairs – International Governance Management who shared his views on policies within the directorate, Ms Reneilwe Mamabolo from Lepelle Nkumpi Municipality – Environmental and Waste management services who provided the insight of frameworks that governs the municipality in terms of environmental issues, Mr Obed Phahlane from Agriculture Research Council (ARC-) – Agro-climatology who made contributions on legislative framework within the organisation.

- Technical support

Special appreciation to Mrs Maureen Fritz from Agriculture Research Council (ARC-Potchefstroom) – Agro-Climatology who provided captured data on weather and climate for the study area. To Dr Maphosa from University of Limpopo, statistics unit, thanks for analysing my quantitative data. Mr Matlala B and Ms Ledile Maleka are acknowledged for the provision study site map.

- Support

A special thanks goes to Kgoši Ledwaba R.P and Kgoši Seloane N.D who attended briefing sessions and validation workshop. I am indeed grateful and would like to remember and thank the friendly and kind Agricultural Advisors from Department of Agriculture and Rural Development, especially Mrs Phatudi K.R, Mrs Mogale M, Mr

Shilajoe T, Mrs Molepo S, Mr Sethole M and Sethole Z, who organised farmers and participated in the research process during data collection and transporting farmers. Smallholder crop farmers and Traditional Council members from Ga-Seloane (Mrs Seloane N, D., Seloane, S.A., Mr Mogashoa G., Mr Seloane M., Mrs Mapulana R.S.), Kekane (Mr Kekana, I.E., Kekana, G., Mrs Mafagane, M.) Ga-Ledwaba (Mr Ledwaba, D., Ledwaba, S., Mr Legwabe, F., Mr Hlonga L) Ga-Mphahlele (Mrs Makgabo, M., Mrs Selepe, R., Mr Maesele, M.G., Mr Kgomoeswana, B.F.), Mathabatha (Mr Mathabatha, L.J Mr Tabana, R.E., Teka, R.M, Kgasago, M.Z) and Mafefe (Mr Nkoane, P., Mr Tobejane, R., Mr Mangwale, M.S) in Lepelle Nkumpi municipality, who assisted me in following local protocols and participated in the validation workshop, the study and shared their experiences with me with great patience. My appreciation and gratitude to Ms Mantsho S., Mr Mogashoa, J., Mr Maja S., and Mrs Mapulane S, for preparing lunch for respondents.

- Traditional protocols

To all Magoshi's, Kgoši Seloane, Ledwaba, Mphahlele, Kekane, Mathabatha and Thobejane, I applaud you for affording me the opportunities to talk to your constituencies and guiding me to follow local protocols. *Ke opa diatla go ba ka difokeng. "Motho ke motho batho"*

Pula...pula ga ene – let the rain comes

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LIST OF ABBREVIATIONS AND ACRONYMS

ANOVA	Analysis of Variance
ARC	Agriculture Research Council
CDKN	Climate and Development Knowledge Network
CDM	Capricorn District Municipality
CIAT	International Centre for Tropical Agriculture
CRT	Critical Race Theory
DAFF	Department of Agriculture, Forestry and Fisheries
DEA	Department of Environmental Affairs
DST	Department of Science and Technology
FAO	Food and Agriculture Organisation
FET	Further Education and Training
FGD	Focus Group Discussions
GCM	General Circulation Model
IDP	Integrated Development Plan
IK	Indigenous Knowledge
IKS	Indigenous Knowledge Systems
IIPFCC	International Indigenous Peoples Forum on Climate Change
IPCC	Intergovernmental Panel on Climate Change
ISCW	Institute for Soil, Climate and Water
IWCK	Indigenous Weather and Climate Knowledge
KAP	Knowledge, Attitude and Perception
KMA	Knowledge Management Africa
LEISA	Low External Input and Sustainable Agriculture
LSD	Least Significant Difference
SADC	Southern Africa Development Committee
SAWB	South African Weather Bureau
SAWS	South African Weather Services
UNDP	United Nations Development Programme
UNEP	United Nations Environmental Programme
WHO	World Health Organization
WMO	World Meteorological Organization

CHAPTER ONE

GENERAL INTRODUCTION AND OBJECTIVES OF THE STUDY

1.1 Introduction

In this chapter, the general introduction, statement of the problem, motivation, research questions and justification of the study are presented.

1.2 Background

Weather and climate are related to community livelihoods, which depend on the environment in which people live and produce food. They are key components influencing crop production, and the main determining factors of daily farming activities (Sivakumar, 2006). Matthews and Stephen (2002) further indicated that climate and weather play an important role in crop production since weather and climate variability affects crop growth and development, defines crop productivity, and determines the cropping season. Furthermore, extreme weather and climate variability, which encompasses drought, temperatures and floods, has a negative impact on the environmental, health and socio-economic issues of smallholder crop production farmers. According to the World Bank (2010) and UNEP (2010), vastly altered weather patterns and climate extremes further threaten agriculture production and food security, which in turn undermine Africa's ability to grow and develop.

Food and Agricultural Organisation (2004) remarked that climate change is comprised of increased intensity and frequency of storms, drought and flooding. Drought and flooding may affect rural communities directly or indirectly by changing the physical and social settings. The patterns of impact of climate change on agriculture was classified into biophysical and socio-economic (Khanal, 2009). However, it is difficult to describe the response of crops to different weather and climate variables due to its complexity. Changes in rainfall patterns and temperature regimes will influence the local water balance and disturb the optimal cultivation period available for particular crops, thereby throwing food and agriculture production out of gear (Sahai, 2012). Hansen (2005) reiterated that crop growth depends more on the distribution of the

weather within a season than on season averages that forecasters typically provide. Porter and Semenov (2005) further supported Hansen that crop growth, development and yield are affected by climatic variability via linear and nonlinear responses to weather variables and the exceedance of well-defined crop thresholds, particularly temperature.

For weather and climate uncertainty and unpredictability to be addressed, there is a need to have a good and realistic weather and climate information. The reduction of weather and climate variability requires community based strategies to advance smallholder farmers to take charge of their vulnerability to weather and climate variability and change. For the majority of weather and climate related hazards and stresses, there has been a tendency for a considerable amount of knowledge and certainty about their characteristics based on historical experience (timing of monsoon rains, patterns of rains, and seasons of heavy frost probability) (Clement et al., 2011). Since knowledge plays an important role in the development of farmers, access to weather and climate information is vital in reducing risks associated with weather and climate.

Long before the introduction of weather stations and the use of Global Climate Models (GCM) developed from global air circulations, communities relied on indigenous methods of predicting weather and climate (Stigter et al., 2005). According to Low External Input and Sustainable Development (LEISA) (2000) and Ajan et al. (2013), traditional farmers have developed different indigenous farming systems finely tuned to many aspects of their environment. The marginalisation of ways of knowing and the underutilisation of Indigenous Knowledge (IK) due to colonialism, suppression, demeaning reference, and production of intellectually colonised mind-set has resulted in the knowledge being less documented and lost (Grenier, 1998; World Bank, 1998a).

1.3 Statement of the problem

Weather and climate assist users in making decisions in weather sensitive situations such as the time of planting and the selection of appropriate crop suitable to the local climate. Despite the provision of western weather and climate information for use by

smallholder farmers, most forecast information is not local specific and are highly technical in nature (Shoko, 2012). The scientific terms used in describing probabilities are not understandable (Mukhala, 2000). However, scientific gains in predicting weather and climate is not understood at local level due to lack of information on particular weather and climate indicators such as rainfall variability (Hulme et al., 2005). Smallholder farmers are unable to access and interpret information due to written language used. Furthermore, information presented to the end-users is ineffective and not helpful to resource poor farmers (Blench, 1999).

Weather and climate information credibility can be achieved only if smallholder farmers at micro-climate are able to interpret, understand and use it. Archer (2003) reiterated that there are weaknesses in the forecast system itself. According to Patt (2001), information is also not tailored to suit target farmers in content and delivery style. Failure to use western weather and climate information may lead to crop failure or loss, which may also affect income and food security. A study by Isabirye (2004) has revealed that there is a lack of understanding by respondents of raw weather data information and its interpretation due to language technicalities in enabling them to make informed decisions on agriculture production. Furthermore, Sivakumar (2006) has also revealed that almost 75 percent of the respondents during a study in Africa have indicated that agricultural research and extension agencies are not involved in the preparation or dissemination of agro meteorological bulletins. According to Sivakumar (2006), there is an increasing demand for a reliable weather and climate information by agricultural advisors and farmers throughout Southern Africa.

Current seasonal weather and climate predictions in the study area do not provide adequate, accurate and accessible information for farm level decision-making. Hammer et al. (2001) reiterates that farmers seldom use the information for farm level decision-making. Furthermore, there is limited understanding of weather and climate information among agricultural advisors and farmers. It is also difficult for smallholder farmers to make informed decisions on the use of information provided. Despite the marginalisation of indigenous weather and climate prediction practised by rural communities and its lack of written information, studies of weather knowledge across

Africa revealed wealth of knowledge from farmers (Briggs et al., 1998 Egypt; Ngugi, 1999 Kenya; Roncoli et al., 2002 Burkina Faso; Luseno et al., 2003 Kenya; Mengistu, 2011 Ethiopia; Manyatsi, 2011 Swaziland; Muguti & Maposa, 2012 Zimbabwe; Okonya & Krosche, 2013 Uganda; Ajani et al., 2013 Nigeria; ZumaNetshiukhowi et al., 2013 South Africa; and Kijazi et al., 2013 Tanzania). Microweather and climate information has been overlooked or unexamined by relevant institutions providing weather services for many years in Sub-Saharan Africa and the ignorance is still continuing.

1.4 Motivation of the study

The majority of smallholder farmers in Limpopo Province practise their crop farming under rain-fed conditions (Whitbread et al., 2011). Weather and climate may have a positive and negative impacts in their farming systems where crops are affected or influenced in different ways. The soil moisture regime may determine the growth of the crop and land preparation. Optimum crop growth can be achieved under optimum temperature and moisture regime. Therefore, weather and climate prediction and information becomes vitally important for farmers to decide on when to start preparing their land, select the variety, and sow the seeds. Weather and climate knowledge becomes very important for a farmer to make an informed decisions. However, weather and climate information provided by the South African Weather Services and other agencies is only addressing weather and climate prediction at macro level within the province. The information provided is neither accessible nor addressing smallholder farmers' needs at the micro level environment.

For the local smallholder farmers within Lepelle Nkumpi Municipality, the information is not valuable and credible. Decision-making based on weather and climate prediction from the western approach led to many farmers abandoning their farming systems, resulting in household food insecurity. In spite of the recommendation disseminated through mass media on weather and climate, farmers still consider their ancient knowledge of weather and climate prediction as valuable and credible. Smallholder farmers have used their indigenous ways of predicting weather and climate for many years based on indigenous knowledge. Therefore, the research question of the study

was formulated on the value of indigenous knowledge in agriculture production focusing on crop production. The central research question asked was: “what role indigenous weather and climate knowledge can play in crop production within Lepelle Nkumpi Municipality, Limpopo Province?” The rationale of the study was based on how indigenous weather and climate knowledge should be integrated with western knowledge to come up with more accurate and usable weather and climate predictions for smallholder farmers in the study area.

1.5 Aim and objectives of the study

The aim of the study was to explore the potential role that indigenous weather and climate knowledge play in supporting crop production in Lepelle Nkumpi Municipality, Capricorn District, Limpopo Province. The specific objectives of the study were: 1) to investigate and describe the nature and types of indigenous weather and climate knowledge for crop production existing in Lepelle Nkumpi Municipality of Limpopo Province; 2) to assess the knowledge, attitudes and perceptions of smallholder farmers in Lepelle Nkumpi Municipality towards indigenous weather and climate knowledge; 3) to review and assess the impact of existing national and local policies on weather and climate on the utilisation of indigenous knowledge for crop production in Lepelle Nkumpi Municipality of Limpopo Province; 4) to establish the link between indigenous and western weather and climate knowledge systems to crop production in Lepelle Nkumpi Municipality of Limpopo Province; and 5) to develop a model for interfacing indigenous and western weather and climate knowledge systems for improving crop production in Lepelle Nkumpi Municipality of Limpopo Province. The research questions for the study were as follows:

- a) What is the nature and type of indigenous weather and climate knowledge for crop production existing in the area?
- b) What are the knowledge, attitudes and perceptions of smallholder farmers in Lepelle Nkumpi Municipality towards indigenous weather and climate knowledge?
- c) What is the impact of existing national and local policies on the utilisation of indigenous weather and climate knowledge for crop production in the study area?

- d) What is the link between indigenous and western weather and climate knowledge systems to crop production in the study area?
- e) How can indigenous and western weather and climate knowledge systems be interfaced in order to improve crop production?

1.6 Significance of the study

Indigenous knowledge plays an important role in the livelihoods of smallholder farmers and communities in general through observing and predicting weather and climate patterns. There is a wealth of weather knowledge based on weather prediction possessed by farmers in sub-Saharan Africa (Ajani et al., 2013). A study by Bharara and Seeland (1994) has found that indigenous knowledge provided an insight in how people perceived a past year and remembered traditional indicators to assist in future years. Farmers in different parts of Africa (Zimbabwe, Kenya, Uganda, Tanzania, and South Africa) have much confidence about the wealth of their weather and climate knowledge (Shumba, 1999; Lucio, 1999; Ngugi, 1999; Kihupi et al., 2002; Mhita, 2006; Chang et al., 2010; Shoko, 2012; Zuma-Netshiukwi et al., 2013).

Indigenous weather predictions have been practised by rural communities for many years before the introduction of weather stations, radio and television, which are currently considered useful in the dissemination of weather information to the farming communities. The practice of indigenous weather and climate predictions tends to disappear or is threatened by lack of awareness and documentation.

According to Chang'a et al. (2010), lack of documentation and death of elderly people who are knowledgeable threaten indigenous weather and climate predictions. Therefore, documentation of indigenous weather and climate prediction will bring much needed alignment in preparedness strategies, and close uncertain, unreliable weather and climate prediction information provided.

However, western weather and climate predictions interface with indigenous weather and climate prediction systems can produce more accurate and user-friendly climate prediction systems for local benefits. Providing ideas through co-ordinated efforts between end-users and scientists will be beneficial in promoting ownership of the

information. Furthermore, the outcomes for interfacing the knowledge systems are its potential to represents a dynamic information base which will support the majority of farmers in the municipality and elsewhere. It is argued in the study that there are indigenous ways of predicting weather and climate, which can enhance reliability and creditability to local crop farmers within the municipality.

1.7. Organisation of the thesis

The thesis is presented in eight chapters. **Chapter 1** provides general introduction and objectives of the study, which include background on weather and climate knowledge, motivation of the study, statement of the problem, purpose/aim and objectives of the study, significance and justification of the study,. In **Chapter 2** the role of indigenous weather and climate knowledge in predicting weather and climate, the definitions of key terms and concepts in the study, conceptual and theoretical framework used in the study, reality about the study phenomenon and summary of literature review and key knowledge gaps is examined. **Chapter 3** focusses on African indigenous worldview, different African worldviews and the study setting. **Chapter 4** describes and discusses the nature and types of indigenous weather and climate knowledge for crop production in Lepelle Nkumpi Municipality of Limpopo Province, introduction, study approach, target population, sample size and sampling procedures, data collection strategies and methods, data analysis methods, validity and reliability of the study, ethical considerations, results, discussion, and conclusions. **Chapter 5** addresses the assessment of knowledge, attitudes and perceptions (KAP) of smallholder farmers towards indigenous weather and climate knowledge, introduction, study approach, target population, sample size and sampling procedures, data collection strategies and methods, data analysis methods, validity and reliability of the study, ethical considerations, results, discussion and conclusions. **Chapter 6** entails the analysis of existing national and local policies on weather and climate on the utilisation of indigenous knowledge for crop production, the introduction, study approach, target population, sample size and sampling procedures, data collection strategies and methods, data analysis methods, validity and reliability of the study, ethical considerations, results, discussion and conclusions. **Chapter 7** reflects on the aligning long term weather and climate knowledge systems of Lepelle Nkumpi

Municipality, the introduction, study approach, target population, sample size and sampling procedures, data collection strategies and methods, data analysis methods, validity and reliability of the study, ethical considerations, results, discussion and conclusions. **Chapter 8** deals with the development of a model of integrating indigenous and western weather and climate knowledge systems to improve crop production, the introduction, study approach, target population, sample size and sampling procedures, data collection strategies and methods, data analysis methods, validity and reliability of the study, ethical considerations, results, discussion and conclusions. Lastly, **Chapter 9** addresses the general discussion, conclusions and recommendations of the study, which comprise introduction, knowledge generated by the study, implications of the findings of the study, limitations of the study, conclusions and recommendations.

CHAPTER TWO

THE ROLE OF INDIGENOUS WEATHER AND CLIMATE PREDICTION

2.1 Introduction

In this chapter, the role of indigenous weather and climate knowledge in prediction is covered. The definitions in this chapter are outlined and provide an insight on key concepts which are used in the chapter.

2.2 Definition of key terms and concepts in the study

Axiology – is the analysis of values to better understand their meanings, characteristics, their origins, their purpose, their acceptance as true knowledge, and their influence on people's daily experiences (Guba and Lincoln, 2005; Chilisa, 2012).

Climate – refers to a more enduring regime of the atmosphere, and represents a composite of day-to-day weather conditions and atmospheric elements within a specified place or region over a long period of time (Schulze, 2010).

Climate change – refers to a change in the state of the climate that can be identified (e.g. using statistical tests) by changes in the mean and/or the variability of its properties that persists for an extended period, typically decades or longer (IPCC, 2007a).

Critical Theory - is a school of thought that stresses the reflective assessments and critique of society and culture by applying knowledge from the social sciences and the humanities (Bowen, 2010).

Decolonising research – is a process for conducting research with indigenous communities that places indigenous voices and epistemologies at the centre of the research process (Smith, 1999; Swadener & Mutua, 2008; Chilisa, 2012).

Epistemology – the division of philosophy that integrates the origin and nature of knowledge (Stenmark, 2001).

Food Security - Food security is the state achieved when food systems operate such that “all people, at all times, have physical and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life” (FAO, 2009).

Indigenous knowledge (IK) – is the systematic body of knowledge acquired by local people through the accumulation of experiences, informal experiments, and intimate understanding of the environment in a given culture (Rajasekaran, 1993). IK is defined by Grenier (1998) as a unique, traditional local knowledge existing within and developed around specific conditions to a particular geographical area.

Kgoro/Kgotla – is a traditional system which is and still serving as a forum for policy formulations, decision making, including political and economic developmental activities and judiciary on litigations (Moumakwa, 2010).

Knowledge – is defined as an activity that would be better described as a process of knowing, taking available information and translating it into action. Knowledge is broadly taken to mean concepts, ideas, insights and routines people use to have meaning to things and events (Sveiby, 1997).

Ontology – is the body of knowledge that deals with the essential characteristics of what it means to exist and the nature of reality (Crotty, 1998; Chilisa, 2012).

Paradigm – is a shared worldview that represents beliefs and values in a discipline and that guides how problems are solved (Schwandt, 2001; Wilson, 2001).

Postcolonial – is defined in anthropology as the relations between nations and areas that they colonised and once ruled (Mann, 2012).

Transformative paradigm – is a worldview based on the premise that researchers and evaluators have an ethical responsibility to address issues of social justice and human rights (Cram & Mertens, 2016).

Smallholder farmers - are defined as those farmers owning small-based plots of land on which they grow subsistence crops and one or two cash crops relying almost exclusively on family labour (DAFF, 2012).

Weather – is the total sum of prevailing atmospheric variables at a given place and at any instant or brief period of time (Schulze, 2010).

Worldviews - are cognitive, perpetual, and affective maps that people continuously use to make sense of the social landscape and to find their ways to wherever goals sought (Hart, 2010)

2.3 Reality about the study phenomenon

2.3.1 Weather and climate knowledge

Weather and climate play an important role in the livelihoods of communities in South Africa. The farming communities are exposed to bad or good weather conditions within their specific environment. However, there are differences among the two concepts. Weather is defined in chapter one of the thesis as the total sum of prevailing atmospheric variables at a given place and at any instant or period of time. Schulze (2010) citing Brauner (2002) has identified weather phenomena such as heat, warmth, humidity, wind movement, lightning, rainbows, clouds, rain, snow or hail as contributors to crop growth. According to Schulze (2010), weather is composed of real phenomena that are observed and experienced within senses and measure with accuracy. Weather is unpredictable and has a positive or negative influence on optimal crop growth.

Furthermore, weather cannot be controlled by a human being. Since weather occurs within a short time, climate is a composite of day to day of weather conditions

(Schulze, 2010). Climate differs considerably from region to region, year to year. However, climate variability is required for relevant periods at an appropriate scale with sufficient accuracy and lead time, in a form that can be applied to the farmer's decision problems (Stone & Meinke, 2006). Earlier emphasis by Cash and Buizer (2005) is that for climate to be effective, it should be grounded on coordinated efforts of defining the problem in decision-making.

2.3.2 Importance of knowledge in agriculture technologies

The possession of knowledge, worldviews, beliefs, cultures and other aspects of knowledge can be analysed by means of cognitive filters, which can be ontological or epistemological (Dondolo, 2005). According to Knowledge Management Africa (2005), a knowledge system is used to understand the processing of knowledge, and is often equated with culture or worldview, terms that refer collectively to a society, its way of life and its underpinning values and beliefs. Studley (1998) argued that different systems of knowledge exist to allow one to understand, perceive, define and experience reality. Röling and Jiggins (1998) regarded technology transfer, farm management development and ecological knowledge as the three types of knowledge systems in agriculture. Knowledge, as Masoga (2005) attested, has its own paradigm and logic, historically the basis for all knowledge. The only way to the centre of knowledge, to understanding knowledge, is through the language of holders of the knowledge (Ntsoane, 2004). Language is key to the construction of knowledge. Knowledge can also be influenced by epistemological interrelationships between place, people, language and animals (Kovach, 2012).

Most agricultural technologies currently used in the world were developed by farmers, and not by scientists. According to UNEP (2007), indigenous knowledge plays a big role in farmers' decisions because traditional societies' livelihoods are closely intertwined with nature. The contribution of IK, as indicated by Srivastava et al. (1996), has assisted farmers through the selection of crop varieties adapted to harsh growing conditions such as millet, sorghum and cowpeas, further practising cropping patterns in minimising the built-up of diseases. A study by Speranza et al. (2010) has revealed that farmers believe in and rely on the efficacy of IK as the basic knowledge system

within which they interpret meteorological forecasts and make decisions regarding agricultural practices. According to Magoro and Masoga (2005), a better understanding of indigenous practices helps to explain why some farmers resist technologies imposed on them by extension officers, researchers and development planners. Indigenous and western knowledge systems differ greatly. It is not appropriate to compare them as simple equivalents.

Indigenous and western knowledge systems are unique, differ from one another and are equally important (Mairura et al., 2008; Munyua & Stilwell, 2013). The differences between indigenous and western knowledge include the fact (a) that they come from different epistemological backgrounds; (b) that their histories differ; and (c) that characteristics and subject matter vary. IK is local specific and western knowledge requires human intervention. According to Mercer et al. (2010), western knowledge is global in nature while IK is more confined in scope.

The comparison is mostly done by non-indigenous people who are collecting indigenous knowledge. Western knowledge has evolved over centuries informed by and documented through the work of philosophers, economists and so forth... It is often referred to as scientific knowledge whereas it excludes the human perspective. Despite claims of those cultured in the western scientific tradition, no one culture has monopoly on the “truth” (Stevenson, 1998). Stevenson (1998) further attested that all cultures have at their core, fundamental and defining values that are not easily grasped, conceptualised or appreciated by people outside the culture.

2.3.3 The value of weather and climate on crop production

2.3.3.1 Dry-land production

2.3.3.1.1 Rainfall

Agriculture in Africa is widely practised under rain-fed conditions, and a complete crop failure due to drought in dry-land production may lead to food insecurity. According to Ajani et al. (2013), 80 % of the estimated 1.4 billion ha of crop land worldwide is rain-

fed, and accounts for 60 % of global agricultural output. Jones and Thornton (2003) have projected that crop yield in Africa may fall by 10-20% by 2050 or even up to 50% due to climate change, particularly because African agriculture is predominantly rain-fed, and hence, fundamentally dependent on the vagaries of the weather. Consequently, peoples' livelihoods and lifestyles are closely linked to weather and climate. According to Tadesse et al. (2014), reduction in yield and increased variability from extreme weather events is likely to increase the long-term mean and volatility of staple food prices. Climate variability, in particular rainfall, poses a direct threat to many communities due to their continuing reliance upon resource based livelihoods.

A study by Mugi (2014) has revealed that conventional data on rainfall and temperature were in line with information from small-holder farmers' perception of how climate has varied over the reference period. Mark et al. (2008) highlighted some of the direct impacts of climate change on agricultural system as: (a) seasonal changes in rainfall and temperature, which could impact agro-climatic conditions, altering growing seasons, planting and harvesting calendars, water availability, pest, weed and disease populations; (b) alteration in evapo-transpiration, photosynthesis and biomass production; and (c) alteration in land suitability for agricultural production.

Recent climate projections indicate increased climate variability in the context of climate change over most parts of the world (IPCC, 2007). A concern raised by IPCC was supported by Vogel (1993) that generally, Southern Africa has a high coefficient of rainfall variation, making droughts a frequent occurrence. The notion was supported by Thornton et al. (2011), indicating that there was a projected increase in rain-fed crop failures to a frequency of every two years across Southern Africa. UNEP (2009) estimated a loss of 0.2 percent in cropland productivity per year globally due to unsustainable agricultural practices.

Most rural areas in Southern Africa have always experienced climate variability, and farmers have always had to cope with a degree of uncertainty in relation to the local weather and environment that surround them and gradually adapting to them. Like

much of southern Africa, Limpopo Province has traditionally had dual agricultural sectors comprising commercial and subsistence based farming systems occupying 15% and 14% of the province's land, respectively (Whitbread et al., 2011). Crop yields and changes in productivity due to climate change will vary considerably across regions and among localities, thus changing the patterns of production. However, adverse climatic conditions will have a bearing on their agricultural production (Mpandeli et al., 2005). A study by Nethononda et al. (2012) revealed that farmers in Rambuda irrigation scheme in Vhembe District of Limpopo Province do not have access to recorded climatic information, and are growing crops on a trial and error basis.

In the process of adapting to climate variability, farmers developed specific farming systems which perform best in their given situation (LEISA, 2000; 2008). However, climate change should not be seen in terms of major disasters, but rather as increased uncertainty (LEISA, 2008). The conventional data on rainfall and temperature can conform to information from small-holder farmers' perceptions of climate variations over a reference period. According to McNeely (1995), indigenous systems of agriculture have adapted to a wide variety of local conditions, produced a diverse and reliable food supply, and reduced the incidence of diseases and insect problems. Ajani et al. (2013) supports McNeely that the adaptation helps farmers achieve their food, income and livelihood security.

The indigenous observations and interpretations of meteorological phenomenon have guided seasonal and inter-annual activities of local communities for millennia (Nakashima et al., 2012). Farmers experience climate change not as a shifting mean but as climate variations (Hansen, 2005). Stigter et al. (2005) have indicated that with respect to agricultural meteorology and agricultural climatology, explicitly no extension agro meteorology or agro climatology were developed to assist the majority of marginal farmers in the design of their production systems.

According to Bohle et al. (1993), the fact that some African communities have survived till today with a fast population growth rate is an indication that they have developed indigenous mechanisms and strategies of coping with climate constraints. The

mechanisms and strategies used by people over the world have been constantly accumulating knowledge through careful observations and the identification of effective techniques and approaches by trial and error (Haseeb & Mohammad, 2011). Bernard (2000) further stressed that the wealth of anthropological literature, which has accumulated over the past two decades, has clearly demonstrated that the destruction of indigenous knowledge and customs in general has had severe ecological and other consequences.

Local capacities were enhanced by building on local coping mechanisms, local innovations and local practices. Olufaya et al. (1998) have found that indigenous cropping systems of mulching, wind protection, shading zero tillage, pest control and intercropping of sorghum, cowpeas and millet is more efficient in resource use under drier conditions than sole crops. According to Stigter et al. (2005) and Ajani et al. (2013), intercropping removes the risk of total crop failure and provide good soil cover that minimises soil erosion. Maimela and Musyoki (2004) reiterated that farmers have proven that soil fertility is achieved through fallowing of land on a rotational basis. Increased weather and climate uncertainty result in crop production failures, which affect the livelihood of communities. However, farmers used their knowledge in observing and experimenting weather uncertainties for many years. Lulama (2000) has indicated that farmers in Uganda use different means to know the future and table future events, including divination and fortune tellers who can predict the beginning and ending of rain.

2.3.3.1.2 Temperature

Temperature plays an important role in the optimum growth and development of crops. Increases in temperature of over two degrees Celsius are expected to have a negative impact on global yields of major crops (IPCC, 2014). Increased variation and changes in mean temperature and precipitation are expected to dominate future changes in climate as they affect crop production (Porter & Semenov, 2005; Ajani et al., 2013). For crops, both changes in the mean and variability of temperature can affect crop processes, but not necessarily the same processes (Porter & Semenov, 2005). Slafer and Rawson (1995) contended that the developmental stage of the crop exposed to

increased temperatures has an important effect on the damage experienced by the plant. Porter and Semenov (2005) further indicated that at regional and global scales, the extent and frequency of changes in climate as it affects crop production seem to be rising and are likely to increase in the future. For the period 1911 to 2009, the National Climatological Database in South Africa has revealed that there has been a significant increase in annual mean temperatures in most regions, with an increase in extreme events and decrease in frosts (Dube, 2011).

2.3.4 Recognition of importance of indigenous knowledge systems in weather and climate

In the face of global climate change and its emerging challenges and unknowns, it is very important that decision-makers base policies and actions on the best available knowledge. The growing awareness is that scientific knowledge alone is inadequate to solve the climate crisis (Finucane, 2009). According the IIPFCC (2009) reported at global forums, indigenous people have long maintained that they have unique contributions to make towards climate decision-making due to their extensive experiential knowledge. Policy support is needed to advance the nature and availability of documented indigenous weather and climate information in local languages throughout the country, putting more emphasis on micro-level where the communities are. Indigenous knowledge about weather and climate is based on locally defined conditions and needs, and is dynamic and natured by observation (Ziervogel & Opere, 2010).

Farmers have tested crops according to different factors which relate to the crop characteristics, output, local environment and market. However, crop failure may differ considerably with the crop variety selected and soils where they are grown.

Farmers' priority in farming is to ensure the availability of food for their families. Climate change tends to perpetuate the poverty cycle (UNEP, 2010). Dry-land farmers continually practise farming using indigenous varieties (millets, cowpeas, sorghum) which are adaptable to the environment, with high nutritional value, and which taste better based on cultural preference. The use of indigenous weather prediction information for farm level decision-making on when and what to plant through the

observation of animals, birds, plants, moon and stars as indicators in Mozambique, Zimbabwe, Uganda and Kenya is described in Shumba (1999), Lucio (1999), Ngugi (1999) and Lulama (2000).

The value and role of indigenous knowledge in designing appropriate research, development and extension strategies that are relevant to local conditions has long been recognised and is well documented (Chambers, 1983; Chambers et al., 1989; Grenier, 1998; Posey, 2004). Shaw et al. (2008) referred to indigenous knowledge as methods and practices developed by a group of people from an advanced understanding of the local environment, which has formed over numerous generations of habitation. In fact, there is no single definition of indigenous knowledge. In simple terms, IK can be defined as knowledge unique to a particular cultured society generated by local people for their livelihood, and passed from generation to generation. However, Grenier (1998) referred IK to the unique, traditional, local knowledge existing within and developed around specific conditions of women and men indigenous to a particular geographic area.

According to CDKN (2013), indigenous knowledge has not been widely considered irrespective of its value in climate science research. Alcock (2010) has reiterated that indigenous knowledge is valuable in its own right from a purely cultural perspective. The role and value of IK on climate variability and adaptation has been ignored for years in research and development. Furthermore, several studies (Ajibade & Shokeni, 2003; Nyong et al., 2007) were carried out to understand and assess farmer perceptions about climate variability and mechanisms employed by farming communities to cope with climate across Africa and elsewhere. It has been found that the relay cropping practised for years is eliminated due to low distribution of rainfall (Ajibade & Shokeni, 2003). However, the understanding of the beginning and end of rain triggered planting of drought tolerant crops such as millet and sorghum. Practices of staggered planting dates and use of varieties with different maturity characteristics are some of ways of limiting risks due to uncertain rainfall and temperature.

Kihupi et al.(2002) posited that before weather stations were put in place, the community and farmers have always had to cope with the environment that surrounds

them and adapting to it. LEISA (2008) reiterated that while farmers were coping with the environment, they developed specific farming systems which perform well in their given situation. The diversity of approaches towards indigenous farming systems and knowledge of family farmers are assets of great value for solving the daunting problems affecting agriculture in the 21st century (Altieri & Koohafkan, 2008). Studies by Sivotwa et al. (2007), Mengistu (2011) and Sanni et al. (2012) have indicated that farmers cope and even prepare for climate change, minimising crop failure through increased use of drought tolerant local varieties, water harvesting, extensive planting, mixed cropping, opportunistic weeding and series of other indigenous farming systems.

The indigenous weather coping strategies were developed through years of observations of several weather indicators and experimentations. Ziervogel and Opere (2010), Manyatsi (2011), Mengistu (2011), Sanni et al. (2012), Shoko (2012), Boillat and Berkes (2013), Makwara (2013), Okonya and Kroschel (2013) and Zuma Netshiukhwi et al. (2013) have revealed that people use several weather indicators (birds, flowering of some trees, cloud patterns, observing stars, the position of the moon and the sun, wind patterns, appearance of insects) to predict the onset of rainfall and planting season in the community. However, the appearance and movement of some insects may indicate a warning for dry season. According to Zuma-Netshiukhwi et al. (2013), farmers using their knowledge are familiar with the relations between weather, crop suitability, crop selection and planting schedule in a particular season. The period on when and what to plant is determined by integrated weather indicators and their interpretation within a specific local environment.

The role of indigenous knowledge is crucial in the development process of local, regional and national policies. According to the World Bank (2009), the development process interacts with indigenous knowledge especially when designing or implementing development programmes or projects. Gorjestani (2000) has indicated that indigenous knowledge is a significant resource which could contribute to the increased efficiency, effectiveness and sustainability of the development process.

2.3.5 Indigenous weather and climate prediction for crop production

2.3.5.1 Beginning of the season

The local weather and climate predictions play an important role in the growth and development of food production. Shoko and Shoko (2013) also attested that the reduction of risks in food production is due to vagaries of weather, and that weather forecasts should be taken into account in all agricultural planning. Moreover, it should be mentioned that farmers from South Africa, like the rest of Africa, relied much on their observation and experience with regards to weather predictions. According to Muguti and Maposa (2012) citing Muyambo (2011), the observations on certain weather phenomenon as deduced from the environment and celestial bodies helped farmers to approximate the imminence of the rain season. Local communities and farmers have developed a rich knowledge base of predicting climatic and weather events based on observations of animals, plants and celestial bodies, among others (Acharya, 2011).

Environmental indicators used by farmers to predict the coming rainy season become available for observation at different times of the year, beginning immediately after harvest and continuing into the new rainy season (Roncoli et al., 2002). Nyong et al. (2007) further stressed that in climate and weather, indigenous knowledge has proven to be more accurate and reliable at local level. Chang'a et al. (2010) posited that various environmental and astronomical indicators, including plant phenology, behaviour and movement of birds, animals and insects are widely used in many parts of Tanzania to predict rainfall. Manyanhaire and Chituta (2015) supported the deliberations that prior to the advent of modern scientific methods, rural communities must have realised that some animals, birds, insects and plants had the capacity to detect and respond to changes in the atmospheric conditions. Indigenous or local predictions provide clues about aspects of climate most salient to farmers and the kind of climate information required by farmers to mitigate agricultural risks (Mafongoya et al., 2017). Mafongoya et al. (2017), citing different authors, further posited that farmers in SubSaharan Africa rely on observation and the interpretation of specific phenomenon such as tree phenology, atmospheric circulation and animal behaviour (Tables 2.1, 2.2, and 2.3).

Table 2.1: Indigenous indicators of weather and climate in SSA-tree phenology

Indicator	Country	Significance
Onset of the rains		
Flowering of the peach tree (<i>Prunus persica</i>), apricot (<i>prunus armeniaca</i>), building of acacia species	Botswana Zimbabwe South Africa Tanzania Mali Nigeria	Beginning of rainy season
Flowering coffee, delonix (<i>Christmas</i>) and mango trees; and other trees	Uganda Tanzania Kenya Burkina Faso	Rains are not far
Season quality		
Behaviour of certain plants: sprouting of Aloe ferox; germination of few leaves on baobab and lamarind trees	Ethiopian South Africa Zimbabwe Zambia Burkina Faso	Indication of good rains
Mango tree (<i>Mangifera indica</i>)	Tanzania Zimbabwe Burkina Faso	Heavy flowering of the mango trees indicates a potential drought season
Muchakata tree (<i>Parinari curatelifolia</i>), gan'acha tree (<i>Lannea discolor</i>), mushuku tree (<i>Uapaca kirkiana</i>)	Zimbabwe Mali Nigeria	Heavy flowering of the trees indicates a potential drought season
Dormancy breaking in certain tree species e.g. mupfuti (<i>Brachystegiabboehmii</i>)	Zimbabwe	Indicates plenty of rain in a few days
Profuse fruiting of certain tree species	Burkina Faso Ethiopia Kenya Nigeria	More fruiting of certain trees indicates a challenging rainy season ahead

(Mafongoya et al., 2017)

Table 2.2: Indigenous indicators of weather and climate in SSA – atmospheric circulation

Indicator	Country	Significance
Onset of the rains		
Moon phases	Uganda South Africa Zimbabwe Kenya, Mali Burkina Faso	Moon crescent facing upwards indicates upholding water and when facing downwards is releasing water in the next 3days
Star constellation	Zimbabwe South Africa Burkina Faso Botswana	Star pattern and movement from west to east at night under skies means rain will fall in 3 days
Winds movement	Uganda Zimbabwe South Africa Burkina Faso Kenya Nigeria Botswana Ethiopia	Winds moving from west to east indicate onset of the rain season
Season quality		
Moon profuse halo	Uganda South Africa Zimbabwe Kenya Mali Burkina Faso	Good rains Disposition of the new moon indicates more diseases and erratic rainfall
Wind swirls	Zimbabwe South Africa Uganda Mali	Frequent appearance is a sign of good rains
Mist-covered mountains	South Africa	Signal of good rains
Temperature	Tanzania	Heat in low area in August indicates there will

	Zimbabwe Burkina Faso Uganda Kenya Nigeria	be more rainfall in the coming season; high temperature in October and November signifies near onset and a good rain season
Strong winds	Tanzania Ethiopia Mali	Strong winds in July through October indicates less rainfall in the coming season
Appearance of many nimbus clouds; appearance of red clouds in the morning	Uganda Zimbabwe	Indicators of rain in 1-3 days
Appearance of fog/haze in the morning	Uganda Zimbabwe Kenya Ethiopia Botswana Nigeria	Indicator of no rain

(Mafongoya et al., 2017)

Table 2.3: Indigenous indicators of weather and climate in SSA- Animal behaviour

Indicator	Country	Significance
Onset of the rains		
Appearance of red ants, rapidly increasing size of the anthills	South Africa Zimbabwe	Good rains are coming
First appearance of sparrows; flock of swallows preceding dark clouds	South Africa Tanzania Uganda Zimbabwe Nigeria Mali	Rain is at hand and farmers should prepare for normal rains
Appearance of certain birds e.g stock Singing nesting and chirping of certain birds	Uganda Tanzania Zimbabwe Burkina Faso Botswana Nigeria Ethiopia	Rain is at hand and farmers should prepare for normal rains
Termite appearance (<i>Ancistrotermes</i> spp)	Tanzania Uganda Zimbabwe	Appearance of many termites indicate near rainfall onset
Bee eater (<i>Merops</i> <i>Hirundineus</i>)	Tanzania Nigeria Mali Botswana	Appearance in October indicates imminent rainfall and/ or onset
Frogs in swampy areas croaking at night	Uganda Zimbabwe	Indicator of onset rainfall
Rock rabbit	Zimbabwe	Its unusual squeaking indicates imminent rainfall
Cicadas (nyenze), day flying chafers (mandere), dragon flies (mikonikoni)	Zimbabwe	Appearance of these signifies imminent rainfall
Season quality		

Grunting pigs indicate low humidity	South Africa	Rains are near
Calves jumping happily	Uganda South Africa	Good rainy season
Certain snakes moving down the mountain	South Africa	Good rainy season
Frequent appearance of tortoises	South Africa	Good rainy season
Appearance of certain insects e.g. millipedes, spiders	Tanzania Zimbabwe Burkina Faso	Indicates coming of heavy rains
Butterfly movement from west to east	Tanzania Burkina Faso	Rainfall is approaching
Armyworms (<i>Spodoptera exempta</i>)	Tanzania Burkina Faso Zimbabwe	Appearance of armyworms on trees during the month of October signifies abundant rainfall in the coming season
Grasshopper (<i>Hesperotetix speciosus</i>)	Tanzania Zimbabwe Uganda	Occurrence of more grasshoppers indicate less rainfall and hunger
Scorpion (<i>Arachnida</i> spp)	Tanzania Burkina Faso	When black or dark scorpions are seen in the month of October, it indicates possibility of a good rainy season
Cattle egret birds (<i>Bubulcus ibis</i>)	Tanzania Burkina Faso Ethiopia	Occurrence of these birds in October indicates onset of rains and a good rainy season
Coucal bird (<i>Centropus</i> spp)		Singing of these birds early in the morning in October indicates the onset of the rains and a good rainy season
Pangolin (scaly ant-eaters)	Tanzania Burkina Faso Zimbabwe	Appearance indicates imminent rainfall occurrence

(Mafongoya et al., 2017)

2.3.5.2 Food security

The spectre of world hunger looms ever larger as the global population fast approaches nine billion in the least developed nations (FAO, 2009). According to Bouis and Hunt (1999), a household is food-secure when all of its members have, all times, access to food of a quantity and quality consistent with an active and healthy life. Sub-Saharan Africa is currently the most food-insecure region in the world (Munang & Nkem, 2011). According to Teja et al. (2012), sub-Saharan Africa has the highest proportion of food-insecure people, with an estimated regional average of 26.8% of the population undernourished in 2001-2012, and where rates higher than 50% can be found. Increasing temperature and decreasing crop growth will have negative impact on food quality and availability. Climate factors are inexorably linked to basics of life, including the availability of food, safe drinking water and good health (WMO, 2001). The impacts of climate change on food systems are expected to be widespread, complex, geographically and temporarily variable, and profoundly influenced by socioeconomic conditions (Vermeulen et al., 2012).

South Africa is largely deemed a food secure nation producing enough staple foods or having the capacity to import food, if needed, in order to meet the basic nutritional requirements of its population (DAFF, 2010). Hart et al. (2009) supported the statement that South Africa seems to be food secure at national level but the same cannot be said about households in rural areas. During the State of National address in the 2010/2011 financial year, food security was reprioritised as one of the top priorities for South African government.

Extreme climate and weather events will with high confidence, reduce food production (Porter et al., 2014). However, the per capita food output has declined in the region with the highest proportion of undernourished people in the world, estimated to be 30% of the total population or 239 million people in 2010 (FAO, 2010). The World Bank (2010) and UNEP (2010) have indicated that weather patterns and climate extremes threaten agriculture production, food security and water and energy security.

2.3.6 Regional, national and local climate practices

2.3.6.1 Macroclimate management practices

The climate is changing, and in order to understand what this means for the risks associated with future production shocks, climate scientists rely on the understanding of a combination of physical and dynamic processes that drive the Earth's system (Challinar et al., 2014). The devastation in parts of the region has arisen as a result of changes in climate, including costs of food and energy, the declining levels of rainfall in parts of the region and the increasing vulnerability (Richards, 2008). The majority of the populations in the SADC Region depend on rainfall for agriculture and livelihoods, but at the same time must contend with the reduction in rainfall (UNDP, 2007).

Weather and climate information is disseminated at national level in every country (Ziervogel & Opere, 2010). According to Sivakumar (2006), about 95 percent of the agrometeorological units presented their data in the form of texts, tables and graphics. The information from weather and climate models paint a bigger picture of climate change, and provides estimates for the likely consequences of different future scenarios of human development; they are not good at providing information about changes at the local level (Ishaya & Abaje, 2008). According to Blench (1999), climate and weather forecasts are based on analogue measurement, and increasingly depend on satellite imagery. The information about expected rainfall is given in probabilities.

General Circulation Models (GCM) are widely used and are founded on assumptions on the evolution of drivers of climate change through sea surface temperature as a predictor. Furthermore, conventional weather and climate prediction is normally done by using statistical and dynamical methods (Johnston et al., 2004). IPCC (2007a) has reported that GCM's failed to simulate intensity, frequency and distribution of extreme rainfall. Climate change projection indicates increased climate variability in the context of climate change over most parts of the world (IPCC, 2007b). Shaka (2008) argued that the interactions between the many processes that govern the earth's climate are so complex and extensive that quantitative predictions of the impacts of increasing concentrations of greenhouse gases on climate cannot be made through simple

intuitive reasoning. Kpadonou et al. (2012) contended that climate models have established that the high rainfall events, devastating floods and heat waves will become more frequent in the world with great annual and seasonal variability.

2.3.6.2 Microclimate management practices

The generic weather and climate forecasts practised does not support local farming communities in making decisions to plan their farming activities. Jacob and Van den Hurt (2009) stressed that global mean temperatures are quite unrepresentative at regional or local scale. Alcock (2010) further argued that climate and weather models are slow, costly to use and their results are only approximate in nature. The agro-climatologists can predict changes in climatic conditions on continental scales but not make predictions at finer resolutions (Stigter et al., 2005). According to Dube (2011), the South African Weather Services (SAWS) can forecast weather on a timescale of up to seven days with a high degree of accuracy, while seasonal and climate forecasting is trickier, as the atmosphere and ocean characteristics change frequently. Dube (2011) further stresses that the Departments of Agriculture and Water Affairs would like SAWS to beef up seasonal forecasts because it is critical to farmers.

Since late 1990's, predicting the weather has become more difficult due to disturbance in the system and adverse socio-economic people themselves (Dube, 2011). If the weather is a chaotic system, then the type of prediction may prove to be impossible. Muguti and Maposa (2012) further indicated that the activity on weather forecasting is an exceedingly complicated process today. The local weather and climate are assessed, predicted and interpreted by locally observed variables and experiences using combinations of plants, animals, insects and meteorological and astronomical indicators (Blench, 1999). According to Hansen (2004), helping farmers map probabilistic information into their own experience base can enhance the utility of the information.

2.3.6.3 Early warning and policy applications

Advance information about the weather and crop production is relevant to decision makers operating at a range of scales from field to national or regional, whose

decisions impact the welfare of farmers (Hansen, 2005). Lumala (2000) has indicated that farmers in Uganda use different means to know the future and table future events, including divination and fortune tellers who can predict the beginning and ending of rain. The most useful forecast information related to farmers are early warnings on anticipating poor or good season, and its commencement.

Early warning systems take different forms depending on the geographical scope (CIAT, 2014). Shocks such as drought, successive failed rainy seasons, and poor harvests drive populations in the hunger gap (Bailey, 2013). The prediction of early warning systems should relate to livelihood and humanitarian crisis (CIAT, 2014). CIAT (2014) further articulated that early warnings from an African perspective include projected increases in extreme drought and flood events, along with longterm climate trends toward increased temperature. According to the World Bank (2013), early warning information must reach appropriate agricultural decisionmakers at a time when the information can lead to positive action. In support to the World Bank, Okonya and Kroschel (2013) reiterated that early warning systems have proven to be indispensable in preparedness for climate events like the onset of the rainfall, floods, droughts and related famine.

A regional climate change policy is critical to guide the activities of the 14 different member states to ensure regional wide climate change policies are pursued through commonly agreed strategies (Richards, 2008). In the face of climate change risks and impacts that remain uncertain and unpredictable, there is a growing need for policies and actions that foster the co-production of new knowledge sets, based upon collaborative efforts involving community-based knowledge holders and natural and social scientists (Nakashima et al., 2012).

2.3.7 Linkage of western and indigenous weather and climate knowledge

2.3.7.1 Opportunities for interfacing indigenous and western knowledge

Knowledge is regarded by Long and Long (1992) as an embodied practice that should be addressed as an interface between the practices and discourses of local communities and the external agents of change, which in particular refer to the western scientific practice. In undertaking the process of interfacing the two knowledge systems, it is important to consider their differences and relevance. As long as the two knowledge systems differ culturally and historically, they might lose the logic of their origin. Ziervogel and Opere (2010) have suggested that indigenous weather and climate knowledge should be used more widely in conjunction with western weather and climate knowledge to increase reliability and acceptability of overall forecasts. The suggestion by Ziervogel and Opere is based on validation, interfacing and dissemination techniques. However, Walker (2004) has differing views to current western weather and climate knowledge provision often regarded as scientific in terms of forecasting, and that:

- It needs to distinguish between different users and different requirements and applications.
- It should be usable among farmers to make certain decisions pertaining to the land to be planted, the crop and cultivar to be used.
- It should be written in the local language.

Barnhart and Kawagley (2005) reiterated that people engage in a form of science when they are involved in the annual cycle of subsistence activities. The nature of the interaction between the two knowledge systems can either support or hinder sustainable development. The insights provided earlier regarding what constitutes knowledge creates confusion and misunderstanding in attempting to interface the two knowledge systems. Gupta and Belnap (1997) indicated that each culture has its own ways of legitimising meaning and handling the semantics of its discourse.

According to Miller et al. (2008), active discussion and continuous negotiation of the different epistemological beliefs held by participants and their implications for knowledge integration and decision-making should be encouraged. The objectives and outputs of the integration should be evaluated in avoiding “intellectual robbery” as indicated by Raymond et al. (2010). According to Green (2012), different reasons to know produce different objects of attention, or different facts. In an attempt to interface indigenous and western knowledge, one should consider their values as indicated earlier about the knowledge systems in order to find the converging and diverging factors. The linkage of the two knowledge systems can contribute to productivity and sustain the farming system, while effectively developing mitigation and adaptation strategies

2.3.7.2 Challenges of interfacing indigenous and western knowledge

The weather forecasting in Kenya by rainmakers from Nganyi family with their sacred shrines pertaining to indigenous trees that they use to predict the weather is combined with that from the Kenya Meteorology Department to produce more accurate weather reports (Thomson Reuters Foundation, 2012). Despite much discussion on the need to produce a comprehensive climate forecast that is more reliable and meet the needs of local communities as indicated by Risiro et al. (2012), the western and indigenous weather forecasts have positives and weaknesses. Indigenous approaches in dealing with weather uncertainties often led to effective risk aversion strategies long before climate science which created a more structured means of dealing with risk. Farming communities have used indigenous science to make decisions of managing risks holistically, while western science is generally using reductionist approaches. Therefore, through documentation, advancement and exploration of indigenous weather and climate knowledge could facilitate access to IK weather and climate for interested persons in the farming sector. Further challenges outlined by Johansson (2013) are as follows:

- ✓ Lack of intergenerational transfer of knowledge
- ✓ Dominance of scientific (western) culture
- ✓ Climate change may alter ecological interactions and indicator species responses
- ✓ Disappearance of key indicators from the local environment

2.4 Summary of literature review and key knowledge gaps

Research works by Stigter et al. (2005), Ishaya and Abaje, (2008), Ziervogel and Opere (2010), Manyatsi (2011), Mengistu (2011), Sanni et al. (2012), Shoko (2012), Boillat and Berkes (2013), Makwara (2013), Okonya and Kroschel (2013), ZumaNetshiukhwi et al. (2013), and Manyanhaire and Chituta (2015) are acknowledged since their revelation on how knowledge systems of weather and climate made contributions to the livelihoods of communities in the Sub-Saharan Africa. The immense contributions made have assisted the researcher in defining the problem faced by local communities and understanding the gaps created by the two knowledge systems (indigenous and western). The knowledge systems are far from interfacing due to resistance from the west, more especially from scientists who are working in silos and not addressing pressing community issues. Furthermore, coordinated efforts seem to be a problem within the three spheres (national, provincial and local) of government in South Africa. From an African diaspora, Kenya, Zimbabwe, Uganda, and Tanzania, collaborative efforts on weather and climate information dissemination seem to be considered widely. This study attempt to address similar concerns raised by researchers as indicated earlier.

The review has shown that indigenous knowledge about weather and climate is valuable and plays an important role in crop production. It is also evident that African farmers have managed to develop indigenous ways of knowing to cope with weather and climate uncertainties. Furthermore, the farming communities have used indigenous science to make decisions in managing weather and climate related risks holistically, while western science is generally using reductionist approaches. Several indigenous weather and climate indicators posit the extensive knowledge acquired in Sub-Saharan Africa. The review has also shown that efforts made to enhance community resilience integrative approaches were not considered. However, there are several gaps identified pertaining to weather and climate (Johansson, 2013).

In this chapter, several concepts were explored which addresses African worldviews, theories, and building on research planning process. An in-depth review of literature reflected on the wealth of indigenous knowledge in advancing the livelihood of

communities. The study conducted by Mafongoya et al. (2017) further attested to wealth of knowledge on weather and climate reflected by knowledge-holders and farmers in the Sub-Saharan Africa.

Throughout this chapter, the researcher has considered the work of Kovach (2010), Smith (2012), Wilson (2008), Denzin, Lincoln and Smith (2008) and Chilisa (2012) in undertaking indigenous inquiry. The views of the scholars are that indigenous methodologies should reflect indigenous worldviews, ontologies and epistemologies. Lincoln and Guba (2005) have argued that any research paradigm should consist of an ontology, an epistemology, a methodology and as well as an axiology. The researcher has invoked methods that emanated from indigenous knowledge, languages, experiences and worldviews. The worldviews of smallholder farmers in the study area are based on who they are, their language, where they come from and what their intentions are. Olsen et al. (1992) suggested that in any society there are dominant worldviews that are held by most members of the society.

For indigenous research to contain its focus on the role it plays in weather and climate, an exploration and documentation process should be based on an indigenous lens. The lens depicted here is to ensure that the research process and its results are beneficial and more relevant to the people and communities. The indigenous knowledge recognition, importance, its methodologies and interfacing with the western knowledge is acknowledged and brought to the research environment by the researcher through philosophical and ontological underpinnings experiences in attempting to maximize cultural safety while seeking entry into the indigenous field. An exploration of theories such as critical, post-colonial and critical race gave new thought of what the researcher can do and further redress the legacies of apartheid in the field of indigenous research. However, the exploration of indigenous methodologies laid the foundation of what indigenous researchers should consider in the decolonization process. The indigenous knowledge holders/owners should not be regarded as respondents but partners in the research process.

CHAPTER THREE

AFRICAN INDIGENOUS PHILOSOPHICAL UNDERPININGS OF THE STUDY

3.1 Introduction

This chapter endeavours to assert to philosophical underpinnings that constitute African worldviews that confer African people the sense of belonging and existence. In this chapter, conceptual and theoretical frameworks are defined and presented in details.

3.2 African indigenous worldviews

The researcher undertook a spiritual journey to unlock the interrelatedness and connectivity of people in the community by clarifying the issues of relation, botho/Ubuntu and collective being. The researcher opines that African people have acted collectively embracing the non-living, living and their environment through selfreflection. Philosophy, as Oyeshile (2008) opined, involves by its very nature a constant process of reflection upon itself. The philosophical ideas are presented that represent the thinking of African people. African ways of knowing and knowledge has not been shaped by western knowledge systems and neither should their future depend exclusively on western worldviews (Kaya, 2014).

According to Kante (2004), African indigenous science encompasses a sophisticated array of information, understanding and interpretation that guides interactions with the natural milieu and cope with fluctuating environment. Nzewi (2005) posited that the African cultural-mental modes of human interaction and knowledge transaction are peculiarly African without prejudice to correspondence with what obtains in other human cultures. Africa is a continent whose histories have been interpreted by its colonisers for the purpose of ensuring that its people are looked at as appendages of the very history that has shaped their lives (Maart, 2014). Hart (2010) further emphasised that all things exist due to the principle of survival.

African indigenous worldviews are guided by the spirituality, collaboration, ethics, communality, humanness and its morality. Creswell (2008) postulated that worldviews are general orientation about the world and the nature of research that a researcher holds. According to Simpson (2000), there are seven principles of indigenous worldview, and these are: 1) knowledge is holistic, cyclic, and is dependent upon relationships and connections to living and non-living beings and entities; 2) there are many truths, and these truths are dependent upon individual experience; 3) everything is alive; 4) all things are equal; 5) the land is sacred; 6) the relationship between people and the spiritual world is important; and 7) human beings are least important in the world. Nisbett (2003) described worldviews in simpler terms as the way in which one views and experiences life. People throughout the world have sustained their unique worldviews and associated knowledge systems for millennia (Barnhardt & Kawagley, 2005).

Smith (2012) echoed that since culture is not static, daily living is inevitably bound to be some combination of the knowledge, beliefs and values that have been maintained, revitalised, and innovated during times of colonisation. African indigenous ways of understanding the African continent remains intact. According to Owusu-Ansah and Mji (2013), the African worldview is based on strong orientation to collective values and harmony rooted in a collective sense of responsibility. However, Shisha (2015) emphasised that different cultures have different ways of experiencing social reality, and different ways of categorising knowledge.

3.2.1 Cosmology

Cosmic views of a culture are the totality of what a group believes about itself: what it is made of, where it comes from, where it is going, what controls its life, the position of individuals in society, purpose of life and the interrelation of all these aspects (Akoto et al., 2008). African societies are rooted in diverse religious belief systems which are guided by the heavenly god. Olumbe (2008) speculated that the Supreme Being is generally distant and unconcerned with the creation having delegated that responsibility to spirits and lesser gods, such as rain, fertility, or forest gods. The beliefs in god and ancestors have emerged from the traditional leaders, elders and participants when opining for rain rituals and divination. Africans are guided by their

spirits in understanding their world. The researcher therefore had to align with the cosmologies within the study area. Dillard (2008) has indicated that she learned three concepts of an African-based cosmology that are crucial to understanding the roots of endarkened feminist epistemological stance, that is: 1) spirituality; 2) community; and, 3) praxis (thought). Spirituality cannot be measured or reduced to neat conceptual categories (Richards, 1980). Spirituality cannot be separated from humanness.

People in communities believe in spirituality in that connectivity with heavenly father prevails and individuals have thinking abilities. However, Akoto (2008) reiterated that the concepts in understanding the cosmic view of the people in communities lies in the immortality of the soul, fantastic views and the role of ancestors. Anyone who conducts indigenous research in communities should understand how those communities conduct its own life. By understanding the cosmos of the study area, the researcher embraced cultural values such as ancestral worship, cultural activities, time factor, history, sacred sites and artifacts. The cultural values are helpful during consultations and interviewing processes.

3.3 Conceptual and theoretical framework of the study

Theorising and conceptualising indigenous research afforded the researcher an opportunity to reflect on the reality of the research. A theory and concept guided research activities in understanding the phenomenon studied. However, the two (a theory and concept) afforded the researcher to systematically develop epistemological paradigms. The development of a conceptual and theoretical frameworks was to show interrelationships or connections between different ideas. According to Smith (2012), the approaches of theories and concepts have shown enormous concern for peoples' origins as peoples and for aspects of linguistic and material culture. Furthermore, in understanding the terms, definition of a concept and a theory was important. Liehr and Smith (1999) defined a *theory* as a set of interrelated concepts which structure a systematic view of phenomena for the purpose of explaining or predicting, and a *concept* as an image or symbolic representation of an abstract idea. According to Welman et al. (2005), a theory may be viewed as a system which orders concepts in

a way that produces understanding or insights, and define concepts as the building blocks of any theoretical model.

A conceptual framework is derived from concepts while a theoretical framework is derived from a theory (Imenda, 2014). The purpose of developing a conceptual and a theoretical framework was to give direction to the study in addressing the research problem. Imenda (2014) further advocated that frameworks guide the individual researcher in terms of specific research questions, objectives leading to a better directed review of literature, identification of appropriate research methods and interpretation of results. An argument by Smith (2012) was that a theory at its simplest level is important for indigenous peoples.

In conceptualising and contextualising indigenous knowledge-holders in order to bring change, a conceptual framework was developed to define the concepts and guide the research process and execution of the intended activities. The purpose of developing the conceptual framework was to analyse realities, knowledge and value of knowledge in addressing concerns of interest within a community setup. The conceptual framework guided the researcher to explore the imbalances within the indigenous discipline by employing interpretive and transformative indigenous paradigms. The researcher's worldview was that verifiable reality exists in the study area and its value should be understood.

The starting point here is that the concepts and practices in indigenous research should conform to indigenous cultural values or the realities of the communities' life under study. Concepts are sometimes viewed as secondary to the strategies and techniques emerging from the dominant paradigm (Yellow Bird and Gray, 2008). Nakata et al. (2012) posited that anti-colonial critique is a fundamental beginning point for unsettling entry level researcher's presuppositions about indigenous western relations.

In Figure 3.1, critical issues relating to the problem detected from the community after cultural connectivity is reflected, and different concepts demonstrated from weak and strong linkages which needs to be addressed to achieve sustainable crop production

within the municipality. The rationale behind the concepts was to put forward the ontological, epistemological and axiological perspectives as informed by philosophical and social reality.

3.3.1 Conceptual framework

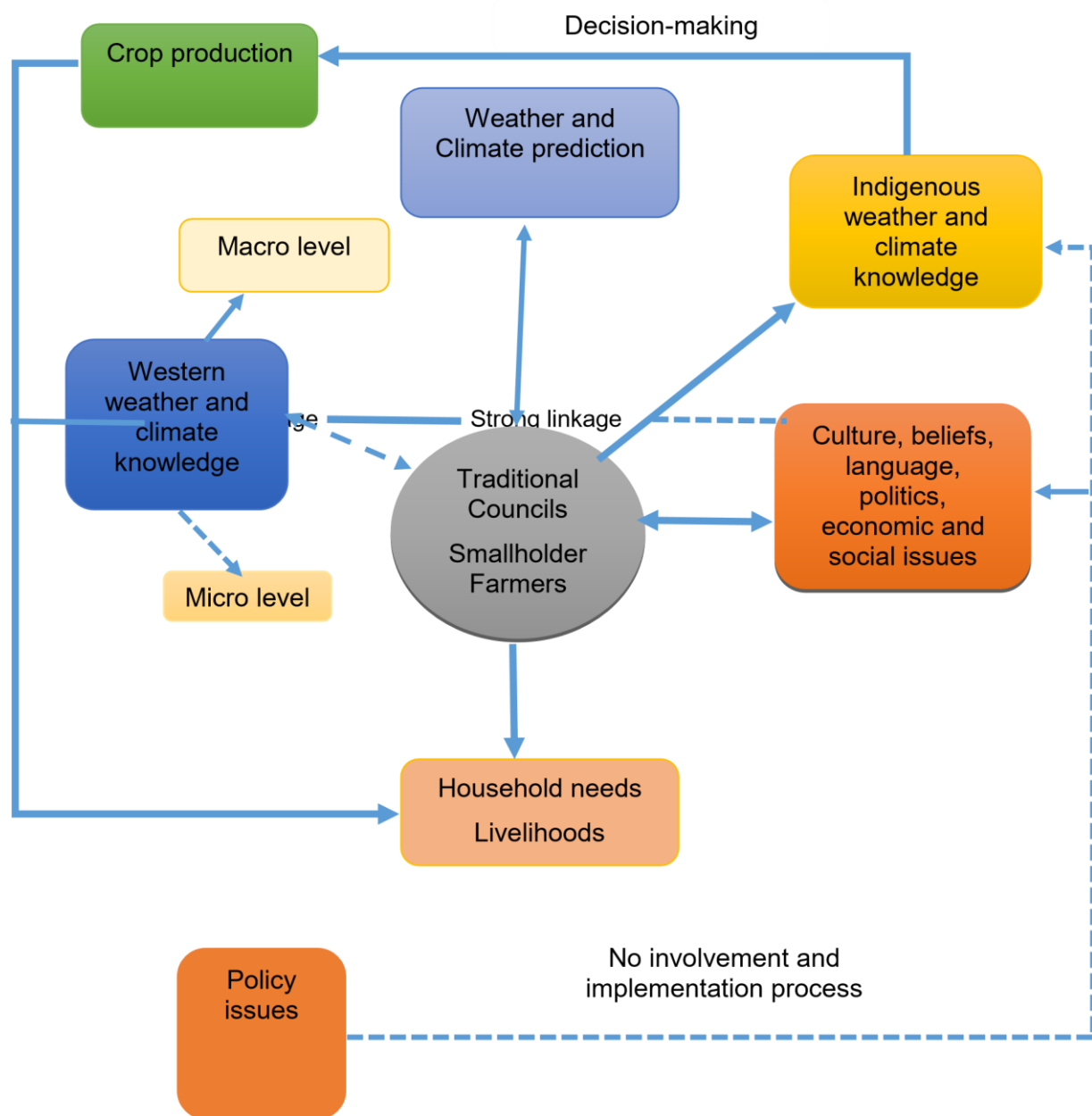


Figure 3.1 Depiction of obstacles of weather and climate knowledge dissemination and utilisation

The concepts are therefore rooted within the indigenous lens since they are emerging from the problem under study. In light of de-valuing rooted concepts, Hart (2010) connoted a rethink and considered perspectives of the community values and aspirations. An emphasis is derived from understanding the interactions or interconnections of the concerns outlined on weather and climate knowledge from a western and indigenous lens. Western weather and climate knowledge has been discussed intensively in the literature, but farmers could not utilise probabilistic information provided and be assisted at a micro-level to make decisions on crop production practices. As shown on Figure 3.1, the dissemination of information on weather predictions is only at a macro-level. There is no linkage at all with microclimate level where the communities are. By generalising weather and climate prediction through the western mode of understanding, smallholder farmers are unable to understand and interpret the information (Jiri et al., 2015).

Furthermore, the linkage between the Agro-climatologists and smallholder farmers is very poor when considering knowledge-sharing. However, smallholder farmers acknowledge that western weather and climate knowledge exists while indigenous weather knowledge is dismissed (Briggs & Moyo, 2012). The decision-making process as depicted on Figure 3.1 is reflected regarding crop production where variety selection becomes a factor. Decision-making is guided by the traditional councils' ways of understanding their environments based on culture, beliefs, language, politics, economic and social issues.

The policy issues may have a negative impact on rural communities towards improving local economy since the traditional councils and smallholder farmers are not involved in the crafting of the policies, and more specifically, policies on their knowledge systems. Smallholder farmers' and traditional councils' positions in food production in addressing their household needs might have been hampered by the demise of apartheid which may further denied them the opportunities of getting relevant and understandable information on weather science alignment. Therefore, the rationale to conduct the study at the micro-level was to advance smallholder farmers in raising

their voices, and documenting and preserving their knowledge on weather and climate systems.

The information on the approaches used in averting climate variability and factors that foster the degree of adaptation by smallholder farmers in the study area was limited. Therefore, this call for a need to consider the role of indigenous knowledge on weather and climate in an attempt to advance smallholder farmers to make decisions to sustain their crop production practices. The study challenges the colonial imposition of the knowledge systems of the communities pertaining to weather and climate. Above all considerations, it is argued that indigenous weather and climate knowledge can enhance and contribute meaningfully to weather and climate predictions if documented, aligned and integrated with western weather and climate prediction systems. In order to advance and liberate the striving communities to achieve their livelihoods, theories that advocate for the study were considered once the theoretical framework was outlined.

3.4 Theoretical framework used in the study

3.4.1 Anti-colonial discursive framework in indigenous research

An anti-colonial discursive framework exploration derive from an epistemological indigenous knowledge lens. Why use anti-colonial discursive framework? The framework was considered in the study to liberate the researcher and the research participants from oppressive ideologies and to make contributions to the knowledge-holders within the municipality. The framework demands that the researcher be placed inside the African experience and African ideals and values at the centre of inquiry framed by African codes, paradigms, symbols, motifs, and myths that give meaning to the history of the African subject and a sense of place in the world arena (Monteiro-Ferreira, 2014). The knowledge of traditional council members and smallholder farmers about their weather and climate was and is refuted, and dismissed as unscientific.

According to Dei (2002), anti-colonialism is a celebration of oral, visual, textual, political and material resistance of the colonised group. The question which can be posed for IK research is: what makes research indigenous without considering

indigenous or decolonising methodologies? Smith (1999) and Dei (2002) opined that decolonisation is a process of demystifying anti-colonial thoughts, with critical engagement of imperialism and colonialism in different spaces. Through the anticolonial discursive framework, the knowledge of the participants are expressed through their own languages, locations, feelings, attitudes, perceptions and cultures.

The anti-colonial discursive framework was considered relevant for the whole study. The advancement of ideas on the challenges faced by the knowledge-holders whether or not they are smallholder farmers or traditional council members related to weather and climate was motivated by the work of Ngugi wa Thiong (1986), Smith (1999), Battiste (2000), Davies (2007), and Fanon (1963;1967) who created the spaces for decolonisation. According to Davis (1989), the anti-colonial approach will liberate those who can only perceive the world through the Eurocentric perspective. The use of anti-colonial approach was to advance the local communities to acknowledge their own perspectives and voices.

Dei (2000) remarked that context is crucial on anti-colonial discursive undertaking, for it is the appreciation of colonised peoples' oral, visual, textual, political and material resistance where there is an interrogation and influence of histories, cultures, ideas and knowledge production for validation and usage. Participants may become oppressed when their ideas, languages, rituals, traditions, spirituality and ceremonies are not taken seriously. The approach envisage that the western institutions continuously produce and reproduce ideologies that are not beneficial to the communities where research is conducted. Furthermore, the framework in the study embraces the local communities' know-how, what and why in evading the western approaches to research. The participants were afforded the opportunities to reclaim their identities and to become what they are. There is indeed a need for a balanced discourse, which can only be reflected through ethical research that acknowledges the power of language.

3.5 African indigenous epistemology

The study was underpinned by describing the indigenous worldview guided by assumptions pertaining to ontology, epistemology, axiology, decolonising methodologies, language, cosmology and theories. The concept of indigenous epistemology is different from the ‘outsiders’ theories, and accounts for specific ways of theorising knowledge (Grincheva, 2013). The views guided the researcher’s thinking, beliefs and assumptions about the society, and framed how the world is viewed (Schwandt, 2001). The approach adopted for the study was based on Chilisa’s (2012) culturally responsive approach where she indicated that no one paradigmatic or theoretical framework is ‘correct’, and that it is the researcher’s choice to determine his own paradigmatic view (Figure 3.2). An indigenous paradigm comes from the fundamental belief that knowledge is relational (Hart, 2010). According to Chilisa (2012), African perspectives view relational epistemology as knowledge that has a connection with the knower. The success of indigenous research lies in connecting with communities.

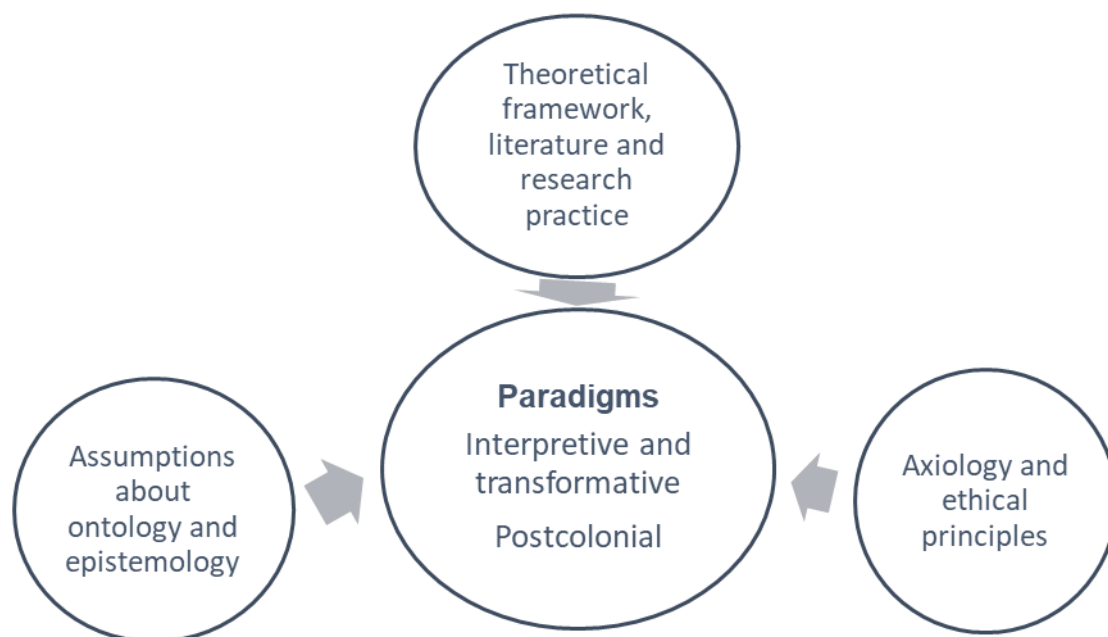


Figure 3.2: Factors determining the choice of an indigenous research paradigm (adapted from Chillisa, 2012)

Relationships between the researcher and knowledge-holders was guided by the paradigms as indicated in Figure 3.2. Therefore a healthy relationship was advocated through relational theory, relational ontology, relational axiology and relational epistemology. A person is inevitably placed in a relationship, through mutual friends or through knowledge, with certain landmarks and events (Chilisa, 2012). Therefore, researcher – knowledge-holder relationship was encouraged in the study.

3.5.1 Relational theory

Relational theory was considered as an entry point to consult, engage and communicate with community members in the study area. Building a relationship with people, and the settings in the study area was essential in affording the researcher the opportunity to be part of the local system. According to Wilson (2001) and Louis (2007), the indigenous paradigm views relationships as central to the research process and not seeing the knowledge of participants as objects. The researcher approached the study area from a relational ontology, epistemology and axiology perspectives which, according to Denzin and Lincoln (2005), is regarded as a paradigm net. Odora-Hoppers (2005) further stressed that in the African context, the relationship with and to nature, human agency and human solidarity prevails. The argument here is that the relational theory provides a platform for decolonising how indigenous research is conducted in communities, and considers realities based on indigenous views.

3.5.1.1. Relational ontology

Throughout the research process, the participants maintained that what is said to be real. Relational ontology has harnessed the researcher's integration among traditional leaders, government departments, participants and the setting. It was evident during the study that traditional leaders want relationships which will be beneficial to them and knowledgeable participants. The entire study has considered aspects of humanness (botho) or moral theory. The *botho* (humanness) within the study was nurtured in order to yield positive outcomes. According to Schoeman (2012), Ubuntu acts as a fundamental ontological and epistemological worldview in Africa. One of the key features of entry to the community is greeting traditional leaders and elders. How

one greets them determines or grant an approval to know the nature of how real they are.

Ubuntu in Sepedi means *botho* - *humanness*. It is a unifying vision, a spiritual foundation and a social ethic (Odora-Hoppers, 2005). The inclusion of *botho* in the study has significance to a set of values, ethics and morality that the researcher must take cognisance of. Pityana (1999) reiterated that *Ubuntu/Botho* defines the baseline for a morality of compassion, communalism and concern for the interests of a collective. *Botho* harnessed a strong, respectful and interactive process with knowledgeable individuals who partake in a research process. According to Absolon and Willet (2004), respectful representation requires the researcher to consider how you represent yourself, your research and the people, events, the phenomena that you are researching. Letseka (2013) pointed out that *botho* prescribes desirable and acceptable forms of human conduct and how they should relate. The acceptance of the researcher's proposal to undertake a study in the municipality has proven that the trust and relationship established by the researcher addressed the notion of realism. The dominant aspect which was noted during the study was the emergence of the spiritual and physical realm (Cajete, 2000).

3.5.1.2. Relational epistemology

Prior to outlining the theory of knowledge, one has to define what epistemology is. Moser (2010) defined epistemology as the theory of knowledge, the philosophical study of the nature, origin and scope of knowledge. The emergence of critical thinking is based on epistemological understanding (Felton & Kuhn, 2007). According to Chilisa (2012), relational epistemology is drawn from relational forms of knowledge as opposed to individual descriptions of knowing, in which people develop as they have experiences with each other and the world around them. It is of paramount importance that knowledge from communities be considered in terms of its nature and certainty. During the study, traditional leaders and participants were considered to be experts in their fields of indigenous knowledge. Felton and Kuhn (2007) further emphasised that individuals' beliefs about knowledge tend to develop from an extreme objectivist stance to an extreme subjectivist one. Conducting an

ethical research entailed thinking about participants as part of the research process in advancing their needs and aspirations.

The research participants' thinking was guided by true beliefs about their knowledge. However, Felton and Kuhn (2007) remarked that a true reflection of knowledge consists of facts that are neither right nor wrong. True beliefs which emerge from the respondents emanated from their local environment, experience, spirituality and memories. The decolonisation platform affords the participants opportunities to have a conscious position on who they are. Ngugi wa Thiongó (1986) and Smith (1999) emphasised that decolonisation is another process pivotal to understanding anticolonial discourse. Chilisa (2012) echoed that a common thread in postcolonial indigenous relational epistemologies is that knowledge arises out of people's relationship and interaction with their particular environment. It is worth noting that knowledge generation is not done in a vacuum.

3.5.1.3 Relational Axiology

In the study, the researcher was guided and influenced by the values which informed the choice of the approach, topic, methods of data collection and analysis. However, Chilisa (2012) echoed that accountable representation of researcher and respectful relationships recognises the web of the living and non-living. Through personal experience of the study area, there were opportunities to form focus groups and key knowledgeable elders through the use of *kgoro* method (Seloane, 2015 personal comm.; and Ledwaba 2015 personal comm.). The *kgoro* method assisted the researcher in bringing people together and allowing them to agree or disagree among themselves. Traditional leaders, smallholder farmers and knowledgeable elders were valued on the basis of their knowhow, and how they relate to the researcher and other relevant stakeholders.

3.6. Use of local language in indigenous research

Language is an important medium of communication and culture upbringing in any community and country. Africa, including South Africa, is facing a complex language paralysis (Masoga, 2005). The colonial powers which arrived in Africa shared the

common belief that they were culturally and linguistically superior to Africans (Kamwembo, 2010). Diop (1999) has indicated that Africa is burdened by an excessive and debilitating dependence on the languages of its colonisers such as English and Afrikaans in the case of South Africa. People all over Africa were forced by colonial policies to abandon their indigenous languages for western languages. In communities, language contains movement, process and transformation (Odora Hoppers, 2005). Chilisa (2012) echoed that language plays an important role in the research process as 1) a means of communication; 2) a vehicle through which indigenous knowledge can be preserved during fieldwork; and 3) a symbol of objects, events and experiences a community considers worth naming. Chilisa (2012) further opined that the way people talk reflects their thinking and who they are.

The researcher did not use English in defining indigenous truths for reasons explained above. The participants from the communities where the research was conducted speak Sepedi. In all traditional councils, the participants freely expressed themselves in Sepedi before and during the interviews. Apparently, the language offered a theoretical understanding of knowledge and indigenous worldviews. The spirit of consciousness that created those languages are remarkably persistent and still embedded in many African communities (Battiste, 2008).

The power of local knowledge can only be realised when the local language is considered to be a vital entry to knowledge development. Each language reflects the interactions between groups by exchanging words, meaning and vocabulary as well as mutual influence (Njoku, 2004). According Kane (2007), co-opting the language of the coloniser is to co-opt racism and to “betray” one’s own self and culture, and to internalise one’s own inferiority. Subjecting participants to foreign language constitutes a dilemma in development. The decolonisation of language can only be achieved once the principles of equal opportunity as in the Bill of Rights (1996) of the South African constitution is persuaded.

Wong and Poon (2010) further warned that omission or addition of a phrase in a translated text may have a significant influence on data interpretation and meaning

and not represent the participants. Different languages have different grammar, different orders, sometimes even words for which other languages do not have any equivalents (Motsei, 2013). Translating Sepedi into English in this kind of study will not serve the intended purpose as demonstrated above. Mohatlane (2014) also attested that translated texts of specific socio-cultural contexts result in *translationese* (meaningless translations) that are culturally unacceptable to the target group. However, interpretations of indigenous knowledge depend on the researcher's attitudes, capabilities and experiences, as well as on the understanding of indigenous consciousness, language and order (Battiste, 2008).

3.7 Indigenous research paradigms and designs

Through the indigenisation of research methodologies, the researcher found the research process acceptable and doable. There is no use to talk about indigenous research without defining the ways in which concepts, new theoretical frameworks and new tools for data collection are developed. The researcher does not subscribe to being a coloniser co-opted by the dominant western discourse on methodology, which uses euro-western standards as universal truths (Chilisa, 2012). It was apparent that the philosophical and theoretical paradigms considered in the study are in consistent with the African worldview. According to Bishop (1998) and Wilson (2001), indigenous epistemologies, worldviews, methodologies and frameworks must form the basis for own knowledge quests and practices.

3.7.1 Interpretive paradigm

Conducting research under the indigenous interpretive paradigm has improved the relationship between the participants and the researcher as the level of trust and willingness to participate seemed to increase. It was important and necessary to consider the indigenous research paradigm which goes beyond the imposition of one worldview upon another, which surpasses ontological and epistemological differences. The study has culturally allowed the researcher to construct trustworthy and authentic accounts in building local understanding from participants' experiences. The interpretive framework assisted the researcher to identify knowledge from its context, practice and belief (Figure 3.3). The researcher believes that reality comes in different

forms. The knowledge worldviews from the participants from different traditional councils in Lepelle Nkumpi Municipality attested to the research question posed.

Denzin and Lincoln (2005) emphasised that as interpretivist, the researcher should be guided by his set of beliefs and feelings about the world and how it should be understood and studied. The emergence of the emphasis by Denzin and Lincoln was that knowledge is relative to history and culture, subject as it exists in multiple forms of representations of reality (interpretations by individuals) (Benoliel, 1996). The researcher remained open to developing theory from the ground throughout the study, assisted by the knowledgeable participants. As Danby and Farrell (2004) conceived, interpretive researchers produce theorised accounts that represent participants' sociological understandings. This implies that epistemologically, the relationship between the knower and the knowledge prevailed. The ontological assumptions and philosophical underpinnings are defined and explained in chapter 2. Therefore, the researcher avoided rigid frameworks such as positivist research, and adopted more personal and flexible research structures which are receptive to capturing meanings in human interaction and make sense of what is perceived as reality (Carson et al., 2001; Black, 2006).

The question posed prior to synthesising the ideas was: *why should knowledge be viewed from a complex system?* According to Woodley (2004), local ecological knowledge can be understood as knowledge that emerges from a complex system of context, practice and belief. It is within this understanding that since all knowledge assumptions are conjunctures, the philosophical underpinnings of each paradigm can never be empirically proven or disproven (Scotland, 2012). Therefore, different assumptions of reality and knowledge emerge and are reflected in the methodology (grounded theory method). In the study, knowledge was viewed through perceptions and experiences of the participants. The researcher synthesised the framework as presented below (Figure 3.3).

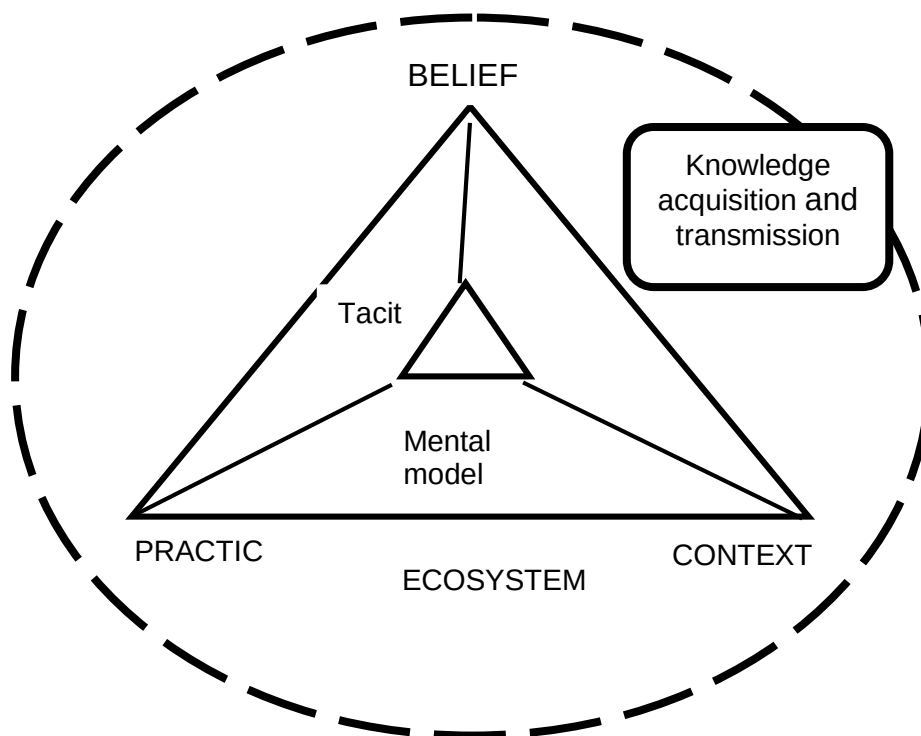


Figure 3.3: The interpretive framework (adapted from Woodley, 2004)

In the interpretive framework/approach, research does not seek answers from the research question rigidly since ideologies are not questioned but accepted. In adopting the framework, the researcher considered knowledge from a contextual, practical and belief lenses. During the collection and interpretation of data, the researcher determined what is regarded as knowledge and views of participants. Furthermore, the idea of multiple perspectives arose from the belief that external reality is variable (Willis, 2007). The researcher chose the qualitative approach in this study so as to understand the world of the participants by gaining insight into their backgrounds, beliefs and experiences (Cohen & Manion, 1994; Yanow & SchwartzShe, 2011).

3.7.4 Transformative paradigm

The study has opted for the **transformative paradigm** since it is crucial for the western and indigenous knowledge to link for overall benefit of the local communities as considered in chapter 5. It was within the researcher's understanding that western knowledge requires to counteract its epistemological dominance which was propelled for generations. The epistemological dominance in addressing the micro weather and

climate issues through the western approach has never materialised. The value of climate and weather forecasting to the farmers may never have been demonstrated to the farming community by the institution developing and promoting the forecast information (Stone & Meinke, 2006). However, Mertens (2010) and Mertens et al. (2009) regarded the transformative framework as a framework of belief systems that directly engages members of culturally diverse groups with focus on increased social justice.

Indigenous ways of predicting the weather form part of the livelihood system of local communities. However, the way weather and climate prediction is presented to end-users is too technical and does not cater for smallholder farmers. The study considered the transformative paradigm on the premise that successful linkage can be possible only when social justice and equity is realised. Mertens and Wilson (2012) commented that the transformative paradigm “pulls together many strands of philosophy” that focus on issues of power and on addressing inequities in the name of furthering human rights and social justice. Human rights and social justice should prevail within the institutions providing weather services in order to sustain the livelihood of communities.

The framework was considered within an understanding of the past injustices experienced by the African farming communities, and therefore transformation becomes a necessity. As Denzin and Lincoln (2005) have indicated, the value of research should be directed towards social justice and should address human conditions in the society. The previous injustice with regards to oppression experienced in South Africa necessitates a change of approach in addressing human conditions. Any possible linkages between western and indigenous knowledge rests on addressing the issue of social justice and human rights (Cram & Mertens, 2016).

When considering the past and present changes, the question that one can ask is: *does transformation currently in the level expected by the research participants to achieve what they want to achieve?* The considerations for the two knowledge systems rests upon the philosophy that underpins epistemological, ontological and

methodological assumptions. Furthermore, as Cram and Mertens (2016) ethically suggested, marginalised farmers express dissatisfaction with research conducted in their communities because their voices are not represented in findings that do not bring about desired transformation that they need. Indigenous knowledge has been subjected to suppressions for many generations, and therefore, farmers' knowledge was not considered, valued and respected. In essence, reality emerges from different individual opinions and common sense within a set of culture and belief systems. Knowledge of the people differs from one locality to another, region to region and country to country.

When an individual person perceives, or interprets something based on his/her senses, that particular individual is culturally appropriate in that environment. Since weather forecasting/prediction is the key factor of the study, smallholder farmers regard the weather as an environmental factor to mankind (Ajibade & Shokeni, 2003). Weather and climate knowledge from the two knowledge systems become critically important to humankind. Sweetman et al. (2010) have emphasised that knowledge reflects the power and social relationships within society, and the purpose of knowledge construction is to aid people to improve society. Therefore, transformation is required on both knowledge systems to aid farmers make concise decisions on overall crop production practices. Moreover, the dominance and oppression of one knowledge system is refuted as described later in the chapter, where post-colonial and critical theories are discussed.

For other transformative ideas to emerge unnoticed, the research process in the study has embraced the problem definition, approaches, data sources, participants, methods, data analysis and interpretation. The methodological decisions are tied to social justice; no single methodology is privileged (Cram & Mertens, 2016). The choice of research methods to be adopted in the study were guided by the researcher's self-conscious and ethical considerations. Consciousness commands steadfastness in upholding the basic tenets that ensure stable, durable and allaccommodating co-existence (Nzewi, 2009). Furthermore, the researcher's interest during the study was

in facilitating change by opting for possible linkage between indigenous and western knowledge.

3.8. Research approach

Overall the study used a mixed-method research approach. This entailed the combination of qualitative and quantitative techniques. According to Sandelowski (2000), two or more paradigms of inquiry can be used to frame the same phenomenon. Williams (2007) opined that the mixed methods approach to research provides researchers with the ability to design a single research study that answers questions about both the complex nature of the phenomenon from the participants' point of view and the relationship between measurable variables.

The western paradigm for research articulates theory and methods which are chosen in order to explain a particular phenomenon and to guarantee an objectivity of research in order to create a desired result (McCutcheon, 1997). Kavoch (2010) emphasised that certain western research paradigms frown upon the relational because of its potential to bias research, while indigenous methodologies embrace relational assumptions as central to their core epistemologies. Bernard and Kawacley (2005) and ACAPS (2012) have explored the difference between qualitative and quantitative methods in addressing research paradigms. The differences are summarised as in Table 3.1.

Table 3.1: The difference between indigenous and western approaches

Approach	Indigenous (Qualitative)	Western (Quantitative)
Usage	To understand behaviour, perceptions and priorities of affected community	To get socio-demographic characteristics of the population
Objectives	• To explore and understand the phenomenon • Provide in-depth understanding of specific issues	• To seek precise measurement, quantity, confirm hypothesis • Provide general overview
Questions	Answers: how, why and what?	Answer: What and how many?
Perspective	Looks at the whole context from within	Looks at specific aspects from outside
Analysis	• Use inductive reasoning • Systematic and iterative process	• Deductive methods • Descriptive statistics

Source: Bernard and Kawacley (2005) and ACAPS (2012).

The method for data collection is respectful of and includes indigenous protocols, values and beliefs that are important in a specific community. The indigenous methodology was not theoretically constructed but conformed to indigenous ethical protocols that shape the methods according to local cultural imperatives (Porsanger, 2004). Owusu-Ansah and Mji (2013) argued that knowledge or science and its methods of investigation cannot be divorced from a peoples' history, cultural context and worldview. What is important for one to consider is that the indigenous methods are originally generated largely from within qualitative research. However, proponents of the mixed methods approach to research advocate doing "what works" within the precepts of research to investigate, to predict, to explore, to describe and to understand the phenomenon (Lohfeld & Brazil, 2002; Creswell, 2003; Johnson & Onwuegbuzie, 2004).

3.9. Decolonising research methodologies

The recognition of indigenous research work conducted by indigenous research methodologists such as Wilson (2008), Smith (1999), Denzin, Lincoln and Smith (2008). Kovach (2010), and Chilisa (2012), who resisted the colonial research approaches, is highly acknowledged. The study considered indigenous research methodologies because it advocated for an anti-colonial discourse. The study also asserted to indigenous worldviews in cognisance of relational ontology, epistemology and relational axiology. Carlson (2016) has emphasised that any research study that has anti-colonial or decolonial aims to consider indigenous methodologies. However, in the study not purely indigenous research methodologies were considered. Having looked at other theories, it was apparent that indigenous research methodologies should be articulated.

Indigenous research is a form of resistance to centuries of colonial domination (Coburn, 2013). Research in indigenous knowledge systems must start by recognising and distilling the philosophical and theoretical formulations framing indigenous creations, and end with outcomes that make significant impacts in the lives and intellectual enrichment of knowledge inheritors (Nzewi, 2007). The indigenous research approach may be defined as ethically correct and culturally appropriate (Porsanger, 1999). According to Denzin and Lincoln (2003), a paradigm must include seven considerations: ethics, accommodation, action, control, truth, validity and voice. A paradigm influences the selection of the method to be used in data collection, analysis and interpretation. According to Wilson (2001) and Kavoch (2010), the paradigmatic approach to indigenous methodologies is based on an indigenous philosophical positioning. Kavoch (2010) emphasised that in a paradigmatic approach to research, be it indigenous or otherwise, methods ought to be congruent with the philosophical orientation identified in the research framework to show internal methodological consistency.

The theoretical value of indigenous approaches has been denied because theorising has been evaluated on the premise of western academic knowledge and epistemology (Porsanger, 1999). Kavoch (2010) postulated that if a researcher chooses to use an indigenous methodological framework, the methods chosen

should make sense from an indigenous knowledge perspective. Indigenous research methods are qualitative in nature and allow the indigenous researcher to hear the voices of those who are silenced, oppressed and marginalised by the dominant social order. Despite critical thinking about the choice of methods, Wulff (2010) supported the notion that indigenous research has interesting connections to qualitative research traditions.

According to Denzil and Lincoln (2008), qualitative research is swift to understanding the meanings, interpretations and subjective experiences of individuals. Denzil and Lincoln further contended that 'indigenists' resist the positivist and post positivist methodologies of western science because the formations are too frequently used to validate colonising knowledge about indigenous people. Kavoch (2010) further stressed that the indigenous paradigm supports decolonising perspectives. Furthermore, the writing by Smith (1999) regarding research approach was that "*they came, they saw, they named, they claimed*". Smith was trying to highlight the colonial research tradition in existence. It is noted that indigenous knowledge systems research is paradigmatic with reference to western methods.

The experience reflected by Macneil and Marsh (2015) was that indigenous research and undergoing indigenous ethics reviews varied. According to Denzin et al. (2008) and Chilisa (2012), the human research ethics governance process interacted with, and in many ways in a reflection of, scholarly discussions on the need for appropriate methodologies. Chilisa (2012) reiterated that in indigenous research, an ethics protocol based on decolonising methodology maximises indigenous participation through the privileging of indigenous voices and rights to participate or withdraw from research based on the participants' terms and interest. This entailed that researchers must always honour the research participants' voices and perspectives ethically and methodologically. Marsh (2011) emphasised that there is an ideological gap that exists between institutional compliance and ethically driven researcher philosophy. According to Heikkilä and Fondahl (2012), the research might be regarded by some researchers as objective or even scientific.

3.10. Indigenous theories of the study

In the study, theories which addresses the value and realities in indigenous research approaches are presented. Theories such as critical, post-colonial and critical race specific are presented and discussed in details.

3.10.1. Critical theory

Critical Theory, seeks to challenge the prevailing orthodoxy of economic rationalism by indicating its harmful effects on individual and societal well-being (Wallace and Wolf, 1999). According Gage (1989), critical theory was introduced after a critique of educational research which was too technical neglecting social inequalities and issues of power. Murphy and Fleming (2006), emphasised that critical theory is drawn into the production of ideological and oppositional analysis via 'grassroots' knowledge production in indigenous communities in a way that animates political resistance to dominating Western theory and intellectualism. The existence of social realities emanated from different human experience, knowledge, views, interpretations and experiences. The understanding of critical theory is that it stands apart from the current order of the world. Consideration of critical theory in this study was to decolonise the ideologies of western approaches to research undertakings. The study is well informed by critical theory as it relates to issues of constructing knowledge together with knowledge-holders and challenges inequalities.

Understanding science in Africa is impossible without coming to grips with what can symbolically be called the soul of Africa (Masoga, 2005). Du Toit (2005) argued that the history of science in the West is a history of the separation of human beings from nature, facts from value, mind from body, and subject from object. According to Wallner (2005), western science or knowledge is riddled with problems of romanticism and tensions, and therefore should not be looked as global.

However, Martin (2008) emphasised that indigenous decolonising knowledge productions appear to be controlled by indigenous knowers on the ground supported by indigenous scholars from within the academy who understands and have subjected to critical analysis the practices of western knowledge production and

practice. An argument by Nakata (2007) was that full access to knowledge about knowledge is a critical pre-condition of those who understand themselves in the world. Nakata et al. (2012) reiterated that indigenous people cannot function as theoretically people to devalue indigenous ways of knowing. Andersen (2012) and Nakata et al. (2012) argued that for students to transform their thinking, they must first engage indigenous knowledge systems of thought and/or be brought to account for their own embodied 'white' privileged identities as beneficiaries of the colonial production.

3.10.2. Post-colonial theory

Post-colonialism is defined in anthropology as the relations between nations and areas they colonized and once ruled (Fischer-Tine, 2011). Post-colonial entails a transition from being colonised and decolonised. According to Mangu (2006), slavery, colonialism and apartheid marked the decline of African Civilisation. Shepherd (2006) contended that colonial-era writers further portrayed Africans as uncivilised, irrational, deceitful and cunning, thoughtless, improvident, ugly, preserve, immoral and lacking intelligence.

The post-colonial theory signifies an attempt by the colonised to re-evaluate, rediscover and reconstruct their own heritage. However, post-colonial theories are applied in various ways, depending on one's disciplinary orientation (Browne et al., 2005). The post-colonial discourse in discussions emanates from Western epistemologies and discourses. Postcolonial indigenous knowledge is grounded in indigenous epistemologies and is concerned with developing knowledge based on indigenous ways of knowing, indigenous worldviews and indigenous research processes (Battiste, 2000). An exploration of indigenous knowledge research in the postcolonial paradigm uncovers and rebuild the identity of the thinking of those oppressed through social, economic and political dominance. The writing by Makgoba (1997) with reference to post-colonial reconstruction of Africa was that:

'Africa has faced some of the great social changes in this century in terms of race, ethnicity, politics, violence, labour relations and industrialization.'

Graduates in the social sciences are going to be a critical component to the success of African democracies as they struggle to emerge from the mess in which they have been. Universities are not only essential for the training and nurturing of highly-skilled scholars in this area, but are poised to make a unique contribution to the overall development of post-colonial Africa (1997)'.

A call for the African Renaissance emerged and relates to self-discovery and the restoration of African people against colonial masters, injustice and inequality. Moreover, its aim is to build an understanding of Africa, its languages and approaches to development. Eurocentric views denying inherent democratic values and practices in Africa and by African peoples were rejected and rightly so by other Africanist or African scholars (Mangu, 2006). The future of African intellectuals lies with the African Renaissance in knowledge reconstruction and decolonising the minds of Africans in order to de-western them. Attention is drawn to the ways in which the past is existing on a daily basis, in every policy and practice through the language used.

Decolonisation can be achieved through research which considers knowledge of African communities by African intellectuals. According to Smith (1999), Battiste (2000) and Ormiston (2010), decolonisation is about privileging, understanding and sharing concerns and worldviews. Nzewi (2007) further posited that knowledge research, invention, theorisation, experimental processing, knowledge empowerment, and modes of literacy, is long been with people before contact with the world outside Africa. Nzewi further stated that it is unfortunate that the unique intellectual constructions and research protocols that make indigenous Africa's mental civilisation have totally eluded, and still elude modern academics. Scotland (2012) advised that researchers need to take position regarding their perceptions of how things really are and how things really work. Discoverable reality exists independently of the researcher (Pring, 2000). For example, *kgoro* is not *kgoro* until someone call it *kgoro*. Reality is constructed through the interaction between languages and aspects of an independent world (Scotland, 2012).

3.10.3 Critical race-specific theories in indigenous knowledge research Critical race theories originated in the late 1970s from the work of lawyers, activists and legal scholars as a new strategy of dealing with the emergence of a post-civil rights racial structure in the United States (Malagon et al., 2009). Critical scholars (Malagon et al., 2009) experienced frustration by creating a research note with traditional, qualitative research methods to accurately understand and document the complex experiences of students of colour, their families and their communities. To address the frustration, Smith (1999) reiterated that the shortcomings require an exposure of the ideological premise and goals of the indigenous qualitative research process. Furthermore, social justice is required within the qualitative research and unwavering commitment to guiding methodological principles.

The critical race theory (CRT) emerged from critical legal studies (Abrams & Molo, 2009), and functions to deconstruct the “apartheid of knowledge” that exists within the academy by validating and honouring our own experiences and forms knowledge (Huber, 2008). According to Malagon et al. (2009), the theory emerged within the historical context as a framework aimed at undermining colour-blind ideology through a deconstruction of its racist premise. Delgado and Stefancic (2001) stressed that CRT was drawn from diverse disciplines such as sociology, history, feminist and postcolonial studies, economics, political science, ethnic and cultural studies. The CRT strives to challenge the Eurocentric difference deficit or minority education frameworks (Abrams & Molo, 2009).

According to Maart (2014), CRT in South African context was that the history of apartheid itself speaks loudly and clearly to the systemic, structural and institutionalised forms of racism that was alive and well within the university system in providing a breeding ground and battlefield for racism within university context. The breeding ground for moral display for English and Afrikaans speaking white South Africans alike was perpetuated (Maart, 2014). Despite attempts by government to curb inequality and racism in South Africa, racism is still in existence twenty years of democratically elected country. Currently, indigenous languages in the country are

not yet utilised in the universities to reflect their recognition like when Afrikaans was used fully during apartheid. The Critical Race theory provides a useful theoretical framework for an examination of the current discussion of differences in academic achievement (Love, 2004). Love regarded CRT as methodologically representing a paradigm shift in discourse about race and racism in education by challenging existing methods of conducting research.

CRT is used in this study to uphold its lens in qualitative research methodology. Indigenous epistemologies and cultures occur when decolonising knowledge in western universities (Smith, 1999). According to Smith (1999) in her *decolonising methodologies book*, indigenous methodologies tend to approach cultural protocols, values and behaviours as an integral part of methodology. The only way to claim indigenous knowledge from the western academy can be through decolonisation. Decolonising knowledge in universities involves a deep sense of recognition of, and challenge to, colonial forms of knowledge, pedagogical strategies and research methodologies (McLaughlin & Whatman, 2008). Smith (1999) and Battiste (2000) highlighted that the decolonisation of knowledge in Western universities usually occurs in tension with traditional Western constructions of indigenous epistemologies and cultures.

3.11. Research ethics and protocols

In conducting indigenous research of this nature, the researcher had to consider local protocols that embrace moral and ethical conduct. Engaging in ethical research within the community setup concerns issues of benefits, promotions, representation and accountability. From the researcher's point of departure, the engagement in indigenous research within the communities was to represent the ideas and experience of the participants with outmost honesty without distorting their knowledge. Denzin et al. (2008) posited that indigenous research should honour indigenous knowledge, customs and rituals and not be judged in terms of neocolonial paradigms.

Mutua and Swadener (2004) and Bishop (2005) have reminded indigenous researchers that they are in the midst of a large-scale social movement of

anticolonialist discourse. Therefore, the challenges that raises fundamental philosophical, epistemological, political and pedagogical issues require a methodology of the heart, prophetic, feminist post pragmatism that embraces an ethics of truth grounded in love, care, hope and forgiveness (Pelias, 2004; Denzin et al., 2008). According to Smith (1999), the term *research* is linked to European imperialism and colonisation.

The study attempted to develop culturally accepted research practices that conform to what the smallholder farmers need (Figure 3.4). Denzin et al. (2008) emphasised the endorsement of a critical epistemology that contests motions of objectivity and neutrality. In the process of critiquing postcolonial theories, indigenous theories should as well be in line with them. According to Chilisa (2012), there are four dimensions in conducting indigenous research: 1) targeting the local phenomenon instead of using extant theory from the west; 2) creating local relevant constructs, methods and theories from local experiences and indigenous knowledge; 3) using integrative approach; and 4) considering the indigenous paradigm. In viewing indigenous research as a moral and political activity, the researcher has adopted interpretive and transformative paradigms.

Prior to conceptualising the problem in the study area, the focus embracing the community was represented as follows:



Figure 3.4: Cultural connectivity (adapted from Hornung, 2013)

The approach used prior to undertaking the study and sharing experience with community members was based on cultural connectivity. The way in which the research was done required a thorough check up and analysis of what occurred and what can be done differently (Hornung, 2013). The approach strengthens connection with the right people for research process. The study embraced different elements which the researcher considered important prior and after research undertaking. The interrelated elements such as consultation, engagement, sensitivity, integrity, reflection and approval within the traditional councils were considered. A description of each element is presented below:

Consultation – this entails consulting relevant people and structures within the community. Once the relevant people have been consulted, a series of meetings begins with the purpose of making a presentation on the purpose of the research.

Engagement – key people are identified at this level from the community to establish protocols.

Sensitivity – adherence to traditional protocols at this level is important to avoid saying and doing what is not supposed to be said and done. This is based on the understanding of cultural practices of the community (Hornung, 2013).

Integrity – the moral fabrics are very important at this level in asserting to cultural practices, values and beliefs of the community. Respect for local practices enhance chances of success of the research. Prior to and after the research has been conducted, integrity should at all costs be maintained.

Reflection – continuous evaluation during and after the research process is vital. Reflection will assist in planning and developing a strategy to establish effective structures which address the issues under study.

Approval – once the research has been completed, the researcher should seek for approval to declare research that has been successfully. Seeking approval from the relevant elders or key people within the community is important. The researcher therefore, is given a guarantee towards safety, cooperation, trust and collaboration.

Furthermore, postcolonial, critical race, relational, critical race-specific, Ubuntu principles, and anti-colonial discursive theories were considered in asserting to honesty and ethical conduct during the research process. Above all the paradigms and theories which were discussed, anti-colonial theory became an entry point in the field of indigenous research in resisting the demise of colonialism.

The anti-colonial approach was considered through indigenous lens in that there should be resistance to the dislocation of African ways of knowing by creating opportunities for participants to reflect on their knowledge, ethics and reality. The adoption of the anti-colonial framework relates to engaging such concepts as colonialism, oppression, colonial counter, decolonisation, power, agency and resistance, as well as claiming the authenticity of local voices and the intellectual

agency of people (Simmons & Dei, 2012). The anti-colonial discursive framework supports different ways of understanding the communities, the world and knowing. Hart et al. (2009) described anti-colonialism as it involves the recovery of traditional knowledge as a strategy that resists the replacement of indigenous ways and knowledge within western ways and knowledge processes endemic in colonialism.

3.12 The study setting and its characterization

The study was conducted throughout Lepelle Nkumpi Municipality, which is one of the local municipalities in Capricorn District Municipality (CDM) in Limpopo Province. The municipality is located 55km south of the district municipality and Polokwane city (24.2500° S, 29.6667° E) (Figure 3.1). The municipality is pre-dominantly rural, and covers an area of 3,454.78km². It is 20.4% of the district's total land area and is divided into 29 wards which comprise a total of 93 settlements (StatsSA, 2011).

As shown on Figure 3.5, Lepelle Nkumpi Municipality is the second largest in Capricorn District with 18% of the district population after Polokwane, which constitutes about 50% of the district's population. The municipality has 29 wards with an average size of 8000 people. According to Statistics S.A (2011), the population by age and gender accounts for a total of 125505 (54.48%) females and 104845 (45.52%) males while young people below 35 years old are at 69%.

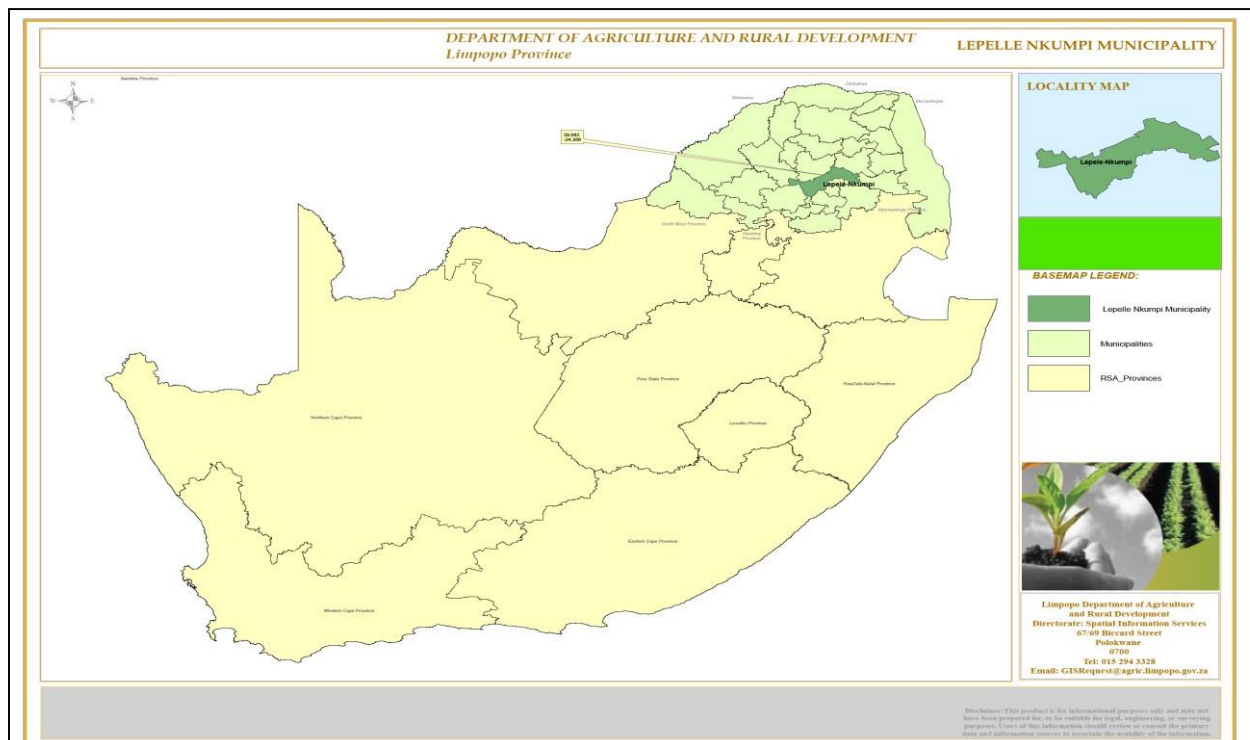


Figure 3.5: Map of South Africa showing the location of Lepelle Nkumpi Municipality in Limpopo Province (Source: Limpopo Department of Agriculture and Rural Development, 2017)

3.12.1 Population of Lepelle Nkumpi Municipality

The population of the study area is estimated to be 230 350, with a total of 59 682 households and an average household size of 3.9 (Stats SA, 2011). About 95% of its land falls under the jurisdiction of Traditional Authorities (StatsSA, 2011; IDP, 2013/14). These traditional authorities are Kekane, Seloane, Ledwaba, Mphahlele, Mathabatha and Mafefe. Social facilities available within the municipality include 116 primary schools, 81 secondary schools, 1 FET College, 19 primary health care clinics, one hospital, four police stations and one magisterial court. According to StatsSA (2011), the population of Lepelle Nkumpi Municipality has grown by 0.1%, second fastest after Polokwane during the last ten years after a sharp decline between 1996 and 2001 when its growth was slower than the rest in Capricorn District (Figure 3.6).

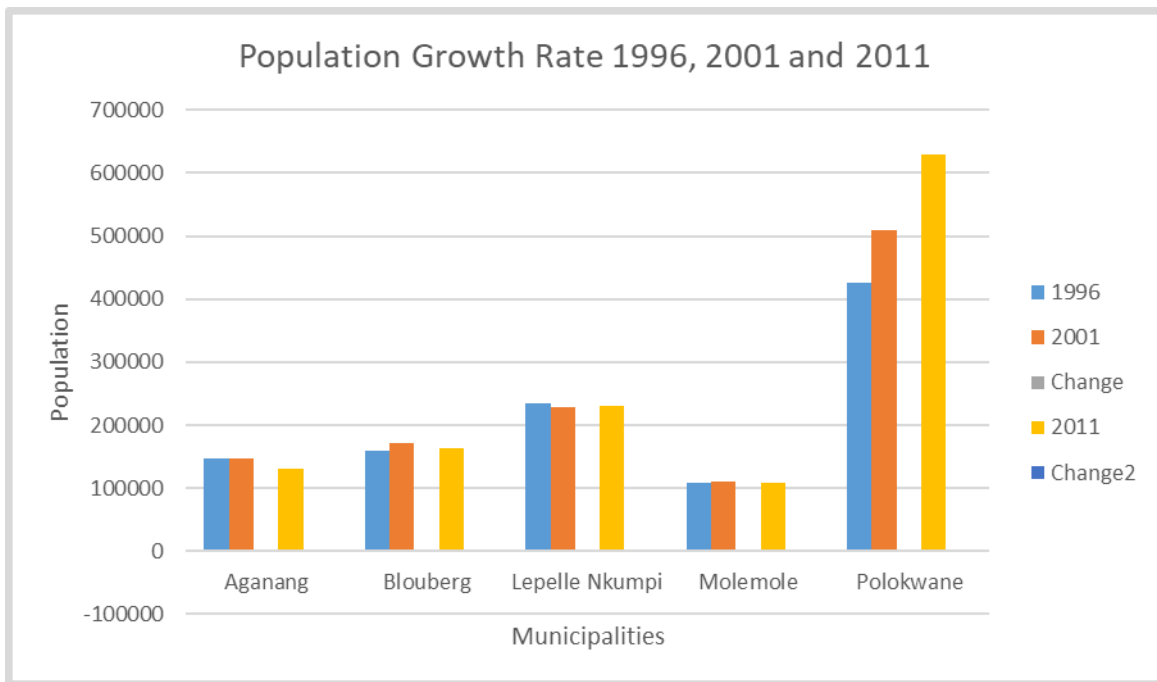


Figure 3.6: Population growth rate between 1996 and 2011 (Stats SA, 2011)

3.12.2 Climate of Lepelle Nkumpi Municipality

Lepelle Nkumpi Municipality receives summer rainfall, and the highest rainfall occurs in the south-eastern boundaries of the Municipality. The mean annual rainfall of the study area ranges from 332 to 1088 mm, the mean monthly minimum temperature from 13 °C to 15 °C in July and the mean monthly maximum temperature from 21 °C to 25 °C in January (Envirogis, 2009; Limpopo Department of Agriculture 2013) (Figure 3.4). Cold spells need to be defined in accordance with the prevailing climatic conditions in an area. According to Orlove et al. (2007), seasonal rainfall variability influences local knowledge, family well-being as well as agricultural production.

The higher rainfall and cooler temperate areas are limited to the higher lying mountainous areas, mostly non-arable due to the steepness of the terrain. However, the annual rainfall in the eastern part of the municipality reaches 1200 mm. Lepelle Nkumpi Municipality has a low and high gradient. The eastern part of the municipality has the higher slope while the western part is completely flat. The first rainy season runs from September to December, with an average of 638 mm within four months, while the second rainy season runs from January to April, with an average of 515 mm. The erratic and abrupt weather and climate variability affects farmers considerably as

they experience periods of flooding and dry spells resulting in crop failure (Stigter et al., 2005).

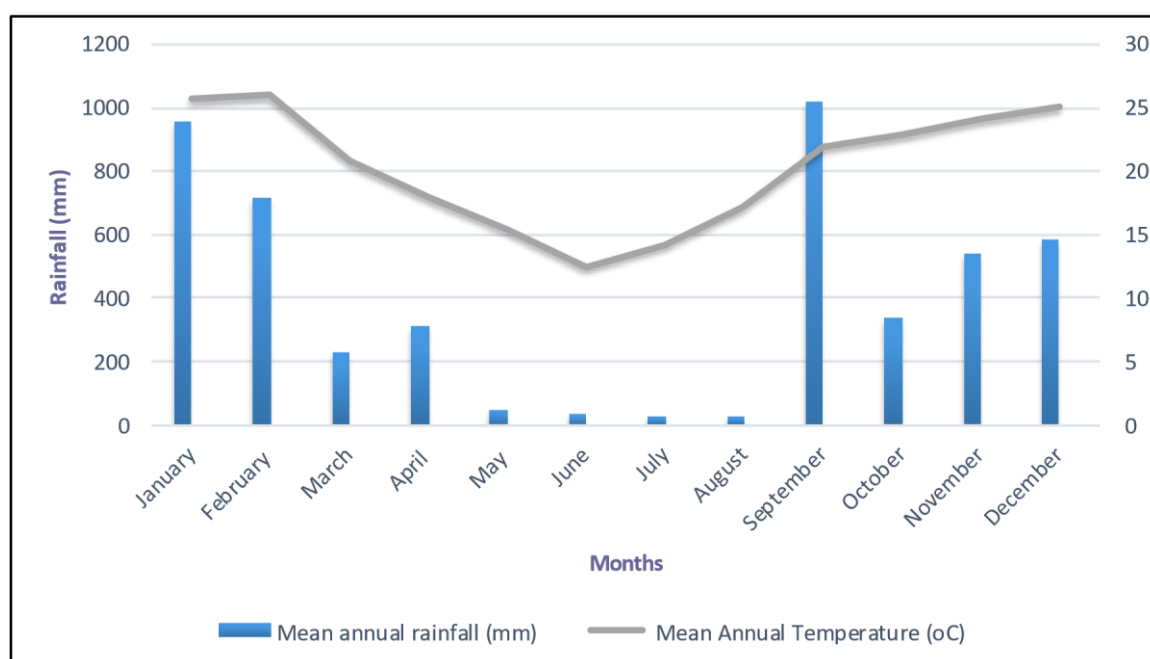


Figure 3.7: Long term mean rainfall and temperature patterns at Lebowakgomo weather station (altitude ~993 m), in Capricorn District of Limpopo Province recorded during 1997-2013. Source: Limpopo Department of Agriculture, 2013.

The growing season of the Lepelle Nkumpi Municipality starts in September and ends in February. The mean growing season days of Lepelle Nkumpi Municipality ranges from 111-123 days (Envirogis, 2009). The soils of the Lepelle Nkumpi Municipality are highly variable but cannot be considered to be a significant limitation for agricultural activities. However, the study area has a high percentage cover of shallower soils, making the soils more vulnerable to compaction, and prone to erosion (Limpopo Department of Agriculture, 2013). Climate and soils play a significant role in the production of crops, but soil quality can mean different things to different end-users.

3.12.3 Crop suitability in Lepelle Nkumpi Municipality

Under dry-land conditions, smallholder farmers decide on what to plant based on their experience. Irrigation becomes a necessity when growing exotic crops. Lack of water supply systems has forced most farmers to participate in dry land farming, 90 % of Lepelle Nkumpi farmers are producing dry land crops such as maize, sorghum and millet (Envirogis, 2009). The municipality is known for the production of maize, sorghum, millet, vegetables, and runner crops like watermelons, cow peas and dry beans. Sorghum and maize seeds are produced by farmers within the municipality. Vegetables perform very well under irrigation as most of them are exotic and depend on rainfall.

CHAPTER FOUR

THE NATURE AND TYPES OF INDIGENOUS WEATHER AND CLIMATE KNOWLEDGE FOR CROP PRODUCTION IN LEPELLE NKUMPI MUNICIPALITY OF LIMPOPO PROVINCE

4.1 Introduction

In this chapter, research approach, data collection, data analysis, results, discussions, conclusion and recommendations are presented. The transcripts from video recorder and data sets are presented to elicit how the responses of the participants were provided.

4.2 Study approach

Qualitative research approach was adopted in the study. The researcher believed that the most effective ways of grasping a phenomenon is to contextualise it. The use of qualitative approach in this chapter perpetuate ontological assumptions about the world. The researcher reflected on the relationships affecting individuals and communities through qualitative approach. According to Krauss (2005), qualitative researchers do not assume that there is a single unitary reality apart from our perceptions. This entails that reality exists in many different ways. Dobson (2002) further attested that critical realists agree that our knowledge of reality is a result of social conditioning and, thus, cannot be understood independently of the social actors involved in the knowledge derivation process. The implication is that researchers working from a realist perspective observe the empirical domain to discover by a mixture of theoretical reasoning and experimentation (Outhwaite, 1983).

The purpose of using qualitative approach had an influence on the theoretical part of the study towards the participatory research approach in deciding where to work (selecting sites), who to work with (who participate) and how to work with participants. The decisions depended fundamentally on what the researcher, in conjunction with farmers, is trying to achieve (Bellon, 2001).

In qualitative research, the researcher has to build on a complex, holistic picture, analyses words, reports details of participants and conduct the study in a natural setting (Khan, 2014). The approach itself dependent on the researcher's and participants' views of reality in the meaning-making process. How knowledge is acquired, depend upon the relationship between the researcher and how he perceives that reality (Craswell, 2007). From an ontological perspective, the nature of reality emerged. The interpretive approach seeks to place communities at the centre stage in knowledge creation. Therefore qualitative research is based upon the observation and interpretations of people's perceptions of different events, and allows the snapshot of the people's perceptions in a natural setting (Guba & Lincoln, 1994).

4.3 Target population

A population is the study of objects, and consists of individuals, groups, organisations, human products and events or the conditions to which they are exposed (Welman et al, 2005). The population of the study area was composed of elderly men and women who are deemed knowledgeable about weather and climate. The population of the study also consisted of smallholder farmers and knowledgeable traditional council members. The participants included in the study were from six traditional councils of the municipality approved by the *Kgoši* of Malatane, Moletlane, Ledwaba, Mathabatha, Mphahlele and Mafefe villages. The participants were purposively selected by the traditional leader (*Kgoši*) together with the council members because they are regarded as knowledgeable about indigenous farming systems and understand the local environment. The other reason for the selection of the participants from the traditional councils (*Meshate*) to participate in the study was that 1) they are regarded by others as those who can represent the community of Lepelle Nkumpi Municipality on indigenous weather and climate issues; and 2) they are elderly people who can reflect on some important historical events related to indigenous knowledge, weather and climate.

4.4 Sample size and sampling procedures

This section outlines the sampling procedure and sample size as determined by the traditional councils in each tribal council within the municipality.

4.4.1 Sampling procedure

A sampling is the process of selecting a small group of people from a group. Sample size depends on the type of research one is going to conduct whether it is quantitative or qualitative research (Neuman, 2011). According to Flick (1998), in positioning qualitative research sampling, the indication was that the sample size should be determined by its relevance to the research topic rather than their representativeness in the way in which the people to be studied are selected. Prior to the initiation of the study, the researcher communicated with six traditional council representatives/officers telephonically requesting to submit letters of intent to conduct research in their respective areas. The response from the chiefs (*Magoshi*) after submitting the letters was that, as one who respects local protocols, the researcher had to present the study to the traditional councils. Once the study has been presented to each traditional council, the *Magoshi* from the six traditional councils endorsed the requests and approved them (Annexure F).

During the interaction with the traditional councils, it was agreed that knowledgeable participants will form part of the research. In qualitative research, often preference is given to key informants who, on account of their position or experience, have more information than regular group members and /or are better able to participate and provide the required data (Welma et al., 2005). Purposive sampling was then used as a starting point because the participants who are insightful and knowledgeable and affiliated were selected by the *Kgoši* in consultation with traditional councils to participate in the research. This method of sampling is supported by Powers and Knapp (1990) and (Streubert & Carpenter, 2007), it involves the selective use of members of the community who have specialised knowledge that is not shared by the rest of the community. Furthermore, sampling as in the qualitative tradition is focused on the application of findings beyond the research sample (Elliot & Timulak, 2005). It was worth noting that in qualitative research, confidence intervals are not envisaged around the population.

4.4.2 Sample size

The desired sample size does not only depend on the size of the population, but also on that variance (heterogeneity) of the variable (Welman et al., 2005). The size of participants were determined by traditional councils who were allowed ample time to provide elders whom the traditional leaders (*Magoshi*) deemed necessary to participate in the study prior to the interviews, and regarded as knowledgeable participants who would represent the councils and be able to interact with the researcher (Table 4.1). The participants from the traditional councils were selected to participate in the interview process after signing a non-disclosure form (Annexure E).

Table 4.1: Participants from traditional councils

Traditional council	Males	Females	Total
1. Batau-Baseloane	5	8	13
2. Kekana	4	1	5
3. Ledwaba	9	5	14
4. Mafefe	9	0	9
5. Mathabatha	6	4	10
6. Mphahlele	7	13	20
Total participants	40	31	71

4.5 Data collection strategy and methods

Prior to the interviews and video recordings, the participants were informed about the study in detail, and were assured about their rights, anonymity and confidentiality. This was done to allow flexibility and honesty during the interview process. The interviews were conducted in community halls and tribal offices, free from distraction. A rapport was established with the participants during tribal council meetings when the study was presented. According to Gill et al. (2008), the establishment of rapport with the participants prior to the interviews is important as this can have a positive effect on the subsequent development of the interview.

4.5.1 Interview guide

The interview guide was used in managing data with analysis in mind. Video recording was led to an amount of rich video data. The interview schedule used during the interview had questions designed in such a manner that it yielded as much information as possible, and addressed the aims and objectives of the study (Annexure D). Open-ended questions without yes or no were used (Gill et al, 2008). From the interview guide, six themes were considered to address the objectives of the study. The themes from the interview guide were identified as follows:

- Western weather and climate information systems
- Indigenous weather forecasting information
- Prediction of seasonal rainfall
- Decision-making in crop production
- Indigenous indicators of weather and past extreme climate events □ Climate change issues

Since an interview guide was one of the tools used during the interactive process, it allowed the environment to be natural and the process to be productive. All the participants were seated and a prayer prior to the interviews was rendered by one of the participants. After the prayer, greetings from the researcher followed and bottled water was distributed among the participants to ease their participation. The approach assisted the researcher in facilitating and coordinating the research activities successfully.

4.5.2 Video recorder

Video is increasingly a significant resource for many contemporary social researchers (Jewitt, 2012). Video recorder is a data collection tool of choice by researcher. Since the study focused on social interaction, it was vital to use the video recorder as a data collection tool. According to Hindmarsh (2010), researchers have used the video for many years. However, video elicitation was considered in the study as it stimulates recall or provides the basis for reflection (Roth, 2009). According to Jewitt (2012), there is no universal right amount of video data to collect; rather the amount of video data

required needs to be determined by the research approach, aim, the questions of the study and the pragmatic questions of time and resource. The use of video recordings during the study was based on the premise that they (video recordings) give greater flexibility than observations (Smith, 1981). Furthermore, Edwards and Westgate (1987) regarded video recording as important in allowing retrospective analysis.

The role of the researcher was to moderate and facilitate the discussions where the participants' experiences and beliefs are responded to positively and with due respect. The discussions were facilitated to ensure that all participants have the opportunity to contribute, and where possible, to allow or encourage reticent participants (Bloor et al, 2001). Jewitt (2012) uttered that the ability of a video to fix something in its time and place can, and often does, have an interesting effect in that it can re-awaken the memories and experiences of a researcher or participants. Moreover, Snell (2011) saw the "sensory overload" of video data as a significant methodological issue in video-based research, including data management, coding and sampling. She further remarked that the benefits of pairing systems qualitative analysis with micro-ethnographic qualitative analysis in order to probe the patterns identified in quantitative results and to anchor and enhance the generalisability of micro ethnographic findings is not a viable theoretical approach for everyone.

A camera man was introduced to the participants before recordings. During the recording, the video recorder captured all participants and viewed the participants who were talking in all respects. During the whole research process, Sepedi was used as a means of communication. The interviews conducted lasted from 1 hour to 1h60 minutes in all areas. An interview short break was provided once topics to be addressed were covered and no further answers or contributions provided. Short breaks were considered for the first four key points on the interview guide to be covered. Once they were completed and no more information is forthcoming, the interviews were declared complete and the participants were thanked for their time well spent with the researcher.

4.6 Kgoro method

A kgoro method was considered in the study as an indigenous entry point to the communities in order to understand their worldviews and cosmic views. The aforementioned requirements gave the researcher the opportunity to explore and interact with the participants using an entry point of ***kgoro method*** (Figure 4.1) to understand the participants' expectations and experiences pertaining to indigenous weather and climate. A researcher-participants relationship was established with traditional councils using the kgoro method. Views, beliefs and experiences based on relational approach emerged and shared with community members.



Figure 4.1: Participants from six traditional councils in Lepelle Nkumpi municipality

The kgoro method has been considered for many years in rural areas as an advisory structure of kgoši (Seloane, 2015 personal comm.). Kgoro played a significant role in generating consensus for proposed actions since it was the place where all matters affecting the community are discussed (Dipholo & Mothusi, 2005). According to Seloane (2015 personal comm.), the kgoro method in development planning and management ensured community commitment and ownership of the development

process. Kgoro embraces the place where policy formulations, decision-making, political and economic development activities and justice system occur. Epistemologically, kgoro relates to the indigenous ways of knowing which derived from teachings by elders disseminated from generation to generation. The teachings emanate through use of indigenous languages and experiences. Within the kgoro principles, the knowledge is revealed and belongs to the group; it can be used, shared but not owned (Seloane, 2015 personal comm.) and (Ledwaba. 2015 personal comm.). Therefore, the researcher considered kgoro as an entry point in the study.

The kgoro method worked well for the researcher from the initial stages of arranging meetings to data collection. It was through the kgoro method that the study begun with the development of theory as grounded within knowledgeable participants. Furthermore, the kgoro method assisted the researcher by providing a conducive environment for all participants to adhere to timeframes at the traditional council halls and offices.

4.7 Data analysis methods

In this section, thematic analysis is outlined by explaining how it was used to reflect on the voices and experiences of the participants.

4.7.1 Thematic analysis

Data analysis in qualitative research does not have a null-hypothesis as an entry point to data collection (Albertse, 2007). According to Albertse (2007), data in qualitative research speaks for itself to enhance one's understanding, interpretation and extrapolation. However, as mentioned earlier, data collection and analysis go hand in hand. The data analysis relied on the ideas (Interpretive framework) that the researcher brings to the data and in the way in which the researcher looks at the data (Vlaederen, 2003). Since the interpretive framework was adopted in the study, data was interpreted from the viewpoint of the participants who provided the data and established their intentions.

Data analysis was based on an interpretative philosophy that voices of participants are real within their terms and frameworks. According to Vlaederen (2003), qualitative data analysis consists of a process of data reduction, thematising and reintegration of the data into a coherent conceptual interpretation. Thematising means level of responses within a data. Sandelowski and Barroso (2003) define a theme as a more implicit and abstract level which requires interpretation. Krauss (2005) pronounced that a theme is the main product of data analysis that yields practical results in the field of study, while Ryan and Bernard (2003) regarded a theme as an attribute, descriptor, element and concept. A theme is further described as “umbrella” constructs which are usually identified by the researcher before, after and during data collection (Welman et al., 2005).

From an interview guide, six themes were used throughout the research process, and recorded videos (V1 to V6) were analysed (Table 4.2). Table 4.2 shows how the themes were analysed. The keywords and their meanings were considered important in data analysis. Elicitation of the essence of participants’ experience provide a meaning (Morse, 2007). Braun and Clarke (2006) regarded thematic analysis as a flexible method for identifying, analysing and reporting patterns within data. Guest and MacQueen (2012) argued that thematic analysis goes beyond simply counting words in a text but identifies explicit and implicit ideas within the data. The use of thematic analysis in the study was to have meanings from the data and to subscribe to the implicit theoretical commitments (Braun & Clarke, 2006). Therefore, an iterative process was observed through thematic analysis.

The interactive nature of participants during the interviews were taken into consideration. The data from the video recorder was transcribed verbatim by the researcher on the basis of the theoretical underpinnings of the research approach of the study and the first-hand knowledge due to the researcher’s involvement in the interview process and participation in verbal and non-verbal interactions with the participants. Verbatim transcription refers to the word for word reproduction of verbal data, where written words are an exact replication of the audio recorded words (Poland, 1995). The process considered during data analysis was based on iteration.

An iterative process is a recursive, repetitive process where issues are repeatedly evaluated (Figure 4.2).

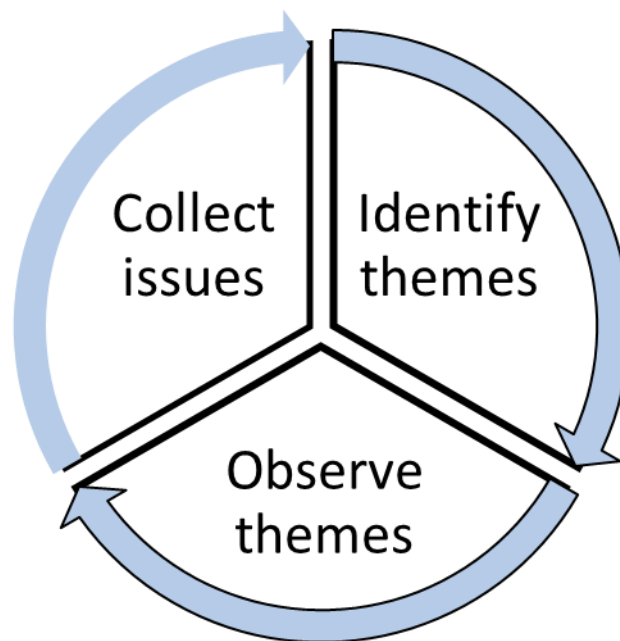


Figure 4.2: Iterative process in thematic analysis

According to Krauss (2005), the ability of qualitative data analysis to generate meaning makes it a unique and powerful epistemological tool for understanding even seemingly mundane experiences. Issues do not emerge on their own and do so as a result of what the researcher wants to know and how data is interpreted. Data from the six traditional councils were analysed as follows:

4.7.2 Video transcription

In this section, the transcripts and data sets are presented to elicit how the responses of the participants were provided. The participants in each traditional councils are presented. However, the transcripts were summarised from Sepedi to English. The recorded video was viewed several times in order to understand the content and to be familiar with the data. During the viewing of the videos from each tribal council, analytical notes were written on different aspects of the data (Figure 4.3). The whole data sets were read to get a picture of the phenomenon being studied. The data was repeatedly read in search of patterns. A description was made on how events were

interpreted from the participants' viewpoint. The analysis consisted of themes and code developments.

A word by word analysis which involves close examination was done in preparation of open coding. According to Strauss and Cobin (1990), the researcher might code by sentence or paragraph and decide which name to give the code. This entails categorising words or sentences which are related or have similar meanings and attaching a code to them. In simpler terms, coding entails the line-to-line assessment of participants' words. It was logical for the researcher to transcribe own interview data because he had first-hand knowledge from his involvement in the interview process, and his participation in both verbal and non-verbal exchanges with the participants (Holcomb & Davidson, 2006).

During the open-coding process, constant comparative analysis was conducted to capture what transpired during the interviews using words of the participants. The speakers were identified by giving them numbers in order to follow each individual contribution. The extent and ways in which researchers code their video data varies considerably (Jewitt, 2012). Open coding pertains to the naming and interpreting of a phenomenon through close examination of the data. Charmaz (1983) has expressed similar ideas that codes serve to summarise, synthesise and sort many observations made from the data. The data from each traditional council was highlighted in different colours to identify similarities and differences. Afterwards, axial coding was considered to relate concepts to each other, whereby irrelevant data was discarded. Welman et al. (2005) remarked that the researcher should identify: a) indigenous categories and keywords; b) comparisons and contrasts; and c) search for missing words.



Figure 4.3: Recorded video clips where the researcher is interacting with participants.

TABLE 4.2: Analysis of video transcriptions from six traditional councils

Themes	V1	V2	V3	V4	V5	V6
1. Western weather and information systems						
1.1 Frequency	Once a week	Weekly	Daily	Daily	Daily	Daily
1.2 Comprehension of information	Not understandable	<i>Important to those who understand</i>	Important to those who understand it	Important for farming	Not understandable due to English language	Important for farming
1.3 Meanings	Not understand percentages	To some people, not all	Not clear	No meaning of percentages	Not local specific	No meaning of degrees Celsius
1.4 Sources	Radio	Radio and TV	Radio and TV	Radio and TV	Radio and TV	Agriculture offices and TV
1.5 Usage	Not useful	To those who understand it	Not useful	Guide tourists	Not useful	Farming
2. Indigenous weather and climate forecasting information						
2.1 Importance	Very important	Very important	Important	Important	Important	Important
2.2 Usage	Farming practice	Farming practice	Farming practice	Farming practice	Farming practice	Farming practice

2.3 Source of information	Observations and own experience	Observations and own experience	Observations and own experience	Observations and own experience	Observations and own experience	Observations and own experience
2.4 Provider of information	Own and grandparents	Own and grandparents	Own and grandparents	Own and grandparents	Own and grandparents	Own and grandparents

3. Prediction of seasonal rainfall

3.1 Rainy season	Guidance by dingaka	Guidance by dingaka	Guidance by dingaka	Guidance by dingaka	Guidance by dingaka	Guidance by dingaka
3.2 Indicators/Tools	Birds, insects, trees, reptiles, moon shapes, stars and wind direction	Birds, insects, trees, reptiles, moon shapes, stars and wind direction	Birds, insects, trees, reptiles, moon shapes, stars and wind direction	Birds, insects, trees, reptiles, moon shapes, stars and wind direction	Birds, insects, trees, reptiles, moon shapes, stars and wind direction	Birds, insects, trees, reptiles, moon shapes, stars and wind direction
3.3 Seasonality	Summer	Summer	Summer	Summer	Summer	Summer

4. Decision-making on crop production

4.1 Weather source	Observation, divination and wisdom	Observations, divination and wisdom	Observations, divination and wisdom	Observations, divination and wisdom	Observations, divination and wisdom	Observations, divination and wisdom
4.2 Crop selection	Drought tolerant	Drought tolerant	Drought tolerant	Drought tolerant	Drought tolerant	Drought tolerant
4.3 Production	Sorghum and millet	Sorghum and millet	Sorghum and millet	Millet. Maize and sorghum	Vegetables, sorghum, cowpeas	Sorghum and millet

5. Indigenous weather indicators and past extreme climatic events						
5.1 Indicators used	Birds, insects, trees, reptiles,	Birds, insects, trees, reptiles, moon	Birds, insects, trees, reptiles, moon shapes,	Birds, insects, trees, reptiles, moon shapes,	Birds, insects, trees, reptiles, moon shapes,	Birds, insects, trees, reptiles, moon shapes,
	moon shapes, stars and wind direction	shapes, stars and wind direction	stars and wind direction	stars and wind direction	stars and wind direction	stars and wind direction
5.2 Description	Appearance of birds, moon shapes, Flowering of certain trees, abundance of fruits on certain tree species, appearance of stars within a particular area, wind direction from north-westerly to south, appearance of insects	Appearance of birds, moon shapes, Flowering of certain trees, abundance of fruits on certain tree species, appearance of stars within a particular area, wind direction from north-westerly to south, appearance of insects	Appearance of birds, moon shapes, flowering of certain trees, abundance of fruits on certain tree species, appearance of stars within a particular area, wind direction from north-westerly to south, appearance of insects	Appearance of birds, moon shapes, Flowering of certain trees, abundance of fruits on certain tree species, appearance of stars within a particular area, wind direction from north-westerly to south, appearance of insects	Appearance of birds, moon shapes, Flowering of certain trees, abundance of fruits on certain tree species, appearance of stars within a particular area, wind direction from north-westerly to south, appearance of insects	Appearance of birds, moon shapes, Flowering of certain trees, abundance of fruits on certain tree species, appearance of stars within a particular area, wind direction from north-westerly to south, appearance of insects
5.3 Timeline of events	1953, 1976	1990, 1997, 1982	1976, 2000, 2015	1967	1956, 1976, 1986, 1990, 1996, 1998	1945, 1947, 1950, 1948, 1949, 1950, 1951, 1956, 1980, 1996

5.4 Mitigation strategies	Selected tolerant crops	Selected tolerant crops	Selected tolerant crops	Selected tolerant crops	Selected tolerant crops	Selected tolerant crops
6. Climate change						
6.1 Changes experienced	Polluted land with nappies contribute to low rainfall	Increased cars and industries emissions, cutting of trees, low rainfall, strong winds	Increased veld fires, mining, seasonal, land pollution	Increased cars emissions, high temperatures due to mining, late rainfall and unexpected strong winds	People are lazy, uneven rainfall and temperatures	Mining causes changes in temperature and rainfall – air pollution
6.2 Length	Seasonal	Seasonal	Seasonal	Seasonal	Seasonal	Seasonal
6.3 Impact	low rainfall and crop production	low rainfall and crop production	low rainfall and crop production	low rainfall and crop production	low rainfall and crop production	low rainfall and crop production
6.4 Strategies of adaption	Select tolerant crops	Select tolerant crops	Select tolerant crops	Select tolerant crops	Select tolerant crops	Select tolerant crops

Source: Video clips 2015

4.8 Ethical considerations

In undertaking this research, the code of research ethics of the North-West University Health Science Ethics Committee (FAST), Ethics number NWU-00492-15A9 was considered (Appendix B). Before visiting any village for the surveys, permission to conduct the study was acquired from the local traditional councils and relevant community leadership structures in Lepelle Nkumpi Municipality, and were contacted for prior informed consent. The participants were briefed in Sepedi on the aims and possible outcomes and benefits of the research. Prior to the interview, a non-disclosure agreement was signed by the participants, representatives from traditional councils and the researcher (D). Permission to use the video was also verbally sought from each tribal council. During the research process, participants were informed about their right to anonymity and confidentiality. Anonymity was achieved by not putting the names of participants during transcription.

Permission to conduct the study was obtained from six traditional councils of Lepelle Nkumpi Municipality after consultative meetings were held with the traditional councils. Participants have the rights to choose to participate or not in the research. They were independently allowed to act in providing their informed consent to be part of the study. Before any consent is given, the purpose of the study was fully presented to them in Sepedi. They were made aware that their participation was voluntary and that they were free to withdraw if a need arose. Verbal consent was given since many participants were elders and unable to read and write. The researcher developed a relationship with the participants as explained earlier in chapter 2.

4.9. Validity and reliability of the study

Since qualitative research is based on subjective, interpretive data and is limited to the experiences of the participants, individual participants are therefore deemed factual and truthful from the research's point of view. Lincoln and Guba (1985) posit that conventional trustworthiness criteria such as validity and reliability are incompatible with the axioms and procedures of qualitative research. From a phenomenological perspective, it is appropriate to indicate that people's perspectives constitute reality rather than the things that they perceive; therefore, differing perspectives are used as evidence by which to judge research (Porter, 2007).

The researcher captured what the participants said, and thus an accurate account of transcriptions. Validity and trustworthiness has been achieved since the research process was consistent with the ethical principles of six traditional councils of Lepelle Nkumpi Municipality. From a relational theory, the researcher created a healthy working relation with the participants and chiefs (*Magoshi*) in the municipality. Furthermore, a workshop for validating the data was conducted four months later after the interviews with selected participants. Since the study wanted to advance the rural communities and promote ethical research, a forum on indigenous weather and climate was formed or established in order to address weather and climate issues for the traditional leaderships within the municipality.

4.10 Results

In this section, six traditional councils from the Lepelle Nkumpi Municipality are presented. The results from the interview guide are also presented, covering western weather and climate knowledge, indigenous weather and climate knowledge, indigenous weather indicators and past events and, lastly changes in weather and climate. The video recordings as guided by the interview guide as transcribed are also presented for each tribal council visited and interviewed. Since data collection and analysis is grounded and occur simultaneously, full transcription of BatauBaseloane, Mathabatha, Ledwaba, Mphahlele, Mafefe and Zebediela traditional councils are also presented. The key concepts which emerged throughout the interviews were identified and coded as follows: *Dingaka*, *Nonyane*, *Ngwedi*, *Dinaledi*, *Mehlare*, *Dikhunkhwane*, *Makeke*, *Moya*, *Digagabi* and *Ditiragalo*. The concepts were grouped based on astronomical and biological indicators. The process of identification and generation of themes was followed until the emergence of concepts significant to facts of data representation.

Each concept was therefore presented and described in detail. The emergence of the themes were noticed in each traditional council. Their occurrences were identical but how often they appeared is not important since the participants were supporting each other during the validation workshop which is reported in chapter 8.

4.10.1 Western weather and climate prediction information

Out of 71 participants from the traditional councils, only 30 participants actively participated and provided the required information as perceived real and truthful. In each traditional council, 5 participants had in-depth discussions and participated actively in addressing questions posed to them. The active participation of individual persons as recommended by the *Kgoši* (chief) enabled the interview process to run smoothly and progressively. The participants provided information, beliefs and shared experiences during the interviews on many occasions, while others were listening. It was revealed during the study that western weather and climate prediction is not considered in planning for production of crops in the area. The participants indicated that the use of western knowledge systems in farming and in predicting the weather has not yielded positive results.

From the six focus group discussions, concerns were raised in that the weather information supplied through radio and television is not always sufficient to guide them to select crops and to plan for ploughing and planting. The groups indicated that they do not understand the figures as presented in percentages, and their meaning thereof. However, some relate to the information which guide people to wear warm clothes, but not guiding them on crop production planning.

The other issue raised was that the local agricultural advisors are unable to interpret the information as provided by the South African Weather Services (SAWS) through Limpopo Department of Agriculture and Rural Development. Moreover, the information provided by SAWS was sometimes believed and mostly not relied upon. Failure to interpret meteorological forecasts compels these participants to consider their indigenous weather and climate forecasts. What emerged from the study pertaining to western weather predictions is presented in Table 4.3, and is supported by transcripts in Sepedi language from one of the traditional councils (Figure 4.3).

Table 4.3: Information on western weather prediction

Nature of knowledge	Type of knowledge
- The knowledge reflected here is codified, recorded, captured and communicated to communities through mass media e.g. radios, TVs etc. - The information is based on the macro, than the micro level, where communities manage their environment. - The seasonal forecast is model-based	Explicit knowledge prevails



Figure 4.4: Participants from Batau Baseloane Tribal council Transcripts:

Monyakišiši: *Pele re ka thoma go nyaka gore re hlalošetšane ditaba: Re: Sa mathomo ke rata go le tamiša Ditau. Lenaneo la rena le amana kudu le ta leratadima. Pele ke thoma dipolelo ke kgopela go shomiša setšea diswantšho le mantšu. Dinyakišišo tša rena di e thekgile kudu mo tabeng ya gore pula ga e sana.*

Monyakišiši: *Naa molaetša wo o tšwelelagomo TV ora go reng mo go lena? Gona le Kwišiša bjang? O a le thuša mo temong?*

Motšearolo 1: *Ehh... nkano e arabela gore re ya e hwetša mara ga re e hwetše enoba gore e tla no ba matlakadibe. Re e hwetša mo seya le moya.*

Motšearolo 2: *Re e hwetša Magoro, le ge ele gore gare e kwišiše ka baka la gore tša kakanyo ya tša boso mola thelebišeneng k age ke ekwa o bolela. Šidile tšona mola ba di bontšha ka diperesente t ša gore Polokwane bosasa bare maru a tla pharaphara kaekae- kolokotela, diperesente tša gona ba di bolediša le ge re sa di kwišiše.*

Monyakišiši: *Taba ye ya diperesente le a e kwišiša?*

*** Ka moka-** *Ga gona le motho o a e kwišišago.*

Motšearolo 2: *Ebile gare e šomiše, le go e latela gare e latele.*

Motšearolo 3. *Etlo ba gore ba badile re tlano bona ge pula e ena. Ge bare go a tonya o tla no bona re apere dijase gore era go reng aowa.*

4.10.2 Indigenous weather and climate prediction information

It was revealed during the study that indigenous weather and climate forecast is highly considered in planning for the production of crops in the area. The participants indicated that the use of their knowledge systems in farming and in predicting the weather has been practised on a daily basis. The study found that knowledge about weather and climate in the area has been accumulated through generations. Most of the participants were pensioners and resided in the municipality for more than 45 years, and their knowledge of indigenous ways of knowing is intensive.

Based on the fact that the participants were coming from the traditional councils, their knowledge about weather and climate was immense. This means that the information provided was reliable and authentic as it is presented by individuals. The discussions with the groups further revealed that rain-making rituals were conducted by traditional councils themselves. The probing questions then focused on the prediction of seasonal rainfall.

Table 4.4: Prediction of seasonal rainfall

Prediction	Method	Decision-making	Probing
Observations and experimenting	<i>Dingaka/traditional doctors, trees, plants, birds, insects, reptiles, moon, stars, wind</i>	Dry spell: rituals, less visibility of animal species, less flowering, abundance of fruits, positioning of stars and moon, wind direction, select sorghum and millet Wet spell: rituals, abundance of birds, flowers, required stars and moon positions, emerging of species, select maize	Different types of rainfall that brings relief to crop production or bring disaster to crop production

Source: FDGs Interviews, 2015



Figure 4.5: Participants from Ledwaba traditional council

Transcripts:

Kgošigadi: Thobela: ke kgopela gore ba bolele setebele. Ke matebele batho ba.

Monyakišiši: Ke ya kwišiša gore lenyaka go tšwetša setebele pele, empa ke tlo palelwa ke go botšiša go tšwela pele. Ge re kwana gare tšweleng pele. Gare boleleng ka segabo rena.

Motšeakarolo 2: *Eh....ke tlano thoma ka gore rena ka mokgo be re gola ka gona, be go bitšwa bakgalabje ba dule fase le bakgoma ba bagolo. Go tlo bitšwa dingaka ba tšholle ditaola. Ge batho ba bolela nnete kamoka, go tlo noba ba ba bedi bao batlago bolela yeo e bego taba. Batlore e gona pula empa gore pula etle, a go namilwe thaba go ye go nyakwa phoofolo, ene bae hwetše phoofolo yeo. Ba a tseba bakgalabe gore batlo šhoma bjang bona. Ba bitša masogana gore bayo kgaya naga. Ge naga e kgailwe pula e tloa.*

Motšeakarolo 5: Be ba šheba gore naledi e dutše bjang. Ba šheba naledi le ngwedi.

4.10.3 Decision-making on crop production

The study has revealed that farming communities base their decisions on local knowhow and years of experience accumulated from their grandparents. It was indicated that through the guidance of Traditional Health Practitioners (*Dingaka*), they are able to consider the weather predicted and own experience through indicators as indicated earlier. Once information on the beginning of the season is declared by the Kgoši, then the decisions are made based on the type of crop to be planted. During the discussions with the participants, it was mentioned that sorghum, which is known as *mohlukahlong*, is considered to be the best variety which can tolerate drought and diseases. Not only sorghum, *leotša* (millet) was mentioned as one of the important stable food crop. Sorghum and millet were also considered for planting during dry spells while *lehea* (maize) was considered under wet spells where moisture content becomes necessary for planting and germination.

Indigenous vegetables such as *dinawa* (cowpea), *ditloo* (Bambara groundnuts) and *leroto* (Cleome), were said to be intercropped with the staples and considered important in their farming practices. However, the planting of crops, according to the participants, was done prior to the arrival of first rains. According to the participants, seeds were sown in the soil and germinated when first rains fell. The decisions to select the crops and to plant them were said to be guided by the decisions taken during rain-making rituals. Furthermore, indicators as in Table 4.5 assisted the communities to know and understand their environment better. The participants have also indicated that rain-making rituals begin on the ninth month of the year being *Lewedi*

(September). The expected rains as indicated begin from *Lewedi* to *Phato* (September to February) (Table 4.6).

Table 4.5: Decision-making on crop production

Information source	Crop selection	Decision	Provision	Probing
Local experience and	<i>Drought tolerant crops such as sorghum and millet</i>	Indigenous weather indicators	Sharing of information through knowledge generations	Observation and experience
Traditional Doctors	<i>Cowpeas and Bambara groundnuts</i>		Understanding months in local names and their meaning	

Source: FDGs Interviews, 2015

4.10.4 Indigenous weather indicators and past extreme events

The study has revealed that rain rituals are considered important before any community member can begin the ploughing and planting process. A consultative process by the chiefs and traditional council members request the services of Traditional Health Practitioners for divination. Other than rituals, indigenous weather indicators and past extreme weather events were listed (Tables 4.7 to 4.19). During the interviews in all traditional councils, it was revealed that Lepelle Nkumpi Municipality has experienced extreme weather and climate events between 1945 and 2011. During the discussions, the participants provided their timeline of events as recalled, and was drawn from the participants in six traditional councils. Whoever mentioned the year of events one would remember and as supported by others, gave rise to the development of the weather and climate timeline. The events ranged from good rains, floods, drought, hunger and loss of lives. The events are summarised in Table 4.17.



Figure 4.6: Mathabatha traditional council

Transcripts:

Monyakišiši: Naa setšo se sa gabolena se bohlokwa?

Motšearolo 2: *Ee. Se bohlokwa. Thaba yela o e bonago ke ya ga Mpobane. Ge re nyaka pula re e kgopela fale (o šupa thaba ya gona). Mo ga Mathabatha ge o ka bona thaba yela e rwere mmuane, o tsebe gore pula ea goroga.*

Motšearolo 3: *Ee.. yona e fela e kgona go bonala, e fela ere mola e rwele mmuane ya thoma go ngala. Mara ke tshepa ke ka tšeo di diregago. Ge e dira bjalo go bitšwa bao ba kgonago go lebelela pula. Ba kgalema dikhutlo ba upa dira. Ge re hlalefa be gona le dingaka tša ka mošhate. Mangaka a šupa dikhutlo gore sefako setle gabotse.*

Monyakišiši: Naa dika tsa setho ka pula ke dife? Mabapi le mokhorro le tlala?

Motšearolo 3: *Dika tša mokhorro ke sefako, sefako se laetša mokhorro. Mehuta ya dipula ke letsota, mamohlake, modupi wa borake (bosobela).*

Motšearolo 4: *Ye nngwe ke ngwedi. Ea ageletša gomme ge e tšholla e tšholla meetse.*

Motšearolo 5: *E kgona le go tšholla malwetši. Maemo a kgwedi a laetša ngwaga wa kgoro.*

4.10.4.1 Dingaka (Traditional Health Practitioners)

The participants indicated that prior to ploughing or selecting the crop to be grown in a particular season, firstly the Traditional leader (*Kgoši*) will call upon all Traditional Health Practitioners (*Dingaka*) within his jurisdiction to come and throw bones (*Ditaola*), diagnose and interpret them and provide answers to whether rain is coming or not. Furthermore, the Traditional Health Practitioners are expected to indicate the type of rainfall and wind if any. Where thunderstorm is predicted, the chief will assign those Traditional Health Practitioners who know how to block the wind to do so. From all the discussions in the kgoros, the participants shared their insight on the initiation of rain.

The participants included women and men who indicated that prior to the beginning of the season, Traditional Health Practitioners (*Dingaka*) are called to foretell how the season will look like. Each traditional Health Practitioner called had to throw bones (*Ditaola*) to know how the season will be. All the participants from the six traditional councils sighted the importance of using Traditional Health Practitioners in rainfall predictions as an important matter at the beginning of the rainy season. From the revelations of bone throwing (*Ditaola*), the chief will declare a bad or good season. After all Traditional Doctors have done so, the chief declares the season open, and farmers start with the ploughing plan. What has also been mentioned is that the ploughing process starts with the chiefs' land and not with the farmers' land. However, except the call of traditional health practitioners, other signs or indicators of good or bad season were mentioned. Table 4.6 reflects on the emergence of nature and the type of knowledge acquired.

Table 4.6: Nature of knowledge from *Dingaka*

Nature of knowledge	Type of knowledge
The rain rituals as articulated are held before agricultural activities can take place. The knowhow is expressed in cultural values, beliefs, local language and through experience and observations rooted in knowing and reaction. The know-how is related to intangible heritage which includes ritual, language, culture, songs, dance and practices pertaining to nature. The seasonal weather prediction is ritual-based.	Tacit and encultured knowledge prevails. The encultured knowledge prevails within the <i>kgoros</i> as the theme is based on the rain rituals.

4.10.5 Indigenous weather indicators and past extreme events

Despite consulting Traditional Health Practitioners, astronomical indicators such as the moon, stars and the wind were identified as very important to the participants (Table 4.7). Based on the indicators, a conclusive statement cannot be made on one indicator in determining or predicting rainfall. The decision on possible rainfall in a particular area is guided by a number of indicators, not on rainfall only but also on crop choice. A short description of each indicator and the nature of knowledge reflected by the participants are presented as follows:

Table 4.7: Astronomical weather indicators

Indicator	Indication	Description
Moon (<i>ngwedi</i>)	Ngwedi wa go ageletša (crescent shape facing upwards)	It shows the possibilities of drought or no rain at all
	Ngwedi wa go tšholla (waning crescent shape)	It shows the possibility of rainfall and diseases when it appears in a particular month
Stars (<i>dinaledi</i>)	Naka – bright star	It appears mostly at the beginning of winter (25 May). It brings coldness and burns trees
	Magakala – appears in the north east and very bright	Its appearance brings very cold spells
	Mahlapolane – accompanies the moon in the Northwesterly side and shiny	Induces onset of rains
	Dithutlwa – clustered on the southern part	Rainy season will begin
	Kgogamašhego – appears through the night	Monitor the nights
Wind (<i>moya</i>)	Moya (Wind direction)	When it blows from north -easterly to south-westerly, it will bring rainfall, the reverse is that it will stop it.

4.10.5.1 Ngwedi (moon)

The special key indicator is said to be the moon. The participants indicated that it is important to read the emergence of the moon every month. The moon shapes are regarded as important. When the moon crescent faces sideways, it signals the release of water or disease, and when facing upwards, it indicates the upholding of water. During interviews, it was indicated that the emergence of the moon every month plays a role in the lives of the community.

Table 4.8: Nature of knowledge through the moon

Nature of knowledge	Type of knowledge
• The observation of the moon crescent becomes vital in crop decision-making process. The knowhow on directions and shapes. • The knowledge reflected here is based on observing the direction of the moon crescent. • The seasonal weather prediction is astronomically-based	Tacit knowledge prevails.

4.10.5.2 *Dinaledi* (stars)

The appearance of stars is said to be used in Lepelle Nkumpi to understand the season well. The participants indicated that when *mahlapolane* is next to the moon and bright, it signals the rainy season. When the *magakala* star appears in the NorthEast of Lepelle Nkumpi Municipality, the night will be very cold. The same as the appearance of Naka the star signals the winter season. Trees and crops grown in that period are burned. The beginning of the rainy season is observed when clustered *dithutlwa* stars appear in the southern side. The *kgogamashego* star appears from east to west. It follows the direction of the sun.

Table 4.9: Nature of knowledge through stars

Nature of knowledge	Type of knowledge
• The classification and naming of stars is through experience and observations. • The knowledge reflected here is based on observations of stars, their position in the sky and movement • The seasonal weather prediction is stars-based	Tacit knowledge prevails.

4.10.5.3 Phefo (Wind)

Wind was also mentioned as one of the important indicators for bringing or dispersing rain. The blowing of strong wind from north to south-westerly is said to be going to collect water, while the reverse will bring no rain at all irrespective of whether or not it is cloudy. It was revealed during the interviews that the wind is considered in the initiation of rainfall. The participants indicated that the directions from where the wind blows is of utmost importance in taking a decision of whether or not to block the wind. Much has been said about old men who specialised in blocking strong winds coming from the south westerly side. It was revealed that when wind blows from east to south-westerly, when it returns, it will bring much needed rains. It was also indicated that wind has a negative impact on the moisture content of the soil because when it blows after receiving rainfall, it dries up the soil and erodes the moisture.

Table 4.10: Nature of knowledge through wind

Nature of knowledge	Type of knowledge
• The knowledge acquired here is not codified, recorded, captured and communicated to communities through mass media e.g. radios, TVs etc. • The knowledge reflected here is based on observations of birds in weather prediction, their actions and movement • The seasonal weather prediction is astronomically-based.	Tacit knowledge prevails.

4.10.6 Biological indicators

The biological weather indicators such as birds, insects and trees were mentioned as important to the participants in guiding them whether the rainfall will be expected or not (Table 4.11).

Table 4.11: Biological weather indicators

Indicator	Indication	Description
Birds (Dinonyane)	Singing of Hlahlamedupi (<i>Burchell's Coucal</i>)	There will be rain in a short period of time. For example, when one hears hlahlamedupi sings, it means the rain is expected soon.
	Peulwane (swallows) flying pattern of the swams	When they fly low, they indicate immediate rain, but when they fly higher, they show dry spells.
	Maakabosana flying in cluster on a particular period	When they fly in flock, they resemble high possibilities of rainfall.
Insects (Dikhunkhwane)	Makeke (termites) when they are busy working	When the termites collect grass and put them in a hole, they indicate onset of rainfall
	Khunkhwane (beetle)– dancing and making a knocking sound	Onset of rainy season.
	Ditshoshane (ants) – appearance in abundance	Appearance of many ants signifies rains.
Letlametlo (typical frog)	The sound of letlametlo during the dry spell	Signal onset of rains.
Trees (Mehlare)	Mohlopi (sheperd's tree) – bearing more fruits	The abundance of fruits reflect drought.
	Toro (prickle pears)- bearing more prickles	Drought spell.
	Motšhidi (wild plum) – more fruits	Drought spell.
	Mothweetla (crossberry raisin)– more fruits	Drought spell.

4.10.6.1 Dinonyane (*Birds*)

It was mentioned more often in all councils that the bird *hlahlamedupi* plays an important role in indicating high probabilities of good rains. When the *hlahlamedupi* makes a *pulaa-pulaa* sound late in the evening, it signals the immediate falling of rain. The arrival of *maakabosana* in clusters has said to indicate the approaching of the rainy season. The appearance of *peulwane* (swallows), according to the participants, that is, when they fly low, they signal the immediate falling of rain. But when fly high, they resemble dry spells.

Table 4.12: Nature of knowledge through birds

Nature of knowledge	Type of knowledge
- The identification, naming and observation of birds behaviour in rainfall prediction emerged. The years of experimenting and observing the movement and the emergence of birds reflect the know-how. - The seasonal weather prediction is birds-based.	Tacit knowledge prevails.

4.10.6.2 Mehlare (trees)

Plants were mentioned as indicators of drought or wet spells. Plants such as *mohlopi*, *mothweetla*, *motoro* and *motshidi* are important in that no one is allowed to cut them as firewood because they are regarded as rain trees. When these trees start blooming in September and bear fruits in abundance, they signal drought spells while the reverse signals wet conditions.

Table 4.13: Nature of knowledge through trees

Nature of knowledge	Type of knowledge
- The plant phenology emerges through naming, identification and the selection of a particular plant. - The knowledge reflected here is based on observations of plant growth relating to flowering and fruit bearing. - The seasonal weather prediction is plant-based.	Tacit knowledge prevails.

4.10.6.3 Dikhunkhwane (Insects)

The knocking sound of rain *khunkhwane* with its tail signals the arrival of a rainy season. The name of the insect was not mentioned in all the areas, but it was highlighted that such a tiny insect can make a disturbing noise by knocking its back on the ground. It was also mentioned that when *ditshoshane* (ants) and *makeke* (termites) collect grass and store them in their holes, it signals the possibility of a rainy season. The participants' understanding is that termite's store food in case rain disturbs them from coming out of the ground.

Table 4.14: Nature of knowledge through insects

Nature of knowledge	Type of knowledge
- The identification, naming, selection and characterisation of insects' behaviour emerged. - The knowledge reflected here is based on observations of particular insects in weather forecasting, their actions and movement. - The seasonal weather prediction is insect-based.	Tacit knowledge prevails.

4.10.6.4 Segwagwa (frog)

In one traditional council, it was indicated that the sound of frogs during the dry season calls upon the rain to fall so that the frogs can have plenty of water for their survival.

However, it was mentioned that the *letlametlo* (a typical frog) enjoys playing inside the water. When the rain has fallen, *letlametlo* will make a loud sound appreciating the arrival of rainfall.

Table 4.15: Nature of knowledge through frogs

Nature of knowledge	Type of knowledge
• The emergence of reptiles during a particular period becomes crucial in rainfall prediction. The identification, naming and characterisation of certain reptiles in rainfall prediction emerged. The knowledge reflected here is based on the observation and emergence of reptiles in rainfall prediction, their actions and movement. • The seasonal weather prediction is reptile-based.	Tacit knowledge prevails.

4.10.7. Past extreme weather events

The past extreme weather events in Lepelle Nkumpi Municipality were clearly articulated by the participants from each traditional council. However, each locality might have experienced extreme weather events differently. The participants reflected on the occurrences of the events from 1956 to 1980. For the past twenty four years, farming communities experiencing and observing weather uncertainties and building on what happened, posit the understanding, views and beliefs on indigenous weather knowledge. As shown in Table 4.16, from the participants' information, the researcher managed to make a summary of the timeline of events. The cultural beliefs that the participants interact with their environment on a daily basis have revealed that elders nominated by chiefs have wisdom. The major extreme weather events has impacted negatively on the livelihood of the communities within the municipality. As indicated in Table 4.16, the socio-economic and political environment posed challenges to households.

Table 4.16: Summary of major weather and climatic events and their impacts

Year	Event	Impact
1945	Severe Drought	Hunger and had to eat yellow maize
1946	Severe Drought	Starvation
1947	Drought	Hunger/Tlala
1948	Drought	Hunger/Tlala
1949	Drought	Hunger/Tlala
1950	Drought	People fed on indigenous melons – legodu
1951	Drought	Starvation
1952	Floods	Plenty of food – melons and watermelon seeds germinated and doves killed by floods
1953	Rain, Thunderstorms and Hail	Crops were produced – food plenty. Ostrich, Doves and other animals were killed
1956	Floods	Trees were uprooted, people were killed by stones falling from the mountains.
1963	Hail	Houses were damaged, cattle, goats and birds killed
1966	Floods	River banks overflowed, roads damaged
1967	Floods, Hail	Roads damaged, trees damaged. People were killed at Mafefe when rocks fell from the mountains
1968	Drought	Rivers became dry, harvests low
1976	Thunderstorms	Rivers revived and overflowed, mud houses fell to the ground, farmers lost a considerable number of animals
1980	Good rains	People harvested tons of crops and animals had enough grazing, plenty of wild fruits

Source: Interviews 2015

Table 4.17: Nature of knowledge through observations and experience

Nature of knowledge	Type of knowledge
• Through observation, action and experience, events related to weather and climate emerged. The knowledge acquired here is not codified, recorded, captured and communicated to communities through mass media e.g. radios, TVs etc. • The knowledge reflected here is based on distinguishing the occurrence of flood, hunger, disaster, good rains and plenty of food associated with the weather. The remembrance of events in sequence justifies the know-how of weather and climate of individual cognitive abilities. • The seasonal weather prediction is event-based.	Tacit knowledge prevails.



Figure 4.7: Participants from Ga-Mphahlele

Transcripts:

Monyakišiši: Ke digata pula tšeo. Ke eng seo le ka mpotšago ka mafula? Phišo le komelelo ye e tseneletšego, le tlala ya mohlopi.

Motšeakarolo 6: *Gona le ngwaga wa 1950. Goile gwa wa tlala e kaakang. Le bao bailego ba leka go lema, gape tlala e hlola ke letšatši. Dibjalo tšeo diilego tša kgotlelela e be ele marotse le magapu. Go be go lewa kgodu, le gona ke legodu ka gore gobe go sena bupi bja go dira kgodu.*

Motšeakarolo 1: *Ya 1950 o e hlabile empa retla e otlolla, ra thušana le wena. E thomile ka 1947, e tšere 47, 48, 49, 50 mong wa rena kamo re lego ka gona a hlokofala. Ka 1950 mong wa kgoro ye a hlokofala, ka 1951 ba bea moepadira, Ngwato, nna kege ke llela go wela ka nako yeo. Ka 1951 re ile ge re swanetše go wela, kgoši a hlokofala ra dika. Rare go dikaeh...meriri ya tloga ba hloma Ngwato, ngwato ka 1951 oile a ntšha lentšu ale mo kgorong are: naga ye ke nyaka go e bušetša morago. Lena le swanetše go wela, mašhoboro a swanetše go ya go thuba. E napa ba modumelela. Re gatile...re gatile – gake tsebe gore ke May goba ke April, Ngwato a swarwa ra napa ra dika, kgoši ga e gona. Ka 1952 mola re re jwalo, a kere ngwato obe a šetše a dirile tše tša go thekga naga, o be a šetše a dirile. Ka 52 gwa ba marotse le mo go sego gwa lema motho, marotse a makoto a patla dikarikana ge di eya ka releng. Bjale pula yeo maeba aile are ntšha lekhwekhwe a bea go bea. Pula ya ngwaga woo goile gwa t šwelela kgodu..tšhaba se sa phela ka kgodu. Ka 53 nna kasa thoma kaya go wela.*

4.10.8 Changes in weather and climate

During the discussions in the traditional councils, it was indicated that the current weather changes in their area are influenced by modern ways of living. Some participants expressed their concerns with the environment and failure by communities, especially youth who do not adhere to cultural norms or indigenous ways of doing things. It was revealed that during the olden days, unwanted materials (*dibeela*) would be gathered from the surroundings and burned. The activity as indicated was regarded as important in the cleansing of the environment or surroundings where people and animals live. It was indicated in all traditional councils

that used nappies and plastics are lying around in the veld. No one is taking the responsibility of land pollution and sources of water. It was pointed out during the discussions that currently, communities experience changes in rainfall and temperature range, and this affects the production of crops.

Table 4.18: Changes in weather and climate

Changes experienced	Period of occurrence	Impact	Adaptation	Probing
Extreme heat, low rainfall. Disappearance of important animals and plant species	<i>Throughout the year</i>	Food insecure, health issues	Cleansing their environment Selecting tolerant crops Utilise their indigenous ways of knowing	Observation and experience

Source: FDGs Interviews, 2015

The participants expressed their concerns on the changes experienced and had to adapt to bad environmental management and defiance of the ancestors. The participants mentioned that crop production is becoming difficult to grow since weather conditions are no longer reliable due to modernisation and the belief that polluted land cannot yield any reasonable amount of rainfall. However, it was suggested that rain-making rituals should continue because farmers receive lower yields and households become food insecure. During the in-depth discussions, the participants felt that intercropping and indigenous ways of approaching farming should continue because people grew up feeding themselves from their land.

4.11 Discussions

From the results, the study participants from traditional councils used and considered a number of indicators to predict the onset of the rainy season. The indicators used to predict weather and climate are based on astronomic and biological indicators. The information provided by the participants reflected commonalities in all traditional

councils. It is clear that individuals from the communities are still conversant and knowledgeable about weather predictions through the observation of local weather indicators. However, the six traditional councils acknowledge indigenous weather and climate prediction in their communities based on agricultural activities. Therefore, their knowledge systems cannot be ignored since they reflected their understanding of their local environment.

The studies on indigenous weather forecasting conducted in Zimbabwe, Kenya, Ghana, Uganda, Tanzania and South Africa by Mafongoya et al. (2017) have acknowledged the existence of indigenous methods of weather and climate forecasting. It was clear that the communities within the municipality rely solely on indigenous weather forecasting than the western approach. Observations based on meteorological and biological indicators may vary from region to region. However, astronomical indicators may be the same in all countries since they reflect the same planet earth (Okonya & Kroschel, 2013). The participants have shown their practical wisdom and know-how (tacit knowledge) while know-why (explicit knowledge) has not been well articulated. Since western weather forecasting is at macro level and not accessible at micro level, it was not important to compare indigenous and western weather approaches.

The indigenous weather and climate knowledge reflected in the study was informed by cultural values and cosmological understanding. Therefore, the knowledge is actually self-validated. Moreover, the useful prediction of the onset and end of the seasons may be a challenge in the future since some biological indicators such as the *hlahlamedupi bird* have disappeared from the areas. Predictions about timing of the onset of the rains are particularly important for long cycle crops such as maize (Orlove et al., 2010).

Changes in climate is posing a threat to the livelihood of the communities. Indigenous conservation methods seem to be disappearing due to modernisation. It was reflected that land surrounding the communities is polluted, and that this affect water sources.

Ishaya and Abaje (2008) have revealed that farmers perceive that the changes in climate occur due to diverse human activities.

4.12 Conclusions

From the study conducted in the six traditional councils, it can be concluded that indigenous knowledge on weather and climate still exists. However, knowledge seems to be held by elderly people who participated in rain-making rituals when growing up. Furthermore, through observations of indigenous weather and climate indicators by smallholder farmers, it was revealed that smallholders are able to plan cropping activities in accordance with observed indicators. The majority of participants have no good command of English in understanding the percentages and predictions from western knowledge systems. It can be attested that revelations in the study that western weather information is not effective and helpful to the majority of people who reside in rural areas under micro-climatic conditions. The participants' use of local language and idiomatic expressions during the interviews commanded a language space in the research process. Furthermore, the use of animals, birds, plants, wind, the moon and stars as indicators seem to guide communities on a day to day life.

The in-depth knowledge and experience of the participants as reflected on the timeline of events justify why their knowledge is important in addressing probabilistic weather information. As shown, indicators are very important and are considered for crop selection and time of planting. The moisture regime for crop performance is determined by the amount of rainfall and temperature regimes. However, the prerairfall sowing of seeds might be helpful to farmers to avoid late planting. Not a single indicator determines the beginning of the rainy or drought season; indicators are used inclusively. Of importance, *Dingaka* or Traditional Health Practitioners play a very key role in conducting rain-making rituals and determining whether there will be a rain or not. Changes in weather patterns were noted and acknowledged on the basis of communities undermining cultural values. It is therefore recommended that:

- ✓ Traditional councils should establish indigenous agro climatology forums within each council, one of which should represent Lepelle Nkumpi Municipality.

- ✓ Indigenous weather and climate awareness campaigns be conducted throughout the municipality at schools.
- ✓ Traditional councils promote conservation of all natural resources, including animals and plants within their ecosystem.
- ✓ Traditional councils should put regulatory measures to protect the extinction of very important plant and animal species used as indicators.

CHAPTER FIVE

ASSESSMENT OF KNOWLEDGE, ATTITUDE AND PERCEPTIONS (KAP) OF SMALLHOLDER FARMERS IN LEPELLE NKUMPI MUNICIPALITY TOWARDS INDIGENOUS WEATHER AND CLIMATE KNOWLEDGE

5.1 Introduction

In this chapter, the design of the study, target population, sampling procedure, sampling size, data collection and analysis, and research ethics are presented.

Furthermore, smallholder farmers' attitudes and perceptions on indigenous weather and climate knowledge are also described. The outcomes of the data collected are using tables, charts and the discussions of the results and conclusions are presented.

5.2 Study approach

In the study, the researcher adopted a quantitative descriptive approach in order to answer the research question or a null hypothesis that there is no difference between groups of smallholder farmers. Parahoo (2006) uttered that the selection of the most appropriate design is important to achieve the aims of the study. A quantitative descriptive research approach was employed in the study, and provided a detailed description of Knowledge, Attitude and Perceptions (KAP) levels of smallholder farmers in Lepelle Nkumpi Municipality. Due to KAP of smallholder farmers in the study area, the researcher considered the study approach from epistemological, ontological and axiological perspectives underlying the relational theory as described in chapter 3 (Figure 5.1). The research approach was chosen to address the objective of the study, which is to assess knowledge, attitudes and perceptions of smallholder farmers in Lepelle Nkumpi Municipality towards indigenous weather and climate knowledge.

Quantitative research emphasises the measurement and analysis of casual relationships between variables within a value-free context (Denzin & Lincoln, 1994). Nzewi (2009) highlighted that the quantitative research methodology has limited reliability in discerning the African thought systems and cultural knowledge interaction

procedures. A descriptive survey was considered in the study to obtain accurate account of the respondents' beliefs, opinions, attitudes and perceptions of smallholder farmers. A self-administered questionnaires was used and distributed by the researcher to collect information from the respondents.

5.3 Target population

Smallholder farmers from the study area were targeted to participate in the study. The exclusion and inclusion of these farmers in the municipality was based on a homogenous group as follows. **Inclusion criteria:** smallholder farmers who produce food crops in the municipality, and **exclusion criteria** were those smallholder farmers who are engaged in livestock farming. Due to the problem of weather and climate variability faced by smallholder farmers in the municipality, it was important to consider food production needs and its impact at a household level. Other considerations were for elderly farmers who produce food crops to address the immediate needs of the household. Smallholder farmers older than 35 years who are regarded as knowledgeable about the topic under study were targeted to participate in the survey. According to Polit and Beck (2010), it is more economic and practical to consider samples than large population. 354 respondents participated in the KAP survey.

5.4 Sample size and sampling procedures

A non-probability sampling procedure was considered in the study. According to Welman et al. (2005), the researcher should rely on the experience, ingenuity and /or previous research findings to deliberately obtain units of analysis in such a manner that the sample they obtain may be regarded as being representative of the relevant population. Purposive sampling was used in administering questionnaires on smallholder crop producers who provided information about indigenous weather and climate knowledge. Given the estimated crop smallholder farmers of about 4,538 in Lepelle Nkumpi Municipality supplied by the Department of Agriculture and Rural Development Office in 2015, the sample size of the study was determined by the survey system calculator (www.surveysystem.com/sscalc 2016). The determination of sample size for 354 respondents was governed by the 95% confidential level and

5.0% margin of error to ascertain the representation and accuracy required. The assumed responses were at 100% distribution.

5.5 Data collection strategy and methods

The strategy for data collection provided the researcher with direction for protocols in the research process. Creswell (2007) regarded data collection strategies as approaches of inquiry. Data collection using a questionnaires, are a useful option to consider when conducting surveys (Mathers et al., 2007). A survey was undertaken by the researcher to efficiently collect information from a group of smallholder farmers, and was easily administered to measure the attitudes and perceptions of smallholder farmers.

5.5.1 Questionnaire

Data was collected using a questionnaire. Before administering the questionnaire to 354 respondents, a pre-test of the questionnaire was conducted. The purpose of the pre-test was to check the time for its completion, the easiness and related problems in completing the questionnaire and the readability and comprehensibility items before the actual data collection. The pre-test was administered to fifteen (N=15) smallholder crop farmers and four (n=4) agricultural officers in the nearby Agriculture service centre, which was not intended for data collection. Considering the smallholder crop farmers and agricultural officers' responses and feedback, minor adjustments and changes were made to validate the instrument.

The completed pre-test information provided the researcher with an understanding of coding and of further analysing the instrument. The statements were translated into the local language of the respondents. The English version of the questionnaire, with the assistance of agricultural advisors, was translated into Sepedi for the respondents to understand its content. Ambiguous statements were rephrased. However, studies conducted previously to assess KAP did not use a trialled questionnaire (Kasper et al., 1994; Ungan & Tumer, 2001).

A questionnaire composed of self-esteem statements was used to gather information from the respondents. Since a measuring scale was used, self-esteem statements were relevant to the respondents to allow them to provide his or her personal views and level of awareness. According to Mann et al. (2004), peoples' concepts and feelings about themselves are generally labelled as their self-esteem. Self-esteem is a personal opinion of oneself, and is shaped by individuals' relationships with others, experiences, and accomplishments in life (Mayo, 2009). Chamberlin (1997) further advances that as clients become more empowered, one will feel more confident in one's ability to manage one's life, resulting in improved self-esteem and self-image. The use of a questionnaire in the study assisted the researcher to gather exceptional information, maintained the respondents' privacy and administered costs.

A questionnaire was divided into three sections i.e. 'A', 'B' and 'C'. **Section A** addressed the demographic structure such as gender and age to allow for any inquiry to relationships among the respondents and their attitudes and perceptions towards indigenous weather and climate knowledge (IWCK). **Section B** consisted of statements measuring the perceptions, which had a four-level scale rating using classifications (1=*strongly disagree*, 2 = *disagree*, 3 = *agree* and 4 = *strongly agree*) with nominal values of 4, 3, 2 and 1, respectively. **Section C** consisted of four scales, which measured attitudes towards indigenous weather and climate knowledge using classifications such as (4 = *very often*, 3 = *often*, 2 = *some of the time*, and 1 = *not at all*). Kirlinger (1986) defined a scale as a set of verbal items to which an individual responds by expressing degrees of agreement or disagreement.

The questionnaire was distributed and administered personally with the assistance of Agricultural Advisors from Limpopo Department of Agriculture and Rural Development to a total of 354 smallholder farmers. The respondents were afforded sufficient time to complete the questionnaire, and the agriculture advisors assisted those who could not write. However, there was no right answer for any statement. The best answer was what the respondents felt was true of themselves during the interview. A 100 percent completion was achieved. Moreover, self-esteem is a means by which individuals,

groups or large populations can enhance their competence and sense of well-being (Sartorius, 1988).

5.5.2. KAP Survey

A KAP survey was considered in the study, and targeted specifically smallholder crop farmers within the municipality, and data was collected about what they know, practised, believed and contextualised. KAP survey is widely and popularly used in medical practices to assess health related issues. According to Launiala (2009), KAP was first born in the field of family planning and population studies in the 1950's. Schopper et al. (1993) and Launiala (2009) argued that KAP was used to understand family perspectives in Africa. However, Stone and Campbell (1984) and Hausamann-Muela et al. (2003) agreed that the KAP survey has established itself among methodologies of investigating health behaviour, and of gaining information on health seeking practices. Furthermore, its attribute is that it provides design, quantifiable data, ease results and generalisability of small samples to a wider population (Stone & Campbell, 1984). KAP explores what the people already know (Jackson, 2005).

The choice for KAP survey in the study was based on its characteristics as outlined by Stone and Campbell (1984) and Jackson (2005). Above all these considerations, the question which was posed pertained to *whose knowledge is that and who should be assessed?* Badenhorst et al. (2006) regarded knowledge as a function of an intention (attitudes), and is about action (practices), beliefs and commitment (values). It was within the understanding of Badenhorst et al. (2006) that assessment should focus on attitudes and perceptions since smallholder farmers have individual values and belief systems. The aim of assessing farmers' perceptions and attitudes was to generate information from smallholder farmers' knowledge on weather and climate. The attitudes and perceptions influence values, which influence worldview about the environment (Dietz et al., 2005).

5.6 Data analysis method

The completed questionnaires were captured in the Excel 2003 computer program, and was sent to a statistician who used the IBM Statistical Package for Social

Sciences (SPSS) Statistics version 23 to analyse the data. The statistician analysed the data independently. Descriptive statistics, frequencies, percentages, mean and standard deviation were reflected while one way Analysis of Variance (ANOVA) was used to test for significant differences between gender (or age groups) in each of the statements regarding perceptions and attitudes of smallholder farmers towards indigenous weather and climate knowledge. The data was also analysed based on the characteristics of the respondents regarding gender and range of ages, influence of gender and age on perceptions and attitudes of smallholder farmers towards indigenous weather and climate knowledge.

5.7 Validity and reliability of the study

5.7.1 Reliability

Reliability is concerned with the findings of the research, and relates to the credibility of the findings (Welman et al., 2005). Parahoo (2006) reiterates that reliability is a necessity, but not a sufficient condition for validity. According to Polit and Beck (2010), reliability focuses mainly on stability and consistency. The understanding of the researcher pertaining to reliability is that measurements should be repeatable. Data collector bias was minimised by the presence of the researcher during data collection. Due to their advanced age, the respondents were afforded bottled water to quench their thirst while addressing the statements in question.

5.7.2 Validity

Validity determines whether the research truly measures what it was intended to measure or how truthful the results are (Joppe, 2000). Welman et al. (2005) defined validity as the extent to which the research findings accurately represent what is really happening in the situation. Validity in quantitative research is described as construct validity, which entails initial concept, question or notion that determines which data is to be gathered and how it is to be gathered (Wainer and Braun, 1998). Golafshani (2003) echoed that the definitions regarding reliability and validity in quantitative

research reveal two positions: 1) reliability opines whether the result is replicable; and 2) validity opines whether the means of measurement are accurate and whether they are actually measuring what they are intended to measure. The rating scale measured the attitudes and perceptions of the respondents. The statements were formulated in a simple language for the respondents to understand. All respondents approached for completion of the questionnaire responded.

Therefore, an adequate sample size considered was justified.

5.7.3 Credibility

The measuring instrument was intensively assessed for its applicability for the understanding by the smallholder farmers. A pre-test on the questionnaire was conducted to confirm its usability and acceptance. The questionnaire was translated into Sepedi from English to afford the smallholder farmers the opportunity to understand its content. Suggestions and recommendations were incorporated into the instrument.

5.8 Ethical considerations

Due to the nature of the study where the attitudes and perceptions of the smallholder farmers were collected, permission to contact the study was sought from three Agricultural service centres (Magatle, Middlekop & Grootfontein) for approval and assistance. Thereafter, all research ethics and local traditional protocols were honoured as indicated earlier in chapter 3. Agricultural advisors from the three Agriculture service centres assisted the researcher by organising farmers within their respective villages through service centre heads. Prior to collecting data, each group of respondents from different villages was introduced to a Sepedi version of the questionnaire to understand what is required of them in terms of its completion. The respondents were informed about their rights to participate or not to participate in the survey. Furthermore, they were informed about the aim of the study and the approach to be used before and after data collection.

5.9 Results

Section A: characteristics of respondents

5.9.1 Characteristics of respondents

The results revealed who are the respondents best described in the study. Based on the analysed data, the study revealed that there were 215 (61%) female and 139 (39%) male respondents (Figure 5.1 and 5.2).

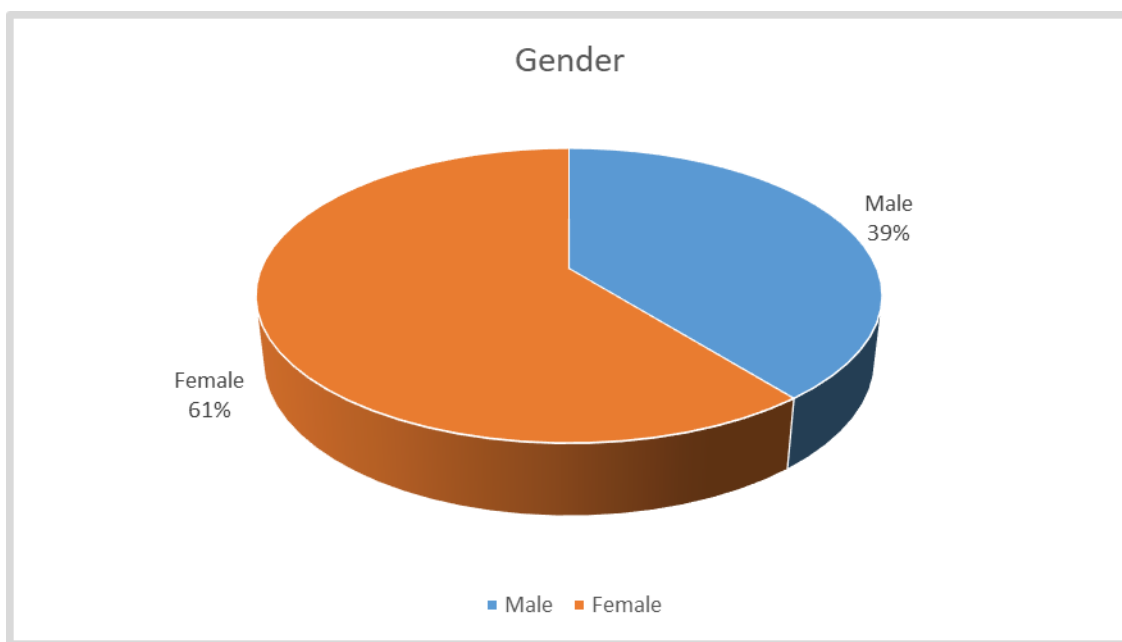


Figure 5.1: Percentage distribution of respondents by gender

Figure 5.2 reveals that only 18.4% of the respondents were in the age group of 35-50 years, while 24.3% were in the age group of 50-60 years. The majority of the respondents (57.3%) were over 60 years of age.

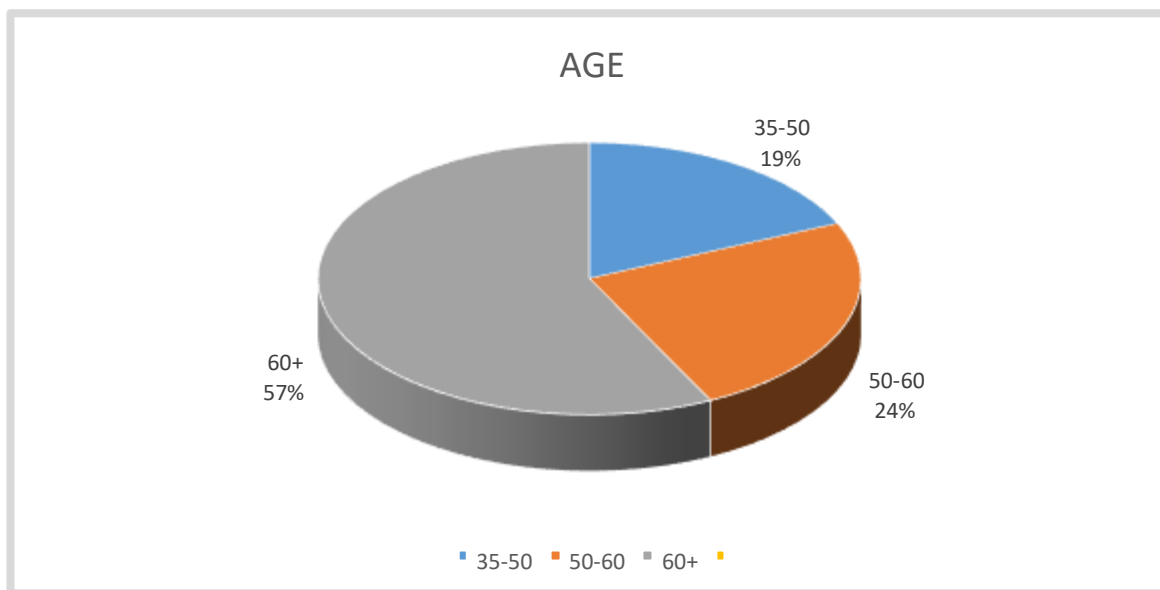


Figure 5.2: Percentage distribution of the respondents in terms of age.

Section B: Perceptions and attitudes of smallholder farmers regarding indigenous weather and climate predictions

5.9.2 Perceptions of farmers towards indigenous weather and climate predictions

In terms of statements pertaining to agreements and disagreements on the prediction of whether or not rain is coming using personal experience, the results from Table 5.1 indicate that about 195 (55.1%) respondents strongly agree with the statement that they can predict whether rain is coming or not through personal experience. About 123 (34.75%) respondents also agree. In other words, about 90% of the respondents are in agreement with the statement, implying that an overwhelming majority of the respondents can predict the coming of rain through personal experience.

Table 5.1: Perceptions of smallholder farmers regarding weather and climate predictions

Perceptions	Strongly agree	Agree	Disagree	Strongly disagree	Total Count
1. Can predict whether rain will come or not from experience	55.1 (195)	34.7 (123)	7.6 (27)	2.5 (9)	100 (354)
2. Can predict rain by observing clouds, the moon and the stars	54.5 (193)	33.1 (117)	9.3 (33)	3.1 (11)	100 (354)
3. Can predict rain by observing behaviour of animals and sound of birds and insects.	59.9 (212)	29.9 (106)	5.9 (21)	4.2 (15)	100 (354)
4. Use indigenous weather and climate knowledge to plan ploughing.	52.3 (185)	37.0 (131)	9.3 (33)	1.4 (5)	100 (354)
5. Can predict whether drought or no drought by observing certain plants, symbols/signs	46.3 (164)	35.3 (125)	14.7 (52)	3.7 (13)	100 (354)
6. Can use indigenous weather and climate knowledge to select the crop to plant	53.4 (189)	34.7 (123)	8.8 (31)	3.1 (11)	100 (354)
7. Benefit from our grandparents' wisdom of weather prediction	61.0 (216)	31.1 (110)	7.6 (27)	3 (1)	100 (354)
8. Can mention types of rainfall and where they appear	64.4 (228)	26 (92)	7.3 (26)	2.3 (8)	100 (354)
9. Can use indigenous weather and climate knowledge to predict extreme temperature in a given growing season	43.5 (154)	39 (138)	14.1 (50)	3.4 (12)	100 (354)
10. Can determine what the climate would be on a particular growing season by observing years sequentially	37.6 (133)	39.5 (140)	16.9 (60)	5.9 (21)	100 (354)
Total	52.8 (187)	30.3 (121)	10.2 (36)	3.3 (10)	100 (354)

Numbers in parentheses are actual counts of respondents

The assessment of perceptions of smallholder farmers shows that 193 (54.52%) respondents strongly agree with the statement that by merely reading clouds, moons and stars, the respondents can tell whether it is going to rain or not at a particular time, and about 117 (33.05%) of them also agree. It means that 88% of the respondents are in agreement with the statement, implying that an overwhelming majority of the respondents can tell whether it is going to rain or not at a particular time. About 212 (59.9%) respondents strongly agree with the statement that through the actions of animals and sounds from certain birds and insects, the respondents can predict whether it is going to rain or not, and about 106 (29.9%) respondents also agree. Therefore, about 90% of the respondents are in agreement with the statement, implying that an overwhelming majority of the respondents can predict the coming of rain through the actions of animals and sounds from certain birds and insects.

Table 5.1 shows that 185 (52.3)% respondents strongly agree with the statement that they can make informed decisions to plan ploughing by considering indigenous weather and climate indicators, and about 131 (37.0%) also agree. In other words, about 89% of the respondents are in agreement with the statement, implying that an overwhelming majority of the respondents can predict the coming of rain through personal experience. About 164 (46.3%) respondents strongly agree with the statement that through the observation of certain plants, symbols/signs, they can predict whether there will be drought or not, and about 125 (35.3%) also agree. In other words, about 82% of the respondents are in agreement with the statement, implying that an overwhelming majority of the respondents can predict the coming of drought through certain plants. Around 189 (53.4%) respondents strongly agree with the statement that they can select crops based on indigenous weather prediction, and about 123 (34.7%) also agree. In other words, about 88% of the respondents are in agreement with the statement, implying that an overwhelming majority of the respondents can select crops based on indigenous weather prediction.

About 216 (61.0%) respondents strongly agree with the statement that their grandparents have proven experience of weather forecasting, and that they benefited from their wisdom, and about 110 (31.1%) also agree. In other words, about 92% of the respondents are in agreement with the statement, implying that an overwhelming

majority of the respondents benefited from the experience of their grandparents. Further 228 (64.4%) respondents strongly agree with the statement that they know different types of rainfall and where they come from. About 92 (26%) respondents also agree. This entails that 90% of the respondents are in agreement with the statement, implying that an overwhelming majority of the respondents know different types of rainfall and where they come from.

Furthermore, around 154 (43.5%) respondents strongly agree with the statement that they can be able to make predictions about extreme temperatures in a given farming season based on personal experience, and about 138 (39.0%) also agree. In other words, about 90% of the respondents are in agreement with the statement, implying that an overwhelming majority of the respondents can make predictions about extreme temperatures in a given farming season based on personal experience. About 133 (37.6%) respondents strongly agree with the statement that by using observation sequentially on a yearly basis, they can determine what the climate would be in a particular growing season, and about 140 (39.55%) also agree. In other words, about 77% of the respondents are in agreement with the statement, implying that an overwhelming majority of the respondents can observe sequentially on a yearly basis what the climate would be in a particular season.

5.9.3 One-way Analysis of Variance (ANOVA)

One-way analysis of variance (ANOVA) was used to test for significant differences between gender (or age groups) in each of the statements regarding perceptions and attitudes of smallholder farmers towards indigenous weather and climate knowledge. The ANOVA results are presented in Tables 5.2, 5.3, 5.4 and 5.5. The comments for the results of each table are given in the paragraph that follows each corresponding table.

Table 5.2: The influence of gender on farmers' perceptions towards IWCK

Statement	Gender	Mean	Standard deviation	p-value	Significance
S1: Through personal experience, I can predict whether rains is coming or not	Female Male	3.576 3.161	0.661 0.797	<0.001	***
S2: Through mere reading of clouds, moons and stars, I can tell whether it is going to rain or not at a particular time	Female Male	3.538 3.131	0.664 0.890	<0.001	***
S3: Through the actions of animals and sounds from certain birds and insects, I can predict whether it is going to rain or not	Female Male	3.586 3.226	0.695 0.883	<0.001	***
S4: I make informed decisions to plan ploughing by considering indigenous weather and climate indicators	Female Male	3.467 3.277	0.693 0.745	0.016	**
S5: Through observation of certain plants, symbols/signs, I can predict whether there will be drought or not	Female Male	3.419 2.934	0.761 0.868	<0.001	***
S6: I can select crops based on indigenous weather prediction	Female Male	3.500 3.175	0.727 0.813	<0.001	***
S7: Our grandparents have proven experience of weather forecasting and I benefited from them	Female Male	3.576 3.431	0.624 0.684	0.040	**
S8: I know different types of rainfall and where they come from	Female Male	3.576 3.431	0.696 0.784	0.059	Ns
S9: Based on personal experience, I am able to make predictions about extreme temperatures in a given farming season	Female Male	3.338 3.022	0.786 0.827	<0.001	***
S10: By using observation sequentially on a yearly basis, I can determine what the climate would be in a particular growing season	Female Male	3.205 2.869	0.848 0.898	<0.001	***

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$, NS Non significant $P > 0.05$: Means that share common letters are not significantly different from each other using least significant difference (LSD) comparison technique.

Table 5.2 presents ANOVA results for gender and perceptions. The table (Table 5.2) is based on the null hypothesis that gender has no influence on perceptions (or there is no gender related difference in perceptions) versus the alternative or research hypothesis which claims that gender has influence on perceptions. The results in Table 5.2 reveal that, with the exception of S8, gender influence was highly significant

(p-value < 0.05) in all nine out of ten perception statements. In other words, the male and female respondents differ significantly in their perceptions of smallholder farmers towards indigenous weather and climate knowledge, particularly for S1, S2, S3, S4, S5, S6, S7, S9 and S10. In general, as shown in Table 5.2, the means of the scores for female respondents are higher than the corresponding means of the scores for male respondents. It can be inferred that female respondents tend to agree more than their male counterparts since the mean scores for female respondents are higher than the mean scores for male respondents.

Table 5.3: The influence of age on farmers' perceptions towards IWCK

Statement*	Age group	Mean & LSD	p-value	Significance
S1: Through personal experience, I can predict whether rain is coming or not	35-50 50-60 60 & above	3.172a 3.369abc 3.508bc	0.006	***
S2: Through mere reading of clouds, moons and stars, I can tell whether it is going to rain or not at a particular time	35-50 50-60 60 & above	3.125a 3.310abc 3.487bc	0.004	**
S3: Through the actions of animals and sounds from certain birds and insects, I can predict whether it is going to rain or not	35-50 50-60 60 & above	3.172a 3.393abc 3.553bc	0.003	**
S4: I make informed decisions to plan ploughing by considering indigenous weather and climate indicators	35-50 50-60 60 & above	3.219a 3.369abc 3.457bc	0.072	**
S5: Through observation of certain plants, symbols/signs, I can predict whether there will be drought or not	35-50 50-60 60 & above	2.875a 3.286bc 3.317bc	<0.001	***
S6: I can select crops based on indigenous weather prediction	35-50 50-60 60 & above	3.234a 3.429a 3.392a	0.263	Ns
S7: Our grandparents have proven experience of weather forecasting and I benefited from them	35-50 50-60 60 & above	3.234a 3.536bc 3.603bc	<0.001	***
S8: I know different types of rainfall and where they come from	35-50 50-60 60 & above	3.250a 3.500bc 3.613bc	0.002	**
S9: Based on personal experience, I am able to make predictions about extreme temperatures in a given farming season	35-50 50-60 60 & above	3.063a 3.321a 3.216a	0.170	Ns
S10: By using observation sequentially on a yearly basis, I can determine what the climate would be in a particular growing season	35-50 50-60 60 & above	2.953a 3.131a 3.085a	0.439	Ns

* P<0.05

**P<0.01

*** P<0.001

NS Non significant P>0.05

Table 5.3 presents ANOVA results for age group and perceptions. The results are based on the null hypothesis that age group has no influence on perceptions (or there is no age group related difference in perceptions) versus the alternative or research hypothesis which claims that age group has influence on perceptions. The results in Table 5.3 reveal that, with the exception of S4, S6, S9 and S10, age group influence was highly significant ($p\text{-value} < 0.05$) in all six out of ten perception statements. In other words, the respondents from different age groups differ significantly in their perceptions of smallholder farmers towards indigenous weather and climate knowledge, particularly for S1, S2, S3, S5, S7 and S8. In general, the results in Table 5.3 reveal that the mean scores for the 35-50 age group are consistently lower than the mean scores for the 60 and above age group.

It can also be noted that S4 is significant at 10% but not at 5% level of significance. For statements S1, S2 and S3, the results in Table 5.3 reveal that the mean scores for age group 35-50 and 50-60 are not significantly different from each other ($p\text{-value} < 0.05$), while the age group 50-60 and 60 and above are also not significantly different from each other ($p\text{-value} < 0.05$). On the contrary, the mean scores for age groups 35-50 and 60 and above are significantly different from each other ($p\text{-value} < 0.05$).

Table 5.3 also reveals that for S5, S7 and S8, the mean scores for age group 35-50 are significantly different from the mean scores of both age groups 50-60 and 60 and above. Additionally, the mean scores for age groups 50-60 and 60 and above are not significantly different from each other at 5% level of significance.

Section C: Attitudes of farmers towards indigenous weather and climate knowledge

5.9.4 Attitudes of farmers towards indigenous weather and climate

In all four statements used to measure attitude, Table 5.4 indicates that about 231 (65.3%) of the respondents very often regard indigenous weather and climate knowledge (IWCK) as important in planning crop production activities, and about 87 (24.6%) often do that. In other words, about 90% of the respondents very often consider the statement, implying that an overwhelming majority of the respondents regard indigenous weather and climate knowledge as important in planning crop production activities.

Table 5.4: Attitudes of smallholder farmers towards indigenous weather and climate

Attitude	Very often	Often	Sometimes	Not at all
		24.58		
1. Indigenous weather and climate knowledge is important in planning crop production	65.25		8.84	1.7
2. Farmers use indigenous weather and climate knowledge in the municipality	49.79	32.2	13.28	4.8
3. Consider indigenous weather and climate knowledge in rainfall and temperature prediction	51.98	29.94	14.41	2.7
4. Consider indigenous weather and climate knowledge for future use	52.97	28.61	15.01	3.4
5. As farmers, we encourage the exchange of indigenous knowledge	59.49	23.23	12.18	5.1
Averages	55.9	27.7	12.7	3.5

About 176 (49.7%) respondents very often use indigenous weather and climate knowledge by smallholder farmers in the municipality, and about 114 (32.2%) also often use IWCK. In other words, about 82% of the respondents are in agreement with

the statement, implying that an overwhelming majority of the respondents use indigenous weather and climate knowledge in the municipality.

A total of 184 (52%) respondents very often consider IWCK in rainfall and temperature prediction, and about 106 (29.9%) also agree. In other words, about 81% of the respondents are in agreement with the statement, implying that an overwhelming majority of the respondents consider IWCK in rainfall and temperature prediction. Respondents comprising about 187 (52.8%) very often consider IWCK as important for future use. In other words, about 81% of the respondents are in agreement with the statement, implying that an overwhelming majority of the respondents consider IWCK as important for future use.

About 210 (59.3%) respondents very often encourage the exchange of indigenous knowledge as farmers, and about 82 (23.2%) often exchange indigenous knowledge. In other words, about 90% of the respondents are in agreement with the statement, implying that an overwhelming majority of the respondents encourage the exchange of indigenous knowledge as farmers. The results revealed that an average of about 55,9% of farmers' attitudes very often consider their knowledge systems while 3.4 % of them do not consider indigenous knowledge at all.

Table 5.4: ANOVA on gender and attitudes

Statement	Gender	Mean	Standard deviation	p-value	Significance
S1a. IWCK is important in planning crop production activities	Female	3.671	0.641	<0.001	***
	Male	3.317	0.790		
S2a. IWCK is used by smallholder farmers in the municipality	Female	3.385	0.837	0.002	**
	Male	3.094	0.884		
S3a. I consider IWCK in rainfall and temperature prediction	Female	3.399	0.810	0.005	**
	Male	3.144	0.889		
S4a. I always consider IWCK as important for future use	Female	3.474	0.774	<0.001	***
	Male	3.072	0.898		
S5a. As farmers, we encourage the exchange of IK	Female	3.455	0.849	0.022	Ns
	Male	3.237	0.929		

* $P < 0.05$

** $P < 0.01$

*** $P < 0.001$

NS Non significant $P > 0.05$

Table 5.4 presents ANOVA results for gender and attitudes. The results are based on the null hypothesis that gender has no influence on attitudes (or there is no gender related difference in attitudes) versus the alternative or research question which claims that gender has influence on the attitudes. The results in Table 5.4 reveal that gender influence was highly significant ($p\text{-value} < 0.05$) in all the five attitude statements. In other words, male and female respondents differ significantly in their attitudes as smallholder farmers towards indigenous weather and climate knowledge. In general, as shown in Table 5.4, the means of the scores for female respondents are higher than the corresponding means of the scores for male respondents. It can be inferred that female respondents tend to agree more than their male counterparts since the mean scores for female respondents are higher than the mean scores for male respondents.

Table 5.5: ANOVA on age group and attitudes

Statement	Age group	Mean & LSD	p-value	Significance
S1a. IWCK is important in planning crop production activities	35-50	3.438	0.556	Ns
	50-60	3.558		
	60 and above	3.550		
S2a. IWCK is used by smallholder farmers in the municipality	35-50	3.063	0.071	Ns
	50-60	3.302		
	60 and above	3.322		
S3a. I consider IWCK in rainfall and temperature prediction	35-50	3.063	0.060	Ns
	50-60	3.361		
	60 and above	3.347		
S4a. I always consider IWCK as important for future use	35-50	3.156ac	0.003	**
	50-60	3.570b		
	60 and above	3.257ac		
S5a. As farmers, we encourage the exchange of IK	35-50	3.250	0.480	Ns
	50-60	3.407		
	60 and above	3.391		

Key: Means that share common letters are not significantly different from each other using least significant difference (LSD) comparison technique.

Table 5.5 presents ANOVA results for age group and attitudes. The results are based on the null hypothesis that age group has no influence on attitudes (or there is no age group related difference in attitudes) versus the alternative or research hypothesis which claims that age group has influence on the attitudes. The results in Table 5.5 reveal that age group influence is significant ($p\text{-value} < 0.05$) only for S4a attitude statement. In other words, the respondents from different age groups differ significantly in their attitudes of smallholder farmers towards indigenous weather and climate knowledge, particularly for S4a. In general, the results in Table 5.5 reveal that the mean scores for the 35-50 age group are not significantly different ($p\text{-value} < 0.05$) from the mean scores for the age group of 60 and above, while the mean scores for the 50-60 age group are significantly higher than those of 35-50 and 60 and above age groups.

5.10 Discussions

The study focused on perceptions and attitudes of smallholder farmers towards indigenous weather and climate knowledge. It was envisaged in this study that the title is very vital since the understanding of the perceptions and attitudes of the smallholder farmers will greatly contribute towards crop production sustenance. The study employed KAP survey with emphasis on the attitudes and perceptions of the smallholder farmers' knowledge. The overall aim in the study was to explain the behaviour of smallholder farmers towards their knowledge on weather and climate. It was considered that attitudes and perceptions of smallholder farmers is directly linked to their environment, and has an effect on farmers' behaviour towards what they know. A similar study by Te Velde et al. (2002) revealed that the farmers' perceptions seem to be based on collective tradition with shared convictions, values, norms and interests and on knowledge that is derived from daily experiences.

Consideration of gender in research and development initiatives is key. The participation of females during the study justifies the adage that: "*Mosadi o swara thipa ka bogaleng*" which translate that: a woman does not become despondent easily when exposed or subjected to difficult situations. It is absolutely factual that agriculture in Africa is represented by females, and make a significant contribution to family farming (Anunobi, 2002). According to Tripp (1991), gender differences remain unaccounted for. Gender in Africa is complicated due to modern state that has its roots in the colonial experience (Anunobi, 2002). A study by Rengalakshmi (2007) and Kalanda-Joshua et al. (2011) supported the notion that men and women usually have different indigenous ways of knowing, and may use it for different purposes. Furthermore, a study by Changa et al. (2010) has revealed that IK is largely held and recognised by the elderly who are normally aged 40 and above.

In this study, age was considered to be the most determining factor in addressing issues pertaining to weather and climate knowledge. There was significant difference regarding attitudes from the age groups in considering indigenous weather and climate knowledge for future use. A study by Breckler and Wiggins (1992) and Bahaman et al. (2010) has also emphasised that attitudes can be based on individuals' degree of like or dislike of something since they simultaneously have both positive and

negative attitudes. From the study elderly respondents considered their knowledge as important for future use. Smallholder farmers in Lepelle Nkumpi Municipality have highlighted the benefits of their knowledge systems through self-assertions.

5.11 Conclusions

The results from the survey have proven that the majority of smallholder farmers in Lepelle Nkumpi Municipality consider indigenous knowledge as important in their crop production systems. Knowledge of smallholder farmers about the types of rainfall, decisions on crop selection and indicators have strengthened their abilities to manage their environment well, and to utilise knowledge gained from their ancestors or grandparents. Farmers' attitudes and perceptions pertaining to the role of indigenous weather and climate knowledge on planning crop activities is more often considered by middle aged and elderly people. Overall, knowledge and perceptions regarding weather and climate simply determine the attitudes that farmers have about it based on their needs and experiences.

Furthermore, the attitudes of smallholder farmers is quite responsive and positive pertaining to indigenous weather and climate knowledge. It can also be concluded that irrespective of any intervention, knowledge about weather and climate is very good among the farmers as they reflected their attitudes towards the statements posed to them. What is more interesting is their submission towards the exchange of knowledge among themselves and their consideration for the use of indigenous knowledge in the future. According to the survey, the majority of smallholder farmers view indigenous weather and climate knowledge as a necessary step for future sustainability in their farming systems. However, the use of indigenous knowledge in weather and climate in the future will have good prospects of preserving, protecting and promoting the valuable heritage. Knowledge should be documented in a systematic way, and local weather and climate forums originating from traditional councils should be established in communities to encourage the use of indigenous know-how and know-why.

CHAPTER SIX

ANALYSIS OF EXISTING NATIONAL AND LOCAL POLICIES ON WEATHER AND CLIMATE ON THE UTILISATION OF INDIGENOUS KNOWLEDGE FOR CROP PRODUCTION IN LEPELLE NKUMPI MUNICIPALITY OF LIMPOPO PROVINCE

6.1 Introduction

In this chapter, an analysis of existing national and local policies on weather and climate are analysed and presented

6.2 Study approach

The study adopted a mixed methodological approach to analyse existing national and local policies on weather and climate on the utilisation of indigenous knowledge for crop production. According to Creswell (1994), the researcher uses multiple methods of data collection and analysis in seeking for convergence. A qualitative and quantitative approach in which interviews and documents are interpreted were adopted. Two paradigms of inquiry can be used to frame the same target phenomenon (Sandelowski, 2000). The researcher considered the interpretive paradigm in the study as guided by beliefs and feelings about the world and how it should be studied (Denzin & Lincoln, 2005). However, the positivist paradigm is also considered since both positivists and interpretivists believe that human behaviour may be patterned and regular (Fekede, 2010). The researcher believes that individuals can be creative and assert to reality. The combination of two paradigms of inquiry afforded the researcher to view the phenomenon from different perspectives.

The researcher initiated the interviews with individuals from government, and tried to understand their interpretations of their policies within their organisations. Document analysis was considered in the study to complement policy gap analysis from key persons from identified institutions or departments. Bowen (2009) regarded document analysis as a systematic procedure for reviewing or evaluating documents. The procedure entails selecting documents which are relevant to the topic under study. Document analysis is considered to supplement the information provided from other

sources such as stakeholders. The process of triangulation emerges under a combined method. Document analysis lies in its role in methodological and data triangulation, and the immense value of documents in case study research (Bowen, 2009). Triangulation helps the researcher to guard against the accusation that the study's findings are simply an artefact of a single method or a single source (Patton, 1990). Furthermore, the researcher triangulated data in an attempt to provide a confluence of evidence that results in credibility (Eisner, 1991). Sandelowski (2000) echoed that a researcher should allow participants to comment on each item on an instrument to appraise its contents and construct validity.

6.3 Target population

The target of the study was based on individuals from government institutions at national and local levels. The population of this study were government institutions where individuals answered the GAP analysis checklists (Annexure G). The institutions were selected based on its involvement in environmental related issues, which are closely related to the topic of the study. Institutions which were considered to participate in the study were as follows:

- Agriculture Research Council – Soil, Climate and Water
- Department of Environmental Affairs –International governance management
- Department of Agriculture, Forestry and Fisheries – crop production
- Department of Science and Technology – IKS policy
- Lepelle Nkumpi Local Municipality – environmental policy
- South African Weather Services – weather services

The selection of published and unpublished documents which reflect environmental issues were considered in the study. The researcher focused on policy documents for the review.

6.4 Sample size and sampling procedures

Sampling procedures has been discussed and presented in the previous chapters. Criterion purposive sampling was used to select different and relevant stakeholders to address the research question. Criterion purposive sampling is a kind of purposive

sampling of cases on preconceived criteria, such as scores on an instrument (Sandelowski, 2000). According to Gioia and Dziadosz (2008), criterion sampling is used to compliment qualitative and quantitative data together. Purposive sampling is a sample selected according to some characteristics of interest, or chosen on the basis of what the researcher thinks to be an average person (Mettrick. 1993; Bless & Smith, 1995). According to Welman et al. (2005), researchers relied on their experience, ingenuity and/or previous research findings to deliberately obtain units of analysis. By using the scores on an instrument, the purpose was to collect more data to discern the extremity of cases. The sample was considered to select relevant lead agencies in the agriculture, environment, weather and climate sector who have knowledge on policy issues to obtain their views on national and local policy situation. The selection of the leading government department or organisations was based on the researcher's experience in linking the phenomenon with the departments.

6.5 Data collection strategy and methods

A mixed method strategy was adopted to seek convergence between qualitative and quantitative methods. However, Creswell (2008) categorised qualitative data into interviews and questionnaires, documents and audio-visual materials. The interviews and document analysis were used to address the phenomenon. Therefore, the researcher opted for the methods aligned to the objective of the study. For the analysis to provide a holistic view, primary and secondary data were considered.

6.5.1 Gap Analysis checklist (Primary Data)

Gap analysis is seen as a process that measures the distance (i.e., the gap) between where a particular item currently stands and where it should be, to better meet the organisation's needs (Murray, 2000). However, the GAP Analysis checklist had self-evaluation questions regarding IKS element for weather and climate policy. The key issue on each question was on findings or corrective measures. GAP analysis checklist was used to gather information about the status of the policies within relevant organisations nationally and locally. A checklist sent to relevant stakeholders was filled and returned. In the checklist, the status of the policies were marked with an X "**not in place**", "**partially in place**" and "**in place**" with nominal scales of 1, 2 and 3. The GAP

analysis checklist provided a list of 10 questions to be answered in a tabular form (Annexure G).

Primary data was obtained from identified stakeholders who were willing to participate in the study. A request to participate in the study was sent to relevant stakeholders through emails, which was sent to the Department of Agriculture, Fisheries and Forestry (Crop production), Department of Science and Technology (IKS Directorate), South African Weather Services, Lepelle Nkumpi Municipality (Environment), Department of Environmental Affairs (International governance management), and Agriculture Research Council- Soil, Climate and Water (Agro climatology). Information from traditional councils about local guidelines or non-documented prescripts were also provided.

Key informant interviews (KIs) were conducted to provide key information on individual perspectives and experiences relating to policies on indigenous weather and climate knowledge. The key findings or/corrective measures elicited the gaps in the existing policies and legislative framework for the indigenous knowledge on weather and climate.

6.5.1.1 Email.

The e-mail in the study was used to send invitation messages to individuals from government institutions. The e-mail eliminated the need to synchronous interview times and allowed the researcher to interview more than one participant at a time (Meho, 2006). Prior to sending the GAP analysis checklist, individual participants were requested to make a contribution to the checklist. An e-mail was so effective since each individual submitted his responses within different days after providing their consent by returning a reply affirming participation in the study. The affirmation was received after the participants were provided with the information about the study. The approach has potential to show the participants that they are important, thereby encouraging them to participate (Dillman, 2000).

6.5.2 Document Analysis (Secondary Data)

Document analysis was considered for assessing existing policies. Corbin and Strauss (2008) regarded document analysis as a systematic procedure for reviewing documents that require data to be examined and interpreted in order to reveal a meaning. According to Bowen (2009), document analysis is a process of evaluating documents to produce empirical knowledge in order to develop understanding. Documents to be analysed consisted of published and unpublished information on policies, laws, local government and traditional affairs reports on indigenous knowledge, weather and climate. The information was retrieved from sources using an internet google scholar and printed materials. The information retrieved was based on environment policies relating to weather and climate as reported in chapter 4. In most cases, key words were used to locate the documents, and where they were not found, a relevant government department was visited to get the copy.

Furthermore, the review of published and unpublished policy document was conducted to gather information on policies that might impact on indigenous weather indicators as outlined in chapter 4. Some were considered to be having an indirect influence on one or two weather and climate indicators. The study adopted different ways in dealing with consistency, which entails selecting documents to be analysed. The selection of documents was primarily on government documents at national and local levels considering indigenous knowledge systems elements (Table 6.1).

Table 6.1: Selected documents for analysis

Policy document	National	Local
	✓	
Indigenous Knowledge Systems Policy 2004	✓	
National Climate Change Response 2004	✓	
Limpopo Department of Economic, Environment and Tourism - Climate Change Adaptation Strategies 2015		✓
Constitution of the Republic of South Africa (Act 106 of 1996) 1996	✓	
National Environmental Management: Biodiversity Act, 2004 (Act No, 10 of 2004)	✓	
South African Weather Services Act 8 of 2001	✓	
Strategic Plan for South African Agriculture 2001	✓	
Comprehensive Rural Development Strategy 2009	✓	
National Climate Change Response White Paper 2011	✓	
Governance of Climate Change in South Africa 2011	✓	
Disaster Management Act (Act 57 of 2002) 2002	✓	
Conservation of Agricultural Resources Act, 1983 (Act no. 43 of 1983)	✓	
SA Disaster Management Framework 2005	✓	

6.6 Data analysis methods

A content analysis was considered in analysing the documents and the scoring for availability. Content analysis is defined as the study of human communications (Babbie and Mouton, 2001). Qualitative content analysis could prove to be a useful tool for analysing data material in case study research (Kohlbacher, 2005). The data from Gap Analysis checklist was assessed based on an individual organisation's contribution on their status and corrective measures. The occurrence in terms of the policy status was based on **not in place (1), partially in place (2) and in place (3)**. The number outside the brackets represents the status, while the one inside represents the number of occurrence.

Secondary data was assessed by reviewing several published and unpublished material related to indigenous weather and climate knowledge. The inclusion of selected materials was based on weather and climate indicators as outlined in chapter 4. However, environmental policies, conservation and any other document contents were read and re-read to cover the information required.

6.7 Validity and reliability of the study

Reliability and validity in the study was guaranteed by triangulation, which is considered to be trustworthy. Triangulation is typically a strategy for improving the validity and reliability of research (Mathison, 1998). Patton (2001) emphasised that triangulation is strengthened by combining research methods. The strength of the study on policies lies in the combination of methods and research paradigms in addressing the issues of convergence. The responses from government institutions has effectively promoted cooperation and reliable results.

6.8 Ethical considerations

For the targeted institutions, it was proper to communicate with them effectively by introducing the purpose of the study. The ideas from the stakeholders were acknowledged upon receipt of the emails understanding their commitment to the study. A respect for the participants was maintained throughout the exchange of emails. The participants from institutions were not compelled to disclose whatever they did not want to disclose. South African Weather Services was afforded the opportunity

not to participate in the research. However, the researcher was governed by the research ethics code of the North-West University. Published and unpublished documents reviewed were referenced as a way of acknowledging them.

6.9 Results

6.9.1 Policy status

From Table 6.2, only institutions related to weather and climate were considered since farmers and traditional leaders seem to be unaware of policy development in the field of weather and climate. However, relevant stakeholders were able to complete the GAP Analysis checklist. Moreover, key institutions such as the South African Weather Services was unable to provide the information due to the fact that they are governed by many policies and would not be able to complete the checklist. The responses from the SAWS representative was that they are not willing to participate due to long legal processes. The results are represented in Table 6.2.

From the results, the Department of Environmental Affairs (DEA) seem to have more policy elements in place (9), with the Department of Science and Technology (DST) having indigenous knowledge components in place (1) and partially in place (7). Almost all institutions lack policy elements reflecting indigenous knowledge pertaining to weather and climate. However, DST seems to be comfortable with the indigenous knowledge systems policy even though weather and climate is not spelled out in the policy document. Furthermore, the Department of Agriculture, Forestry and Fisheries (DAFF), Institute for Soil, Climate and Water (ISCW) and Lepelle Nkumpi Municipality have no IKS policy elements in place.

Table 6.2: Policy Gap Analysis

IKS Elements: Weather and Climate Policy	DST			DAFF			ISCW			DEA			LNM			Occurrence	
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3		
a) Define environmental policy	x					x			x			x			x	1(1), 3(4)	13 (2.6)
b) Policy appropriate to the end users		x		x			x					x	x			2(1), 1(3), 3(1)	8 (1.6)
c) Commitment to continual improvement		x				x	x					x		x		2(2), 3(2), 1(1)	11 (2.2)
d) Policy commitment and compliance to environmental requirements		x				x			x			x			x	2(1), 3(3)	14 (2.8)
e) Framework to set and review the environmental policy objectives and targets		x		x			x					x	x			2(1), 1(3), 3(1)	8 (1.6)
f) Policy reflects documentation, implementation and maintenance		x		x				x				x		x		2(3), 1(1), 3(1)	10 (2)
g) Inclusion of indigenous components of weather and climate in policy		x		x				x				x			x	2(2), 1(1), 3(2)	11 (2.2)
h) Indigenous Knowledge Systems policy			x	x			x					x	x			3(2),1(3)	9 (1.8)
i) Indigenous Knowledge Systems policy part of environmental policy		x		x			x			x			x			2(2), 1(3)	5 (1.2)
j) Environmental policy accessible, readable and available to public		x			x		x					x	x			2(2), 1(2), 3(1)	9 (1.8)

Source: Interviews, 2015 1- not in place, 2 – partially in place, 3 – in place

The detailed information provided by the relevant stakeholders are described below:

6.9.1.1 Directorate: Environmental and Waste Management Services – Lepelle Nkumpi Municipality

The role of the directorate is to manage the overall environmental management of the municipality. The municipality has scored about five points of IKS elements reflecting the unavailability of procedures, framework, IKS policy, accessibility and readability of the policies. Whatever is partially in place within the municipality scored only two. One (1) environmental policy is in place and two (2) are documented and implemented. However, their environmental policy complies with other environmental requirements, it is defined and includes indigenous components relating to the weather.

In addressing or making corrective action based on the findings, the municipality is intending to:

- Write the policy using the language that end users will understand, not English.
- Improve the policy even though is more legislative and difficult to translate.
- Review and document the policy
- Update the website to allow end users to access policies.

6.9.1.2 Directorate: Plant Production - Department of Agriculture, Forestry and Fisheries (DAFF)

The role of the directorate is to manage the development and implementation of policies, programmes and strategies to support and improve sustainable plant production practices.

The results from DAFF show that many, almost six out of ten IKS elements, are not in place. However, only three elements are in place while one is partially in place. It was reflected that DAFF operation is also based on DST Policy, while the participant is not aware about other IKS elements.

6.9.1.3. Directorate: International Governance Management –Department of Environmental Affairs

The role of the department is the coordination and facilitation of international environmental governance and relations. Out of ten IKS elements, the directorate scored almost nine elements in place and only two not in place. The directorate has outlined the National Environmental Act and various prescripts being promulgated, including the climate change Response Policy paper. The directorate is deemed to be consulting widely relating to the question about the procedure and end user. According to the participant, NEMA, NEM: BA, NEM: PA, NCCRP are public documents that are available. However, the participant was not sure whether the IKS policy is present in the organisation or not. Further review showed no IKS considerations in the policy.

6.9.1.4 Directorate: Indigenous Knowledge Systems – Department of Science and Technology

The role of the directorate is to manage advocacy policy development activities in the department. The outcomes from DST was that almost seven IKS elements are partially in place while two are not in place and one is in place. The reflection from DST was that the IKS policy of 2004 is in place. However, its relevance in terms of the topic under study was important. The notes from the participant from DST were that:

- Policies are integrated in the DST's grand challenges – bio economy strategy
- The Department is putting a strategy on earth systems in place
- Earth observation forms part of the DST's programme
- The framework to review policies are sourced from NRF to agencies outside the department.
- IKS centre within the department is addressing issues of climate change and IKS.
- IKS policy addresses environmental issues.

6.9.1.5 Directorate: Agro-climatology – Agricultural Research Council

The role of the directorate is to disseminate weather forecast information to farmers.

The IKS elements scored by directorate not in place was six, two partially in place and another two in place. The participant did not submit notes to reflect on the status of the gap within their organisation. Due to the fact that they provide weather forecasting information, the environmental policy is key to their day to day work.

6.9.2 Reviewed documents

The researcher reviewed about twelve documents from different directorates. Of the twelve documents, indigenous knowledge systems policy reflects on the importance of IKS in Agriculture, Health and other fields. The policy does not put more emphasis on indigenous weather science. The rest of the documents do not reflect any indigenous weather and climate prescripts (Table 6.3). However, there are great improvements on climate change policy but local knowledge is not incorporated in the policy.

Table 6.3: Policy documents reviewed

Policies/Acts	Purpose	Status of indigenous weather and climate considerations in the documents			
		1 = not reflected	2 = Partially reflected	3= reflected	Frequency
Indigenous Knowledge Systems Policy 2004	Enable a framework to stimulate and strengthen the contribution of indigenous knowledge to social and economic development in RSA	✓			
South African Weather Service Act 8 of 2001.	Maintain, extend and improve the quality of meteorological service for the benefit of all South Africans	✓			
Limpopo Department of Economic, Environment and Tourism - Climate Change Adaptation Strategies 2015	To articulate Limpopo shared vision for responding to climate;	✓			
Constitution of the Republic of South Africa (Act 106 of 1996)	Protects basic human rights, in this case the environmental and property rights	✓			
Comprehensive Rural Development Strategy 2009	Land reform, agrarian transformation and rural development; need for infrastructure and services in rural areas.	✓			

Strategic Plan for South African Agriculture 2001	The plan sets out the framework for the development of action plans, key performance indicators, service delivery standards, monitoring and evaluation systems and time frames to address shortcomings within the agricultural sector, with a focus on good governance, integrated and sustainable rural development, knowledge and innovation, international coordination, and safety and security.	✓			
National Climate Change Response White Paper 2011	This White Paper presents the South African Government's vision for an effective climate change response	✓			
Governance of Climate Change in South Africa 2011	Aims to provide informed recommendations for appropriate governance and coordination mechanisms that can support the mainstreaming of climate change within all spheres of government.	✓			
Disaster Management Act (Act 57 of 2002) 2002	The Act is aimed at setting up systems for (a) preventing or reducing the risk of disasters; (b) mitigating the severity or consequences of disasters; (c) emergency preparedness: (d) a rapid and effective response to disasters; and 45 (e) post-disaster recovery and rehabilitation	✓			

Conservation of Agricultural Resources Act, 1983 (Act no. 43 of 1983)	The Act provides for control over the utilization of natural agricultural resources in South Africa in order to promote the conservation of soil, water sources and vegetation, and the combating of weeds and invader plants.	✓			
SA Disaster Management Framework 2005	Act provide an integrated and coordinated disaster risk management policy that focuses on preventing or reducing the risk of disasters, mitigating the severity of disasters, preparedness, rapid and effective response to disasters, and post-disaster recovery	✓			
National Environmental Management: Biodiversity Act, 2004 (Act No, 10 of 2004)	The objective of the Act is for the protection of species and ecosystem that warrant national protection, the sustainable use of indigenous biological resources as well as the fair and equitable sharing of benefits arising from bio- prospecting involving indigenous biological resources.	✓			

Source: document analysis 2016

6.9.3 The non-documented policy prescripts: indigenous guidelines

Several communities indigenous to their environment have practised indigenous ways of governance through the implementation of guidelines or undocumented policy prescripts in dealing with day to day activities. The main undocumented prescripts as outlined by participants during the interviews conducted earlier during the study in the six traditional councils was that of *diila*. The *diila* concept has been used for millennia by communities throughout the municipality and South Africa as a preventative measure to avert unlawful acts. The following guidelines used to prevent unlawful acts are as follows:

- Children are prohibited from harvesting unripe wild fruits during the rainy season because the area might experience a hail storm.
- No one is allowed to throw unwanted materials (*dibeela*) in the veld because the materials will disturb the occurrence of rainfall.
- At the beginning of the rainy season, community members should go to the veld to collect *dibeela* in the process of purifying the land.
- No one is allowed to cut trees of cultural importance such as *Morula* (*Sclerocarya birrea*), *Mopipi* (*Foetid shepherd tree*), *Mosehla* (African wattle) and *Mohlopi* (Shepherd tree).

These guidelines impacted positively on the knowledge of communities in weather and climate. The policies or guidelines are not documented but they were of significant important for the livelihoods of the communities. The dominant western education schooling system prevented communities from exercising their indigenous ways of learning and practice. Therefore, the development of policies by policy makers tends to ignore the voices of the communities they are formulating the policies for.

6.10 Discussions

The combination of research approaches yielded positive results in that what has been reflected in published documents correlate with what individuals from institutions provided. Despite all the published and unpublished policies within the country, no policy is impacting on the indicators as indicated in chapter 4 because the participants are only observing and experimenting. Even the listed plant and animal species regarded as threatened are not subjected to any threat. In terms of section 57 (1), (2) and (4) of the National Environmental Management: Biodiversity Act 10 of 2014,

prohibition and protection is linked to weather and climate indicators. The constitution of South Africa, Act 108 of 1996, provides for the overarching regulatory framework for environmental governance in South Africa. It stipulates that everybody has the right to an environment that is not harmful to their health and wellbeing and balances the rights of people to enjoy social and economic development while having their environment protected. However, non-documented local guidelines show how communities managed and interacted with their environment.

The constitution further allocates environmental responsibilities across government spheres, and provides for the groundwork for the “architecture of entitlements” from which the country can pursue adaptation options (Madzwamuse, 2010). However, the listed species are of a concern to communities because they disappear from the local environment due to many factors such as population increases, disturbance of their natural habitat, and so forth. . Only one indicator (*mohlopi*) was listed in the government gazette RSA of 20 November 2014 volume 593 on page 122. Furthermore, the contributions made by relevant stakeholders were informative.

The key stakeholder, South African Weather Services did not make any contributions to the study after many attempts were made to indicate the importance of the study. The feedback received from SAWS shows elements of discomfort and imposition of western norms within the organisation. However, the mandate of SAWS is to maintain, extend and improve the quality of meteorological service for the benefit of all South Africans (SAWS, 2001). Whether the researcher assesses and reviews the impact of policies pertaining to weather and climate, the coordinated efforts should be reflected within the country in terms of flexibility towards communities. Policy formulation is still considered by those who are not directly affected by food insecurity at a household level.

6.11 Conclusions

Since the South African government has not yet reached the level where all its citizens have equal opportunities and transformed to improve the lives of rural communities, their knowledge systems, policy formulation and implementation remains a challenge. Even though the voices of the communities are not incorporated in policy documents, these communities depend entirely on the non-documented measures put in place

within the community. It is very important that the policies within government structures link with each other to address community concerns. The weather science is still in the control of those who push the western ideologies. Documents from the environment as used in the assessment provided a platform for the indigenous weather and climate knowledge since it (the environment) becomes very critical at the micro climate level where the communities reside.

It is therefore, recommended that knowledge of the communities should be considered in policy formulation at an initiation stage. Participation in policy formulations or development should be encouraged and supported by the government in order to sustain and promote knowledge management. Awareness campaigns should be promoted in rural areas to encourage communities to be aware of any policy development which might affect their livelihoods. The government should also promote a top down approach in research and policy development.

CHAPTER SEVEN

ALIGNING LONG TERM WEATHER AND CLIMATE KNOWLEDGE SYSTEMS OF LEPELLE NKUMPI MUNICIPALITY

7.1 Introduction

In this chapter, a study approach is presented in detail. A data collection strategy was used to collect primary and secondary data. Content analysis as a method of analysing data, results, discussions and conclusions and recommendations are described.

7.2 Study approach

An exploratory research approach was adopted in the study to embrace both primary and secondary data. Exploratory research uses an open, flexible and inductive approach to research and is commonly used to gain insights into the phenomenon being studied (Durrheim, 1999). Exploratory research is associated with qualitative approaches to research. Qualitative research is commonly used to explore ideas from different sources. Pope et al. (2000) and Smith (2000) posited that qualitative research is more commonly used to inductively explore and provide detailed description of a phenomenon, and is distinguished by its reliance on inductive reasoning to interpret and structure the meanings that can be derived from data.

Qualitative data analysis occurs concurrently with data collection so that the researcher can generate an emerging understanding about research questions, which in turn informs both the sampling and the questions being asked (DiCiccoBloom and Crabtree, 2006). Through exploratory research, the researcher was able to understand relationships between variables from primary to secondary data. Exploratory research is therefore governed by primary and secondary data, which is guided by the theoretical perspectives. The integration of methodological approaches strengthens the overall research design and added benefits. Both primary and secondary data can be either qualitative or quantitative.

7.2.1 Primary data

The primary data of the study was derived from the participants and observations by the researcher. Primary data provides information about virtually any facet of life and surroundings. Walliman (2011) regarded primary data as data observed, experienced or recorded close to the event, the nearest one can get the truth. Primary data is most generally understood as data gathered from the information source and which has not undergone analysis before being included in the needs assessment (ACAPS, 2011). Furthermore, observational data is very useful in overcoming discrepancies between what people say and what they actually do (Patton and Cochran, 2002).

7.2.2 Secondary data

Secondary data are data that have been interpreted and recorded (Walliman, 2011). Secondary data assisted the researcher in making sure that the information assessed is of good quality. According ACAPS (2011), secondary data is information typically collected by researchers not involved in the current assessment and has undergone at least one layer of analysis prior to inclusion in the needs assessment. Secondary data in the study comprised weather and climate data for four weather stations in the municipality, reflecting the average total rainfall, temperature, average daily minimum and maximum temperature, and average wind speed.

7.3 Target population

The same group of knowledgeable participants from traditional councils as presented in chapter 4 were considered in the study. Furthermore, a historical data on weather and climate was considered to elicit indigenous and western ways of understanding weather events. The historical weather and climate data was provided by the Agriculture Research Council in Potchefstroom.

7.4 Sample size and sampling procedures

A sampling procedure as described in chapter 4 was followed. The traditional council members were purposively selected for the interviews as described in chapter 4 as they are knowledgeable about their locality and weather and climate patterns. The interviews were conducted to a manageable 13 knowledgeable participants (both male and female) emanating from six traditional councils who were able to share their experiences on weather events during their lifetime. The selection of the group was through the interviews conducted in each traditional council as elicited in chapter 4.

Realising the importance of the *Kgoro*, the same group that provided the information earlier during the study was used. According to Rhoades (1982), interviews with groups of farmers are frequently livelier than with only one person. Group interviews are useful for tapping the collective wisdom or memory of a community (Mettrick, 1993).

7.5 Data collection strategy and methods

Quantitative and qualitative designs were used to elicit the information provided. In this study, two data types were collected. Data on historical weather and climate events was collected during the interviews with knowledgeable traditional council members from six traditional councils using an interview schedule. The interviews were recorded using a video camera, and were later transcribed verbatim as described in chapter 4. Secondly, long-term climatic data was acquired from the Agriculture Research Council in Potchefstroom for the localities within the municipality. A timeline of rainfall and temperature events was drawn from the participants, and thereafter collated to the recorded empirical rainfall and temperature data for the past 30 years sourced from the Agriculture Research Council (ARC).

7.5.1 Long-term climatic data

A long-term climatic data was used to indicate the period of weather patterns for the past 30 years. The data provided the averages on rainfall, temperatures and wind speed. Therefore, the data assisted the researcher to present the information in the form of graphs.

7.5.2 Interview guide and video recorder

As described in chapter 4, an interview guide was used to gather information on historical climatic events, which occurred in the municipality. The interview guide was administered to participants from all six traditional councils who are knowledgeable about indigenous weather and climatic issues. In the process of administering the guide, a video recorder was used to capture the conversations. The video transcripts were later transcribed verbatim, and afforded the researcher to develop a timeline of events in a chronological order.

7.6 Data analysis methods

Qualitative content analysis was adopted in the study. Content analysis is a method of analysing written, verbal or visual communication messages (Cole, 1988). Welman et al. (2005) described content analysis as a quantitative analysis of qualitative data, which allows the researcher to test theoretical issues in order to enhance understanding of the data (Elo and Kyngäs, 2008). It is a dynamic form of analysis of verbal and visual data that is oriented towards summarising the informational contents of the data (Morgan, 1993). Sandelowski (2000) opined that qualitative content analysis is the least interpretive of the qualitative analysis approaches in that there is no mandate to re-present the data in any other terms but their own. According to Carley (1990), specific concepts or variables in qualitative texts cannot necessarily be studied in a quantitative way because concepts or variables may have quite different meanings when relationships between them are taken into account.

In content analysis, the analysis involves examining the contents of the sources to record the relative incidence of themes as well as the ways in which these themes are portrayed (Welman et al., 2005). A new data was considered as analysis continued. The researcher has to organise qualitative data and grouped them together to yield a reasonable meaning. Video transcriptions have been subjected to a systematic and iterative process of searching categories and integrating data. Through the transcriptions, the analysed data on weather events was used as reported in chapter 4. Each video was assessed based on historic events in each traditional council. The historical data from different traditional councils was grouped and synthesised based on checklist used. For long-term climatic data, average totals of rainfall, and temperature (minimum and maximum) were captured (Figure 7.1, 7.2, 7.3 7.4 and 7.5).

7.7 Results

From the interviews conducted with the six traditional councils, knowledgeable participants revealed more impressive and devastating information about weather events during their time. The results were based on the years of events and impact observed (Table 7.1). Videos from the traditional councils are represented by V1 to V6. Qualitative descriptive and sourced data was also analysed through categorisation into rainfall, temperature and wind, and then presented by means of graphs.

Table 7.1: List of years of climatic events

	V1	V2	V3	V4	V5	V6
Year of events	1953, 1976	1990, 1997, 1982	1976, 2000, 2015	1967	1956, 1976, 1986, 1990, 1996, 1998	1945, 1947, 1950, 1948, 1949, 1950, 1951, 1956, 1980, 1996

From Figure 7.1, it was clear that the observations made by the participants contributed greatly to the livelihood of the communities. Extreme weather events which occurred, especially drought occurred for almost six years in succession from 1945 to 1951. After experiencing drought, the communities were then subjected to floods and thunderstorms. The results show that after 1966, the communities received good rains coupled with flooding.

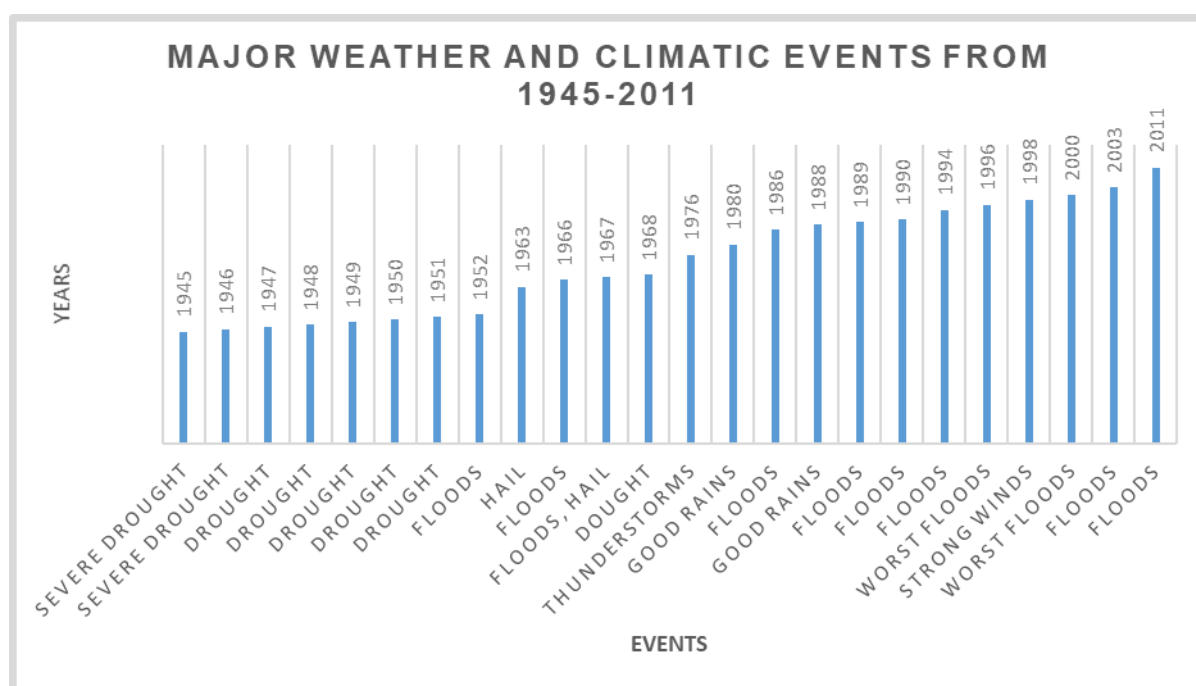


Figure 7.1: Major weather events in Lepelle Nkumpi Municipality from 1945 to 2011
(Source: Traditional Council members' interviews)

According to Kabanda (2017), drought in Limpopo Province occurs in different categories (Severe, Moderate and so forth) depending on other forcing factors. In this study, no such categories were defined. However, the Traditional Council members

were able to recall droughts that had severe impacts on their livelihood. Therefore, this study adopts the term severe drought.

Severe droughts were observed during 1945 and 1946, while other droughts remembered include those of 1947, 1948, 1949, 1950, 1951, and 1968. Recollection of floods events were those which occurred in 1952, 1966, 1967, 1986, 1989, 1990, 1994, 1996, 2000, 2003 and 2011. The worst floods were experienced in 1996 and 2000. These adverse weather phenomena could affect severely the community livelihood. Since agricultural production can be significantly affected by the risks posed by weather, while crop growth and yield can be affected by stress factors due to weather and climate variations. Although adverse weather and climate were experienced during those times, it is clear that smallholder farmers were adapting and surviving under varying conditions of severe drought and worst floods. It was demonstrated in Chapter 4 on compiled weather timeline and its impact on the livelihood of the communities. Changes were observed and survival strategies developed. Traditional Council members' recollections were not enhanced by conventional weather observation and forecasting at any time – after all, during that period the weather stations were not yet in place. According to Kolawole et al. (2014), not only personal experience counts on indigenous weather observation and forecasting - but trend analysis also counts.

7.7.1 Aligning participants' information and weather station information

It is evident that observations by knowledgeable participants are in conflict with what has been recorded through weather stations. For example, the participants do not use conventional units such as millimetres to measure the amount of rainfall within an area, but use their intuitive understanding. What is good or bad in relation to drought is observable. The two knowledge systems are incomparable since no knowledge is superior to the other. The information provided by the participants was observed and experienced before the introduction of weather stations in 1974 to date (Figure 7.1). Twenty years prior to the introduction of weather stations, has proven that the participants are indeed knowledgeable about their environment by recalling extreme weather events. Probabilistic information acquired from personal experience is processed and applied more effectively than information acquired from statistical descriptions (Hansen et al., 2004). As mentioned earlier, less contribution has been made from the conventional weather recorded information. Rainfall and temperature

records assist in determining the extent of drought, heavy rains and heat waves that can affect negatively or positively on crops. Any crop failure or success is associated with the knowledge.

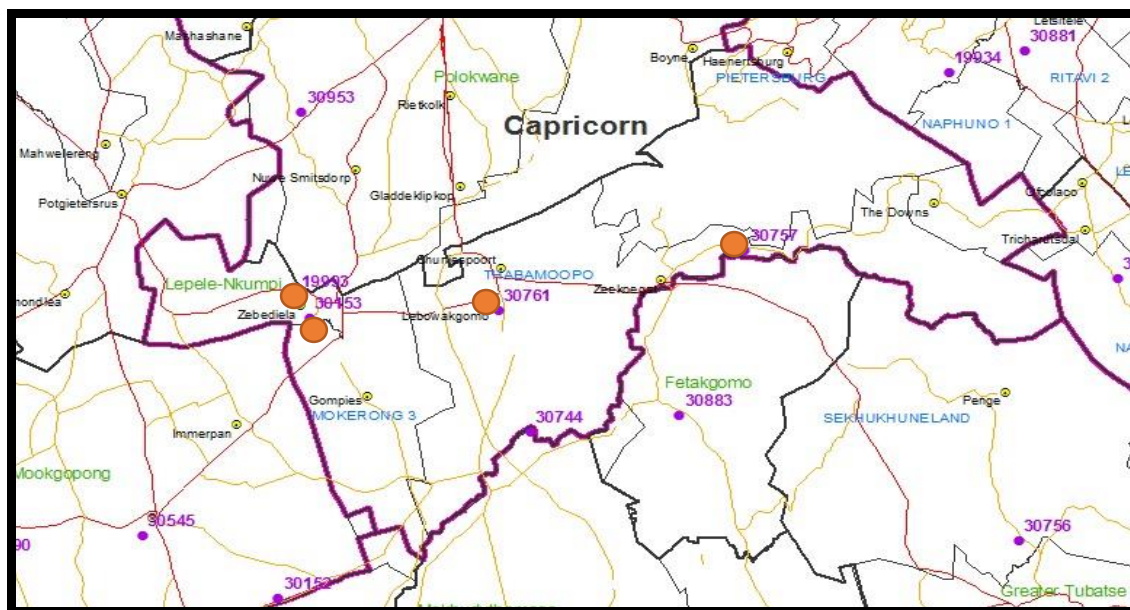


Figure 7.2: Shows the location of three weather stations in Lepelle Nkumpi Municipality (19993/30153; 30761 and 30757) **Source:** South African Weather Bureau (SAWB) (1986).

Figure 7.2 shows the three weather stations which monitor daily weather in Lepelle Nkumpi Municipality. Zebediela station (19993/30153) is located in Zebediela Citrus Estate on the western part of the municipality. Lebowakgomo station (30761) is located in the middle of the municipality where government offices are located, while Grootfontein station (30757) is located in the eastern part of the municipality. The data from the three stations does not show any significant difference when assessing mean rainfall from October to March (summer season) and May to September (winter season).

7.7.2 Mean monthly rainfall at three weather stations in Lepelle Nkumpi Municipality

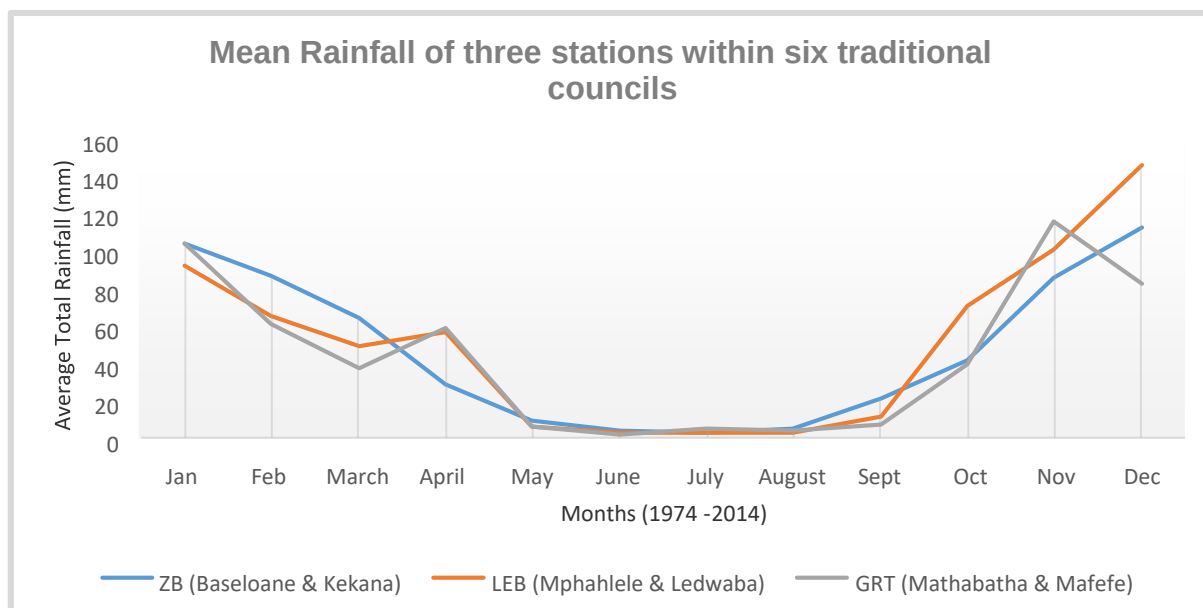


Figure 7.3: The mean rainfall (mm) pattern at Zebediela (altitude ~1250 m), Lebowakgomo (altitude 968 m) and Grootfontein (altitude 720 m) weather stations for the period 1974-1995. (**Source:** South African Weather Bureau (SAWB), 1986).

Figure 7.3 above indicate a summer rainfall area in Lepelle Nkumpi municipality for the period 1974 – 1995. . Mean rainfall in the three-rainfall station from May to August is below 10mm of mean monthly rainfall, which is a common pattern of summer rainfall area in Lepelle Nkumpi municipality. The three weather station indicate an onset of the rainfall season in November with mean rainfall of above 60 mm. Lebowakgomo (LEB) area has the highest mean rainfall from September to December while Zebediela (ZB) has the highest mean rainfall from January to March. Even though ZB has a high mean rainfall during January to March period, Lebowakgomo, Mathabatha & Mafefe area have a high mean rainfall in April. However, Mathabatha and Mafefe receives a low mean rainfall throughout the entire summer season.

Despite the mean rainfall as depicted from the three weather stations, Lepelle Nkumpi municipality experienced a decreasing trend from February to September and an increase from October to January. However, assessed local weather and climate as grouped and synthesised from different traditional councils in Lepelle Nkumpi municipality was predicted and interpreted through observable variables such as plant phenology, biological, and astronomical indicators. The severe or extreme occurrences of weather and climate events

as given figure 7.1 provide a framework that traditional councils and smallholder farmers use to explain relationships between particular events and changes (Mertz et al, 2009).

7.7.3 Mean annual rainfall in Lepelle Nkumpi Municipality from 1974 to 2014

Hydrological imbalance in any country can be caused by a period of long abnormality of dryness. Severe drought occurrence has a direct impact on food production. From Figure 7.3, Baseloane and Kekana tradition councils receives an average total rainfall of 40mm to 85mm, respectively. In the other traditional councils, there were no weather stations until 2006, and the data for that period is not available. The Zebediela weather station had to service Zebediela Citrus Orchard during the 1970's. Although, the data collected was not meant to assist the smallholder farmers within the two traditional councils.

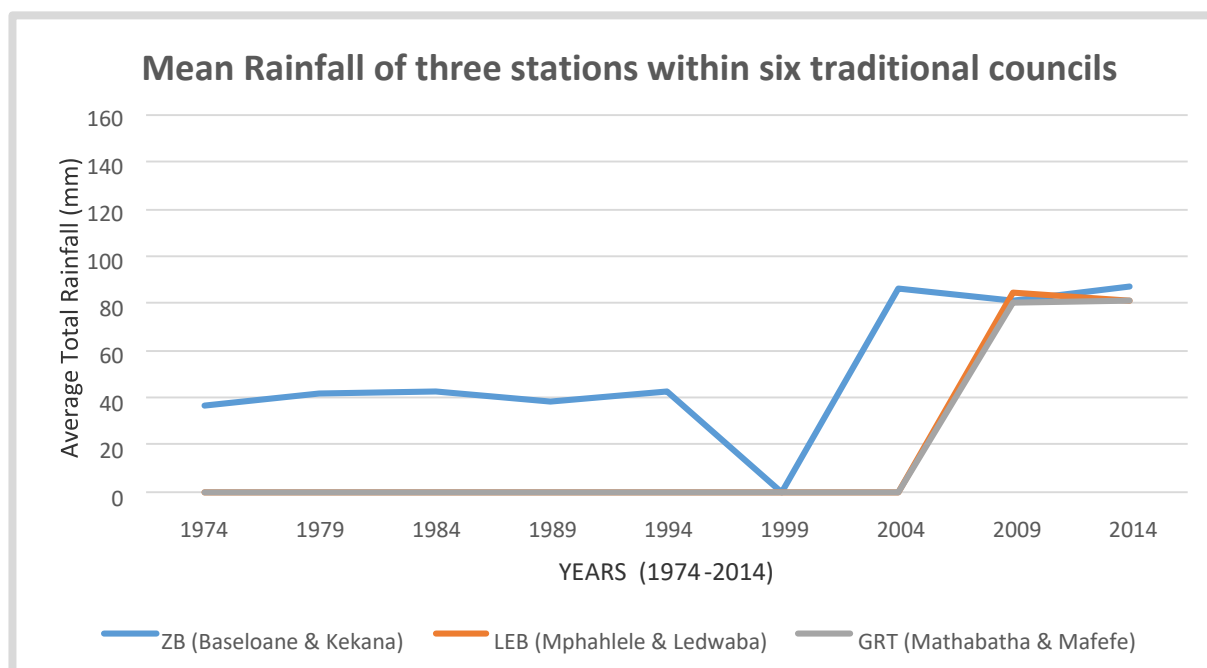


Figure 7.4: Mean annual rainfall at Zebediela (altitude ~1250 m), Lebowakgomo (altitude 968 m) and Grootfontein (altitude 720 m) weather stations for the period 1974-1995. (**Source:** South African Weather Bureau (SAWB), 1986).

Figure 7.4 shows the mean annual rainfall of Lepelle Nkumpi municipality from 1974 to 2014. From 1974 to 1994, Zebediela (ZB) received mean rainfall around 40 mm and dropped from 1994 to 1999. However, the rainfall picked up again in 1999 from 0 mm to almost 83 mm in 2014. The other two localities, Lebowakgomo and Grootfontein

shows an average total rainfall of 0 mm from 1974 to 2004. The data for the two stations were not recorded for the period based on other unknown factors. However, Mbogga et al. (2009) posit that the shorter the historical time interval of interest, the less reliable the climate surfaces are due to the inability to represent unique local weather patterns over short term interval. According to the knowledgeholders or participants, the period between 1976 to 2011 Lepelle Nkumpi municipalities received floods disputing the information recorded for the two localities. From 2004 until 2014, the area had an average total rainfall of above 80 mm.

7.7.4 Monthly mean maximum temperature in the three localities

Figure 7.5 shows that maximum temperatures in January, February and December are at a range of 29 to 31 °C than August. In Zebediela (ZB) (Batau Baselaone and Kekana villages) and Lebowakgomo (LB) (Mphalahlele and Ledwaba vilages), the average monthly maximum temperatures are below 30 °C while Grootfontein area receives around 33°C during January, February, November and December, respectively. However, average monthly maximum temperatures below 25 °C were experienced in both areas during the period between May and August. .

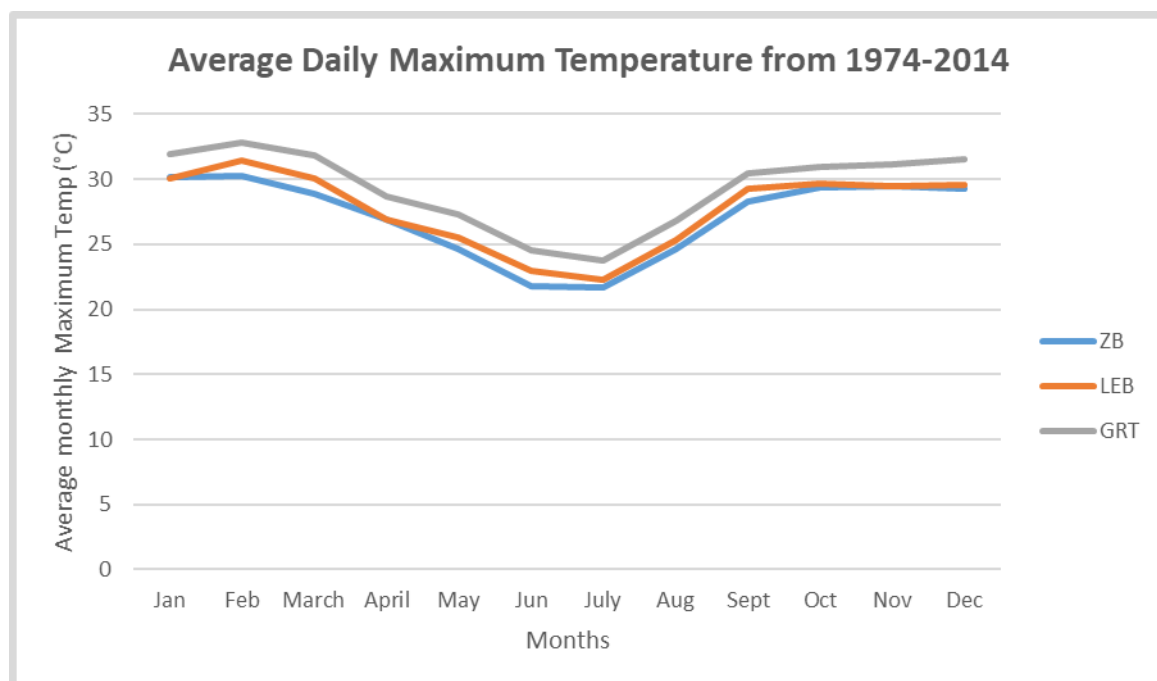


Figure 7.5: Average monthly maximum temperature from 1974-2014

Source: South African Weather Bureau (SAWB) (1986).

7.7.5 Mean minimum temperature in the three localities

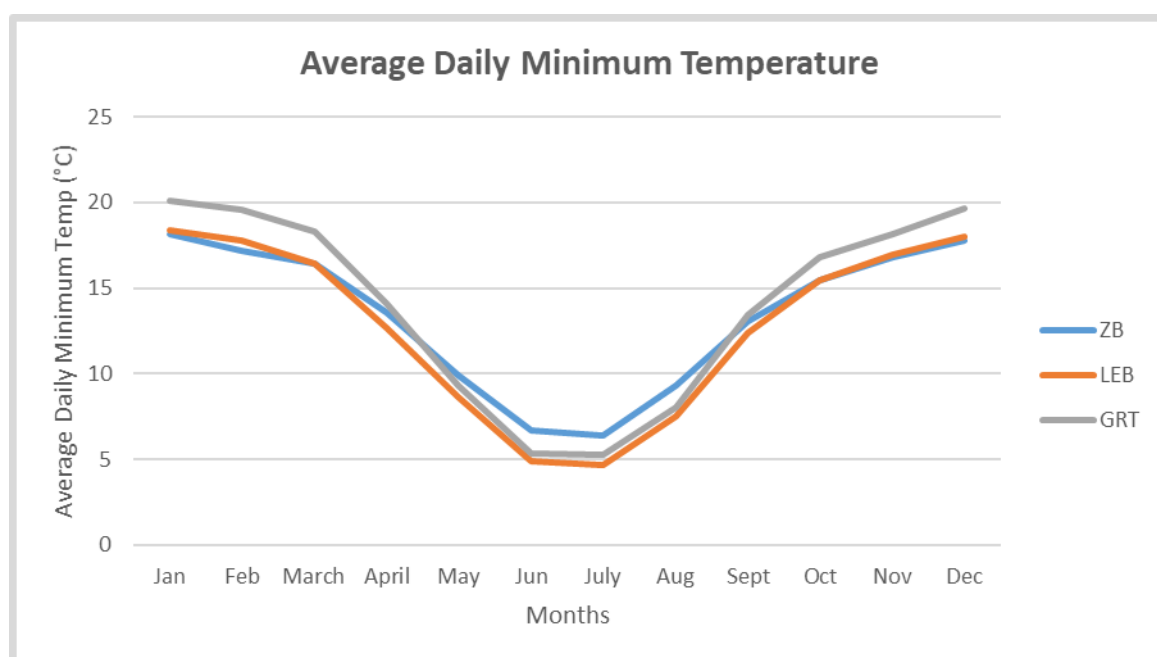


Figure 7.6: Average daily minimum temperature (**Source:** South African Weather Bureau (SAWB), 1986).

Figure 7.6 show average daily minimum temperature area in Lepelle Nkumpi municipality. Average temperature from June to July is below 10 °C of daily monthly temperature. Monthly temperature shows an onset of average daily minimum temperatures in October with average temperatures of above 15 °C. Lebowakgomo (LEB) and Zebediela (ZB) has average daily temperature of less than 20 °C. Even though both LEB and ZB have average minimum temperature above 15 °C in January to March, Grootfontein alone has an average daily minimum temperature of 20 °C. However, there is no different between the three localities on temperatures below 15 °C.

The participants as indicated earlier are not using western weather variables such as degrees Celsius. Therefore, the variables such as (*tonya*) cold, (*borutho*) cool and (*fiša*) hot are commonly used by the participants when reflecting on temperatures within their environment. The coldness and hotness of minimum and maximum temperatures are not measured as indicated but felt through human bodies. The human feeling of whether it is cool or hot, determines how an individual react on temperatures. However, participants have reflected on a very hot summer month such

as December as *letsatsi la motshidi* (sun of the wild plums). It is therefore noted that the two knowledge systems of weather prediction are not comparable in terms of variables used (degrees Celsius vs plant phenology/human body).

7.8 Discussions

From the results, recorded information from the participants reveals different approaches to weather and climate knowledge. The nature of information provided by the participants cannot be linked to only one western weather and climate knowledge. The recorded information from the weather stations and memories of people differ. The participants reflected on the years of observing and experimenting on drought, wet and flood conditions. What defines drought, wet and flood conditions differs epistemologically. As indicated earlier, there is no knowledge superior between the two knowledge systems. It was not easy to compare the two based on the variables used on the western system. The consistency of indigenous weather and climate knowledge and western weather and climate knowledge is only a step to facilitate their linkages.

Considering recorded information from weather stations and that of the farmers, it was clear that the two knowledge systems are completely different. Irrespective of their differences, one can complement the other. However, Alexander et al. (2011) suggested that in areas where temperature data is not in place, indigenous knowledge narratives may be able to serve as proxy records. There is much emphasis on the indigenous knowledge to be complimenting western knowledge; much has not been said about the western knowledge complimenting indigenous knowledge.

Power relation in South Africa is still more prevalent. There is wider gap to implement Indigenous Knowledge policy since its inception in 2004. Even the South African Weather Services as outlined in Chapter 5 has not changed; they are still implementing western ideologies to address weather and climate issues. Knowledge from the west is still dominating academic fields dealing with environmental sciences, meteorological and climatological studies. Agrawal (1995) argues that the basic distinction between the two knowledge systems is artificial. The mistrust is regarded by Ammann (2007) as too abstract, analytical and divorced from the needs of rural people. Hiwasaki et al. (2014) stressed that linking different knowledge is a long-term process that requires the building of trust and relationships and the commitment of all stakeholders involved.

According to Domfeh (2007), African countries continue to face major challenges on how to reconcile indigenous knowledge and modern/western science without substituting each other, respecting the two sets of values, and building on their respective strengths of several studies by Abah et al.(2015); Mazzocchi, (2006); Millar and Dittoh (2004) who have the same concern as Domfeh. Farmers are known to make decisions on cropping patterns based on local predictions of climate and decisions on planting dates based on complex cultural models of the weather (Nyong et al., 2007; Die, 2011; Briggs, 2013; Hiwasaki et al., 2014; Keane et al., 2017).

7.9 Conclusions

As long as the South African government is not reactive towards the implementation of the indigenous knowledge systems policy, the linkage between the two knowledge systems will not be possible. Researchers from academic fields are still translating research findings using western mode of interpretations. Indigenous weather knowledge has been under-estimated for too long, and linkage with western weather knowledge is non-existent in Africa. Only collaborations were made possible by rainmakers in western Kenya and farmers in Southern Malawi (Guthiga & Newsham, 2011; Kalanda-Joshua et al., 2011) and not linkage. South Africa is very slow in addressing issues of indigenous knowledge as part of the knowledge economy. It is worth noting that indigenous weather and climate knowledge cannot simply subscribe itself to western knowledge approaches.

The South African Weather Services is not attempting to address and create opportunities and to support local farmers at micro weather and climate level. Decisions taken by smallholder farmers on crop production are far linked to the weather and climate provided by the South African Weather Services and Limpopo Department of Agriculture and Rural Development. Crop yield cannot be linked to information provided through western knowledge due to its uncertainty and unreliability. Alignment of weather and climate knowledge would require reliable information on both knowledge systems.

The alignment process can only be achieved through local and national government supporting community initiatives. To avoid any cultural imperialism or unsustainability, western worldviews need to appreciate local worldviews. It is recommended that the South African Weather Services consider indigenous knowledge systems of weather

forecasting/prediction as vital in addressing poor weather forecasting information provided. Local initiatives on weather and climate information should be considered in order to achieve a comprehensive weather and climate information without compromising any knowledge system.

Furthermore, farmers should be encouraged to lead local initiatives and to provide guidelines/protocols on how it can be done. Weather and climate should be packaged using local language for better understanding and utilisation. Workshops and awareness campaigns should be conducted by both western and indigenous scientists in order to strengthen the linkage process. Community forums on weather and climate should be established in the municipality.

CHAPTER EIGHT

A MODEL OF INTEGRATING INDIGENOUS AND WESTERN WEATHER AND CLIMATE KNOWLEDGE SYSTEMS TO IMPROVE CROP PRODUCTION

8.1 Introduction

In this chapter different approaches are explored to elicit the ways in which indigenous and western weather and climate knowledge can be integrated. The chapter report on research validation workshop conducted at the municipality. The objective of the study guided the researcher and the participants in developing interactive processes. The results of the workshop as guided by the participants are discussed and presented.

8.2 Study approach

The study adopted a participatory research approach. The purpose of using participatory approach in research was to afford the participants opportunities to meet and interact with each other, and to validate the research outputs from the interviews conducted within their six traditional councils in the process of developing a model. Participatory research encompasses the utilisation of diverse approaches in providing the participants opportunities to voice their displeasures. An argument by O' Malley and O' Donoghue (2001) is that empowerment is achieved when people develop their own solutions than imposing ideas on them. Participatory research is a research approach which involves participants throughout the research process. Participatory research methods are geared towards planning and conducting the research process with those people whose life-world and meaningful actions are under study (Bergold & Thomas, 2012). Furthermore, indigenous research involving participants encompasses the relational epistemological, relational axiological and relational ontological underpinnings which are governed by the relational theory as described earlier in chapter 2.

Much has been said about the issue surrounding the study approach, epistemology, axiology, ontology and relational issues in chapter 2. Knowledge of participants in a participatory approach is vital in a workshop setting. Building relationships with communities assert to successful interventions and long term relations. Bergold (2007) regarded participatory research as a methodology that argues in favour of the

possibility, the significance, and the usefulness of involving research partners in the knowledge production process. In considering the participatory research approach in the study, knowledge generating activities outlined in the title becomes vital and encouraging. It was envisaged that the participatory approach promotes collaborative efforts. The essence of collaborative efforts is manifested in openness, experience, personal views and effective communication. Sampling within the participatory research lies on the purposive approach. The purpose of using the method was to give voice to the participants in order to reflect on their own experiences about their environment. However, Bellon (2001) advised that the key decisions for a scientist using the participatory approach are to decide where to work (site), who to work with (participants) and how to work with them.

8.3 Target population

8.3.1 Focus Group Discussion

Focus group consist of a small number of individuals that are drawn together for the purpose of expressing their opinions on a specific set of open questions (Welman et al., 2005). Three focus groups comprising of 5 participants each were selected carefully to address the question posed on the phenomenon. The activities introduced to the groups were as follows:

- Introduction of the theme or topic of the day (leading main question)
- Outline rules for group work/discussions
- Make presentations of group outcomes

According to Albertse (2007) a well-ordered discussion, a group of participants can share their thoughts and ideas and so inform on their attitudes, perceptions and behaviour regarding a specific topic. Traditional council representatives from six traditional councils were considered for the validation research workshop. The participants were purposively selected to participate in the workshop due to their experience and knowledge reflected during the first stages of the research undertaken in different traditional councils. Intimate knowledge of the phenomenon of interest is possessed by participants who meet or exceed specific criteria by the virtue of their experience, making them information rich (Palinkas et al., 2013). Almost 26 participants who made contributions during the research process as reported in

chapter 4 were considered for the workshop to validate their outputs. The indigenous weather and climate knowledge workshop was held on the 16th of March 2016 at Lebowakgomo, Lepelle Nkumpi Municipality Hall. The aim of the workshop was to share understandings and views on how to integrate indigenous and western weather knowledge regarding weather prediction/forecasting.

8.4 Sample size and sampling procedures

The same participants as mentioned in chapter 4 were considered in this chapter. The researcher had to consider a self-selection or purposive sample which implies that the participants who are involved in the research are recommended to participate in the knowledge validation workshop due to their experience and knowledge. According to Patton (2002), purposeful sampling is a technique widely used in qualitative research for the identification and selection of information-rich cases for the most effective use of limited resources. Bernard (2002) further attested that continued use of purposive sampling techniques, the researcher learns how to choose informants efficiently and wisely. In this study, best knowledge-holders were selected to answer research question.

Furthermore, the researcher decides what needs to be known and sets out to find people who can and are willing to provide the information by virtue of knowledge and experience (Lewis & Sheppard, 2006). By virtue of selecting key individuals, the researcher's intention was to maximise efficiency and validity. Knowledge validation workshop comprising of 26 participants, traditional council members, and agriculture advisors was considered to be a platform for knowledge sharing. A validated workshop took place at Nkumpi Lepelle Agriculture Hall, Capricorn District in Lebowakgomo from 16 March 2016, and was held under the theme: *"how can we integrate the two knowledge systems about weather and climate?"* The main objective of the workshop was to find synergies between indigenous and western weather knowledge systems in developing an integration model relevant to local application.

However, other organisations such as Limpopo Department of Agriculture and Rural Development and Department of Agriculture, Forestry and Fisheries (DAFF) representatives from the Crop Production section were considered to participate in the workshop. Other participants from the Department of environmental Affairs, Lepelle Nkumpi Municipality, climatologists and meteorologists from the Agriculture Research

Council and the South African Weather Services were invited to the research validation workshop.

8.5 Data collection strategy and methods

A participatory research strategy and conversational method were used in collecting data during knowledge validation workshop.

8.5.1 Conversational method

The study adopted a participatory research approach. The purpose of using a participatory research approach was to afford participants opportunities to meet and interact with each other and validate the research outputs from the interviews conducted within their six traditional councils. Participatory approach encompasses the utilisation of diverse approaches in providing participants opportunities to voice their displeasures. An argument by O' Malley and O' Donoghue (2001) is that empowerment is achieved when people develop their own solutions than imposing ideas on them. Therefore, a conversational method was adopted for the study. According to Kovach (2010), conversational method aligns with indigenous worldview in that it honours morality as means of transmitting knowledge and upholds the relational need which is necessary to maintain a collectivist tradition.

Conversational method necessitated the introduction of knowledge validation workshop for the research conducted earlier and for making coordinated recommendations. Mettrick (1993) posits that the participants can also be regarded as key informants as they are essential to virtually any kind of study which includes social dynamics. Fundamentally, integrating indigenous knowledge with western knowledge first begins with knowledge construction and development processes (World Bank, 1998a).

The method can best be described as dialogic approach to gathering knowledge that is built upon an indigenous relational tradition. Furthermore, the relational factor emerged that the researcher is familiar with the participants and creditability has been built. The relation was guided by the context in which the research is conducted and guided by the economic, social, spiritual and overall welfare of the participants. The usage of conversational method in the study evokes several distinctive characteristics such as knowledge, relational, decolonization and local protocols (Kavoch, 2010).

Deeper conversations can only be achieved when participants have trust on the researcher. The conversational method necessitated the introduction of a workshop for the research conducted earlier and for making coordinated recommendations. Mettrick (1993) further echoed that the participants can also be regarded as key informants as they are essential to virtually any kind of study which include social dynamics. Fundamentally, integrating Indigenous knowledge with western knowledge first begins with knowledge construction and development processes (World Bank, 1998b).

In the process of constructing knowledge, the researcher played a 24-minute video showing participants expressing themselves about what they know best about indigenous weather predictions. After the video showing inserts of Focus Group Discussions in each traditional council, the researcher outlined the procedure to be followed in group work. The participants were given the opportunity to pick red, green and white markers which enabled them to belong to a selected marker. The groups were then divided into three, and the participants were randomly given coloured stickers. Group 1 was given a green sticker, group 2 pink and group 3 a white sticker. The markers were important in group selection and identification. The participants were then grouped per stickers (Figure 8.1).

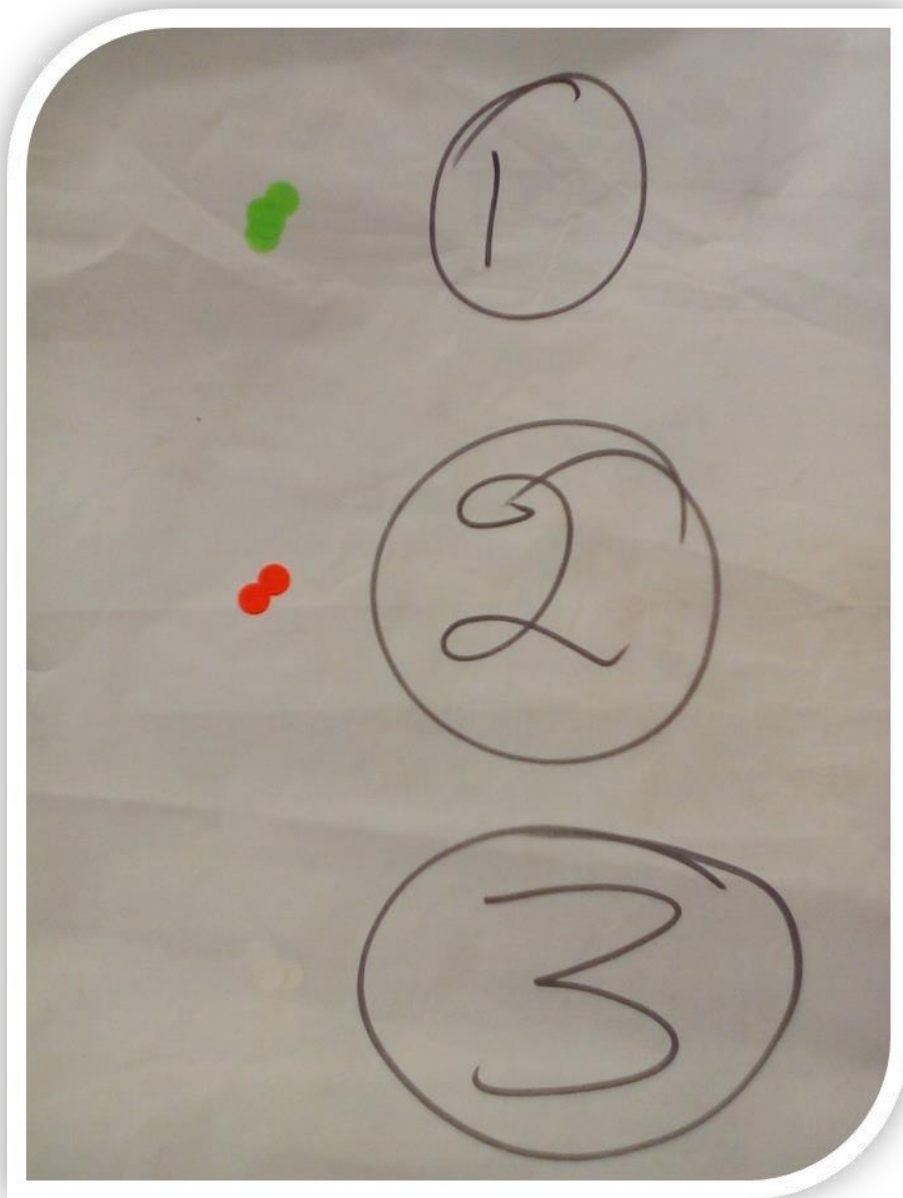


Figure 8.1: Colours given to each group

Each group was requested to elect a leader who would present their outputs. Each group was then expected to present their views, and after the participants had completed their tasks and discussions (Figure 8.2), a comparison of emerging themes was made. Flip charts were distributed and used for writing the themes raised. After all the presentations from the three groups, converging and diverging ideas were listed and consolidated. The results from the groups written on a flipchart by the participants are presented in figures 8.6, 8.7 and 8.8. Table 8.1 shows how each group presented their views using their local language, which was later translated into English.

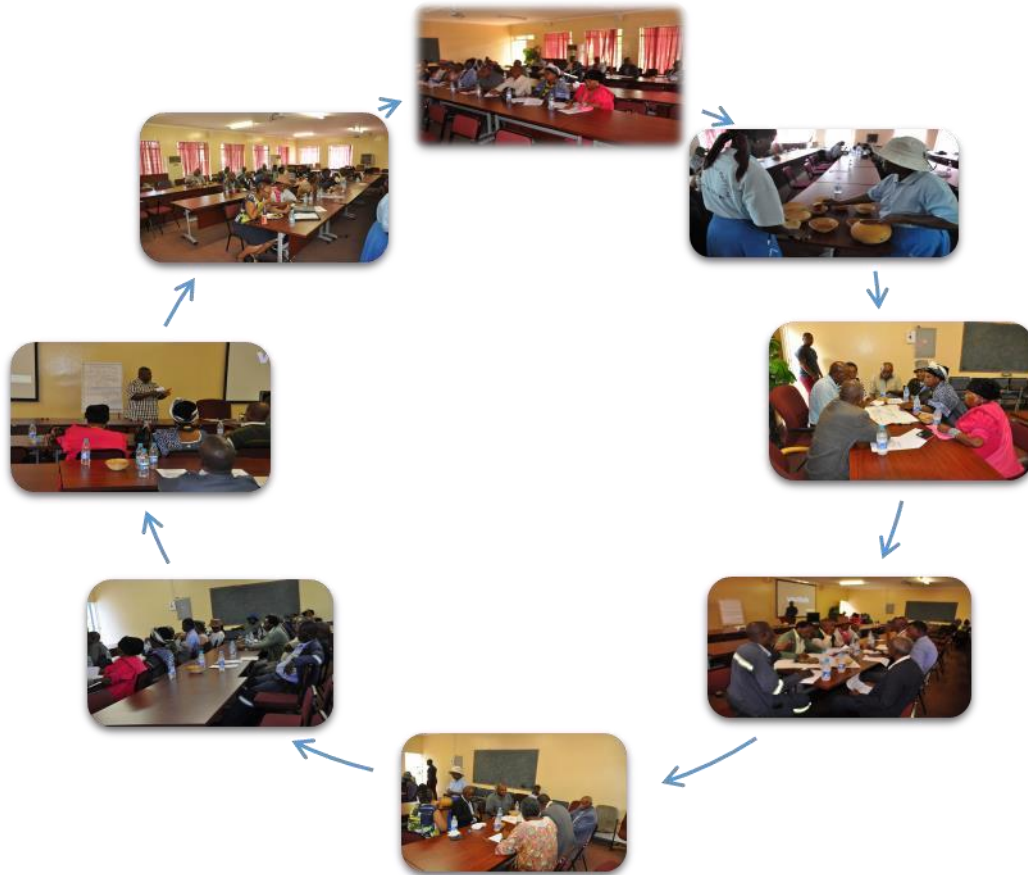


Figure 8.2: Knowledge validation workshop activities (conversational approach)

The method can best be described as a dialogic approach to gathering knowledge that is built upon an indigenous relational tradition. Furthermore, the relational factor emerged that the researcher is familiar with the participants and credibility has been built. The relation was guided by the context in which the research was conducted and by the economic, social, spiritual and overall welfare of the participants. The usage of the conversational method in the study evokes several distinctive characteristics such as knowledge, relational, decolonisation and local protocols (Kavoch, 2010). Deeper conversations can only be achieved when participants have trust on the researcher.

8.6 Data analysis

Data analysis in qualitative research explores information from the perspective of both groups and individuals and generate case studies and summaries rather than lists of numeric data (ACAPS, 2012). According to Burns & Grove (2003), data analysis is a mechanism for reducing and organising data to produce findings that require interpretation by the researcher. However, Yin (1994) opined that case studies are

empirical investigation of phenomenon within their environmental context, where relationships between phenomenon and environment is not clear. Data analysis spiral by Creswell (1998) which is applicable to most qualitative methods was adopted. (Figure 8.3). The data in this study was acquired from the perspectives of the groups which attended validation workshop.

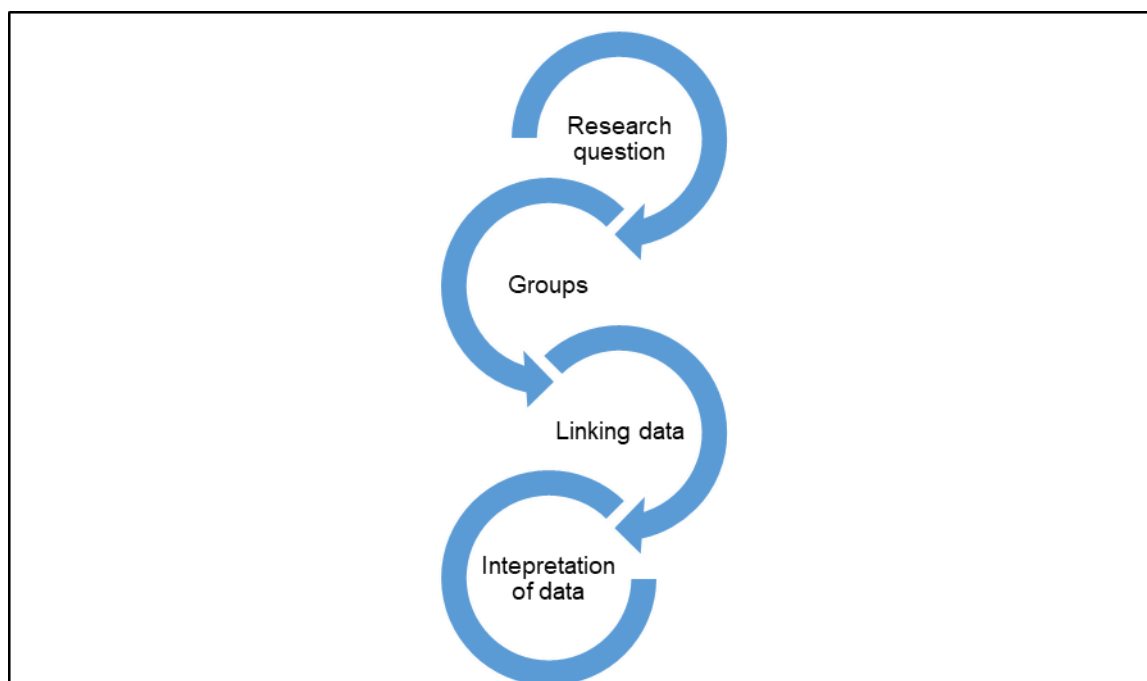


Figure 8.3: Sequence of study approach (adopted from Creswell, 1998)

Data analysis process occurred when group discussions outcomes were presented by the participants. Group discussions were facilitated by the researcher using local language. The researcher had to read and re-read the data set produced by the groups to the participants. Thereafter, a meaning making approach was conducted to check with participants about what they have written is the true reflections of what they mean. Sufficient time was allocated to each group to make thorough descriptions of their discussions while the researcher observed and took some notes. After listening to the participants' descriptions during the presentations, the researcher decided to select key words from each group after identifying converging and diverging ideas or thought. According to Chilisa (2012), community members who were involved in data collection should also participate in the analysis and interpretation of the findings and in data-informed challenges and solutions in the community. Therefore, the researcher was able to contain cultural sensitivity in identifying key words/themes to be outlined and

summarised. The data was coded into 'meaningful units', key words and codes to determine categories or themes.

Converging and diverging ideas from the participants were tabulated. In order to understand the data, each flipchart was read and re-read carefully. The treatment of the data under discussion as demonstrated by the participants collaboratively in constructing their discussions was provided. The outcomes of the groups were presented by the group leaders, and the researcher consolidated the converging and diverging thoughts (Figure 8.4). Converging and diverging ideas were written on clean flipcharts reflecting their concerns, challenges and opportunities. The participants also made contributions in the process of consolidating their work. The outcomes from the group work were read several times to allow more contributions from the participants. The results were collated and analysed by the researcher and presented to the participants for verifications and amendments. Thereafter, the groups prioritised emerging issues of concerns and agreed on them.

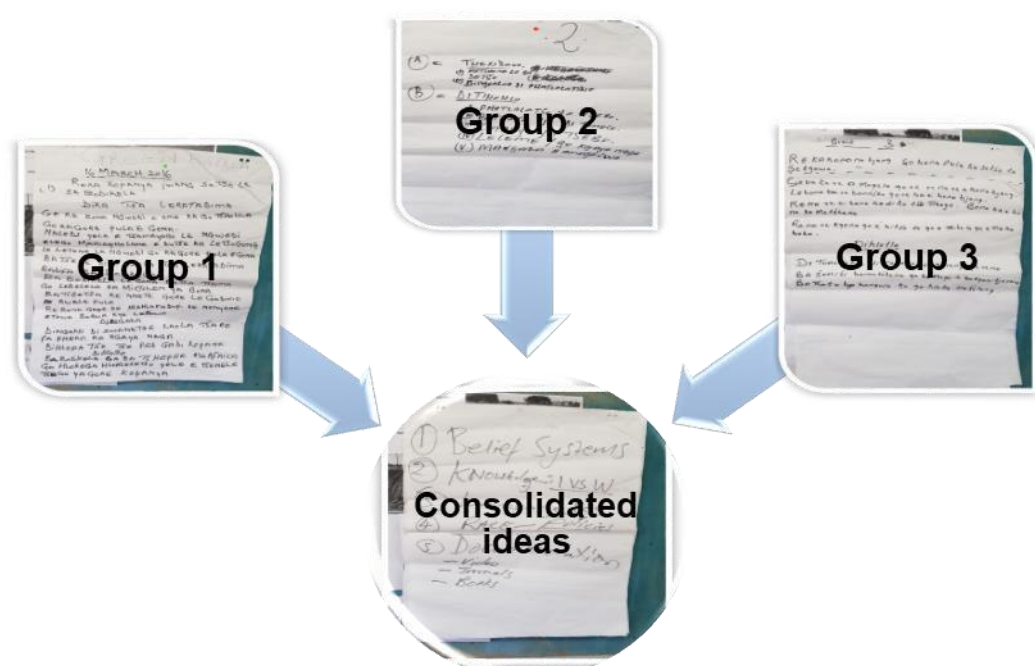


Figure 8.4: Linkage of group work findings

Finally, the data was integrated and summarised together with participants using English words in concurrence with Sepedi words for participants and represented by a table.

8.7 Validity and reliability of the study

The nature and type of knowledge on weather and climate prediction was validated through a workshop where the participants shared their understanding and experiences, and made recommendations. The idea here was not all about what was valid or reliable, but the real truth emerging from the participants themselves, telling the researcher and other stakeholders about what they have experienced regarding weather and climate issues. According to Chillisa (2012), the research participants should see themselves in the descriptions. Postcolonial indigenous perspectives of validity in indigenous research lies in concepts of fairness, self-reflexivity, voice and ontological authenticity (Guba & Lincoln, 2005). The indigenous research study is based on interpretive and subjective data. Therefore validity and reliability are not entirely applicable to qualitative research (Strauss & Corbin, 1998). The interpretations are not based on the researcher's perspective but that of the participants (Thomson, 2011).

8.8 Ethical considerations

Ethical considerations as described in chapter 2 and 4 also apply in this chapter where cultural connectivity and sensitivity are maintained.

8.9 Results

Results from knowledge validation workshop are presented in different forms or in two fold. Firstly, the conversations are presented as group work which represented the voices of the groups (Figure 8.2). To understand the content of the writings, each group was analysed and followed narratives by the researcher reflecting key themes/words. Secondly, thematic analysis within groupings reflected converging and diverging results and the information from the groups thematically grouped. The results included purposefulness, decolonising aim, tribal epistemology, space for self-location, adherence to tribal ethics and protocol (Kovach, 2006). Reflective analysis was conducted by the researcher on group results. The significant of conversations of the groups was the relational factor that the researcher and participants know each other (Kovach, 2012).

Active participation from traditional council members revealed that the participants have common understanding, knowledge and experience of researched phenomenon. As shown in Figure 8.2, knowledge validation workshop activities justify why the

participatory approach can yield better outputs without outsider influence. The output of the workshop validated what has been presented in chapter 4 and 5 in that the self-esteem of respondents and participants prevailed. Consolidated outputs revealed participants common concerns and challenges about the two knowledge systems. The participants were given the opportunity to explore and to share their experiences among themselves during consolidation process.

8.9.1 Group results

As indicated, each group presented their results after completing the tasks given to them. The groups were afforded the opportunities to state what can be done to address the gap between indigenous and western weather predictions. In group 1, 2 and 3, the following outcomes were presented based on what can be done and the challenges faced by the knowledge-holders. The results from the three groups are presented in tabular form. What emerged from the groups reflect their concerns, challenges and opportunities.

Table 8.1 Views from the groups

Group	Goka dirwa eng	What can be done
1	Dihlopha tše tše pedi diswanetše go kopana	The two knowledge systems should be combined
2	• Therishano: Metshene le setšo	• Discussions: machines and traditional
	• Dingwalwa di phatlalatšwe	• Documents should be distributed
3	• Ge baka re amogela gore rena re e bona bjang le bona bare bontšha gore bae bona bjang	• If they can accept us about how we look at it and how they look at it.
	• Rena re kgona go e bitša le go e thiba ge etla ka bobé	• We know how to call and stop the rain (thunderstorm)
	Dihlotlo	Challenges
1	Ba bodikela gaba tshephe ma Aforika	The west doesn't have faith and trust in Africans

	Go hlokega hlotloetšo yewe e tseletšego ya go re kopanya	Lack of encouragement in meeting the west
2	Phatlalatšo ya tsebo	Dissemination of knowledge
	Bothata bja ditumelo	Problems of belief systems
	Kopanyo ya tsebo	Integration of knowledge
	Leleme	Language
	Mangaka a amogelwe	Acceptance of traditional health practitioners
3	Ditumelo tše difapanego gareng ga rena	Different belief systems among ourselves
	Bašomiši ba metshene gaba amogele bokgoni bja rena	Agro meteorologists Climatologists don't accept our knowhow
	Go hloka mašelang	Lack of money

After the presentations, a consensus was reached in that some ideas had converged and diverged. Through discussions, an agreement was reached on what seemed to be key issues and concerns. The consolidation of challenges and concerns are summarised below. The collective information provided by the participants reflected had differing views on knowledge systems. The emphasis from the groups were based on the belief system, race, language, knowledge system and documentation. The issues raised during a group discussions and feedback session are described as:

- a) **Belief system** – concerns were raised on the issue pertaining to different religious belief systems. The issue was raised as the participants were trying to emphasise the importance of cleansing the land. Rainfall rituals, as elaborated by the participants, encompass an in-depth understanding of the culture and spirituality. The participants believed that once belief systems differ, a coordinated effort cannot be achieved.
- b) **Knowledge systems**- The participants felt that western knowledge is given priority and regarded as superior to their knowledge. Their biggest concern was that their knowledge should be taken seriously.

- c) **Language** – it was regarded as the blockade to development since local language plays an important role in understanding the local phenomenon and the environment. The participants regard language as key to any form of development as the language used relating to the weather is, in most cases, English. Failure from government to promote local languages will result in project or programme failures.
- d) **Race** – the participants feel that the issue of race is also a concern because discrimination is still intact in South Africa. Participants have also indicated that policies on weather and climate are not supporting their cause.
- e) **Documentation** – the participants also highlighted the importance of documenting their weather knowledge through videos, books, journals, pamphlets and other means of recording their know-how.

8.10 Discussions

Based on the results, as reflected by the participants, it is evident that there are many concerns regarding the situation in the country which affects local development initiatives. The imbalance of the past regime is not yet dismantled due to the recurring western knowledge dominance and approaches. Knowledge-holders' concerns might derail the possibilities of integrating the two knowledge systems due to some factors. Language has been considered as one determining factor in addressing local issues, and in putting forward the voices of the participants in addressing their challenges. An effective communication can only be achieved through a communicative language of the local people. Furthermore, the belief systems emerging in the country and locally affect the way things are done in diverse communities. The initiation of rain rituals entails believing in what has been practiced by elders in the past generations. As long as the curriculum at school level is yet to be changed, further degradation of local know-how will intensify.

As outlined in the study, the most challenging issue is documentation of indigenous weather and climate indicators before any collation can be made with western weather knowledge. Once the documentation is done, and indicators from both knowledge systems are well interpreted using the local language and terminology, the integration interest can then be defined. Basically, there seems to be a lack of western scientists' interests in downscaling weather information at a micro level making interfacing difficult to implement. Furthermore, government and private sector on environmental

issues should develop programmes which support indigenous weather prediction systems. Several authors (Lucio, 1999; Ngugi, 1999; Shumba, 1999; Millar & Dittoh, 2004; Die, 2011; Shararech & Mohammad, 2014) have reflected on attempts to integrate the two knowledge systems but failed due to lack of support from the western knowledge systems. It was evident from the study that there is a lack of government support at local and national level.

The comments and challenges reflected from the findings requires a rethink of collaborative effort between the two knowledge systems. According to Jones and Jenkins (2008) collaboration between two groups may represent an unwitting imperialist demand. .

8.11 Conclusions

Knowledge validation workshop was very useful and important to the researcher and the participants in developing relationships for better understanding of the phenomenon. A one-to-one discussion led the researcher and other stakeholders to embrace weather prediction practices and their implications. Furthermore, documentation of ideas and issues raised should always be correctly done for future reference. It was agreed in the workshop that the two knowledge systems should be integrated with each other without compromising the other. The participants raised very genuine concerns about the damage made by westerners, and acknowledged that a lesson has been learned from experiences of the imbalance of the past.

Furthermore, it should be noted that knowing relate to socially constructed ideas by people who have relationships and connections with each other, the living and nonliving and the environment (Chilisa, 2012). Any attempt to integrate the two knowledge systems will require coordinated efforts from western researchers, indigenous researchers, policy makers and indigenous knowledge holders (Figure 8.5). Concerns raised by the participants require provincial and national interventions. Moreover, comprehensive weather and climate knowledge awareness campaigns supported by the municipality and provincial government should be considered.

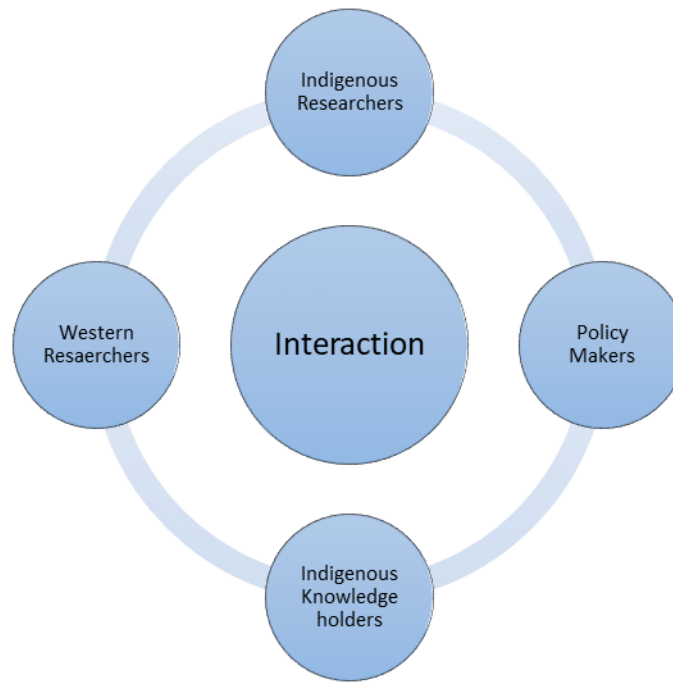


Figure 8.5: A recommended approach or a model towards integration of knowledge systems

Constructivist theory believes that people should construct their own knowledge rather than be told on what to do or know. It is within this understanding that the integration process requires further engagements with relevant departments or stakeholders concerned with weather and climate issues. The knowledge validation workshop has encouraged an interactive process which has afforded the participants opportunities to raise their concerns and challenges. As Haynes et al. (2008) advised, an integrated strategy should be developed within the communities through a dialogue based on respect and communication between associated stakeholders and the communities.

CHAPTER NINE

GENERAL DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS OF THE STUDY

9.1 Introduction

In this chapter, the generation of knowledge, implications of findings, limitations, conclusions and recommendations of the study are presented.

9.2 Generation of knowledge by the study

The study has examined the role played by indigenous weather and climate knowledge in addressing crop production related issues in Lepelle Nkumpi Municipality. The study attempts to introduce African worldviews of indigenous research on weather and climate. How people define their environment is coupled with the identification of indigenous research paradigms which guided the study and the researcher in understanding indigenous research approaches. The articulation of theories aligned to indigenous research guided the study to critically define the epistemological, ontological and axiological perspectives. However, the consideration of the relational theory was based on the premise that the researcher should develop a very strong relationship with the communities where the study was conducted. Relationship with the research participants and focus groups strengthened cooperation during the interview process and allowed access to traditional councils within the municipality.

The strength of the research is in its heavy reliance on the relational theory, which encompasses relational epistemology, ontology and axiology. The development of a healthy relationship with traditional councils ensured the success of the study. Weather prediction within the municipality can be regarded as functional because almost all the participants and focus groups revealed vast knowledge and experience about the phenomenon. The knowledge shared among the participants, focus groups and the researcher is valuable in attempting to address the concerns/ problems in the municipality. However, the researcher acquired knowledge from the study by understanding what epistemology, ontology and axiology are. Furthermore, the research paradigms used in the study guided the researcher in documenting the knowledge of participants and focus groups. The study revealed that traditional councils and smallholder farmers have knowledge and experience of their environment. The truth, reality and beliefs of traditional councils and smallholder

farmers are guided by African worldviews because what has been said is meaningful. The use of local language prior and after data collection made the research processes much easier to understand traditional councils and smallholder farmers' contributions. Ethical research had to be persuaded to adhere to local protocols. Communicating with traditional councils and smallholder farmers using the local language encouraged effective participation. The identification of indigenous weather indicators mentioned in the study shows persisting wisdom of traditional council members in the municipality.

Methodologically, by employing mixed methods, the study adopted a decolonising research approach. Scholars such as Smith (1999), Kovach (2012) and Chillisa (2012) have emphasised the application of indigenous methodologies or decolonising methods in indigenous research. Indigenous research and approaches are the cornerstone of the study, as they afforded the researcher opportunities of exploring knowledge and experiences of participants in indigenous research. Even though other positivist research methods were used during the study, it was important to strengthen the linkage or integration of the two knowledge systems. The researcher explored research methods such as KAP, Conversational, qualitative content analysis, document analysis, Gap checklist and Kgoro. Quantitative and qualitative research designs were considered in the study. However, an interview schedule, questionnaire, video camera, emails, GAP checklist, and workshop were useful data collection tools in the study.

9.3. Implications of the findings of the study

The study suggest that a relationship between the researcher and participants or knowledge-holders requires mutual understanding of the phenomenon and environment. A reflection of positive impact to the researcher and traditional councils was recognised during and after the research process. Its value to the researcher and the researched provided a platform of relationally to implement new strategies and methods of data collection and analysis. In undertaking an indigenous research standpoint, local protocols were embraced and considered. The application of different research paradigms enabled the researcher to articulate about knowledgeholders and smallholder farmers. An emphasis in implementing decolonising research methods form a basis for the research on indigenous ways of knowing. However, aligning

knowledge systems posited a true reflection of the truth and realities of knowledge-holders and smallholder farmers in the municipality.

The application of theories in the study guided the research process and provided the researcher on their suitability and usability. The validity and reliability of the data chapters was ensured through writing, interviewing, analysis and documenting weather and climate knowledge of knowledge-holders. Sustainable and practical linkage of the western and indigenous weather prediction knowledge can be addressed through raised concerns regarding race, language etc. An age and sex factor plays an important role in addressing development issues. Majority of respondents in addressing indigenous weather and climate knowledge were women. Therefore, women played a role in reflecting on indigenous ways of understanding weather and climate but men were very accurate in deliberating on the phenomenon. Furthermore, recommendations made on policy issues requires a coordinated effort during the development and implementation process. The study suggest that policies related to indigenous weather and climate be formulated and implemented to address the needs of communities at micro-climate level. However, the reflection of the study is to document the knowledge of knowledge-holders and farmers properly.

9.4 Limitations of the study

Given the aim and specific objectives of the study, there was only one limitation inherent in the five aspects investigated. Not all key stakeholders consulted regarding environmental policy issues responded as expected. The South African Weather Services participation was crucial since its mandate is to provide reliable weather and climate information to the citizens of the Republic of South Africa. It was expected from them to share their ideas and make contributions in an attempt to address the micro-weather and climate knowledge and information to better support the discrepancies of the past.

9.5 Conclusions

Challenging positivists' epistemological dominance in research sphere, it was not easy to consider African indigenous underpinnings of the study to reframe the indigenous ways of knowing. Outlining the worldviews of the respondents in the study encouraged the researcher to be considerate to indigenous ways of doing things. More emphasis in the study rested in the relational theory, focussing on the co-researchers being

smallholder farmers and traditional council members in Lepelle Nkumpi Municipality sharing wealth of ancient wisdom.

The study has revealed that the nature and types of indigenous knowledge can guide individuals to understand different knowledge systems. Weather and climate prediction using tree phenology, animal behaviours, atmospheric and astronomic indicators is central to the study. The identification of indigenous weather indicators in the study shows how local communities observe weather and climatic events as they unfold. Traditional health practitioners (*dingaka*) are regarded in the study as central to divination and the conduction of rain rituals. A conclusive statement cannot be made through the observation of one or two weather indicators. A study conducted by Mafongoya et al. (2017) for Sub-Saharan Africa has concluded that long-time weather and climate observations by smallholder farmers is coupled with a considerable level of knowledge.

The inclusion of elderly men and women who showed considerable knowledge was vital for the study. Indigenous research undertaken together with knowledge holders has prospects of success. In spite of indigenous knowledge on weather and climate not reflected in the policy documents, relevant stakeholders and key informants provided essential information for the study. The contributions made to the study by different stakeholders are recognised. However, South African Weather Services should be considerate of their mandate on weather and climate.

Local language usage during the study was critical in ensuring that effective and efficient communication prevails. It was important for the researcher and the participants to understand each other during the research process. It is perceived in the study that smallholders' self-esteem statements during the survey was relevant and reliable in terms of reflecting their knowledge, attitudes towards and their perceptions about indigenous weather issues. Weather prediction indicators are reliable, truthful, acceptable and accurate. The combination or integration of indigenous and western weather knowledge can provide reliable and coordinated weather information for the end-users. A validation research workshop yielded positive responses about what participants deem important to them and future generations. It was important for the researcher to allow research participants ample time to express themselves in such platforms. The reflections of participants about what is good or bad

pertaining to weather and climate information provided by weather services, contributed immensely to the findings and recommendations of the study.

9.5 Recommendations

It is recommended that the following issues be considered by Lepelle Nkumpi Municipality and Limpopo Province to further enhance the livelihood of communities in rural areas:

- Document the nature and types of indigenous knowledge on weather and climate.
- Create awareness campaigns at school levels to propagate indigenous weather research and development.
- Establish indigenous research platforms in communities.
- Promote interaction processes between indigenous and western researchers on weather and climate.
- Encourage policy reform to address indigenous weather and climate knowledge gaps in South Africa.
- Encourage farmers and traditional councils to maintain and effectively assess their valuable heritage.
- Monitor indigenous indicators to ascertain their extinction.
- Establish indigenous weather and climate projects within councils and municipally as a whole.
- Encourage elders to participate in weather and climate forums, open days and farmers' days.
- Involve youth in transforming findings into action

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APPENDICES

APPENDIX A: RESEARCH PROPOSAL AND TITLE APPROVAL



NORTH-WEST UNIVERSITY
YUNIBESITHI YA BOKONE BOPHIRIMA
NOORDWES-UNIVERSITEIT
MAFIKENG CAMPUS

FACULTY OF AGRICULTURE, SCIENCE AND TECHNOLOGY
SCHOOL OF RESEARCH AND POSTGRADUATE STUDIES

Tel: +27 18 3892531
Fax: +27 18 3892052
E-mail: ushotanefe.ush@nwnu.ac.za
Internet: <http://www.nwnu.ac.za/>

CERTIFICATE OF APPROVAL OF RESEARCH PROPOSAL AND TITLE REGISTRATION

This is to certify that: Magaro MD - 17061008

Whose proposal is titled: Investigation of the role of indigenous weather and climate knowledge on crop production: the case of Lepelle Nkupi municipality in Limpopo Province

Was considered by the Faculty Research Committee on the 10 November 2015 and approved.

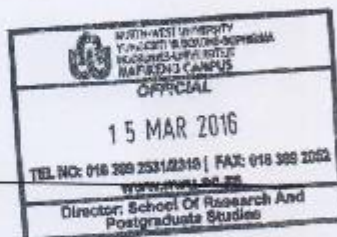
Proposed Qualification: PhD IKS

Supervisor (s): Prof SA Materechera
Prof T Kabanda

Signature: Director SRPS

Prof Ushotanefe Useh

Name: Director SRPS



Date

APPENDIX B: ETHICS APPROVAL OF PROJECT



NORTH-WEST UNIVERSITY
YUNIBESITHA BOKONE-BOFHIRIMA
NOORDWES-UNIVERSITEIT

Private Bag X6001, Potchefstroom
South Africa 2520

Tel: (018) 299-4900
Faks: (018) 299-4910
Web: <http://www.nwu.ac.za>

Institutional Research Ethics Regulatory Committee

Tel +27 18 299 4849
Email Ethics@nwu.ac.za

ETHICS APPROVAL CERTIFICATE OF PROJECT

Based on approval by the Health Science Ethics Committee (FAST), the North-West University Institutional Research Ethics Regulatory Committee (NWU-IRERC) hereby approves your project as indicated below. This implies that the NWU-IRERC grants its permission that, provided the special conditions specified below are met and pending any other authorisation that may be necessary, the project may be initiated, using the ethics number below.

Project title: An exploration of the role of indigenous weather and climate knowledge in crop production: the case of Lepelle Nkumpi municipality in Limpopo province																																											
Project Leader: Prof SA Materechera & Prof T Kabanda																																											
Ethics number:	<table border="1"><tr><td>N</td><td>W</td><td>U</td><td>-</td><td>0</td><td>0</td><td>4</td><td>9</td><td>2</td><td>-</td><td>1</td><td>5</td><td>-</td><td>A</td><td>9</td></tr><tr><td colspan="3">Institution</td><td colspan="3">Project Number</td><td colspan="3">Year</td><td colspan="3">Status</td></tr><tr><td colspan="15">Status: S = Submission, R = Re-Submission, P = Provisional Authorisation, A = Authorisation</td></tr></table>	N	W	U	-	0	0	4	9	2	-	1	5	-	A	9	Institution			Project Number			Year			Status			Status: S = Submission, R = Re-Submission, P = Provisional Authorisation, A = Authorisation														
N	W	U	-	0	0	4	9	2	-	1	5	-	A	9																													
Institution			Project Number			Year			Status																																		
Status: S = Submission, R = Re-Submission, P = Provisional Authorisation, A = Authorisation																																											
Approval date: 2014-03-30	Expiry date: 2017-03-30																																										
Category	Minimal																																										

Special conditions of the approval (if any):

- All queries regarding this application received from the Health Sciences Ethics Committee (FAST) must be addressed and clarified.

General conditions:

While this ethics approval is subject to all declarations, undertakings and agreements incorporated and signed in the application form, please note the following:

- The project leader (principle investigator) must report in the prescribed format to the NWU-IRERC:
 - annually (or as otherwise requested) on the progress of the project,
 - without any delay in case of any adverse event (or any matter that interrupts sound ethical principles) during the course of the project.
- The approval applies strictly to the protocol as stipulated in the application form. Would any changes to the protocol be deemed necessary during the course of the project, the project leader must apply for approval of these changes at the NWU-IRERC. Would there be deviation from the project protocol without the necessary approval of such changes, the ethics approval is immediately and automatically forfeited.
- The date of approval indicates the first date that the project may be started. Would the project have to continue after the expiry date, a new application must be made to the NWU-IRERC and new approval received before or on the expiry date.
- In the interest of ethical responsibility the NWU-IRERC retains the right to:
 - request access to any information or data at any time during the course or after completion of the project;
 - withdraw or postpone approval if:
 - any unethical principles or practices of the project are revealed or suspected,
 - it becomes apparent that any relevant information was withheld from the NWU-IRERC or that information has been false or misrepresented,
 - the required annual report and reporting of adverse events was not done timely and accurately,
 - new institutional rules, national legislation or international conventions deem it necessary.

The IRERC would like to remain at your service as scientist and researcher, and wishes you well with your project. Please do not hesitate to contact the IRERC for any further enquiries or requests for assistance.

Yours sincerely

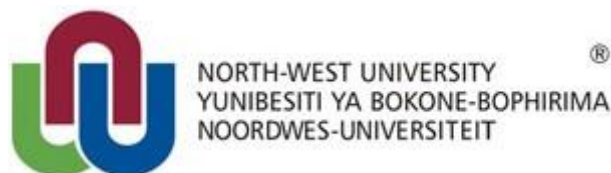
Prof LA
Du Plessis

Digitally signed by Prof LA Du Plessis
DN: cn=Prof LA Du Plessis, o=North-West
University, ou=Campus Radio,
email=Linda.DuPlessis@nwu.ac.za, c=ZA,
Date: 2015.02.24 08:16:11 +0200

Prof Linda du Plessis

Chair NWU Institutional Research Ethics Regulatory Committee (IRERC)

APPENDIX C: KAP SURVEY QUESTIONNAIRE



TOPIC: THE ROLE OF INDIGENOUS WEATHER AND CLIMATE KNOWLEDGE IN CROP PRODUCTION: THE CASE OF LEPELLE NKUMPI MUNICIPALITY IN LIMPOPO PROVINCE, SOUTH AFRICA

SURVEY QUESTIONNAIRE

Questionnaire number:

Research aim: The overall **aim** of the study is to explore the potential role that indigenous weather and climate knowledge can play in supporting crop production in Lepelle Nkumpi Municipality

Name of Respondent: _____

Municipality: _____

Village: _____

Tribal Authority: _____

Province: _____

Date of interview: _____

	Name	Signature	Date
Field enumerator			
Data captured			

Structured interviews will center on the themes listed below:

SECTION A: Profile of Respondents

1. Gender (please tick)

Male	(1)
Female	(2)

2. Age of respondent:

35-50	(1)
50-60	(2)
60+	(3)

SECTION B: PECEPTIONS OF SMALLHOLDER FARMERS TOWARDS INDIGENOUS WEATHER AND CLIMATE KNOWLEDGE

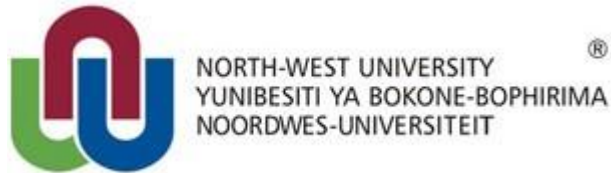
Statement*	Strongly agree (4)	Agree (3)	Disagree (2)	Strongly disagree (1)
S1: Through personal experience, I can predict whether rains is coming or not				
S2: Through mere reading clouds, moons and stars, I can tell whether it is going to rain or not at a particular time				
S3: Through the actions of animals and sounds from certain birds, insects, I can predict whether it is going to rain or not				
S4: I make informed decisions to plan ploughing by considering the indigenous weather and climate indicators				
S5: Through certain plants, symbols/signs, I can predict whether there will be drought or not				
S6: I can select crops based on indigenous weather prediction				
S7: Our grandparents have proven experience of weather forecasting and I benefited from them				
S8: I know different types of rainfall and their direction where they come from				
S9: Based on personal experience, I am able to make predictions about the extreme of temperatures in a given farming season				
S10: By using observation sequentially on yearly basis, I can determine what the climate would be in a particular growing season				

SECTION C: ATTITUDES OF SMALLHOLDER FARMERS TOWARDS INDIGENOUS WEATHER AND CLIMATE KNOWLEDGE

Statement	Very Often (4 points)	Often (3 points)	Some of the time (2 points)	Not at all (1 point)
S1a. IWCK is important in planning crop production activities				
S2a. IWCK is used by smallholder farmers in the municipality				
S3a. I consider IWCK in rainfall and temperature prediction				
S4a. I always consider IWCK as important for future use				
S5a. As farmers, we encourage the exchange of IK				

NB: IWCK (Indigenous Weather and Climate Knowledge)

APPENDIX D: INTERVIEW GUIDE



INTERVIEW GUIDE FOCUS GROUP DISCUSSION (FDG)

1. Western weather and climate forecasts information

How often do you receive weather and climate forecast information? Do you understand it? What does it mean? How do you get the information? Can you use the information and for what?

2. Indigenous weather and climate forecast information

Is indigenous weather and climate forecast information important in your area? How do you use it? Where is the information come from? Who provide the information?

3. Prediction of seasonal rainfall

How do you predict the beginning and the end of the rainy season? What are indicators or tools used to predict a good or bad season? What is good and bad season?

4. Decision making on crop production

Do you base your decisions on weather information derived from what? What crop do you select for dry or wet spells? Do you make decisions for crop production based on what?

5. Indigenous weather indicators and past extreme climatic events

What are the indigenous indicators used in predicting weather? Are you able to describe them? Can you do a timeline of experienced extreme climatic events? What strategies or risk aversion approaches in mitigating the harsh conditions related to crop production?

6. Climate change

What are the changes experienced currently in your area? How long does the changes occur? What impact does the changes do to the production of your crops? How do you adapt to the changes?

APPENDIX E: NON-DISCLOSURE AGREEMENT FORM



Non- disclosure agreement form

Indigenous Weather and Climate Knowledge Identification and Documentation procedures

This document serve as an agreement between the researcher, traditional council and knowledge holders/participants, that the identification and documentation of indigenous weather and climate knowledge is important for the protection and management thereof. It is a process which will be handled in care and foresight, and the following key principles will be considered:

1. Traditional council and participants, holds information collectively in the same way that an individual owns his/her personal information
2. Traditional council and participants are within their rights in seeking to control all aspects of research and information management that impact them
3. Traditional council and knowledge holders must have access to information and data about themselves, regardless of where it actually held, and they the right to manage and make decision regarding access to their collective information ; and
4. Traditional council and participants should have passion of the document of the data.

Participant's signature: _____

Traditional Council Rep Signature: _____

Researcher's name (in print): _____

Researcher's Signature: _____

Date: _____

A. Before documenting Indigenous Knowledge

1. The researcher will address prior informed consent (PIC) with the Traditional Council and knowledge holders/ participants.
2. The researcher will ensure that documentation of everything will be done in a precise and acceptable manner.
3. The researcher will not disclose undisclosed indigenous know-how.
4. The researcher will check and clarify the role of other partners such as research assistants and Lepelle Nkumpi Department of Agriculture and Rural Development Agricultural Advisors.

B. During documentation the researcher:

1. Will not disclose the documented data, unless a firm decision has been made by traditional council and the participants who participants
2. Will identify the participants who provide the information and those who claim ownership, and record this information unless they prefer not to have it recorded:
3. Will prioritise define, types of indigenous knowledge resources during the documentation (e.g. indigenous knowledge & traditional council resource at risk of disappearance, Indigenous & traditional council resources susceptible to commercial use. Indigenous knowledge involving the useful arts etc.) and
4. Will manage relationships with other parties through confidentiality and other contractual agreements.

C. After documentation the researcher:

1. Will not disclose documented indigenous knowledge unless there has been a clear decision, based on the agreed strategy, that those elements should not be disclosed
2. Will only disclose the information for the agreed purpose which is for study
3. Will only disclose the information for the agreed purpose which is for study and protect confidentiality through confidentiality agreements if there is a need to stop it from being disclosed further; and
4. Review the possibility of positive IPRs protection of the documented indigenous knowledge, and do not forget that innovative indigenous knowledge developments can be eligible for IRPs protection

Participant's signature:

Date:

Researcher's name (in Print)

Researcher's signature:

Date:

APPENDIX F: PERMISSIONS TO CONDUCT RESEARCH IN THE VILLAGES

LEDWABA-NDLOVU TRADITIONAL COUNCIL

Postal Address:
Private Bag X60
Lebowakgomo
0737



Physical Address:
Stand 199
Ga-Ledwaba - Moshate
0781

Enq. F.J. Letwaba Cell 082 304 5127 Fax 086 653 0842 email letwabaf@ananzi.co.za

02 September 2015

North- West University

Faculty of Agriculture , Science and Technology, Indigenous Knowledge Systems
Centre

MMABATHO 2035

Attention : Mr Magoro M.D

REQUEST FOR A PERMISSION TO CONDUCT RESEARCH IN YOUR VILLAGES

This serves to acknowledge receipt of your letter on the above to Ledwaba-Ndlovu
Traditional Council.

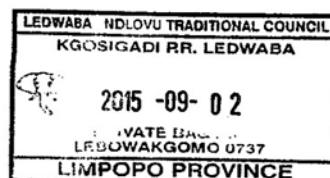
The Council has the pleasure to inform you that permission has been granted

Kindly inform Council according and advise us as to the proper procedure to follow in
this regard.

We trust you find the same in order and wait to hear from you.

Yours faithfully

Kgosi R.P Ledwaba



Board Members Kgosi R.P. Ledwaba, Kgosi R.P. Ledwaba, Kgosi R.P. Ledwaba, Kgosi R.P. Ledwaba,
Mr John Malose Ledwaba, Mr Ezekiel Malose Ledwaba, Mr Johannes Chum Ledwaba, Mr Malose
Phele Ledwaba (Secretary) And Mr F.J. Letwaba (spokesperson)

BATAU BA SELOANE TRADITIONAL AUTHORITY

PUSO SETSHABA YA BATAU BA GA - SELOANE



Lepelle Nkumpi Municipality (Ward 1)
Capricorn District (LIMPOPO)

P.O. Box 1
Malatane
0604
Tel / Fax: (015) 662-0138
(Region of POLOKWANE)

Enq : Rashilo M.N.
Tel : 015 662 1800
Fax : 015 662 1811

Date : 04 September 2015

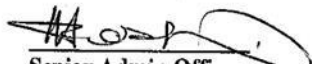
ATT : MR. MAGORO M.D.

DEAR SIR/MADAM

SUBJECT: PERMISSION TO CONDUCT RESEARCH IN OUR VILLAGES OF GA-SELOANE.

1. The above matter refers.
2. Batau Ba Seloane Traditional Council under the Chairperson of Kgoshigadi Ngwanamohube Dina Seloane grand Mr. Magoro M.D. the permission to conduct the research for his studies.
3. The council will appreciate the copy of full research report.
4. Your co-operation on this matter will be highly appreciated.

Yours Faithfully :


Senior Admin Officer
Batau Ba Seloane T/Council
Rashilo M.N.


Kgoshigadi ND Seloane
Batau Ba Seloane



KGOSHI MADIMETJA SELLO KEKANA III



Zebediela Ndebele Traditional Council
Private bag X500
GROOT-HOEK
0628
2015 – 08 – 31

Tel/fax: 015 642 3068
Cell: 079 280 6113

Attention: Mr. Magoro M.D.

RE: APPROVAL TO CONDUCT RESEARCH AT ZEBEDIELA LOCATION

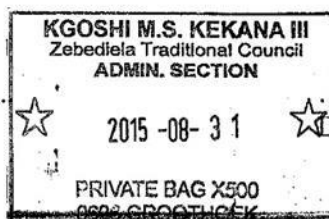
Dear Sir | Madam

As per your letter dated 28 August 2015 requesting permission to conduct research at our localities, Kgoshi M.S. Kekana III and the Zebediela Ndebele Traditional Authority hereby approve your request.

Hope you will find this in order.

Yours faithfully


.....
Traditional Secretary




.....
Deputy Traditional Chairman


.....
KGOSHI MADIMETJA SELLO KEKANA III



NORTH-WEST UNIVERSITY
YUNIBESITHI YA BOKONE-BOPHIRIMA
NOORDWES-UNIVERSITEIT

Faculty of Agriculture, Science and
Technology_Indigenous Knowledge
Systems Centre

IKS Centre
Private Bag X2046, Mmabatho South Africa, 2735
Tel: +2718 389-2111 Fax: +2718 392-5775 Web: <http://www.nwu.ac.za>

28/08/2015

TO: Maefefe Traditional Authority
Lepelle Nkumpi Municipality

REQUEST FOR A PERMISSION TO CONDUCT RESEARCH IN YOUR VILLAGES

Dear Sir/Madam

My name is Magoro M.D, and I am a PhD student at the North West University in Mafikeng Campus. The research I wish to conduct for my Doctoral thesis involves. *The role of Indigenous weather and climate knowledge in crop production: A case in Lepelle Nkumpi Municipality.* This project will be conducted under the supervision of Professor Materachera (NWU-South Africa) and Professor Kabanda (NWU-South Africa).

I am hereby seeking your consent to approach a number of smallholder farmers and knowledgeable elders within the kgoro in the municipality as participants in the project.

Upon completion of the study, I undertake to provide the Department of Agriculture and Rural Development, Traditional Authority with a bound copy of the full research report. If you require any further information, please do not hesitate to contact me on [082 9666 343, 015 632 8600, and mdmagoro@gmail.com]. Thank you for your time and consideration in this matter.

Yours sincerely,
[Magoro M.D]
North West University





LIMPOPO

PROVINCIAL GOVERNMENT

REPUBLIC OF SOUTH AFRICA



MATHABATHA TRADITIONAL COUNCIL



To: Magoro M.D

Sir/Madam

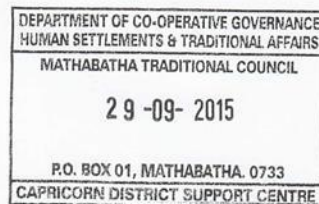
Re: Request for permission to conduct research in your villages.

The above mentioned institution recommends your request to conduct research, as per discussions held on the 22nd-09-2105.

Hope for your kind consideration.

Yours Faithfully

Administration Officer



Moshate Seleteng
Ga-Mphahlele
PO Box 166
Mphahlele 0736

Tel /Fax : (015) 634 0011



08 / 09 / 2015

North West University
Mr Magoro M D
Private Bag X2046
Mmabatho
2735

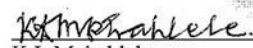
Sir

PERMISSION TO CONDUCT RESEARCH IN OUR AREA

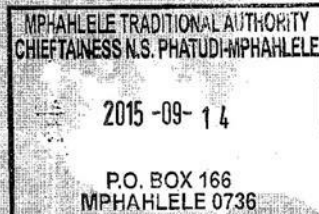
1. The above matter refers
2. Mphahlele Traditional Council under the Leadership of Kgoshigadi N S Phatudi-Mphahlele gives Mr Magoro a permission to conduct researches in our villages.
3. At our Traditional Council Office, the meeting will be held on the 23 September 2015 @ 10H00 if there is a need for presentation.
4. You can engage with Headmen/women at their respective villages/kgoro.
5. Hoping you will find this in order.

Yours faithfully


G N Mphahlele
Admin Officer


K L Mphahlele
Headman


NS Phatudi-Mphahlele
Kgoshigadi



APPENDIX G: GAP ANALYSIS CHECKLIST

GAP ANALYSIS CHECKLIST

The IKS gap analysis is a self-evaluation. A series of questions will help you review and assess the impact of existing national and local policies on weather and climate on the utilization of indigenous knowledge for crop production. This assessment will provides and helps you to identify existing policies and procedures and others. By conducting the analysis, you will recognize strengths and weaknesses of your organization's current policies and determine the extent to which your operations conform to the Constitution of South Africa.

There are three check boxes to the right of each of the questions on the Gap Analysis Checklist. In respond to each question, place an "X" or a check in the block that best describes the status of the component as it relates to your Organization.

Name:		Area:	
Title:		Organization:	
Phone:		Directorate:	
Roles and Responsibilities:			

IKS Element: Weather and Climate Policy							
		Indicators of Conformity	Status			Finding / Corrective Action	Notes
			Not in place (1)	Partially in place (2)	In place (3)		
1.	Is the organization defined its environmental policy?						
2.	Does your procedure (process) for the environmental policy ensure that the policy is appropriate to the end users?						
3.	Does your environmental policy within the defined scope of your organization commit to continual improvement?						
4.	Does your environmental policy within the defined scope commit and comply to other environmental requirements?						
5.	Do you have a framework to set and review the environmental policy objectives and targets?						
6.	Does your procedure of the environmental policy reflect documentation, implementation, and maintenance?						
7.	Does your environmental policy include indigenous components relating to weather and climate?						
8	Does your organization have Indigenous Knowledge Systems Policy?						
9	Does IKS policy form part of your environmental policy?						
10	Is the environmental policy accessible, readable and available to the public?						
Status subtotals:							
Status Total:							
Percentage complete:							