Indigenous Knowledge and Climate Change: Insights from Muzarabani, Zimbabwe

by

Nelson Chanza

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Promoter: Dr Anton H. de Wit

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Dedication

To my mother, Thokozile (Thokozayi).

It was on one of the days in 2006 when we were busy weeding a dry maize field in the village. We had gone for three solid weeks without a single drop of rainfall, a situation that you described as peculiar. By that time, I did not figure it that you were referring to observable changes in the local climate system. Vividly, I can remember that on the same evening, you accurately predicted that the eastern-Mozambican current we experienced signalled the coming of rainfall in the next few hours. Amazingly, we received heavy downpours on the same night. My worry is that this knowledge will be lost as your generation vanishes. In recognition of your invaluable knowledge, I dedicate this thesis to you.

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My two solid years of family detachment have proven beyond doubt that my prudent wife, Nyasha is a gift from God. She defied all the odds to make sure that our kids Tabitha, Angel and Prophecy received adequate parental care. In particular, she braved the demanding questions that our son incessantly pressed concerning his father's whereabouts – *Dadie varipi mama? Vanouya rini? Vanodii kuuya kumba?* Her diligent support made this output possible.

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The genesis of this academic achievement is traceable from my mother's unwavering commitment towards my education. I salute her unmatched support and vision despite the fact that the dark side of her time could not offer similar education opportunities.

Finally, the office stories that my friend Vuso 'manufactured' always punctuated our busy daily schedules with laughter. It is incredibly hilarious to tell the coincidence that has entwined us since 1998 from high school, then through undergraduate and postgraduate degree studies, until finding each other again in this foreign land. I will never forget your interesting analogous story about how you entered into science. Indeed, you are now firmly embedded in the scientific community but the challenges ahead of us are not simple. We need to make a difference to the same communities that shaped us.

Declaration

DEPARTMENT OF ACADEMIC ADMINISTRATION
EXAMINATION SECTION
SUMMERSTARND NORTH CAMPUS
PO Box 77000
Nelson Mandela Metropolitan University
Port Elizabeth
6013

Nelson Mandela Metropolitan University

for tomorrow

Enquiries: Postgraduate Examination Officer

DECLARATION BY CANDIDATE

NAME: NELSON CHANZA

STUDENT NUMBER: S213332744

QUALIFICATION: PhD ENVIRONMENTAL GEOGRAPHY

TITLE OF PROJECT: INDIGENOUS KNOWLEDGE AND CLIMATE CHANGE: INSIGHTS FROM MUZARABANI, ZIMBABWE

DECLARATION:

In accordance with Rule G4.6.3, I hereby declare that the above-mentioned treatise/ dissertation/ thesis is my own work and that it has not previously been submitted for assessment to another University or for another qualification.

SIGNATURE: NChanza

DATE: 12/03/2015

Abstract

Discourse characterising climate change has largely revolved around aspects within the realm of impact identification, mitigation and adaptation. Apparently, a burgeoning appetite to examine the role of indigenous knowledge (IK) now confronts the fronts of climate science, policy and practice. The surge in attention to local-based knowledge is attributed to growing challenges posed by change and variability in the climate system. This study argues that indigenous-based knowledge is capable of filling knowledge gaps and validating current understanding about climate change particularly at local levels. Essentially, the paucity of knowledge about local climatic events can be circumvented by engaging indigenous 'scientists' whose many years of direct contact with the environment have equipped them with the indispensable knowledge, skills and experiences to understand the same.

Primarily, the thesis' objectives were threefold. One, it captured useful indicators of climate change and variability from the understanding of the indigenous people, which can also be used to enhance understanding of climate change impacts.Two, it drew from the knowledge, experiences, skills and practices of the locals in order to inform appropriate community level mitigation and adaptation interventions. And, three, it highlighted the fact that knowledge of the indigenous people can be used to direct research on climate change.

The study area (Muzarabani in Zimbabwe) experiences recurrent droughts and floods and its villagers rely predominantly on climate-sensitive livelihoods. As such, it was selected to provide a reliable case on IK practices and experiences of the people witnessing climatic events. The study was framed within an epistemological and methodological configuration of emancipatory pedagogy that looks at the generators of climate knowledge as 'scientists' in their own right. A qualitative elicitation interviewing technique involving in-depth discussions with traditional leaders and elderly knowledgeable citizens was conducted. The participants were selected through chain referrals until the level of theoretical saturation. In addition,

directed field observations, document analysis and key informant interviews with other respondents selected through theoretical sampling enhanced the robustness of data acquisition methods. Group-based participatory data analysis and reflexive pragmatism also enhanced rigour and quality of research findings intended to balance between the strictures of the scientific audience and the views of the knowledge generators.

Three key themes were derived from IK-climate change linkages as: indigenous-based indicators of climate change, indigenous-based mitigation and indigenous-based adaptation. A range of indigenous-based indicators identified pointed to a progressively drier climate with shorter growing seasons that are also punctuated by mid-season dry spells. A trend towards increased desiccation of water bodies (rivers, ponds and vleis) was further observed. There is also an upsurge in the abundance and pestiferous nature of *Macrotermes* spp, *Quelea quelea* and *Acanthoplus discoidalis*, which are most likely related to climate change. Some of these indicators closely match with those used in mainstream climate science and they also serve to understand climate change impacts at a finer local level of analysis.

Indigenous-based mitigation is mainly driven by the notion of sacredness where the locals regard forestry, certain trees and vleis as sacrosanct. Tampering with these is believed to upset the spirits who have powers to influence climate. Opportunities associated with IK deployment in climate mitigation are understood from the viewpoint of enhancing greenhouse gas (GHG) sinks and that of reducing vulnerability to extreme climatic events. Specifically, this can be achieved through enhancing GHG sequestration through forestry and land-use management initiatives; that is, reducing emissions from deforestation and forestry related degradation (REDD+) and Land Use and Land-Use Cover and Forestry (LULUCF). These two are the dominant schemes adopted by the Intergovernmental Panel on Climate Change (IPCC) to govern climate mitigation. Indigenous disaster risk management (DRM) strategies abound in drought, famine, flood and violent storms through various forms such as Zunde raMambo, *nhimbe*, rain-making ceremonies and community early warning systems (EWS).

The locals in Muzarabani are not passive observers of the changing climate system. Increasing environmental risks necessitates them to devise countermeasures for responding to climatic stimuli with the intention of minimising harm and/or enhancing the benefits brought about by the same. Thus, a portfolio of IK-based adaptation strategies best described as an assortment of short-term coping practices and long-term adaptive strategies were identified. These range from exploitation of ecosystem services, agricultural based interventions, riverine farming, traditional phenological knowledge (TPK) to migration. Therefore, it was revealed that community-based adaptation (CBA) can adequately leverage on IK to improve adaptive capacity and build community resilience against climate change.

Clearly, the complementary role of indigenous-based knowledge cannot be disputed, given the demonstrated range of applications from identifying several indicators of change and variability in the climate system, examination of climate change impacts, to identification and assessment of mitigation and adaptation options. The study advises that exogenous climate interventions need to be congruent with indigenous-based strategies to avoid maladaptation. To the climate research community therefore, it should be realised that IK is useful both as leads and as baseline knowledge for future work on the impacts of climate change, and in the assessment of climate interventions. In this regard, the remaining challenge is to formulate a framework of constructive dialogue between indigenous scientists and conventional scientists so as to make sure that the mutual benefits of the two knowledge forms are adequately harnessed. Handled well, such collaborative effort would ensure enhanced climate change knowledge for successful mitigation and adaptation strategies. Handled poorly, there is a risk that the developmental needs of communities exposed to climatic events would not be addressed.

Key words: *CBA*, *climate change, IK, indigenous-based adaptation, indigenous-based indicators, indigenous-based mitigation, Muzarabani, qualitative research, REDD+, sacredness*

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List of Acronyms

AAS	-	African Academy of Sciences
CAMPFIRE	-	Communal Area Management Programme for Indigenous Resources
CAQDAS	-	Computer-Aided Qualitative Data Analysis Softwares
CBA	-	Community-Based Adaptation
CBD	-	Convention on Biological Diversity
CCO	-	Climate Change Office
CDM	-	Clean Development Mechanism
CDR	-	Crude Death Rate
COP	-	Conference of Parties
CPU	-	Civil Protection Unit
DA	-	District Administrator
DRM	-	Disaster Risk Management
DRR	-	Disaster Risk Reduction
EBA	-	Ecosystem-Based Adaptation
ET	-	Emission Trading
EWS	-	Early Warning Systems
FCCSZ	-	First Climate Change Symposium of Zimbabwe
GCMs	-	Global Circulation Models
GHG	-	Greenhouse Gas
IFRCRCS	-	International Federation of the Red Cross and Red Crescent Societies
IK	-	Indigenous Knowledge
IKS	-	Indigenous Knowledge Systems
IMR	-	Infant Mortality Rate
IPCC	-	Intergovernmental Panel on Climate Change
ITCZ	-	Inter-Tropical Convergence Zone
JI	-	Joint Implementation
LULUCF	-	Land use and Land Use Cover and Forestry
MDC	-	Movement for Democratic Change
MDGs	-	Millennium Development Goals
MENRM	-	Ministry of Environment and Natural Resources Management

MEWC	-	Ministry of Environment Water and Climate
MMR	-	Maternal Mortality Rate
MP	-	Member of Parliament
MSD	-	Meteorological Services Department
MZEP	-	Mid-Zambezi Elephant Project
NAMAs	-	Nationally Appropriate Mitigation Actions
NCCRS	-	National Climate Change Response Strategy
NGOs	-	Non-Governmental Organisations
PA	-	Provincial Administrator
PG	-	Provincial Governor
PM	-	Provincial Minister
PWMAZ	-	Parks and Wildlife Management Authority of Zimbabwe
RCS	-	Research Council of Zimbabwe
RDC	-	Rural District Council
REDD+	-	Reducing Emissions from Deforestation and Forestry Related Degradation Programme
SADC	-	Southern African Development Community
SDGs	-	Sustainable Development Goals
SIRDC	-	Scientific and Industrial Research and Development Centre
TPK	-	Traditional Phenological Knowledge
UNCED	-	United Nations Conference on Environment and Development
UNDP	-	United Nations Development Programme
UNDRIP	-	United Nations Declaration on the Rights of Indigenous Peoples
UNEP	-	United Nations Environment Programme
UNESCO	-	United Nations Educational, Scientific and Cultural Organisation
UNFCCC	-	United Nations Framework Convention on Climate Change
UNGAS	-	United Nations General Assembly
UN-OCHA	-	United Nations Office for the Coordination of Humanitarian Affairs
ZAMSOC	-	Zambezi Society
ZANU-PF	-	Zimbabwe African National Union – Patriotic Front
ZINWA	-	Zimbabwe National Water Authority

CHAPTER 1

CLIMATE CHANGE CHALLENGE: AN INTRODUCTION

Climate change is destroying our path to sustainability. Ours is a world of looming challenges and increasingly limited resources. Sustainable development offers the best chance to adjust our course.

Ban Ki Moon

1.1 Introduction

Climate change remains a global problematique. Of late, discourse has shifted towards developing sustainable mitigation and adaptation measures to contain the effects of climate change (Allison *et al*., 2011; Arnold, 2011; Giddens, 2011; IPCC, 2012; IPCC 2014a; IPCC, 2014b). The greatest challenge, however, is that impacts of climate change are multifarious and the domain of these impacts is multifaceted. Notable adverse impacts include; declining water and forestry resources; changes in distribution of fauna and flora with decimation of biodiversity; reduced agricultural productivity; geographic spread of pathogens and vector-borne diseases; and turbulent weather and climatic disasters (McCarthy *et al*., 2001; Thornton *et al*., 2006; IPCC, 2007b; Low, 2008; Hutchins, 2009; Allison *et al*., 2011; Kusangaya *et al*., 2013; IPCC, 2014a). It is also widely acknowledged that some of these impacts are actually a result of environmental degradation and climate change merely compounds them (Adger *et al*., 2007; Berkes, 2009; Sönke *et al*., 2010; Makhado *et al*., 2011; Cornell *et al*., 2013; IPCC, 2014a).

Given the crosscutting nature of the impacts, knowledge of climate science should be holistic. In climate change discourses therefore, the collective knowledge, ingenuity and action of all stakeholders (including communities affected by climate change) deserves special attention. This view puts indigenous people to the centrality of climate research. Aside from being vulnerable victims of climate change (Boko *et al*., 2007; Nyong *et al*., 2007; IUCN, 2008), long-time residents relying on ecosystem-based and climate-sensitive livelihoods are highly attentive to environmental change and variability (Berkes & Jolly, 2001; IPCC, 2007b; King *et al*., 2008; Gearheard *et al*., 2009; Peloquin & Berkes, 2009; Turner & Clifton, 2009; Green & Raygorodetsky, 2010; Green *et al*., 2010; Nakashima, 2012). Therefore, their inclusion in environmental issues cannot be disputed.

Essentially, the lenses of scientific enquiry ought to cover traditional communities in which indigenous knowledge systems (IKS) are prevalent. This can enhance understanding of climate change interventions against the paucity of knowledge about current and future climate, and the increasing challenges associated with the phenomenon. Therefore, the role of indigenous knowledge (IK) in climate science should also characterise current discourse of impact assessment, mitigation, adaptation and policy formulation. IK is a locally developed knowledge form, acquired in situ, through progressive study of the community's interaction with the environment (Berkes *et al*., 2000; Ajibade & Shokemi, 2003; Brook & McLachlan, 2008; Mapara, 2009; Orlove *et al*., 2010; Labode *et al*., 2012). Research that explores local knowledge, views, observations and responses of people experiencing variability and change in the climate system can contribute in enhancing understanding of the subject. Overall, the study argues that indigenous-based knowledge is capable of filling knowledge gaps and validating current understanding about climate change particularly at local levels.

For the purpose of exposition, this chapter provides a background to the phenomenon of climate change. It describes the major manifestations of climate change at various levels and dimensions, with particular emphasis on the sensitivity of Zimbabwe to the known and anticipated effects of climate change. Central in this analysis, is the recognition that the country's rural communities value their IK in many aspects. This means the robustness of climate change interventions in rural Zimbabwe is informed by acknowledging the existence of this knowledge form. Thus, climate science discussed here incorporates the indigenous thought about the subject. This view guides the philosophical and epistemological framework of the thesis. A definition of the problem driving the enquiry is also articulated. This is later augmented by a detailed explanation of the research motivation, which, aside from serving to enhance understanding of climate science, also informs formulation of climate change strategies that recognise community-based knowledge in their praxis. The chapter concludes by relating the stated research objectives to the chapter outlines of the whole thesis.

1.2 Background to Climate Change and Impacts

Climate change is generally understood as a long-term change or variability of the climate system. Events related to this change such as violent storms, hurricanes, floods and droughts, continue to attract attention of global community to consider mitigation and adaptation as main policy interventions (IPCC, 2001; Robinson & Herbert, 2001; Adger *et al*., 2003; Pielke, 2005; Stehr *et al*., 2005; Tol, 2005; Wilbanks, 2005; IPCC, 2007b; IPCC, 2007c; Bizikova, 2012; IPCC, 2012; IPCC 2014a; IPCC, 2014b). Mitigation involves devising measures both to reduce sources and to enhance sinks of greenhouse gases (GHGs), while adaptation involves responding to impacts induced by climate change. This section examines the global effects of climate change in general and on the livelihoods of people in Zimbabwe in particular. A detailed description of the environmental aspects of Muzarabani (the study area) and its predisposition to climate change related hazards is propounded in Chapter 2.

1.2.1 Global Impacts of Climate Change

The science of climate change, though still on-going, is a well-researched field. A review of the Intergovernmental Panel on Climate Change (IPCC) assessment reports indicates that impacts of climate change on natural and human environments are inconclusive, but increasingly devastating (IPCC, 1990; IPCC, 1995; IPCC, 2001; IPCC, 2007b; IPCC, 2014a). Two major reasons can be cited for uncertainties in climate change. Firstly, Berkes (2009) cites the fuzzy logic principles which explain that, when a phenomenon becomes too complex, our precision in understanding it falls. Secondly, the term ‘change’ itself implies that the impacts are always variable. Based on the projections made by scientists, the anticipated changes in the climate system though certain, are not always precise but can either be understated or overstated.

Nonetheless, current knowledge about the impacts is phenomenal. Recent observed changes in climate, attributable to increased global warming from GHG emissions, indicate devastating impacts on natural and human environments across the global divide. For instance, the recent statistics by the World Meteorological Organisation (WMO) indicate between 1990 and 2013, a 34% rise in radioactive forcing – the warming effect of the climate – attributable to long-lived GHGs, mainly carbon dioxide, methane and nitrous oxide. In 2013 alone, atmospheric concentration of carbon dioxide, methane and nitrous oxide was 142%, 253% and 121% of the pre-industrial era (1750) respectively (WMO, 2014). The IPCC documents copious literature on climate change from the science of the phenomenon, its drivers, vulnerability of communities, mitigation and adaptation, to the policy issues around the subject. Specifically, the Fourth Assessment Report (AR4) of the IPCC summarises the following facts (IPCC, 2007b: 2-13):

- Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level.
- Global GHG emissions due to human activities have grown since pre-industrial times, with an increase of 70% between 1970 and 2004.
- There is high agreement and much evidence that with current climate change mitigation policies and related sustainable development practices, global GHG emissions will continue to grow over the next few decades.
- High frequencies and intensities of extreme weather, together with sea level rising, are expected to have mostly adverse effects on natural and human systems.
- Anthropogenic warming could lead to some impacts that are abrupt or irreversible, depending upon the rate and magnitude of the climate change.
- Anthropogenic warming and sea level rise would continue for centuries due to the time scales associated with climate processes and feedback, even if GHG concentrations were to be stabilised.

Clearly, inferring from this synthesis, it is evident that the impacts projected by the IPCC span various facets of human development; energy, transport, human settlement, health, industry, agriculture, tourism, water and forestry. As shall be discussed in Chapter 3, these impacts can either be positive or negative, depending on society's adaptive capacity (Adger *et al.*, 2003; Stehr & von Storch, 2005; IPCC, 2007b; IPCC, 2014a).

Another important observation is that climate change impacts are likely to worsen given the complexity of the earth's atmospheric system. What is quite disturbing is the revelation that, assuming mitigation measures are to be successfully adopted, say through an energy policy that arrests any future emission such as switching over to a global green economy, the impacts will still be felt at all scales. This is attributable to the time lag in the complex climate system for effective carbon assimilation (IPCC, 2007a; Hutchins, 2009; IPCC, 2013).

The nature and magnitude of the impacts are also perturbing. For example, the 2007 IPCC Synthesis Report presents a whole range of sectors affected by climate change. These are summarised in Table 1.1.

Table 1.1 Projected impacts of climate change across sectors

Phenomenon & major direction of trend	Examples of major projected impacts by sector			
	Agriculture, forestry & ecosystems	Water resources	Human health	Industry, settlement & society
Over most land areas, warmer & fewer cold days & nights, warmer & more frequent hot days & nights	Increased yields in colder environments; decreased yields in warmer environments; increased insect outbreaks	Effects of water resources relying on snowmelt; effects on some water supplies	Reduced human mortality from decreased cold exposure	Reduced energy demand for heating; increased demand for cooling; declining air quality in cities; reduced disruption to transport due to snow, ice effects on winter tourism
Warm spells/heat waves. Frequency increases over most land areas	Reduced yields in warmer regions due to heat stress; increased danger of wildfire	Increased water demand; water quality problems, e.g., algal blooms	Increased risk of heat-related mortality, especially for the elderly, chronically sick, very young and socially isolated	Reduction in quality of life for people in warm areas without appropriate housing; impacts on the elderly, very young and poor
Heavy precipitation events. Frequency increase over most areas	Damage to crops; soil erosion; inability to cultivate land due to water logging of soils	Adverse effects on surface and underground water;contamination of water supply; water scarcity may be relieved	Increased risk of death, injuries and infections, respiratory and skin diseases	Disruption of settlements, commerce, transport and societies; pressures on urban & rural infrastructures; loss of property
Area affected by drought increases	Land degradation; lower yields/crop damage and failure; increased livestock death; increased danger of wildfire	More widespread water stress	Increased risk of food & water shortage; increased risk of malnutrition; increased risk of water- and food-borne diseases	Water shortage for settlements, industry and societies; reduced hydro-power generation potentials; potential for population migration
Intense tropical cyclone activity increases	Damage to crops; uprooting of trees; damage to coral reefs	Power outages causing disruption of public water supply	Increased risk of death, injuries, water- and food-borne diseases; post-traumatic stress diseases	Disruption by flood and high winds; withdrawal of risk coverage in vulnerable areas by private insurers; potential for population migration; loss of property
Increased incidence of extreme high sea level	Salinisation of irrigation water, estuaries and fresh water systems	Decreased freshwater availability due to saltwater intrusion	Increased risk of death & injuries by drowning in floods; migration-related health effects	Costs of coastal protection versus costs of land relocation; potential for movement of populations and infrastructure

(Source: IPCC, 2007b:13)

It is evident from Table 1.1 that the projected impacts of climate change and those experienced so far could be both positive and negative. However, this generalised presentation can be misleading since it has a tendency of shadowing the reality of place-specific impacts, which are only properly understood through localised studies. Notwithstanding this generalisation, some important facts need to be understood about the evidence collated in the illustration. For example, most of the anticipated positive impacts are mainly a function of adaptive capacity. Adaptation literature (for example, Patt & Gwata, 2002; Grothmann & Patt, 2005; Thompkins & Adger, 2005; Grothmann & Reusswig, 2006; Deressa, 2009; Turner & Clifton, 2009; Brockhaus *et al.*, 2013) indicates that adaptive capacity is a function of many variables. There are social, technological, political, economic and psychological dimensions that influence the degree of vulnerability on the one hand, and resilience and capability to respond on the other hand. Detailed attention to this argument is given in Chapter 3.

Generally, when examined in an African context, opportunities associated with climate change are hard to materialise. There is evidence that developing countries tend to be seriously devastated by events associated with the phenomenon owing to multiple stressors not limited to poverty, HIV/AIDS, political conflicts, poor governance, marginality and neglect by policy-makers (Sperling, 2003; McCaig, 2005; O'Brien, 2009; Nielsen *et al.*, 2012). One way of examining the exact nature of climate change, or to check if indeed opportunities exist, would be to downscale research focus to the level of communities experiencing climatic phenomena. In Africa, however, there has been limited attention by scholars to pursue studies in this regard (IPCC, 2012) and Zimbabwe is not an exception. Thus, this study focuses on understanding the local effects of climate change and how this can be enhanced using IK.

The next sections look at the impacts of climate change on development before presenting the African situation in general and drawing closer to the Zimbabwean experience in particular.

1.2.2 Impacts of Climate Change on Development

The confluence between climate change and development has widely been adumbrated. A closer analysis reveals that climate change influences sustainable development. Most scholarship (for example, Cohen *et al*., 1998; Hobinson & Herbert, 2001; Sperling, 2003; Adger *et al*., 2005; Thornton, 2006; APN, 2007; Yohe *et al*., 2007; Sönke *et al*., 2010; Bizikova, 2012) describe this relationship as two-way; that is, climate change influences sustainable development, which in turn is influenced by climate change. Sustainable development in the context of climate change can be understood as devising mitigation and adaptation strategies whose benefits can benefit society in perpetual continuity. The Secretary General of the United Nations, Ban Ki-Moon, has this to say about this relationship:

> *We have to limit global temperature rise or we will never achieve sustainable development and eradicate extreme poverty.…But addressing climate change is also a great opportunity to support all our sustainable development goals. At the same time, the actions we take on sustainable development can help tackle climate change. The two are interdependent and mutually supporting.*

According to Nyong *et al.* (2007) incorporation of IK can be valuable in devising sustainable climate change mitigation and adaptation strategies that are framed within local-specific contexts with valuable input from the people affected. In a similar focus, IPCC (2007b) expresses the fact that communities in marginal areas and whose livelihoods are directly dependent on natural resources (such as those of Muzarabani described in Chapter 2) are highly vulnerable to climate change. This implies inclusion and participation of indigenous people if interventions are to be sustainable. Chapter 3 gives an elaborate analysis of the linkage between climate change and development.

Of late, climate change has been understood as a major drawback to the Millennium Development Goals (MDGs) (Kreft *et al*., 2010). The MDGs are a collection of progress markers towards sustainable development. For example, given other development stresses facing poor countries discussed in Section 1.2.3 below, adaptive capacities may not match with the magnitude and severity of the challenges posed by a changing climate. Possibly, this can stymie the realisation of the MDGs. In Africa, in particular, the fear is that climate change may even reverse progress towards development (Boko *et al*., 2007; Kreft *et al*., 2010). The greatest challenge here is that climate change is a crosscutting issue permeating all the eight MDGs either directly or indirectly, and/or with one reinforcing others. The direct impacts relate to those that hamper efforts toward elimination of hunger and poverty, health improvement and promotion of environmental sustainability. These indirectly and variously hinder efforts toward education, gender and women empowerment promotions. The post 2015 development agenda has now shifted towards a focus on sustainable development goals (SDGs), where climate change is likely to be a key issue for attention. In this regard, consideration of communities experiencing climate change should be emphasised if indeed the SDGs are to be realised.

1.2.3 Climate Change Experiences in Africa

If the major forcing behind climate change is to be isolated as anthropogenic global warming, then climate change in Africa is a paradox. This is because the continent has a very minimum contribution to atmospheric GHGs, yet it suffers worst from their effects (Den Elzen, 2005; IPCC, 2013). Africa's contribution to global GHGs is just about 3%. Of this, the largest proportion of GHG emissions comes from agriculture and land use practices (57%), followed by the energy sector (32%), according to Nyong *et al* (2007). This unfortunate incidence has even ignited serious debate in climate policy fora. For example, the three recently held meetings of the United Nations Climate Change Conference of Parties (COP) 17 (2011), 18 (2012) and 19 (2013) in Durban (South Africa), Doha (Qatar) and Warsaw (Poland), respectively, ended in a policy gridlock largely because of the inferior position of developing countries in the anthropogenic driven climate change mantra. Specifically, the agenda for COP 19 was 'Going green, reducing carbon-footprints and pledging commitment to the Kyoto Protocol.' In addition, the theme for the Rio+20 United

Nations Conference on Sustainable Development embraced the idea of 'green economy' in the context of sustainable development.

However, it is yet to be seen if these discussions are to meaningfully provide any tangible benefits to Africa, a continent unjustly captivated by the worsening effects of climate change. Furthermore, the expected 2015 Paris climate agreement (COP 21) in France is still not clear as to how developing countries are to benefit from climate funds.

With reference to Africa, multiple stresses pose serious vulnerability to climate change. The continent's propensity to anticipated climate change is mainly a function of a vicious combination of such factors as endemic poverty; poor governance; weak and limited institutional capacities; limited capital, technology and ingenuity; environmental degradation; natural disasters; and political conflicts (Boko *et al*., 2007; Low, 2008; Chirisa & Chanza, 2009; Allison *et al*., 2011; IPCC, 2012). Although a range of opportunities emerge through wealth, technology, education, information, skills, infrastructure and access to resources, these may not be realisable due to unsustainable pathways toward adaptation. Instead, evidence of climate change is noticeable in its broad impacts ranging from decreased agricultural production and food insecurity; water stress and water quality problems; ecosystem damages; inundation of low-lying land; and human health problems (Boko *et al*., 2007; Parry *et al*., 2007; IFRCRCS, 2014; IPCC, 2014a). A summary of facts on the magnitude of these impacts is given in Box 1.1.

Box 1.1 Projected regional effects of climate change in Africa

The following facts have been noted about the effects of climate change in Africa:

- The impacts of climate change are likely to be greatest where they co-occur with a range of other stresses (e.g., unequal access to resources; enhanced food insecurity; poor health management systems. These stresses, enhanced by climate variability and change, further enhance the vulnerabilities of many people.
- An increase of 5 to 8% (60 to 90 million ha) of arid and semi-arid land is projected by the 2080s under a range of climate change scenarios.
- Declining agricultural yields are likely due to drought and land degradation, especially in marginal areas. Changes in the length of growing period have been noted under various scenarios. Areas of major change include the coastal systems of southern and eastern Africa. Under most scenarios, mixed rain-fed, semi-arid systems are shown to be heavily affected by changes in climate in the Sahel. Mixed rain-fed and highland perennial systems in the Great Lakes region in East Africa and in other parts of East Africa are also heavily affected.
- Current stress on water in many areas of Africa is likely to be enhanced by climate variability and change. Increases in runoff in East Africa (possibly floods) and decreases in runoff and likely increased drought risk in other areas (e.g., southern Africa) are projected by the 2050s.
- Any changes in the primary production of large lakes are likely to have important impacts on local food supplies. For example, Lake Tanganyika currently provides 25 to 40% of animal protein intake for the population of the surrounding countries, and climate change is likely to reduce primary production and possible fish yields by roughly 30%. The interaction of human management decisions, including over-fishing, is likely to further compound fish off takes from lakes.
- Ecosystems are likely to experience major shifts and changes in species range and possible extinctions (e.g., fynbos and succulent Karoo biomes in southern Africa).
- Mangroves and coral reefs are projected to be further degraded, with additional consequences for fisheries and tourism.
- Towards the end of the 21st century, projected sea-level rise will affect low-lying coastal areas with large populations. The cost of adaptation will exceed 5 to 10% of GDP.

(Source: Parry *et al*., 2007:59)

The key challenge, however, is that the exact distribution, magnitude and shape of the impacts are only partially understood in Africa owing to *inter alia*, limited understanding of the climate system and the unpredictability of the climate. The next section discusses challenges associated with climate change studies in Africa.

1.2.4 Knowledge Informing Climate Science and its Limitations

When it comes to the understanding of the climate phenomenon and its associated events, climate change scholarship is still highly biased in the developed world. A 2013 report by the African Academy of Sciences (AAS) reveals that despite consensus on the current and future impacts of climate change on the continent, significant uncertainties exist on the exact nature of future changes. The report further cites that between 1981 and 2009 scientists from Africa contributed less than 2% of global climate change scholarship (AAS, 2013). Possible reasons behind this development are advanced here.

First, the complexity of the phenomenon requires highly specialised models for projecting future scenarios of a changing and variable climate system. For instance, Global Circulation Models (GCMs) used in climate change projections require specialised training to acquire knowledge and skills for their good application and interpretation, aspects that are largely lacking in the developing world. Of the various models used in the prediction of future climate events, most of them, according to Thornton *et al.* (2006), still fall short of explaining local specific climate situations especially in Africa. Despite reporting on advances in measurements and modelling capabilities, IPPC's Fifth Assessment Report (AR5) also admits that the robustness of most models is limited to global and regional scales and will need downscaling to simulate local climatic conditions (IPCC, 2013).

Second, the North has a combination of human, financial and technical capital in their research institutions and universities which are usually supported by a robust government policy towards scientific research and development. On the contrary, sufficient resources and support for a solid research base in most African countries are usually lacking. In Zimbabwe the Research Council of Zimbabwe (RCZ) and the Scientific and Industrial Research and Development Centre (SIRDC), the main research agencies, for example, remain underfunded to meet climate research and other research obligations.

Third, a clear climate policy is mostly lacking in the developing world. Where such a policy exists, it may not be properly implemented owing to limited resources amongst other reasons. As a result, climate issues are always relegated to the peripheries of development policies and programmes. This is evident in Zimbabwe where climate policy development has been an on-going exercise for several years without being finalised. The fear is that such delays in coming up with a clear framework of action is likely to restrain intervention efforts by climate stakeholders.

Fourth, climate change itself remains a highly contested subject when it comes to financing its interventions at the political front. This means most governments of the developing world decide to remain in passivity when it comes to climate science funding. Put simply, rarely do we find a specific budget being allocated for funding climate research in most African governments. Where interest in the subject is seen, it only comes as reactive ex post interventions following risks posed by extreme weather and climate events (Chirisa & Chanza, 2009; IFRCRCS, 2010). The 2014 Tokwe-Mukorsi floods in central Zimbabwe are a typical case that compelled government to seek US$20 million for the urgent evacuation, relocation, sheltering and provision of safe water and other requisite amenities to the over 60,000 people affected by the disaster (Herald, 18/02/2014).

Fifth, the climate change conundrum where Africa for instance, with minimum contribution to the anthropogenic forcing behind the phenomenon, heavily suffers the greatest pinch, is itself a distraction. Consequently, unless driven by some international funding, climate change research in Zimbabwe, for example, has remained purely academic with limited action for decision making at policy level. The existence of a dichotomy between science and decision makers is also cited by AR5 Working Group II's report on the impact, vulnerability and adaptation situation in Africa (IPCC, 2014a).

Clearly, such limitations sufficiently call for an approach in scientific enquiry whose raison d'être is to enhance understanding of climate change at local level. Aside from building knowledge about local specific impacts of the phenomenon, the view considered in this study capitalises on the knowledge of the people who have religiously been monitoring conditions of the climate system from their many years of close contact with and observation of the environment around them. Thus, in the current tempo where scientists seek to understand change and variability in the climate system, where policy makers grapple with conflicting and complex policy options, and where practitioners face implementation challenges of mitigation and adaptation strategies, the potential utility of IK in these discussions deserves some attention. With this in mind, it is pertinent to scale down to the analysis of Zimbabwe's climate system.

1.3 Geographic Profile and Climate of Zimbabwe

Spatially, Zimbabwe is a landlocked country located in the southern region of Africa between latitudes 15^{0} 30” and 22^{0} 30” south of the Equator and between longitudes 25^{0} 00” and 33^{0} 10” east of the Greenwich Meridian. It is sandwiched between Mozambique to the east, South Africa to the south, Botswana to the west and Zambia to the north and northwest (see Figure 1.1). The country has a total land area of about 390,757 km^2 and is divided into ten administrative provinces: Harare (the capital region), Bulawayo, Mashonaland Central, Mashonaland East, Mashonaland West, Manicaland, Masvingo, Midlands, Matebeleland North and Matebeleland South.

Figure 1.1 Geographic location of Zimbabwe and its administrative boundaries

(Source: www.ezilon.com)

Zimbabwe has a population of 13,061,239, out of which 67% is found in rural areas (ZIMSTAT, 2013a). This means much demographic attention has to be focused towards the rural communities, which support a larger proportion of the people. Of particular mention is the fact that the rural population mostly relies on the natural environment in terms of their energy and food demands. Consequently, coupled with the climate change effects reported by GoZ-UNDP/GEF (2009a), Brown *et al* (2012), Mugandani *et al* (2012) and Gukurume (2013), the environment is under immense pressure (MENRM, 2010).

Topographically, Zimbabwe is elevated in the central plateau which defines its central watershed stretching from the southwest to the northwest at altitudes between 1,200m and 1,600m. This main watershed is 650km and 80km in length and width, respectively. The highest elevation is along the eastern border with Mozambique where mountain peaks range between 2,300m and 2,500m above mean sea level. About 20% of the country consists of the lowveld under 900m with the Zambezi and Limpopo river valleys found in the north and south, respectively, having the lowest altitude of around 500m (www.atlaspedia.com). The geography of the Zambezi Valley, the area constituting the study site, is described in detail in Chapter 2.

Climatically, Zimbabwe is characterised by a sub-tropical climate with four distinctive seasons; cool season from mid-May to August, hot season from September to mid-November, the main rainy season running from mid-November to mid-March, but punctuated by several dry spells, and the post rainy season from mid-March to mid-May. The lowest minimum temperatures are recorded in June/July and the highest maximum temperatures in October/November. The mean monthly temperature varies from 15^0C in July to 24^0C in November while the mean annual temperature varies from 18^0C on the highveld to 23^0C in the lowveld. Altitude has a strong influence in moderating climate, with the Eastern Highlands experiencing cooler temperature compared to the low-lying areas of the lowveld (MENRM, 2012a).

Zimbabwe is generally a semi-arid country with low annual rainfall reliability. The mean annual rainfall is 650 mm but geographically it ranges from around 350 to 450 mm per annum in the southern lowveld to 1,000 mm per annum in the Eastern Highlands (Unganai, 1996; MENRM, 2012a). Of late, Zimbabwe has been experiencing variable precipitation patterns, mostly characterised by erratic rains from year to year owing to changing climate (Chagutah, 2010; Mugandani *et al*., 2012; Gukurume, 2013; Makarau, 2013).

Ecologically, the sub-tropical climate supports luxuriant growth of flora and fauna in both terrestrial and aquatic ecosystems. Dry miombo woodland, mopane woodland and other woodland types with serpentine grasslands found in the Great Dyke constitute the flora. A montane forest interspersed amongst high-altitude grasslands and heath is found in the Eastern Highlands. Zimbabwe's forestry resources cover approximately 66% of the total land area. Almost 15% of Zimbabwe is under some form of statutory protection within national parks and other protected areas. The country relies on surface water resources for 90% of its requirements while groundwater supplies the remaining 10% (MENRM, 2012a; Murwira *et al.*, 2013).

Broadly, Zimbabwe's environment faces threat from increasing competing demands of both society and the economy. According to a report on the state of the country's environment (MENRM, 2012b), notable key drivers of unsustainability can be summarised as:

- Overpopulated rural areas despite the government's land reform and resettlement programme.
- Growing poverty and its attendant problems of resource over-exploitation.
- Poor wildlife management through excessive timber and fuelwood extraction, game hunting and poaching, ultimately leading to deforestation and decline in biodiversity.
- Threat of alien species such as the water hyacinth in some of the country's water bodies like Lake Chivero and Manyame River.
- Small-scale and other illegal alluvial mining activities contributing to siltation of major surface water bodies.
- Rapid urbanisation where the population continues to exert pressure on the few resources available and on limited and obsolete infrastructure in towns and cities.
- Industrial, domestic and municipal waste, continue to pose a serious health problem especially in large urban areas.
- Significant increase in respiratory and water borne diseases.
- Water scarcity due to variability of rainfall and ineffective water management measures, including pricing and pollution control.

- Droughts and floods (in some areas) are an overriding factor in the degradation of agricultural lands leading to decline in household agricultural productivity, threat on livelihoods and loss of lives.

1.4 Climate Change Experiences in Zimbabwe

Like any other country in Africa, Zimbabwe seriously confronts climate change. The scenario of climate change impacts presented in Section 1.2.3 is evident in Zimbabwe. Local studies show some matches in the nature of climate change impacts (Chamaillé-Jammes *et al*., 2007; Kahinda *et al*., 2007; Mano & Nhemachena, 2007; Mutasa, 2008; Aguilar *et al*., 2009; GoZ-UNDP/GEF, 2009; Gwimbi, 2009; Unganai & Murwira, 2010; MENRM, 2012a). These impacts are synthesised in a 2012 report to the United Nations Framework Convention on Climate Change (UNFCCC) by the then Ministry of Environment and Natural Resources Management (MENRM) as:

- Significant shifts in agro-ecological zones with a serious impact on cropping choices particularly by the majority peasantry;
- Threat on ecosystems associated with biodiversity decimation;
- Shrinkage of areas suitable for growing major food and cash crops;
- Reduced rangeland carrying capacity for both livestock and wildlife;
- Shrinkage of major catchments with subsequent desiccation of streams and rivers; and
- Spatial spread of and intensity in water and temperature related diseases like malaria.

The combined negative effects of the phenomenon on agriculture, health, water resources, rangelands, biodiversity and agro-ecological regions further pose serious threat to human settlements, the economy and tourism. Selected climate change pointers on agriculture, water resources and health and human settlements are presented in the next sub-sections.

1.4.1 Impacts of Climate Change on Agriculture

Zimbabwe is divided into five agro-ecological or natural regions based on studies carried out in the 1960s (Mugandani *et al*., 2012). Agricultural planning is however, still based on this outdated climate classification scheme shown in Figure 1.2. The authors argue that the scheme used is no longer accurate owing to changes in climate. Generally, the agro-ecological delimitation is a function of a mixture of three main variables; namely, effective rainfall, temperature and soil quality, which in turn influence agricultural potential. Rainfall patterns and crop production progressively deteriorate as one moves from Region 1 to Region 5. Region 4 is important in this research as it constitutes the study area. A further description of the characteristics of this agro-ecological zone is given in Chapter 2.

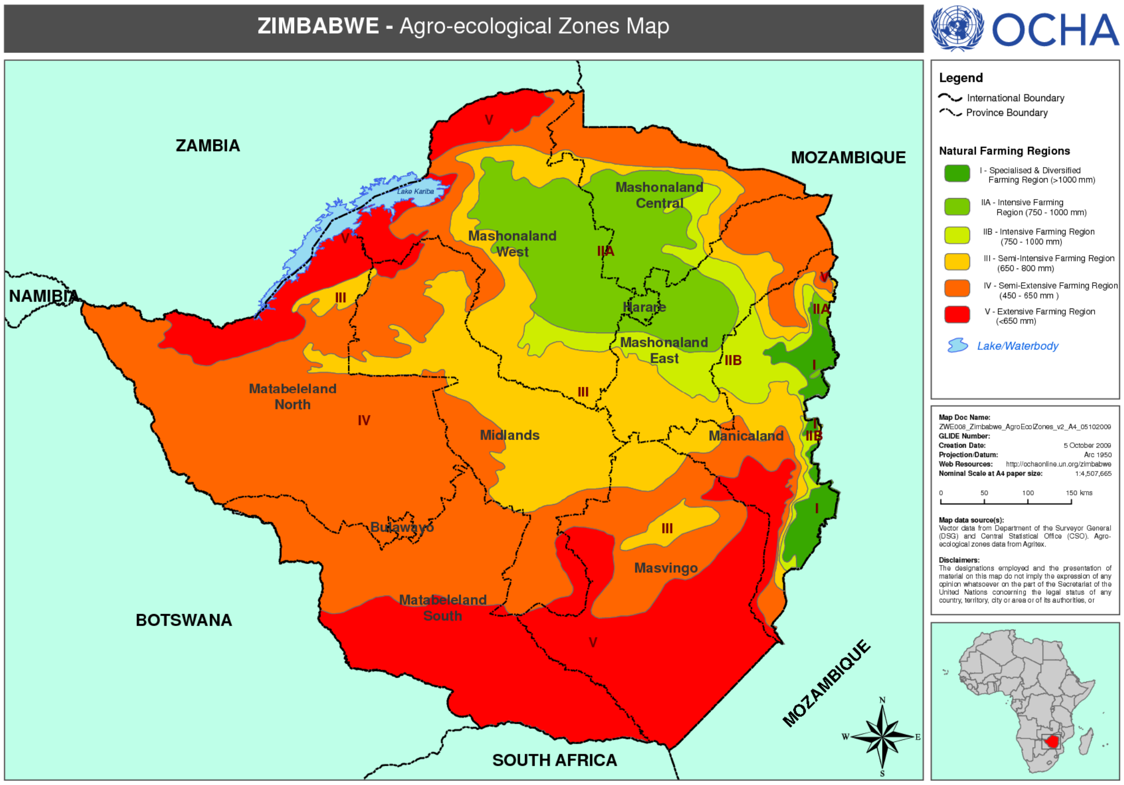

Figure 1.2 Zimbabwe's agro-ecological zones

(Source: www.docstoc.com)

Meteorological facts point to increased variability of rainfall, rain days and temperature (MENRM, 2012a; Mugandani *et al*., 2012), which collectively influence agriculture. Zimbabwe is experiencing more hot and fewer cold days than before as a result of climate change and variability (Unganai, 1996; Zhakata, 2004; Mutasa, 2008; GoZ-UNDP/GEF, 2009; Brown *et al*., 2012; MENRM, 2012a; Mugandani *et al*., 2012; Makarau, 2013). For example, driven by a concern that climate change might have influenced the country's agro-ecological regions, Mugandani *et al* (2012) carried out a study that confirmed significant shifts in natural regions, which is indicative of climate change and variability. They concluded that Zimbabwe's highly productive agro-ecological regions (Region 2 and 3) are shrinking in size at the expense of drier regions (Region 4 and 5) with serious implications for food security.

This warming trend is a confirmation of Unganai's (1996) earlier study that shows a 0.1^0C rise and 1% decline in temperature and rainfall per decade, respectively.

Revised studies by Kahinda *et al* (2007) and later by Unganai and Murwira (2010) reveal that the country's annual mean surface temperature has warmed by about 0.4^0C from 1900 to 2000, with the period from 1980 to date being the warmest. This has led to increasing aberrations in the timing and amount of rainfall received. Generally, precipitation has declined by 5% since 1900. Rains have been noted to be erratic and more unpredictable and the main rainy season has been characterised by trends of irregularities. The MENRM's (2012a) report traces the trend towards reduced rainfall or heavy rainfall and drought over the past 30 years. A careful analysis of these facts implies that diurnal temperature range is decreasing while deviations in precipitation are increasing, with far reaching consequences on agriculture (see Figure 1.3).

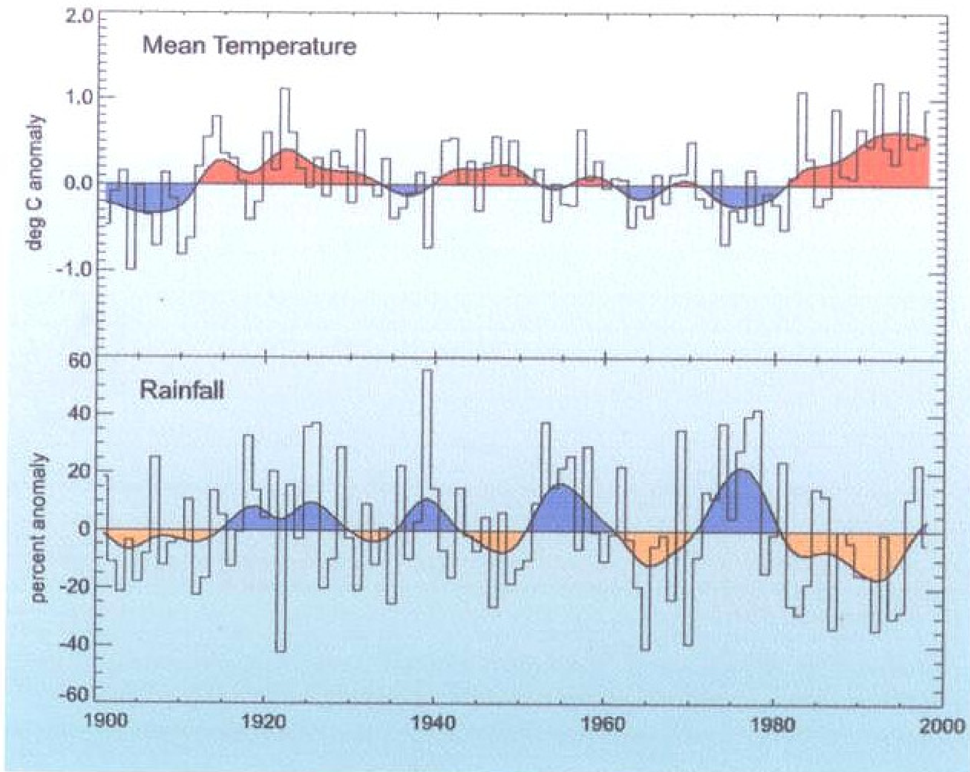

Figure 1.3 Changes in mean annual temperature and rainfall

1901-1998 (top panel), and annual rainfall, 1901-1998 (bottom panel), across Zimbabwe. Changes are with respect to the average 1961-90 climate values of 21.3ºC and 662mm, respectively

(Source: www.grida.no/graphicslib/detail/climate-change-in-zimbabwe-trends-in-temperature-and-rainfall_85e5)

Credit: Philippe Rekacewicz, UNEP/GRID-Arendal

The decade 1986 to 1995 was recorded to be 15% drier than average. On a different note, there are also substantial periods such as the 1920s, 1950s and 1970s that have been much wetter than average. As a result of these variations, the effects of climate change on agriculture in most places can be summarised as an oscillation between drought and floods with serious effects on food security. This is typical the situation in Muzarabani. The adverse impacts are largely felt by the poor communal farmers whose livelihoods are solely dependent on rain-fed agriculture. Manifestations of climate change impacts on agriculture are evident in crop failure, desiccation of water points, drying of pastures and death of livestock, cumulatively leading to decline in agricultural productivity (GoZ-UNDP/GEF, 2009; Brown *et al.*, 2012; Gukurume, 2013). Overall, the negative impacts of climate change on agriculture have featured prominently in IPCC's assessment reports (IPCC, 2001; IPCC, 2007b; IPCC, 2014a). In Chapter 2, the study examines the propensity of communities in Muzarabani whose agriculture-dependent livelihoods have been seriously affected by successive drought and floods, plunging them into abject poverty.

1.4.2 Climate Change Impacts on Water Resources

Analysis of Zimbabwe's catchment areas also gives a clear picture about the effects of climate change. The seven distinctive catchment areas shown in Table 1.2 have been highly sensitive to climate change. Observed changes in rainfall and temperature patterns also affect the hydrological processes through surface runoff and river flows, which subsequently is evident in terms of catchment characteristics.

Table 1.2 Hydrological changes in Zimbabwe's catchment areas

Catchment	Annual average rainfall (mm)	Percentage decrease in rainfall over the last century (%)	Percentage seasons that translated into droughts (%)
Gwayi	608.3	7.7	17.8
Manyame	806.4	3.8	15.6
Mazowe	825.7	5.3	15.6
Mzingwane	473	15.3	24
Runde	591.9	11.1	22.2
Sanyati	716	12.5	20
Save	778.7	14.7	15.6

(Source: ZINWA, 2004)

Data recorded over the past century has shown some marked increase in meteorological droughts as shown in Table 1.2. The decrease in precipitation in sympathy with the phenomenon is evident in the behaviour of catchments, which are getting drier. Low (2005) argues that most parts of the country are getting warmer and drier. Effects of climate change have been recorded to be more intense in the lowveld areas of the country, which are climatically drier. This explains why Mzingwane, Runde and Save have mostly recorded significant decreases in rainfall over the past century. The Zambezi Basin (within which the study area is located) is said to be worst affected by a projected 40% decline in run-off (Brown *et al*., 2012). Based on the 1961-1990 average, annual rainfall levels are estimated to decline by up to 20% by 2080. This means the existing water resources deficiencies associated with drier regions are likely to worsen (Brown *et al*., 2012; Mugandani *et al*., 2012). As shall be discussed in Chapter 2, this has far-reaching implications on agrarian and natural resource dependent communities in rural areas. From the analysis given by Gumbo (2006), the water sector is severely affected by other non-climate stressors such as unsustainable water and land use practices, overpumping, pollution, watershed degradation, wetland loss, proliferation of aquatic weeds and sedimentation.

Persistent drought, coupled with a 25% estimated increase in climate change induced evapotranspiration (Brown *et al*., 2012), has seriously impacted on surface and ground water systems. With 80% of the country's water being consumed by the agricultural sector, these conditions further impact negatively on agriculture and food security (Gumbo, 2006; MENRM, 2012a). Furthermore, high temperatures and desiccation of wetlands reduce run-off leading to decline in water levels in major rivers and dams. This has dire consequences on aquatic ecosystems, water supply, irrigation infrastructure and hydro-power stations such as the Kariba Dam that meets much of the energy needs of Zimbabwe and Zambia.

Drought and high temperatures also exert pressure on water and sanitation requirements of the population. This is likely to reverse the gains realised in improving access to safe water and sanitation since 1980. For example, Chagutah (2010) reports a 40-60% fall in access to safe and reliable water supply mainly in Zimbabwe's urban areas. In rural areas, on the other hand, a water crisis resulting from climate change presents a serious threat to human security. It has been shown that the phenomenon has the potential to worsen the gender inequalities as women and children take up more responsibilities in securing water for domestic use (IFRCRCS, 2010). Clearly, climate change can be blamed for worsening the water deficit challenge in the country.

1.4.3 Impacts of Climate Change on Health and Human Settlement

The irregularities in the distribution of temperature and precipitation discussed in the preceding sections pose serious implications on the settlement sector. Overall, climate related hazards reported in the country include tropical cyclones, floods and flash flooding, drought and intra-season dry spells, thunderstorms and lightning, hailstorms, heavy rains, ground frost and heat waves (MENRM, 2012a; Makarau, 2013). Low-lying areas are vulnerable to climate change-induced flooding. Most of these places are concentrated northwards toward the Zambezi River Valley and southwards toward the Save River Valley and Limpopo River Valley owing to marked decrease in altitude. The climate science community has attributed the increase in the likelihood of occurrence or strength of extreme weather and climate events to climate change (IPCC, 2012; IPCC, 2013).

Vulnerability is also influenced by hydrology. For example, to the north floods expose Mazarabani villagers owing to the confluence of the Zambezi and Musengezi rivers, while to the south the confluences of Save, Odzi and Nyanyadzi rivers, Mwenezi and Bubi rivers, Gwayi and Shangani rivers expose the Save, Malipati and Kamativi communities, respectively. Of late, an increase in the frequency of floods and tropical cyclones has been linked to climate change (Unganai & Murwira, 2007; MENRM, 2012a; Herald, 10/02/2014). These events pose serious risks to the communities through loss of crops, infrastructure damages, injuries and exposure to diseases, loss of assets, homes and lives. It is on record that such disasters are related to climate change (ibid).

The inundation of low-lying areas poses health problems due to the spread and harbouring of vectors that cause diseases like cholera, typhoid, malaria and meningitis. For example, in a study of climate change on epidemiology in Zimbabwe, Hartmann *et al* (2002), using sixteen climate change scenarios, reveal that the geographical distribution of malaria could change, with previously unsuitable areas becoming suitable for transmission as the *Plasmodium* vector takes advantage of the new conditions. Matawa and Murwira (2013) also projected expansion in habitats of certain disease vectors owing to changes in temperature and rainfall in some parts of the country.

1.5 Zimbabwe's Vulnerability to Climate Change

The scenario presented in the preceding analysis reveals that Zimbabwe is highly vulnerable to threats posed by climate change. Given that the economy is primarily agro-based with the majority of the peasantry populated in rural areas and dependant on climate-sensitive livelihoods such as arable farming, livestock rearing and various ecosystem services, climate change is indeed a threat.

The phenomenon is occurring in a set-up where realities of other non-climatic stressors have already brought untold suffering to the people (Chirisa & Chanza, 2009; Chagutah, 2010), exposing the majority of the poor to extreme climatic events and disasters. The link between poverty and vulnerability has been well articulated from climate change (Thornton *et al*., 2006; Boko *et al*., 2007; IPCC, 2012) to disaster management literature (Vaz, 2000; Gwimbi, 2009; UNISDR, 2009; IFRCRCS, 2010; Satterthwaite, 2011; Lovell *et al*., 2012; IFRCRCS, 2014). To Vaz (2000) the level of exposure to these threats is a function of community poverty, which in turn influences adaptive capacity (Patt & Gwata, 2002; Adger *et al*., 2007; IPCC, 2012; Brockhaus*et al*., 2013). A detailed analysis of climate change and poverty is exposited in Chapter 3.

In most rural remote areas like Muzarabani, the combined effects of drought and floods related to climate change continue to subject the population to acute poverty, a crisis worsened by poor rural development planning (Chanza, 2011; Kamete, 2011; UN-OCHA, 2011). Where poverty is the daily experience, a fertile ground for disaster risk to communities is provided. The report by the International Federation of the Red Cross and Red Crescent Societies (IFRCRCS) (2010) also advances this argument about the disaster risk divide skewed disproportionately towards poor societies. The detailed analysis of the geography of the study area and how this influences or is influenced by vulnerability to a changing climate is presented in Chapter 2.

1.6 Zimbabwe's Response Strategy to Climate Change

Zimbabwe is a climate-sensitive country in two main aspects. Firstly, the country is highly prone to climate change and variability as previously expressed. Secondly, it is one of the countries that seriously accept climate change as a reality. The purpose of this section is to assess the strategies in place and the major developments that have characterised climate change response in Zimbabwe. This analysis is necessary in order to understand how the institutional framework has addressed issues related to climate change, including understanding the extent to which these strategies have been sensitive to the participation of indigenous communities and their IK.

It is a fact that unless urgently addressed, climate change has the potential to undermine many of the positive developments made towards meeting the country's development goals. Zimbabwe's seriousness in addressing climate change can be traced as early as 1992 when it started to participate in international climate regimes. At international level, Zimbabwe is a signatory to the two major environmental laws governing climate change; namely, the UNFCCC signed and ratified in 1992 and the Kyoto Protocol ratified in 2009. The UNFCCC aims to stabilise GHG concentrations to levels that would not interfere with the earth's climate system, while in addition to sharing the objectives of the Convention, the Kyoto Protocol commits industrialised countries to stabilise their GHG emissions.

There are three innovative market-based mechanisms to the Kyoto Protocol: Emissions Trading (ET), Clean Development Mechanism (CDM) and Joint

Implementation (JI). The ET mechanisms focus on carbon markets, while the JI enables industrialised countries to carry out joint implementation projects with other developed countries or countries with economies in transition. The CDM, which involves investment in sustainable development projects that reduce emissions in developing countries, is of singular relevance in the Zimbabwean context. Currently, Zimbabwe has only one CDM registered project known as the Sable Chemicals Tertiary N_20 Abatement Project, which is supported by the United Kingdom. This large-scale project has potential to reduce an estimated 473,759 metric tonnes of CO_2 equivalent per annum (UNFCCC, 2014).

Zhakata (2007) notes the following impediments to CDM projects in Zimbabwe:

- Lack of domestic legal or institutional framework (e.g. lack of title to emission rights);
- Lack of local or regional financing sources to execute CDM projects;
- Limited capacity among various stakeholders to formulate and develop CDM projects; and
- Limited understanding of the opportunities that CDM represents for the country.

According to Brown *et al* (2012), other mitigation and adaptation projects are constrained by the uncertainty associated with climate variability. Clearly, like many African countries, Zimbabwe is yet to exploit fully the benefits associated with climate change, despite being a member of the UNFCCC since its inception in 1992.

Although demonstrating a quantum leap in mainstreaming climate change issues in national environmental policies and plans, the country still lacks a clear and robust strategy for climate change interventions in general. Currently, Zimbabwe does not have a clear climate change policy. Climate change issues are generally covered in environmental management policy and strategies. Environmental management issues are administered under the aegis of the Ministry of Environment, Water and Climate (MEWC), formerly MENRM. These are governed mainly by the National Environmental Policy and Strategies of 2009 that complement the Environmental Management Act (Chapter 20:27) promulgated in 2002, and other complementary legislation pertaining to environmental protection, monitoring and sustainable management. As such, climate change issues are not specified.

Furthermore, the environmental policy and legislations have been largely ineffective in halting environmental degradation in Zimbabwe. Major issues constraining environmental management are summarised by Tevera *et al* (2007) as; political and economic climate, conflicts with other objectives and policies; underlying market structure and institutional framework; lack of supporting inputs and infrastructure; failure to address the root causes of the problems; and lack of adequate consultation.

Recognition of the issue of climate change has seen the rebranding of the ministry responsible for environmental issues as the MEWC in 2013. This was intended to make sure that climate issues are to get adequate policy and planning attention at government level. However, it is yet to be seen if the revamped ministry would diligently formulate and implement a strategic approach that comprehensively attends to aspects of mitigation, adaptation, technology, financing as well as public education and awareness on climate change. The fear is that this may end up as a rhetorical commitment to recognising climate change.

Another important development in national climate change response is the establishment of a Climate Change Office (CCO) in 1996. The office was created under the technical support of the United Nations Development Programme (UNDP) to co-ordinate climate change activities following a previously sectoral segmentation in response strategies. As such, the specific objectives of the CCO, according to MEWC (2013), are to, *inter alia*:

- Review the implementation of the UNFCCC in the country and other related legal instruments;
- Compile Bi-annual Update Report and National Communication report every two and three years respectively, submitted to the UNFCCC in fulfilment of the Government's obligations under the Convention;
- Provide technical guidance to the Designated National Authority, a unit that operates under the Environmental Council of Zimbabwe, responsible for assessing climate change renewable energy projects proposals that seek funds from carbon trading;
- Coordinate implementation of the Nationally Appropriate Mitigation Actions (NAMAs), a mechanism created by the UNFCCC to ensure that developing countries reduce emissions through promotion of efficient and green energy policies;
- Coordinate and advise on the United Nations Programme for Reducing Emissions from Deforestation and Forest-related Degradation (UN-REDD+); and
- Mobilise financial resources for climate change implementation in the country.

The major challenge hampering successful operation of the CCO is inadequate funding. Notably, since its inception, funding for the CCO's activities has largely been project-based, without allocation from the mainstream national budget (Zhakata, 2013 *interview*). This can be blamed for stymieing robust interventions on policy development and climate change strategies. Apparently, there is no on-going co-ordinated research on climate change issues, except for the activities of the office. Past and current research projects have remained purely academic, without feeding into mainstream climate programming (ibid). For example, since the 2000-based estimates, the current status of GHG emissions from the energy, waste, industry, mining, forestry and agricultural sectors have not been adequately quantified (Matarira & Mushore, 2013).

When it comes to responding to climate change, Zimbabwe joins the tempo characteristic of African countries in attending to the phenomenon. Constraints cited are mainly; limited human, institutional and financial resources and lack of technology (Frost, 2001; IPCC, 2007; Chagutah, 2010; Brown *et al*., 2012; MENRM, 2012a). According to the 2013 National Climate Change Response Strategy draft document, the challenge for the country is in developing adaptation and mitigation strategies that address complex impacts of the phenomenon. A key point to note, however, is that policy formulation and interventions are chiefly driven by Western-based knowledge. The incorporation of IK, experiences and practices of the people affected by climate change remains a challenge. To this end, this thesis argues that unless backed by input of local knowledge and experiences, such interventions are likely to be futile when judged by their effectiveness on communities affected by climate change.

Important to note is that climate change research has also tended to follow at a distance in sympathy with this policy void. Current efforts are mainly segmented and where research is conducted, it has remained purely academic. This means climate change research has not been linked to policy development. Acknowledging this problem, initiatives to link climate research with development are a recent practice. The government of Zimbabwe, under the auspices of the Meteorological Services Department (MSD), mooted a forum dubbed ‘First Climate Change Symposium of Zimbabwe (FCCSZ)’ held from 19th to 21st June 2013 in Harare. Through this platform, scientists were expected to share impact studies and experiences in order to guide national climate change policy and mitigation and adaptation strategies. IKS featured as a sub-theme of the climate conference, indicative of the potential role it could have in climate science in Zimbabwe. However, it remains to be seen if this initiative is to have a meaningful impact on taking the climate change agenda forward.

1.7 Climate Change and Indigenous Knowledge

In this section, an attempt is made to show how the concept of IK has been treated in climate science. Notwithstanding the phenomenal interest in IK in climate change fora and climate literature, it is also discussed here that the concept has not been widely adopted in the Zimbabwean case.

Scholarship on climate change and IK is still fairly new, but rapidly growing. A first attempt appears to be that by Berkes and Jolly (2001) who assessed adaptive capacity to climate change of the Inuvialuit of the Canadian western Arctic community. Nyong *et al* (2007) later looked at the value of IK in climate change mitigation and adaptation in the African Sahel. King *et al* (2008) studied the Maori's environmental knowledge of local weather and climate in New Zealand. A year later, Gearheard *et al* (2009) investigated knowledge and meteorological data to understand changing wind patterns of the Inuit, Nunavat in Canada. Phenomenal attention to the topic is also seen from Lefale (2009) whose studies were on traditional ecological knowledge of weather and climate of the Samoa, a Polynesian community in the South Pacific; Peloquin and Berkes (2009) on dealing with ecological complexity of hunters in James Bay, Subarctic Canada; Green *et al* (2010) on IK of weather and climate of the Aboriginal and Torres Strait Islanders in Western Australia. In Kwazulu-Natal in South Africa, Jlyane and Ngulube (2012) explored IK applications in weather forecasting. These and other cases are further discussed in Chapter 3.

What should be known here is that the production of IK is contextually grounded (Maila & Loubser, 2003) and given the case-specific approaches limited to the areas studied, the Zimbabwean context deserves some attention. In Zimbabwe, IK practices are in various forms. Attention to the topic of IK has largely been on its deployment in agriculture and disaster management (for example, Patt & Gwata, 2002; Gwimbi, 2009; Mubaya, 2010) and apparently, not much has been done to isolate IK in climate change science. This study aims to understand climate change as observed and experienced by local indigenous people and to explore specific IK and practices relevant in understanding climate change mitigation and adaptation.

The IPCC, a global scientific body established by the United Nations Environment Programme (UNEP) and the WMO, a group that provides authoritative international communication on the scientific understanding of climate change fully recognises IK as a strategy in mitigation and adaptation. This is evidenced by the inclusion in its AR4 and AR5, distinctive sections on IK (IPCC, 2007b; IPCC, 2014a). IPCC acknowledges that the value of IK extends beyond the local level realm to the attention of scientists and planners in strategies to address community development challenges. It has also been argued that incorporation of IK in climate change can lead to development of interventions that are pragmatic, cost-effective, participatory and sustainable (Berkes & Jolly, 2001; Robinson & Herbert, 2001; Klein *et al*., 2005; Nyong *et al.,* 2007; IUCN, 2008; King *et al*., 2008; Berkes, 2009; Green & Raygorodetsky, 2010).

IK has also attracted international legislative attention. On the 13th of September 2007, the United Nations General Assembly (UNGAS) adopted the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP). Articles 25 to 32 of the Declaration recognise the participation of indigenous peoples in environmental management initiatives. Specifically, Article 32:1 recognises that indigenous people have a reservoir of science potentially useful in environmental issues as stated (UN, 2008):

> *Indigenous peoples have the right to maintain, control, protect and develop their cultural heritage, traditional knowledge and traditional cultural expressions, as well as the manifestations of their sciences, technologies and cultures, including human and genetic resources, seeds, medicines, knowledge of the properties of fauna and flora,....*

Evidently, the wave of interest in climate change and IK has gathered momentum. This thesis follows this argument by studying the potential utility of IK, experiences, skills and technologies of the people in Muzarabani in order to contribute to the adequate understanding of climate change science. The next section focuses on how IK has been understood in Zimbabwe.

1.8 Indigenous Knowledge Systems in Zimbabwe

There is a substantial pool of empirical evidence pointing to the environmental-spiritual connections in Zimbabwe. The application of IK can be traced to time immemorial. Before the influx of Europeans in 1890, it is believed that local people sustainably used their own knowledge in environmental management under the prudent guidance of traditional leaders and ancestral spirits. Land was held subject to the guardianship of the ancestors and traditional leaders ensured the sustainable utilisation of natural resources. For instance, important information on natural resources management was recorded in unique forms such as proverbs, totems, myths, rituals and ceremonies. Burning or cutting down of trees without good reasons was prohibited. Water resources were regarded as sacred and therefore protected from pollution. Traditional leaders with the guidance of spirit mediums enforced these rules (Williams & Muchena, 1991; Mohamed-Katerere, 2002). Even in some societies today, environmental issues are still inter-woven with cultural beliefs.

Nonetheless, the rush towards modernity characteristic of many African societies remains a key threat to IK recognition in Zimbabwe. Staggering from a colonial epoch, there are numerous IK practices and varied views of their usefulness in modern society in general. Yet, IK present both a national heritage and national resource base that should be protected, promoted, developed and conserved (Smith, 1999).

It is also believed that many people, particularly the young generation and urbanites, have a limited understanding of this knowledge, perhaps only understanding it in the form of woven baskets, handicrafts for tourists or in the form of traditional dances. Instead, this knowledge covers indigenous technological knowledge in agriculture, fishing, biodiversity conservation, atmospheric and climatological knowledge and management techniques. Thus, it is a fact that the IK view remains shrouded in myths and controversies across the societal divide in Zimbabwe. However, there is growing evidence on the utility of IK in environmental issues like drought management in agriculture in Zimbabwe (Patt & Gwata, 2002; Mubaya, 2010; Risiro *et al*., 2012) and elsewhere (Duerden, 2004; Satterthwaite, 2011; Andrade & Rhodes, 2012; Constantino *et al*., 2012).

What is crucial about indigenous practices is that they embrace the strategies of mitigation and adaptation that are driving climate change policy regimes. For example, sustainable forest conservation is an important mitigation measure capable of enhancing carbon sequestration, thus mitigating against GHG emissions. Traditional ecological knowledge, such as understanding the behaviour of certain animal species, can act as an early warning in seasonal patterns, thereby strengthening a community's resilience against climate irregularities. This system however, has been exposed to different forms of administration and governance from colonialism to post-independence regimes that have largely been insensitive to IK. At present, imposed land tenure systems have been largely blamed for impacting negatively on indigenous arrangements (Mohamed-Katerere, 2002).

Notwithstanding these threats, rural societies in Zimbabwe continue to adopt IK in various aspects of their daily activities. Mawere (2010) argues that despite a continued cultural onslaught on African thought, particularly their knowledge and belief systems through the spread of the Western scientific worldview, local people, particularly the rural population, have maintained their traditional thought and values. A case in point is that of droughts of 1981/02, 1991/02 and 2002/03, which had massive negative impacts on the livelihoods of the majority of the peasantry. It is thought that the adoption of IK through food gathering and preservation strategies in most rural areas was a necessary adaptation strategy that saved them from what was otherwise potentially tragic (Mararike, 2013 *interview*). Against this background, such knowledge, practices, views, technologies and skills of the indigenous people deserve attention in the current agenda for climate change research. As described in the next section, the study problematises a policy trajectory whose foundations have ignored the worldview of the communities witnessing climate change and affected by its impacts.

1.9 Definition of the Research Problem

Substantiated facts elsewhere, that indigenous people matter significantly in climate science discourses (Berkes & Jolly, 2001; World Bank, 2004; IPCC, 2007b; Nyong *et al*., 2007; IUCN, 2008; King *et al*., 2008; Berkes, 2009; Turner & Clifton, 2009; Green & Raygorodetsky, 2010; Lefale, 2010; Leonard *et al*., 2013) have not been sufficiently understood and pursued in climate change interventions in Zimbabwe. Overreliance on Western-based knowledge is not only believed to give a coarse-grained understanding of the phenomenon, but could also lead to piecemeal strategies. Scholars like Boko *et al.* (2007) and Turner and Clifton (2009) suggest that IK can improve understanding of climate change, its effects and ways to adapt to and remedy its impacts, a scope not focused on by past research in Zimbabwe.

Paradoxically, the knowledge that has informed mitigation and adaptation strategies excludes the participatory input of the local communities targeted by those interventions. Thus, a void exists in the climate change planning and policy arena for the integration of IK. This poses problems especially when trying to deal with related climate hazards at the community level. Failure to recognise IK has raised fears that current interventions imposed by technocrats may remain models rather than practical tools for implementation. There is a possibility that communities could remain sceptical to imported extraneous climate change interventions.

In addition, there is evidence that most rural areas are exposed to extreme climate events such as drought and floods with dire consequences on lives and livelihoods (Chamaillé-Jammes*et al*., 2007; Kahinda *et al*., 2007; GoZ-UNDP/GEF, 2009; Gwimbi, 2009; Mano & Nhemachena, 2009; MENRM, 2012a). Change and variability in the climatic system is isolated as the forcing behind these hazards. However, understanding of the magnitude and severity of climate change has not been fine-grained to specific parts of the country, including Muzarabani. This is also a gap from past research. Interventions in this regard have mainly remained humanitarian without offering practical solutions to minimise the community's vulnerability. As interventions are devoid of indigenous input, they are likely to remain costly to government and targeted communities, yielding the obvious results of rhetoric. Therefore, the roles of IK, from understanding climate change to devising mitigation and adaptation strategies, require research attention in order to understand how this knowledge form can inform appropriate interventions in Zimbabwe, whose results could also be potentially useful if applied elsewhere for ongoing and future strategies for climate change.

To this end, this research sets the discourse in climate change problematique by adopting a participatory research approach incorporating the indigenous local community feeling the pinch of climate change into mainstream thinking about the phenomenon. Generally, this approach is still peripheral in addressing community development challenges and so far has not been adopted specifically to address climate change issues in Zimbabwe.

1.10 Research Questions and Objectives

Stated in this section are the main research questions and objectives. The research design and methods narrated in Chapter 4 are guided by the research questions, while the chapter outline of the thesis is guided by the objectives stated herein.

1.10.1 Research Questions

The enquiry of IK and climate change pursued by this study sets to examine the following main questions:

- What epistemological and methodological paradigms are useful in understanding the utility of IK in climate science? Can these approaches provide clues for rigorous research necessary in harnessing the knowledge of people who have been closely observing climate-related changes in their specific environments?

- What knowledge do indigenous people in Muzarabani hold that is indicative of noticeable change and variability in the climate system, and relevant in complementing current understanding about climate change?

- What are the scientific, cultural and technological practices by indigenous people that are useful for guiding climate change mitigation and adaptation in Muzarabani?

- What factors influence IK utilisation in climate change mitigation and adaptation in Zimbabwe and Muzarabani in particular?

- In what way(s) do(es) IK influence adaptive capacity of the communities responding to climate change?

- Can climate observations and narratives of indigenous people give insights or clues for rigorous scientific investigation on the aspects of the phenomenon?

1.10.2 Research Objectives

Primarily, the study's purpose is threefold:

- First, it intends to capture useful indicators of climate change and variability as understood by the local indigenous people.

- Second, it aims to understand how IK can be used to complement mitigation and adaptation projects or plans at community level.

- Third, it seeks to determine if observations and experiences of the indigenous people can be used to inform mainstream research on climate change.

The primary objectives are further dissected to inform the chapter outlines of the thesis which specifically intends to:

(a) Present a review of the biophysical and socio-economic characteristics of Muzarabani and analyse how these predispose the community to climate change impacts or influence their adaptive capacities (Chapter 2).

(b) Develop a suitable theoretical and conceptual framework for analysing IK and climate change (Chapter 3).

(c) Identify appropriate epistemologies, methodologies and research methods for exploring IK and climate change in Muzarabani (Chapter 4).

(d) Determine indicators of climate change and variability that are used by the indigenous people in Muzarabani (Chapter 5).

(e) Identify and assess the scientific, cultural and technological practices of indigenous people that are relevant in climate change mitigation and/or disaster risk reduction (Chapter 6).

(f) Identify and assess indigenous-based adaptation strategies and evaluate how IK influences the community's adaptive capacity and resilience against climate events (Chapter 7).

(g) Present major highlights of IK-based indicators, mitigation of and adaptation to climate change and identify emerging areas for productive climate research based on insights from indigenous people in Muzarabani (Chapter 8).

1.11 Justification of the Study

As communities continue to be seriously exposed to hazards induced by climate change (Cocchiglia, 2006; Low, 2008; IFRCRCS, 2010; IPCC, 2012), there is a need to adequately understand the phenomenon particularly from the perspectives of communities at risk in order to inform appropriate policy directions. While the acquisition of Western-based knowledge has been and is still invaluable in international and national policy directions, it has been inadequate in the face of escalating environmental problems (Smith, 1999) and climate change crisis (Boko *et al.*, 2007; Turner & Clifton, 2009) and would need to be complemented by indigenous-based knowledge particularly at grassroots level where strategies are implemented. There is increasing acknowledgement that all aspects of human life will at least to some degree be affected by climate change (Hutchins, 2009; Giddens, 2011; IPCC, 2014a). It is against this background that climate change becomes a relevant topic for study in both academic and policy development discourse.

With past research concentrating mainly on scientific models of the phenomenon, little has been done in exploring and validating IK in climate change science in Zimbabwe. Such gaps can be costly to communities experiencing climate events and development agencies. The implications of this development are suggested here. One, the research outputs under conventional scientific enquiry may be purely pedagogic jargon that fails to provide practical implementation directions understood and accepted at grassroots level. Two, practitioners in climate change interventions may have challenges in simplifying research results to the satisfaction of the local people experiencing climate change events. Three, the consequence would likely be the usual technocratic rhetoric in a context of community subjugation. This gives credit to a study whose strengths are grounded in participatory analysis of the scientific, cultural and technological strategies, practices and activities of the local people vis-à-vis coping with climate events.

Distinctively, the study embraces an indigenous-based epistemic paradigm that shapes a participatory methodological enquiry involving an outsider scientist and the local ‘scientists’ in order to adequately understand the topic of climate change at grassroots level. This approach serves to attend to the problems and/or opportunities associated with climate change from the perspectives and knowledge of the people experiencing climatic events. IK on its own is scientific and has developmental knowledge aspects that need to be adequately tapped if meaningful and successful interventions are to be realised. Esteva (1992) stresses that IK enables us to exploit the frontiers of discourse and knowledge of the sciences and to explore avenues of cognitive latitudes in a framework of collective dialogue and emancipation. Embracing this view is relevant in the current debate on climate governance as discussed in Chapter 3.

IK becomes necessary in addressing climate change in several ways. For instance, when comprehensively attending to all phases of the disaster management cycle (preparedness, mitigation, response and recovery), IK can be harnessed to complement conventional strategies, reflecting input of local communities at each of these stages to ensure effective interventions informed by indigenous ingenuity. Such a strategy can empower the affected communities, which is a necessary stride in strengthening community resilience against vagaries brought about by climate change. In this way, if there are benefits related to the phenomenon, they would be realisable at grassroots level.

In addition, given a tradition where interventions have largely remained top-down, with a possibility of hindering their success, findings from this research can be potentially useful in informing strategic policy implementation in climate change mitigation and adaptation. Previous strategies have failed to exploit knowledge of the people who are targeted by those interventions. The results can be used to enhance understanding and utilisation of climate change strategies by communities, and to inform and influence the national planning and policy agenda. To the scientific community, aside from complementing current understanding about climate change, results generated by this study are also potentially useful in indicating research gaps and areas requiring the refinement of mainstream science.

With regard to choice of the study area, the Zambezi Valley remains a focal case in climate science owing to increased drought and flood occurrence – hazards that continue to attract media and policy attention in Zimbabwe. This justifies the choice of studying Muzarabani District, which occupies the lower parts of the giant Zambezi River Basin. As shall be seen in Chapter 2, the combination of noticeable climate change effects and a typical indigenous African society that has strong ties to indigenous cultural beliefs and practices, makes the area a suitable reference point for studying the topics of IK and climate change.

1.12 Scope and Limitations of the Study

This study explores IK in climate change in general, but is limited in its focus and primary data acquisition on Muzarabani. As the epicentre of climate change effects in the country, this area is chosen to give a reliable reflection of IK views and practices in a typical rural African society. The study acknowledges that an exploration of IK in climate change science would require an extended coverage in order to map the paraphenalia of knowledge and practices across the country so as to make study generalisations. However, as discussed in Chapter 3, the IK concept itself is unique in the sense that it is local-specific and is adequately understood in a case study methodological paradigm discussed in Chapter 4. Notwithstanding this consideration, the methodology adopted sets an open latitude for a discourse that draws insights from scholars of both IK and climate change that are external to the study area.

Conceptually, the study embraces a sustainability science framework that argues for an agenda to democratise science. This is discussed in detail in Chapter 3. This notion was the central theme of the United Nations Educational, Scientific and Cultural Organisation (UNESCO) Declaration on Science and the Science Agenda Framework held in Budapest, Hungary in 1999. It argues that local people should see science as a shared asset that helps them to seek practical solutions to their problems. For instance, in containing the effects of climate change at a local level, technocrats can leverage on the experiences and knowledge of the indigenous people in order to enhance the impact of interventions. Philosophically, the thesis adopts an epistemic view of emancipatory pedagogy grounded in IK thinking. The approach looks at Muzarabani as a 'Science Academy' and the locals engaged in the study as 'scientists' (Odora-Hoppers, 2002). This paradigm is adequately pursued in Chapter 3 and 4.

The topics of IK and climate change articulated in this thesis have called for an approach that may be contestable in the environmental geography field. Perhaps, it is a question of orientation in the physical-human geography dichotomy whose debate cannot be addressed on this doctoral research platform. In the words of Williams (2003:53) "..the philosophical and methodological gap between the utmost expressions of realism and relativism seem pretty well unbridgeable." In essence, therefore, the strategy adopted here is an attempt to make science more participatory. It bears allegiance to the notion of sustainability science whose objective is to seek realistic solutions to human developmental challenges. When analysed in climate science pedagogy, it responds well to the global imperative of making science accountable to the problems created by the same. The basic tenet of this view is that research should contain an agenda of empowering the people affected by the problem. This study, however, still embraces an objective and scientific approach to qualitative research by emphasis on robustness in methodology and rigour in the various methods of data collection and analysis that are detailed in Chapter 4.

1.13 Conclusion

This introductory chapter has presented climate change as a problematique associated with an inadequacy of information to guide pragmatic policy interventions at all levels. Essentially, the argument advanced here is that in the face of escalating climate change challenges, IK-based knowledge should also occupy space in research and policy discourses. In this regard, research on the role of IK in informing mainstream science and technocratic attention to the issue of climate change is crucial.

The whole thesis is segmented into eight chapters informed by the objectives presented in Section 1.10.2 of this chapter.

Chapter 2 provides a broad analysis of the study area from various facets; that is, social, economic, biological and physical, vis-à-vis the community's propensity to climate change. This analysis is necessary in order to contextualise the study.

Chapter 3 presents a conceptual and theoretical framework for the analysis of IK and climate change. This is backed by a review of relevant scholarship on these concepts, including assessment of empirical literature, with the intention of identifying research gaps on the same.

The methodological framework for studying IK and climate change is given in Chapter 4. The architecture of this chapter is largely based on a research article published on the same.

Chapter 5, 6 and 7 deal with the research findings. Chapter 5 documents indicators of climate change and variability that are understood by the local people. These indicators are also used to understand climate change impacts and related phenomena in the community. Chapter 6 and 7 gather the scientific, cultural and technological practices of the locals for climate change mitigation and adaptation, respectively. Chapter 7 goes further by assessing the extent to which these strategies influence the community's adaptive capacity and resilience against climate events identified in Chapter 5.

The thesis concludes by presenting some major highlights coming from the preceding chapters, drawing mainly from the methodology of enquiry (Chapter 4), indigenous indicators of climate change (Chapter 5), indigenous-based mitigation against climate change and climatic events (Chapter 6) and indigenous-based adaptation (Chapter 7). Avenues for productive research in IK and climate change are also summarised in Chapter 8. These major reflections are used as a premise for giving insightful recommendations to specific stakeholders in climate change.

CHAPTER 2

AN ENVIRONMENTAL ANALYSIS OF MUZARABANI

Muzarabani means an extensive low-lying plain covered with fertile alluvium and associated with much wet conditions. This area was largely a vlei that could trap animals. When we were still kids five decades ago, we could easily catch kudus trapped in the mud. Now, our young ones wouldn't believe this story because the environment has changed in our own eyes.

Elderly Respondent in Muzarabani

2.1 Introduction

Given that climatic events are spatially variable, and for the purposes of placing the study into context, it is necessary to examine specific environmental conditions in the research setting. This chapter reveals climate change experiences against environmental factors in Muzarabani. It begins by presenting an overview of the study area, and describing the main physical features, climatic conditions and socio-economic situations. This forms the backdrop for analysing the propensity of and/or potential opportunities for the area to climate change. Thus, an environmental analysis of Muzarabani exposited here is necessary to inform subsequent chapters of this thesis.

2.2 Muzarabani: Some Connotations and Denotations

The name Muzarabani when translated in the local Shona language: *mu* (i.e., inside), *zara* (i.e., full) and *bani* (i.e., low-lying), means 'in a low-lying area'. Expressed geographically, the word implies a community in a flat valley plain of a floodplain. The area is associated with valley or lowland people, linguistically referred to as the *Goba* or *Gova,* meaning wetland or riverine valley (Chief Muzarabani, 2013 *interview*). This is a dialect Shona cluster of those who occupy the lowlands, which form the country's lowveld. Clearly, here the risk of inhabiting such an environment is even reflected in the name 'Muzarabani' itself. To the locals, being associated with the valley is a form of identity that defines their history, livelihoods and culture, to the extent that the risks of inhabiting the area tend to be overshadowed by this sense of place and belonging in space. Therefore, it is important to note that the cultural and traditional orientation of the people is central in understanding the geography of Muzarabani as shall be seen in this analysis.

A study of the local spirits associated with land ownership and earth shrines in the Zambezi Valley has traced the origins of the inhabitants to the first wave of migrants that came from the Great Zimbabwe in the mid-1600. This northward movement of people from southern Zimbabwe to the Dande Valley (a name given to the northern lowveld areas covering Mbire, Guruve, Muzarabani and Mount Darwin districts) was motivated by desire to exploit the attractive good and rich rock-salt (Byers, 2004; Chikozho-Mazarire, 2009), despite the threats of tsetse flies and malaria mosquitoes during that time.

During the colonial era, Centenary was the official name given to the district. However, following independence in 1980, there has been some move to revert to the local traditional name, Muzarabani. It is also important to note that even now, the names Centenary and Murabani are often deployed interchangeably in the country's reports. There are also other districts in the country whose re-naming was meant to link to the indigenous roots of places, which can be understood as an attempt to re-define the cultural closeness to people's environments. This view is profoundly pursued by Chikozho-Mazarire (2009) in a discussion of the history of the people of Zimbabwe.

2.3 Geographical Characteristics of the Study Area: An Overview

Presented in this section is the geography of the research setting. The physical location of the area is first given. Later, a description of the physical and ecological characteristics of the area and their influences on settlement forms, socio-economic practices and livelihood activities is given. First, it is important to describe the location of the research setting before attending to detailed analysis of the bio-physical and socio-economic aspects.

2.3.1 The Physical Location of Muzarabani

Muzarabani is a rural district situated along the Mozambique-Zimbabwe border in Mashonaland Central Province, about 220km north of Harare, the capital. The physical boundaries and location relative to the surroundings are shown in Figure 2.1. The district occupies a total land surface area of 2,744 km^2 of the northern part of Zimbabwe with Mozambique to the north at 31^0 05' E and 16^0 25' S.

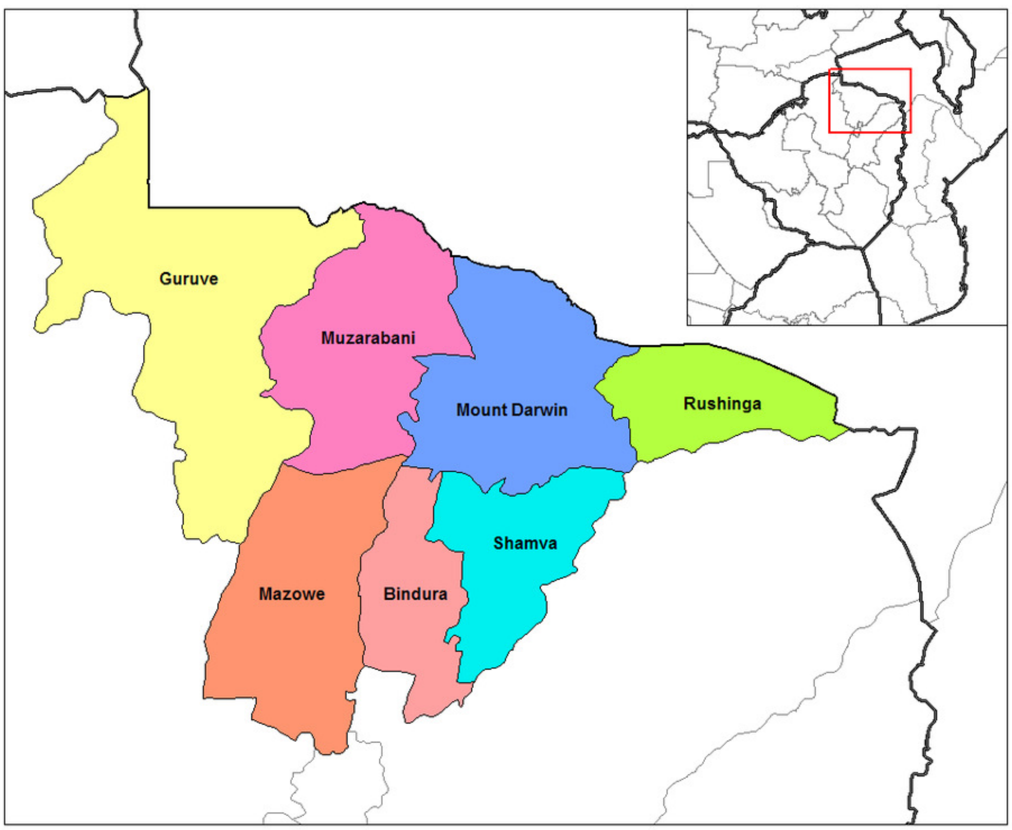

Figure 2.1 The location of Muzarabani District

(Source: www.docstoc.com)

The area is located in Mashonaland Central Province on the eastern part of the Zambezi Valley associated with low altitude zones of below 500m. The Zambezi River is the largest river basin in the Southern African Development Community (SADC) with a basin area extending through Angola, Botswana, Malawi, Mozambique, Namibia, Tanzania, Zambia and Zimbabwe (see Figure 2.2). Apart from being home to over forty million people, states in the Zambezi Basin watershed use the river for drinking water, fisheries, irrigation, hydropower generation, mining and industry, ecosystem and biodiversity management, and tourism, among other uses. As such, interests in the basin are huge and competing (Kirchhoff & Bulkley, 2008; ZAMCOM/SADC/SARDC, 2013). Therefore, in the context of climate change, it becomes necessary to understand the local specific benefits and/or risks associated with the Zambezi Basin inhabitants, an approach pursued in this chapter.

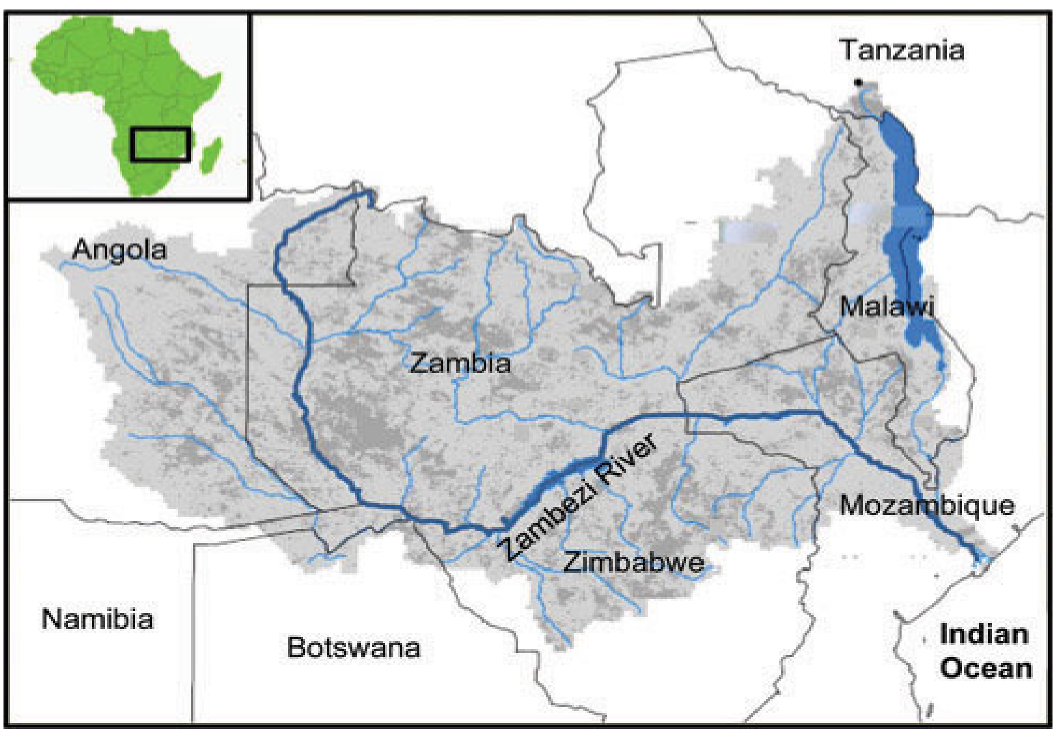

Figure 2.2 The Zambezi River Basin

(Source: World Meteorological Organisation: www.wmo.int)

Overall, Muzarabani District is divided into three distinct agro-ecological zones: the flat Zambezi Valley in Region 4 to the north; the mountaineous plateau of the highveld in Region 2 to the south; and a band of escarpment mountains seperating the two zones in Region 3. Given this diversity in geographical characteristics of the district studied, much attention shall be given to the dryland valley area, that is, Region 4.

2.3.2 Physical Characteristics

Here, a description of the altitude, geological, hydrological and climatic features is given. However, the climate information presented is based mostly on old data owing to paucity of meteorological data available for the specific area studied. Reasons for this are mainly attributable to the absence of weather recording stations in Muzarabani, limited capacity of the MSD in climate inventory and unconsolidated past research efforts in the area.

Altitude

Topographically, the Zambezi Valley has a relatively flat, undulating valley floor whose elevation ranges from 350m to 500m. Specifically, the altitude of the study area ranges from 350m to 455m. This has an important influence on hydro-meteological events such as floods. The Zambezi Escarpement to the south progressively rises to about 1,450m, and to over 1,600m in the Mavhuradonha Mountains (Lister, 1987). As shall be seen later in this section, this influences the climate of the area.

Geology, Landforms and Soils

The Zambezi Escarpment is the southern extension of the Great Rift Valley of Africa rising from the valley floor to shape the high plateau region of central Zimbabwe. The escarpment is made up of a combination of gneisses and achists derived from the basement complex, as well as interfoliated mafic and gabtroic rocks found on the Great Dyke. The escarpement gigantically extends from the Kariba block at the far west, before terminating far east of the Mavhuradonha Mountains where the low altitude of the Zambezi Valley encroaches southwards towards Rushinga District (Lister, 1987; Hargrove, 2003).

The area of interest is the plain given by the widening of the Zambezi Valley to about 80km south of the escarpment towards the Zambezi River marking the northen boundary with Mozambique. The valley floor is made up of Cretaceous pediment features derived from the escarpment. Denudational effects of the rivers draining from Zimbabwe's Central Watershed passing through the mountains towards the Zambezi River have led to deposition of colluvium, alluvium or lacustrine sediments. The older Karoo beds are found lying beneath the Cretacious rocks. There is still active erosion of the valley floor leading to deposition of silt and alluvium over the river banks (TILCOR, 1972; Lister, 1987; Hargrove *et al.*, 2003). As shall be seen later, these alluvial soils are an important feature in the agrarian livelihoods of most families in Muzarabani.

Superimposed on this geological milieu, is the effect of landforms and the resultant soils. Large amounts of alluvium are still being deposited by the Zambezi tributaries whose velocities diminish as the rivers encroach the foot of the escarpment. The valley mainly consists of well drained soils capable of forming a soil pit in excess of 12m in some locations. In other places, poorly drained soils lead to the formation of shallow ponds or pans, which are also important hydrological features of the area (TILCOR, 1972; Byers *et al.*, 2001).

Siallistic group of soils dominate most areas. The clay fractions are predominantly illite or illite-montmorillonoid mixed layer minerals. These soils mainly have calcareous accumulation in the lower column or underlying material. The morphology of the profile is attributable to the presence of significant amounts of exchangeable sodium or water soluble salts, or to the past influence of sodium during pedogenesis (TILCOR, 1972; Lister, 1987).

Towards the escarpment, soils are moderately shallow to moderately deep whose texture varies from loamy sands over sandy loams, or sandy loams over sandy clay loams, varying depending on catenary positions and variations in parent colluvium. Other areas along the escarpment base have deep medium to moderately heavy-textured soils, usually calcareous and formed on colluviums and alluviums (*ibid*). These rich soils are important for supporting a rural economy of the Muzarabani people.

Hydrology

According to Lister (1987), the influence of the Pliocene erosion surface together with the horizontally-bedded Mesozoic sediments has enabled development of river systems that are tributary to the major Musengezi River. Collectively, this network of rivers channels into the Zambezi River before emptying into the large Lake Cabora Bassa in Mozambique. The main rivers draining from the central watershed region passing the escarpment towards the northern Mozambican border are Musengezi, Utete, Hoya, Nzoumvunda and Musingwa. Numerous streams dissect the valley floor and collectively empty into the major rivers. These rivers have an important social, economic and ecological value in supporting human and wildlife populations in the area.

Of late, most of these rivers dry up during the long dry season, only discharging during the short rainfall season. Other important hydrological features are the large pools that are found along the course of major rivers. Numerous shallow ponds or pans are also dotted across the valley. These provide a supplementary source of water for both humans and their livestock and wild animals particularly during the wet season before the desiccation associated with the dry spell.

Climate

The Muzarabani climate is a characteristically perfect match with the area's topography. The mean annual rainfall progressively decreases from 1,000mm in the longer wet season stretching from November to mid-March in synchrony with high altitude, then decreases to 800mm along the base of the escarpment until it gets to as low as 650mm received between December and March in the Zambezi Valley. The district is characterised by relatively high mean temperatures ranging from 20^0C in July to 30^0C in November, with a long dry season of at least eight months from April to November or mid December, if the rains are delayed. This means the area has no risk of frost. The only temperature extremes are associated with very high temperatures in September/October/November.

Evidently, the targeted area is climatically challenged. The Lower Muzarabani, which is an area of interest in this study, falls in Region 4, characterised by semi-extensive farming that is expected to appropriately adapt to the periodic seasonal droughts and severe dry spells common during the rainy season.

Muzarabani falls within part of the country which is affected by the Inter-Tropical Convergence Zone (ITCZ), a seasonal phenomenon that shapes the rainfall regime of southern Africa during summer, whose influence in Zimbabwe is largely felt in December/January/February period. Most of the rainfall is associated with this phenomenon and occurs during this period. Orographic rainfall brought about by the Mavhuradonha Escarpment is also an important consideration in the precipitation of the valley floor.

Evapotranspiration is at its highest during September/October/November when average maximum temperatures are highest. The monthly average relative humidity at Chirundu, one of the nearby meteorological stations, was once recorded by TILCOR (1972) as ranging from 37% in October to 82% in February. This is now likely to have diminished owing to a drier climate reported in the country (MENRM, 2012a). The prevailing wind was also reported to be predominantly northeast (TILCOR, 1972).

2.3.3 Ecology and Ecosystems

A combination of climate, topography and edaphic factors supports a complex unique ecosystem with high flora and fauna species diversity. Trees, in terms of species composition, reflect altitude, since the range of species found is largely similar to that found in other lowveld areas of Zimbabwe. The magnitude of individual tree species, however, supports the suggestion of higher rainfall and excellent soils that are unique in this valley. A mixture of escarpment woodland and miombo (*Brachystegia* spp. and *Julbernadia* spp.) woodland occupies the escarpment forestry (Byers, 2004; Murwira *et al*., 2013).

The valley flora is dominated by mopane-terminalia woodland (*Colophospermum mopane* and *Terminalia stulhmani*) and mopane-combretum woodland (*Colophospermum mopane and Combretum apiculatum*), with a dense riverine thicket of mixed species along the rivers. Pure stands of mopane woodlands become prominent on poorly drained soils. Within the well-drained soils, the relationship between vegetation and different soil types is not necessarily distinctive. *Sterculis quinguiloba* is fairly common on the colluvial slope but absent on the sedentary soils. Conversely, the latter is dominated by tree species such as *Lennea stuhlamanii*, *Markhamia obtusifolia* and *Combretum apiculatum* (TILCOR, 1972; Drummond, 1981; Byers, 2004).

There are noticeable changes in grass species on the poorly-drained land from *Hyparrhenia-Andropogon-Digitaria* dominance to an increase in *Setaria* species, *Eleusine coracana, Hackelochloe granularis* and *Cyperus annabillis*, with *Mariscus cyperoides* and *Finistristlis hispidula* in pan areas (TILCOR, 1972; Drummond, 1981). There is also prolific grass growth on cleared land associated with highly palatable grass species for supporting livestock production. As shall be seen in Chapter 7, locals are now preferring to keep livestock than concentrating on crop cultivation owing to an increasingly drier climate and related drought incidences.

Patches of forests in the area are favoured by elephants as refuge zones particularly during the dry season when the *musau* (*Ziziphus mauritiana)* berry is ripe. These pockets are actually wildlife corridors facilitating elephant movement from the Mavhuradonha Wilderness Area across the Zimbabwe-Mozambique border into the Magoe District in Tete Province of Mozambique. These forests can therefore be used to understand the ecology of elephants and other animals in the face of climate change.

The tall, well-developed riparian riverine vegetation mainly dominated by *Acacia* species has managed to withstand some modifications from both humans and wildlife populations. The uniqueness of this biodiversity, according to Byers (2004), is that tree species common in different types of forests and woodlands are all found sharing some space in one ecosystem in Muzarabani. To climate scientists, this can be useful in studying how such unique ecosystems respond to climate change.

Byers *et al* (2001) identify three aspects that make the Muzarabani dry forests unique: they are very diverse in woody plant species, have a number of plants that are rare not only in Zimbabwe but also in the whole Zambezi Valley, and are an unusual assemblage of species from different ecological communities. As such, this area has been prioritised as a conservation zone. It became one of the first districts to pilot a community-based wildlife management scheme in 1987, commonly known as the Communal Area Management Programme for Indigenous Resources (CAMPFIRE). Under this programme, responsibilities and activities to manage wildlife are delegated and devolved to rural local authorities, embracing the philosophy where benefits from the scheme should accrue to the communities that co-exist with the wildlife. Revenue generated through sport hunting and other tourism ventures, for example, are invested in community projects such as road development, health and education facilties.

Elephant research and management in the district are under the auspices of the Parks and Wildlife Management Authority of Zimbabwe (PWMAZ), with support from the Zambezi Society (ZAMSOC) and the Mid-Zambezi Elephant Project (MZEP).

ZAMSOC, which started its operations in the district in 1989, works in promoting biodiversity and wilderness values through sustainable natural resource management within the Zambezi Basin.

The MZEP was mooted in 1997. Its primary objective is to study the ecology of crop raiding elephants in order to improve elephant management through research and monitoring programmes. Some of its projects include the radio tracking of collared elephants, the development of a district-wide crop damage assessment scheme, and experimentation with techniques to curtail elephant-human conflicts (MZEP/ZAMSOC, 2000). In 2000, the MZEP and the ZAMSOC reported that the elephant population in the district was contiguous with the adjacent Guruve and Magoe districts. This signifies the importance of the area in trans-boundary wildlife management. About 120 elephants are estimated in the Mavhuradonha area (*ibid*).

Undoubtedly, the significance of the environment in shaping the livelihoods of the Muzarabani rural community deserves emphasis. As shall be analysed in Section 2.3.5, the rural economy and settlement characteristics of the villages are shaped by the ecology of the area.

2.3.4 Land Cover and Land-use

Besides influencing faunal and floral distribution, the three distinctive topographical features also shape land cover and land-use practices in the district. Essentially, in terms of land cover, there is an assortment of forested land, shrubs and vegetation, cultivatable land, settlements and hydrological features.

The Mavhuradonha area occupies about 650km^2 of the escarpment mountains, with vegetative shrubs and grasslands interspacing settlements found on the highveld. Areas that are not forestry or grasslands are mainly covered by crops or left bare depending on the season. The specific area of interest has patches of unique dry forest interspersed with human settlements in the valley. These forests covering between 70 to 300ha are typified by a closed-canopy, dry season assemblage of deciduous indigenous tree species. Where there is no cultivation, the rest of the areas are dominated by shorter woodland vegetation of different types (Byers *et al.*, 2001; Byers 2004).

In terms of land-use, Muzarabani exhibits a montage of wildlife, cultivation and settlements. Thus, three land-use categories can be isolated: communal farmlands, large-scale commercial farms and wildlife. The wildlife area is bordered to the south by large-scale commercial farming on the highveld south of the escarpment, to the east and west by small-scale subsistence farming in the high altitude zones, and to the north by a continuous boundary of communal farms in the floodplain. This third category consists of the villages targeted in the study. Wildlife related land use in the Mavhuradonha area includes commercial hunting safaris, guided tourist safaris, horse riding and natural resource extraction by the locals.

Essentially, the human-environment interactions are a significant determinant of the geography of the study area. As shall be seen in the next section, these interactions are mainly influenced by the IKS of the local people.

2.3.5 The Socio-economic Environment

In the preceding review, it was described that a sharp physiographic contrast exists between the lower and upper Muzarabani areas owing to the influence of the Mavhuradonha Mountains and altitude. The Lower Muzarabani area, where this study is based, occupies the lowveld while the latter is found in the highveld area. This physiography has an important effect on the social and economic aspects of the area as explained in this section.

The section starts by detailing the demographic profile of Mashonaland Province. It then reviews the political government and administrative structures of the study area, including the cultural beliefs and practices of the people in relation to their IKS.

2.3.5.1 Demographic Characteristics

According to the 2012 National Population Census, Mashonaland Central Province is divided into ten administrative districts: Bindura Urban, Bindura Rural, Guruve, Mazowe, Mbire, Mount Darwin, Muzarabani, Mvurwi, Rushinga and Shamva. The research area falls within Muzarabani District. Bindura Urban is the provincial capital at the centre of the administrative functions of the province. Of the the province's total population of 1,152,520, 567,140 are males while 585,380 are females (see Table 2.1). This gives a proportion of 8.8% to the total national population. The province's 2.3% population growth rate ranks second after Harare. With a total area of 28,347 km^2, it has a population density of 40 persons/km^2 (ZIMSTATS, 2013a; 2013b).

Overall, Zimbabwe exibits a youthful population. The proportion of the young population; that is, those under the age of 15 years is 41% while that of the old population, age 65 years and above, is 4%. In Mashobaland Central Province, the proportion of the young population is 42.8% while that of aged population remains unchnaged at 4%. Muzarabani, in particular, has 45.6% and 3.7% of the young and aged population, respectively. As shall be seen in Chapter 4, the latter group is important since the participants targeted fall within this old age category.

It can also be noted that more females than males survive to the age of 65 years and more. Generally, the sex ratio, which defines the average number of males per 100 females is 96.9, way higher than the national average of 93. In Muzarabani, this ratio is even higher at 99.2 (ZIMSTATS, 2013a). This means females are slightly more plentiful than males in the district (see Table 2.1).

Table 2.1 Total population by sex, Mashonaland Central Province

District	Population			
	Male	Female	Total	Sex Ratio
Bindura Urban	21 026	22 649	43 675	92.8
Bindura Rural	62 520	62 699	125 219	99.7
Guruve	60 490	63 551	124 041	95.2
Mazowe	116 255	117 195	233 450	99.2
Mbire	40 604	41 776	82 380	97.2
Mt Darwin	103 203	109 522	212 725	94.2
Muzarabani	61 160	61 631	122 791	99.2
Mvurwi	5 018	5 531	10 549	90.7
Rushinga	35 504	38 536	74 040	92.1
Shamva	61 360	62 290	123 650	98.5
TOTAL	567 140	585 380	1 152 520	96.9

(Source: ZIMSTATS, 2013b)

A total of 122,791 people are found in Muzarabani. Out of this figure, 61,160 are males, while 61,631 are females. There are 26,928 households in the district, with an average household size of 4.6 people, which is considered the highest in this province. About 28% of these households are female-headed. The population is predominantly rural with only 2.9% found in urban settings. A total fertility rate of 4.8 children per woman, above the national average of 3.8 is seen as the highest in the province (ZIMSTATS, 2013a; 2013b).

Another important demographic assessment is to look at the mortality level, which serves as a health indicator and quality of life. The Infant Mortality Rate (IMR), which refers to number of children dying in the first year of life out of 1,000 born alive, was recorded as 78, a value higher than the national statistic of 64. Muzarabani district's IMR is slightly lower than the provincial mean at 77. The ratio of the risk of dying from maternal related causes, commonly referred to as Maternal Mortality Rate (MMR) was 556 people per 100,000 live births. Again, this ratio is higher than the national figure of 525. The Crude Death Rate (CDR) is expressed as the number of deaths per 1,000 of the population in a given period, usually a year. In Muzarabani, the CDR is 11.6, a figure above the national one of 10 deaths per 1,000 of the population per annum (*ibid*). From this analysis, it can be concluded that all the fertility and mortality indicators in Muzarabani are higher than the national averages indicating that the quality of life in the district is poor. This situation can be attributed to the poor health services reported by the Zimbabwe Demographic Health Survey (ZDHS) (2012). The situation is possibly a result of deprivation and remoteness that are aggravated by flood-induced damage of transport and communication infrastructure, which are climate related.

About one fifth of the inhabitants are believed to be long-term residents, while the rest are immigrants (Byres, 2004). According to him, land hungry immigrants were attracted into the valley to venture into the then lucrative cotton farming. Of late, however, the area's attractiveness is slowly being lost owing to climatic and non-climatic stressors.

2.3.5.2 Governance and Political Administration

Administratively, Muzarabani District is divided into 29 wards. Of these, 14 are found in Lower Muzarabani while the remaining 15 are in Upper Muzarabani. As previously reported, the study focused on those wards found in Lower Muzarabani. Table 2.2 lists the names of the district wards. All the targeted wards have a rural subsistence economy where the villagers' livelihoods are predominantly agrarian based.

Table 2.2 Distribution and characteristics of wards in Muzarabani

LOWER MUZARABANI		UPPER MUZARABANI	
Ward	***Characteristics***	***Ward***	***Characteristics***
Chadereka	Rural, subsistence economy	*Batambudzi*	Rural, with largely newly resettled families
Chiwenga	Rural, subsistence economy	*Chaona*	Rural, subsistence economy
Dambakurima	Rural, subsistence economy	*Chawarura*	Rural, subsistence economy
Gutsa	Rural, subsistence economy	*Chidakamwedzi*	Rural, with newly resettled families
Hoya	Rural, subsistence economy	*Chinyani*	Rural, with newly resettled families
Hwata	Rural, subsistence economy	*Chiwashira*	Rural, subsistence economy
Kairezi	Rural, subsistence economy	*Chiweshe*	Rural, with largely newly resettled families. Has a mission hospital, the only district referral hospital (St Alberts)
Kapembere	Rural, subsistence economy	*Gatu*	Peri-urban set up, with district administration offices
Machaya	Rural, subsistence economy	*Mawari*	Rural, with newly resettled families
Maungaunga	Rural, subsistence economy	*Mukwengure*	Rural, with newly resettled families
Muringazuva	Rural & urban, but predominantly rural. The latter has a growth point, a commercial hub of the district	*Mutute*	Rural, with newly resettled families
Museredza	Rural, subsistence economy	*Mutuwa*	Rural, with newly resettled families
Mutemakungu	Rural, subsistence economy	*Nyamanetsa*	Rural, with largely newly resettled families
Utete	Rural, subsistence economy	*Palms*	Rural, with newly resettled families
		Runga	Rural, with newly resettled families

(Source: Modified from Muzarabani RDC Report, unpublished)

Rural District Councils (RDCs) are the legal authorities responsible for the affairs of rural districts. So, the district is run by the Muzarabani RDC who are *de jure,* the local government representative, as governed by the Rural District Councils Act. On the other hand, there exists the *de facto* customary leadership arrangement in terms of the day to day affairs of the community.

In terms of constituency boundaries, lower and upper Muzarabani are referred to as Muzarabani North and Muzarabani South constituencies, respectively. An elected Member of Parliament (MP) represents each constituency, while an elected Councillor represents each ward. Apart from contributing in legislative forums in parliament, the MP who represents his/her constituency in national government issues is also expected to tackle developmental issues of the area. Each Councillor oversees developmental issues in his/her ward and tackles developmental issues at RDC level.

At the time of study, the two MPs and 29 Councillors belonged to the ruling party, the Zimbabwe African National Union – Patriotic Front (ZANU-PF). Since its formation in 1999, the main opposition party, Movement for Democratic Change (MDC) has not won any parliamentary or local council seat in Muzarabani. This means that the area in mainly dominated by ZANU-PF supporters. Important to note here is that the MPs and Councillors, depending on the political situation prevailing, may supplant the roles of RDCs and traditional leaders. For example, during the run-up to national elections and the post-election period of 31st July 2013, the influence of these politicians could be largely felt. As shall be discussed in Chapter 4, this knowledge is of particular importance in designing the research procedure for data acquisition. This is mainly because these politicians are among the main gatekeepers to be consulted before a researcher's entry into the study area.

Above the RDCs, a District Administrator (DA) is the overall authority responsible for district administrative issues. The DA reports to the Provincial Administrator (PA) who also works under the office of the Provincial Minister (PM), formerly a Provincial Governor (PG). The roles of the PM and the PA are sometimes blurred and overlapping. Overall, local government affairs are presided over by the Minister of Local Government, Public Works and National Housing.

2.3.5.3 Customary Leadership Arrangements

Moving in tandem with the legal administrative system is the customary arrangement. In this system, a headman (*sabhuku*), who reports to a ward chief (*sadunhu/mambo*), and then a district chief (*ishe*), in this linear order, administers each village. There are three chiefs in Muzarabani: two paramount chiefs (*madzishe*) and one sub-chief (*mambo*). Chief Kasekete and Chief Hwata preside over the valley land east and west of Musengezi River, respectively. Ironically, Chief Muzarabani from whom the area is named falls under Chief Kasekete. The politics of this disputed chieftainship, as explained by Mararike (2011), dates back from the period of colonial government. He narrates that chiefs who were not loyal to the colonial administration were dismissed and replaced by the more co-operative ones. The sacked bona fide chiefs ended up losing their chieftainships. Such disputes are still featuring in present-day Zimbabwe and Muzarabani serves as a typical case.

Legislation governing the administration of rural areas has largely remained a rhetorical commitment in Zimbabwe. Despite wide recognition of local values, little progress has been made in wedging customary law into mainstream law. In practice, however, communities continue to apply customary administrative systems particularly in environmental management (Mohamed-Katerere, 2002; Mararike, 2011). Key in this analysis is the understanding that the customary law is the only available platform capable of fathoming IK, a central theme driving this thesis.

According to Mohamed-Katerere (2002), customary law defines a system of rules on substantive and procedural rights, decision-making processes and institutional arrangements that apply to a defined group of people under local indigenous knowledge systems. In Zimbabwe, customary law has tended to be subjugated in the prevailing dual legal system. Various modifications of the legal status have not been sympathetic to indigenous law. The caricatured delineation and exclusion of customary law from the legal status is seen as the major threat to the former's existence. Nevertheless, the prevailing social and economic conditions in rural settings have necessitated the dominance of the customs. In reality therefore, customary law continues to be practised.

A few instances, though of cosmetic nature, under which customary law is considered, include: the Traditional Leaders Act, where traditional leadership institutions have a minimum role in natural resources management; and the Communal Lands Act, where traditional leaders could participate in respect of land allocation. The major challenge, however, is the failure to meaningfully include traditional leaders in the execution of these statutory provisions.

2.3.5.4 Cultural Beliefs and Practices

Muzarabani is home to the Korekore tribe, a subgroup of the Zimbabwe's largest ethnic group, the Shona. Within the Shona culture, belief in traditional systems and ancestral spirits is a central religious practice shaping society. As such, it is believed that despite being a general Christian society, the people have not been completely detached from their ancestral doctrines. Within this belief, ancestral spirits have power and influence over daily activities and the lives of the living (Mararike, 2011). The invasion into the area by other Shona tribes, mainly the Karanga and the Zezuru from central Zimbabwe, according to the local chiefs, has made little impact on this strong ancestral bond. As such, the sacredness of the area is well understood by inhabitants across the demographic spectrum. As detailed in the next section, these beliefs and practices are important in shaping their IK.

2.4 Indigenous Knowledge Systems in Muzarabani

Management of environmental resources in most parts of rural Zimbabwe, including Muzarabani can be understood in terms of the customary governance system. Within this system, IK is regarded as a force behind people's survival. In this section, the centrality of IK in shaping the environment of Muzarabani is presented. This proceeds by analysis of the customary governance system and its influence on environmental management in the study area.

A discussion of environmental management in rural Zimbabwe can adequately be understood in terms of the customary governance system. Within this traditional institutional arrangement, local people have a strong belief in their spiritual connection to the environment. They see it as a moral obligation to conserve environmental resources. The responsibility for ensuring compliance with local rules and customs rests with the chief. With support from advisors (*dare*) and immediate subordinates (headmen), the chief can monitor adherence to rules including enforcing local sanctions. Guidance in decision-making can also be sought from the spirit mediums (*masvikiro*). In some instances, the chiefs can also consult their wives before community meetings, reflecting gender sensitiveness in this governance system (Mohamed-Katerere, 2002; Mararike, 2011; *field interviews*).

The application of customary laws in natural resource management, in the view of Mohamed-Katerere (2002), is highly influenced by such factors as migration, Western education, Christianity and the dependence of the locals on the formal sector. In Muzarabani, therefore, the community has not been immune to the impacts of such factors. Their combined influence, however, has not completely weakened the traditional fabric in the area. For example, in an examination of the role of traditional religious beliefs and traditional leaders in nature conservation in the area, Byers *et al.* (2001) discover that traditional spiritual norms have greatly influenced human behaviour in the protection of forests. They also found limited forestry disturbances in areas where traditional leaders are empowered to exert their influences on nature conservation as opposed to high rates of forestry loss in such areas associated with the post-independence relative disempowerment of the political system.

Byers (2004) argues further that an interaction between ecology and traditional religion explains the existence of forests in Muzarabani. Accordingly, a conservation strategy of nature and culture linkages shaped by traditional beliefs, values and institutions enshrined in the local customary governance system has led to the existence of unique stands of forests in the area. In recognition of the inviolability of such places, thickets of unique dry forests that have been protected under traditional knowledge systems could be particularly useful in understanding the impact of long-term climate change on ecosystems.

Evidently, the environmental history of wildlife conservation in Muzarabani is a function of traditional management arrangements and practices. Unlike the mainstream economic view of wildlife in other parts of the world, in such places as Muzarabani, the major motivation behind nature conservation is traditional religious beliefs. In this scheme, religious and spiritual beliefs through sacred sites and forestry are understood as motivational aspects behind nature conservation and environmental protection (Byers *et al*., 2001; Byers, 2004; Mararike, 2011). Box 2.1 gives a description of traditional knowledge systems relevant in environmental management, which has been in existence for numerous years in Zimbabwe.

Box 2.1 Typical indigenous knowledge systems that existed in Zimbabwe

Traditionally, societies in Zimbabwe practised and enforced wildlife conservation through timely hunting of animals and birds, avoiding indiscriminate killing and fostering selectivity. Societies believed wanton killing was punishable by the spirits and as a result control mechanisms are found in traditional taboos, totems and customs. In some tribes, the customs or totems forbid people from eating certain animals, e.g., scavengers such as vultures and hyenas. Taboos forbade the killing of young animals and females in gestation. Hunting in scared places was also prohibited. The killing of rare species such as the python and pangolin could only be done with permission from the chief. Trees were protected through traditional taboos and customs. Certain trees were not cut because of their cultural importance, e.g., the *Parinari* sp (Mutowo) under which ceremonies were held.

Chiefs played an important role in safeguarding their peoples' access and rights to resources. All land was held in communal tenure, and the headman or sub-chief was responsible for allocating each family grazing and arable land. Even though resources were held in common, there was commitment to their protection because communities had real rights to manage the resources and benefited from them. With the intrinsic value of resources lost, people overexploit resources for survival and individual gain. As colonialism entrenched itself, the people also lost their most fundamental right – freedom. With that gone, the people lost all other rights and access to resources.

(Source: Ncube *et al*., 2002:115-117)

It is also necessary to understand how the natural environment and social factors discussed here influence the economy of the rural community. The next section attends to the issues that shape the Muzarabani economy.

2.5 The Muzarabani Rural Economy

Muzarabani exhibits a differentiated peasantry economy that bears allegiance to the physiographic characteristics described earlier. An economic contrast exists between the two district zones. As previously shown, the Upper Muzarabani is characterised by natural regions 2 and 3 which support intensive and semi-intensive farming, respectively (see Table 2.3). In terms of modern life, this zone, occupying the area up the escarpment towards Harare, resembles the modern world. On the contrary, the Lower Muzarabani, extending deeper into the valley towards Mozambique, is viewed as the past (Byers, 2004). This has important implications in understanding the socio-economic aspect of the study area, which in this view, can be said to lag behind in terms of modernity.

Table 2.3 Characteristics of Zimbabwe's agro-ecological zones

Agro-ecological Region	Rainfall (mm)/yr	Farming system
1	> 1000	Specialised diversified farming
2	750 - 1000	Intensive farming
3	650 – 800	Semi-intensive farming
4	450 – 650	Semi-extensive farming
5	< 650	Extensive farming

(Source: USDA, 2004)

A key element of the pattern and choice of settlement is related to the subsistence economy that influences the spatial behaviour. According to Chikozho-Mazarire (2009) this pattern has dominated the Zambezi and Limpopo lowveld areas since the 15th Century. Historically, the economy of the local people has been associated with an assortment of subsistence agriculture and pastoral pursuits. These activities were supplemented by hunting wild animals and gathering wild fruits, which used to be abundant in the area. In those early times, the tsetse-infested valley could not support the now lucrative livestock production. Animal husbandry gathered impetus around the 1980s, following the success of tsetse control programmes.

Earlier, the communities had limited differentiation in socio-economic status since the then scattered homesteads solely concentrated their cultivation along river banks. As waves of migrants invaded the area, starting around the 1960s and gathering momentum in early 1980s, following relaxation of migration laws after independence, the communities became more differentiated based on dryland agriculture and livestock production. Thus, the farming history of the area is mostly characterised by rain-fed production of such crops as maize, sorghum, groundnuts, *rapoko* and cowpeas (Parker and Osborn, 2001). These crops are grown mainly for subsistence purposes.

Around 1967, cotton was introduced as a commercial crop. The families then later ventured into agricultural enterprises. With cotton as a cash crop, incomes from cotton farming were invested into livestock production. This saw a shift from a subsistence traditional economy to a diversified commercialised economy. Farmers could then purchase such agriculture implements as ploughs, cultivators, harrows and scotch carts, which are exclusively ox-drawn. This enabled them to maximise the hectarage under cotton and maize production (field interviews). Now Muzarabani is one of the renowned cotton-producing districts in Zimbabwe. Given the susceptibility of the area to drought, cotton, which is a drought tolerant crop, has been highly preferred over other crops.

The ecological, social and economic importance of wildlife has led to the realisation that sustainable management of the resource hinges on the blessings of local populations living alongside it. However, in most areas where the philosophy has been translated into practice, this co-existence has not been a perfect one. In an assessment of dual season crop damage by elephants in the area, Parker and Osborn (2001) observe incidences of wet season and dry season crop raids. Wet season crop damages occurred mainly on farmlands around protected wildlife areas, while dry season damages were confined to farms along major rivers. They also observed damage by elephants on homesteads. This suggets that while there is desire to conserve elephants, when carefully analysed at community level, the widespread devastation that they cause make them more of a liability than a community asset. The mooting of CAMPFIRE described earlier serves to address these issues.

Concern has also been raised in some places in proximity to the game reserve. The villagers worry that animal diseases transmitted from the protected areas hamper livestock production. This means the families face difficulties in rearing livestock, yet keeping cattle remains a key livelihoods option in an increasingly dry climate.

2.6 Vulnerability to Climatic Events

Essentially, the major economic livelihood activities in this largely peasant community are climate-sensitive. For instance, during periods of drought, most crops wilt before the completion of the growing season leaving the people food insecure. In worst-case scenarios, drought poses a double tragedy to farming as livestock die due to lack of grazing pastures and water. Even though in some areas floods bring fertile soils for cropping, the magnitude and severity of these events could outweigh the perceived benefits of crop production.

The combined effects of drought and poor cotton market have exposed the people to poverty. For the past decade, cotton farmers have been engaged in a protracted fight over commodity prices and this has become an annual regularity. Instead of coming with a clear policy meant to regulate the industry, government puts the blame on the oligopolistic nature of buyers who, through their cartels, commonly exploit the poor and vulnerable farmers (Sunday Mail, 29/09/2013).

In 2012, the Parliamentary Committee on Agriculture reported that farmers held cotton as the price per kilogramme for first grade cotton plummeted from US$1.05 to US$0.40. The poor yields of 700kg/ha are attributed mainly to climate change and limited input support schemes. Crop production dropped from 350,000 tonnes in 2012 to 140,000 tonnes in 2013, with the area planted also declining from 450,000 to 241,849 ha during the same period. Fluctuations in international lint prices have exposed the government's incompetency to protect the local cotton industry (Herald, 24/12/2013; Sunday Mail, 29/09/2013).

Unfortunately, these developments are always impinging mainly on poor farmers in places like Muzarabani who, because of drought, are forced to barter-trade their livestock. Apparently, not all the efforts by the government to restore farmers' viability through various committees have yielded any positive results for the farmers. Consequently, some of the families are now pondering leaving the valley for other places over the escarpment, which they perceive as better for the lucrative tobacco farming industry.

In recent years, an increase in rainfall intensities in the Zambezi River Basin has been a challenge mainly to downstream communities including Muzarabani. The last decade alone has seen recurrent floods pushing rivers in Chiwenga, Chimoyo and Kairezi villages bordering Mozambique to maximum capacity. Each year the Zambezi River Authority, a regional organisation responsible for the management of the Zambezi River, is forced to open floodgates of the Kariba Dam as a way of regulating the water volume in the dam. This always poses flood hazards in Mbire and Muzarabani districts downstream the Kariba Dam. Heavy precipitation incidences are also a threat to the area as water from Lake Cabora Bassa in Mozambique is pushed upstream (UN-OCHA, 2007; Sunday Mail, 18/12/2011).

Most families whose homesteads are established in the floodplain and along the river banks defy annual flood warnings given by the MSD and the Civil Protection Unit (CPU). To them it appears that the main worry is food security and not the flood threat. It is also believed the increased demand for land resulting from the increasing influx of immigrants and attractiveness of the fertile floodplains are the major reasons for practising farming along river banks. This situation exposes the villagers to loss of lives, crops, livestock and property due to flooding. Most villages in the area are located in the floodplains and along Dande, Musengezi, Kadzi, Hoya, Ruya and Nzoumvunda rivers. Kairezi Village, for example, is just within a 30 kilometre radius of the giant Lake Cabora Bassa.

In December 2007, the United Nations Office for the Coordination of Humanitarian Affairs (UN-OCHA) reported that about 1,260 people were displaced by floods in Muzarabani (UN-OCHA, 2007). In the 2013/14 rainfall season alone, six people died of flood-related incidents from the incessant rains (Mufunga, on ZBC-TV). This situation generated a humanitarian crisis. Some victims suffered fractures from the rubble of felled huts. These people urgently required food, water, medicine, tents, cooking utensils, clothes, blankets, among other needs as their homesteads were severely inundated, with some people being marooned and crops washed away. Severe damage of infrastructure like roads, bridges and power supplies make the area inaccessible when flooding occurs. The storm damage on health infrastructure worsens the crisis. Flooding also leaves hectares of standing water which become breeding grounds for mosquitoes that spread malaria and other water-borne diseases (UN-OCHA, 2007; 2011; Herald, 10/01/12; Herald, 06/02/14).

Droughts, alternating with floods, are worsening the situation in Muzarabani. As noted previously, Region 4 is a dry climate. The change in the climate has given farmers in the area a short, unreliable and unpredictable rainfall-growing season, bringing frequent droughts. Meteorological data indicate that rainfall in the province has now been confined to three months from December to February punctuated by up to five dry spells (Makarau, 2013). As a result, the shorter rainy season causes crops to wither before they mature because of water stress.

Communication in the area is very poor. The poor roads, flood damaged bridges and telecommunication lines, combined with the absence of radio and television signals, deprive the area of access to communication and information.

Besides experiencing unprecedented droughts and floods, the area is overburdened with HIV and AIDS, malaria and tuberculosis (ZDHS, 2012), exposing it into a begging district relying mainly on donor organisations (Sunday Mail, 18/12/2011).

Undoubtedly, the propensity of Muzarabani towards climate-related events cannot be overemphasised. The situation triggers humanitarian intervention from several governmental and non-governmental agencies that always come in to try to avert this crisis.

2.7 Conclusion

Emerging from this analysis is the understanding that a combination of climatic and non-climatic forces has become entrenched as drivers of vulnerability to the agrarian villagers living in Muzarabani drylands. Floodplains bring mixed fortunes to communities attracted to them. While the low-lying landscape favours development of fertile alluvial soils from frequent flooding that offer attractive opportunities for farming activities, the risks posed by floodplains are often ignored by communities earning a livelihood from them.

An important point about the cost-effectiveness of livelihoods practices in such areas is pivotal. The question whether the realised and anticipated benefits of floodplains exceed the costs associated with flood hazards in the face of escalating risks induced by climate change arises. This can best be addressed through a cost-benefit analysis type of enquiry, which is beyond the scope of this study. However, in Chapter 6 and 7, an attempt is made to identify and assess if the mitigative and coping strategies in place can be adequate countermeasures against climatic perturbations.

Recurrent drought and floods have devastated the community in many aspects; notably, crop damages, loss of homes, destruction of infrastructure, diseases, school drop-outs, loss of household assets and deaths. For many communities, these events are now annual crises, leaving them in an almost perpetual cycle of disaster, displacement and recovery. Against this background, Muzarabani becomes a focal point in the study of climate change. As shall be seen in the next chapters, it is also logical to assess how the community's IK can be used to enhance understanding of climate change and strategic policy and planning interventions.

Worth particular mention in this analysis, however, is the need to highlight the context surrounding humanitarian assistance in Zimbabwe in general. Given the limitations of government to provide social nets to its citizens, most of the interventions are provided by local and international non-governmental organisations (NGOs) whose agenda is always queried by the government. This creates a vicious impasse between government and the NGOs. Government on the one hand accuses NGOs of masquerading as humanitarian agencies while pushing a regime change agenda. NGOs on the other hand blame the government for failure to put in place an operating environment conducive for them to leverage on in averting the humanitarian crisis caused by the latter's failure. As a result the vulnerable people are enmeshed in this endless impasse.

From a disaster management perspective, the crisis created requires further study given that in most situations interventions either delay or fail to get to the affected people. The question about the impact and sustainability of these interventions and how locals perceive them is outside the scope of this thesis, but has been a public spotlight for several years in Zimbabwe. It is argued in this study that empowering the locals to use their IK, skills, practices and strategies as leverage can be one of the sustainable ways of addressing entrenched vulnerabilities exacerbated by climate change with the intention of building their resilience against climatic events.

CHAPTER 3

INDIGENOUS KNOWLEDGE AND CLIMATE CHANGE: A CONCEPTUALISATION

Part of this chapter is adapted from the following forthcoming publication:

Chanza, N. & de Wit, A. (*forthcoming*). Enhancing Climate Governance through Indigenous Knowledge: Case in Sustainability Science. *South African Journal of Science*.

3.1 Introduction

Change and variability in the climate system continues to captivate the world. This has generated much interest in studying the topic of climate change. Notwithstanding this growing interest, the technocratic divide still faces a mammoth task in understanding how the 'science' of the indigenous people can contribute to the broad climate change discourse. In illustrating a framework for the analysis of IK and climate change, this chapter argues that making climate change an implicit prerogative for natural sciences does not work. The view advanced here is that in the domain of pragmatism, mitigation and adaptation should primarily be understood as social concepts deeply embedded in community understanding. To achieve this, relevant scholarship documenting IK and climate change is attended to.

The chapter also examines whether an interface between two forms of knowledge: conventional knowledge and IK, can give practical hints in building community resilience against risks and disasters posed by a changing climate. Overall, the analysis is underpinned by the concept of sustainability science, a framework that recognises the two sciences (conventional science and indigenous science) as models of climate change learning and response strategies. To do this, the chapter first attends to definitions of key concepts and terms central in the study. The chapter builds and expands from generic definitions in climate science in order to conceptualise a robust framework that encapsulates the key concepts necessary in guiding subsequent chapters.

3.2 Key Concepts and Definitions

A discussion of IK and climate change is dogged by complexities in both terminology and definitions. The task is also further complicated when trying to link these concepts into an environmental science discipline. In this section, it is argued that lack of universality in defining these concepts could be the major reason behind difficulties in building consensus on how to embrace IK in climate science. Against this milieu, an attempt is therefore made to develop operational definitions that assist in designing a framework for studying and understanding IK in climate change science. Figure 3.1 first presents a schema of the linkages of key concepts defined.

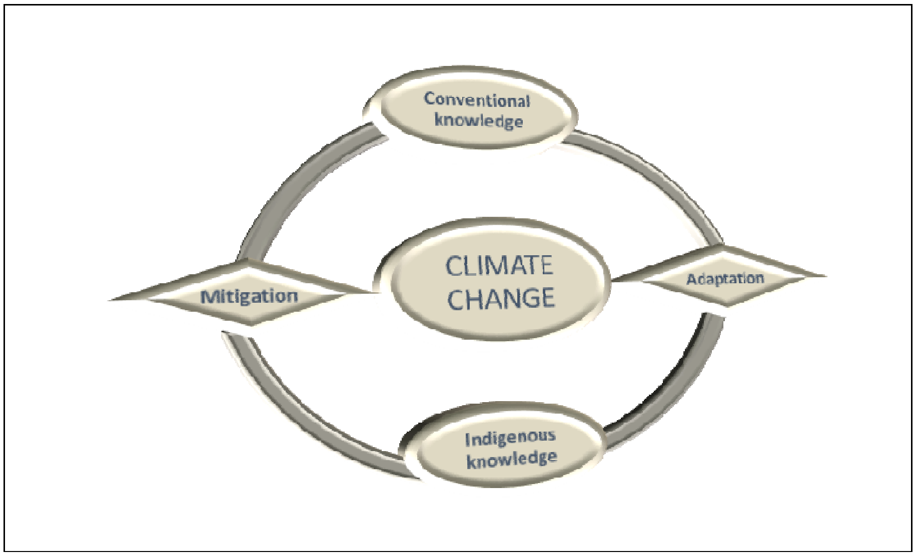

Figure 3.1 The scope of conceptualisation

From this schema, it can be argued that comprehensive attention to the issue of climate change ought to embrace both conventional knowledge systems and indigenous knowledge systems in order to inform appropriate mitigation and adaptation strategies. This view is the domain of the conceptualisation focus of this chapter.

3.2.1 Problems with Defining Science

The Collins Dictionary Online defines science as: *Systematised knowledge derived from observation, study, and experimentation carried out in order to determine the nature or principles of what is being studied.*

In the McMillan Dictionary, the term refers to: *The study and knowledge of the physical world and its behaviour that is based on experiments and facts that can be proved, and is organised into a system.*

After spending a year working on the definition of the same, the British Science Council collated this: *Science is the pursuit of knowledge and understanding of the natural and social world following a systematic methodology based on evidence*.

Clearly, from these definitions, there is no homogeneity in conceptualising science. For example, if one attempts to figure out what is being studied one will end up in either the physical world or the social world, or both. Both worlds are scientific, but parallel. There appears to be some consensus on the question 'why'. Here, the purpose of the study is unanimously agreed as that which generates knowledge. But another problem arises: how the knowledge is generated. The heterogeneity in the methodology under which science is conducted can be seen through various emphases; 'observation', 'measurement', 'experimentation', 'reading' and 'synthesising' what has already been studied; or 'interviewing' people with knowledge. However, some common ground can be established when specific terms like 'study', 'knowledge', and 'systematic' are depicted. What is important in this argument is that focus should be on the purpose of knowledge gathering rather than on the scientification of the subject.

The term 'science' itself denotes a very wide range of activities implicitly inviting a more generalised definition. For example, Larner and Snieder (2009), hint that numerous scholarship comments on the philosophy of science have not helped in coming up with a universal definition. To them, science can be understood as "the activities aimed at understanding the world around us" (p. 11). This world, however, is not only natural, but also political, social, economic and psychological. The world can also be understood as our environment from which the discipline environmental science emerges.

Environmental science is commonly understood as the study of the bio-physical and socio-economic aspects of the environment – where the environment denotes our surroundings. As illustrated in Figure 3.2, the facets of the environment are various.

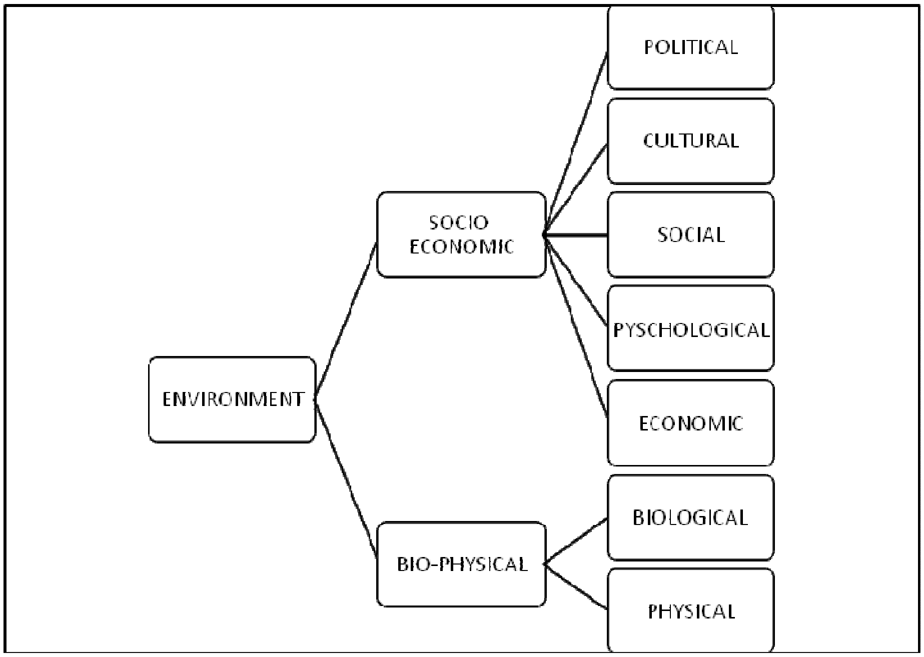

Figure 3.2 Facets of the environment

As humanity, we inhabit an environment that exists in space and time. The study of the spatial and temporal nature of this environment is called 'environmental geography'. Geography as a science looks at the need of knowing, seeing, recording, interpreting and disseminating facts about spatial attributes. The scheme presented in Figure 3.2 reveals the multifaceted nature of the environment; that is political (governance and administrative system), cultural (norms, views and practices about the world), social (human relationships and practices), psychological (about our feelings, attitudes or emotions), economic (about our production), biological (fauna and flora) and physical (climate system and matter). What needs to be understood here is the interconnectedness of these components.

The socio-economic environment is influenced by the bio-physical environment and vice-versa. Humanity is central in this relationship. For example, though the physical environment is capable of changing naturally, it is the human-inducing effect that can also destabilise the climatic system. This destabilisation resulting in noticeable change or variability in the climate system is called climate change - the topic under study. To study the way this phenomenon works and the resultant effects, we need science. Besides, the multifaceted nature of the environment (Figure 3.2) calls for an approach that is holistic and multi-disciplinary. In essence, we need a broad and more generalised definition of science as advocated by Larner and Snieder.

Aside from science being behind environmental ills, science is also blamed for failing to address problems such as climate change. In climate change pedagogy, such failure can emanate from compartmentalising the definition to natural science purity. In this study therefore, science is understood as a multifaceted activity, operationally defined as 'an activity to understand complex environmental challenges and seeking solutions to the beneficence of humanity.' Within this thinking, science is simplified to pave the way for the incorporation of the knowledge of people affected by challenges such as climate change. Albert Einstein's argument that ''we cannot solve our problems with the same thinking we used when we created them'' is a reminder of the need for this inclusivity approach in addressing environmental problems. In a similar critique, Sorlin (2013) argues for a re-conceptualisation of environmental expertise to include the social sciences and humanities, against a background where conventional environmental expertise faces challenges in giving sustainable clues in curbing global environmental challenges.

Similarly, Turner and Clifton (2009) view climate change as a complexity where its causes are both environmental and social, and its impacts are multidimensional and multifaceted in both space and time. In an earlier argument, Boko *et al.* (2007) express the fact that the economic and social aspects of climate change cannot be adequately addressed by Western-based science alone. So, in conceptualising the science of climate change, this broad scope is pertinent. This notion draws from the sustainability science standpoint, which is discussed extensively throughout the chapter.

3.2.2 Defining Climate Change

Climate change as a science has not been immune to the definitional flaws characterising most environmental concepts. Therefore, it is important to understand first the term climate before giving attention to the definition of climate change. This study embraces the IPCC definition of climate given in Box 3.1. The IPCC also uses different average periods, mainly ranging from twenty to thirty years, to describe climate.

Box 3.1 Definition of Climate

Climate in a narrow sense is usually defined as the average weather, or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years. The classical period for averaging these variables is 30 years, as defined by the World Meteorological Organization. The relevant quantities are most often surface variables such as temperature, precipitation and wind. Climate in a wider sense is the state, including a statistical description, of the climate system.

(Source: IPCC, 2007a:942)

Because it is viewed as a global problematique, a framework to tackle climate change exists in international regimes. Thus, the two frameworks: the UNFCCC and the IPCC are the dominant reference points used by the climate change community.

Article 1 of the UNFCCC defines climate change as:

> *A change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere which is in addition to natural climate variability over comparable time periods.*

To the IPCC, climate change is defined as:

> *A change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings, or to persistent anthropogenic changes in the composition of the atmosphere or in land use.*

Although both definitions talk about change or variability in the climate system over time, a distinction can be made between them. The UNFCCC's view has a narrow focus since it concentrates on humans as the forcing behind the phenomenon. On the contrary, the definition according to IPCC's is broader. It clearly points out that forcings can be both anthropogenic and natural. Pielke (2005) argues that UNFCCC has misdefined climate change. To him, the problem with this narrow focus by UNFCCC is that it only addresses anthropogenic GHGs as a destabilising force in the climate system. Therefore, in terms of interventions, policymakers may prefer mitigation to adaptation. Yet, policy orientation should also be geared towards addressing the impacts.

Owing to the inherent challenges in understanding the climate system, the IPCC prefers to use the terms 'climate change and variability' in referring to the concept of climate change. Variability refers to the spatial and temporal deviations in mean state of the climate. This variability may either be naturally-induced (internal variability), or anthropogenically-induced (external variability) and/or both. The important thing to understand here is that whatever the cause; the climate that we are experiencing now is not the same as it was over a period of more than twenty years ago.

This study simplifies the IPCC's generic definition of climate change to refer to any change in climate over time, whether due to natural variability or as a result of human activity, or both. It is also important to analyse if this definition can be understood at the level of indigenous or local communities, a key concept underpinning climate change discussion in this thesis. From a local knowledge perspective, it is difficult to describe the change and variability in statistical terms. The quantitative bias in the definition given by IPCC may restrain participation of indigenous people in the climate change debate. A more inclusive approach needs to recognise that change and variability are; not only statistical, but can also be expressed qualitatively as long as those changes have a record spanning the 20 to 30 year periods considered by the IPCC. Within this qualitative narrative, indigenous people can use their knowledge and experiences to interpret climate change.

3.2.3 Conceptualising Indigenous Knowledge

Researchers with a burgeoning appetite to understand IK applications on the subject increasingly invade environmental science literature. This ranges from texts found in many university and research institution libraries, to print and electronic journals, including those narrating the application or contribution of IK in addressing developmental issues in general. The current wave of interest in the concept is partly because of the growing acknowledgement on limitation of conventional science in addressing environmental issues (Agrawal, 1995; Briggs, 2006; Berkes, 2009; IPCC, 2007b; Brook & McLachlan, 2008; IPCC, 2010; Nakashima, 2012), and mainly because of the wide recognition of its utility in developmental issues (DFID, 1999; Berkes, 2000; Maila & Loubser, 2003; World Bank, 2004; Morris, 2005; Mapara, 2009; Lefale, 2010; Lwoga *et al.*, 2010; Goduka, 2012; Mkabela & Castiano, 2012).

IKS have been characterised by various definitions, theoretical conceptions and dimensions. Terminologies for this knowledge form are also multifarious as shown in Table 3.1. Generally, terms like ‘local’, ‘traditional’ and ‘indigenous’ knowledge appear more frequently. Although expressed heterogeneously, scholarly review of the definitions reveals homogeneity in meanings. This is an implicit invitation to adopt convenient terminology and definition. Thus, the study prefers to use the terms IK and IKS interchangeably since these are deployed more frequently in literature cited. In this dual deployment, use of IKS also bears allegiance to the scholars who put emphasis on the process in which the knowledge is shaped and understood.

Interestingly, all scholars who have treated this concept in Zimbabwe, prefer the term IKS (Muchena & Williams, 1991; Larson, 1998; Mutema, 2003; Mapara, 2009; Mawere, 2010). IPCC also use IK and IKS interchangeably. Generally, it is necessary to acknowledge that these terms actually mean the same thing as evidenced by the literature cited. The study also adopts terms used by Agrawal (1995) who refers to advocates of IK as *neo-indigenistas* and the belief that IK has something to offer as *neo-indigenismo.*

Table 3.1 Various terminologies characterising IKS

Terminology	Scholar(s)
Indigenous knowledge	Warren (1991); Agrawal (1995); Grenier (1998); Berkes (1999); Lillejord and Soreide (2003); World Bank (2004); Wallner (2005); Nyong *et al.* (2007); Sekine *et al.* (2009); Speranza *et al.* (2009); Green *et al.*(2010); Green and Raygorodetsky (2010); Lwoga *et al.* (2010); Roos *et al.* (2010); Workineh *et al.* (2010); Nakapipi (2011); Goduka (2012); Jiyane and Ngulube (2012)
Indigenous knowledge systems	Muchena and Wiiliams (1991); Larson (1998); Maila and Loubser (2003); Mutema (2003); du Toit (2005); Morris (2005); Le Grange (2009); Mapara (2009); Mawere (2010); Mkabela and Castiano (2012)
Local knowledge	Warren (1991); Briggs (2006); Peloquin and Berkes (2009); Labode *et al.* (2012);
Traditional ecological knowledge	Berkes *et al.* (2000); Ajibade and Shokemi (2003); Lefale (2010)
Traditional knowledge	Berkes (2009); Nakashima *et al.* (2012); Leonard *et al.*, (2013)
Traditional phonological knowledge	Lantz and Turner (2003); Turner and Clifton (2009)
Indigenous climate knowledge	Olove *et al.*(2009)
Local peoples' knowledge	DFID (1999)
Folk knowledge	Berkes (1999)
Farmer knowledge	Mauro and McLachlan (2008)
Rural people's knowledge	Kothari (2002)
Local ecological knowledge	Brook and McLachlan (2008)

The problem with the word ‘indigenous’ has been echoed by many scholars. Mutema (2003) concurs with Agrawal (1995)’s concern about derogatory characterisation of the term. They decry that traditional thought systems have been rendered primitive and at worst dismissed as non-existent. Such terms as ‘savage minds’, ‘primitive cultures’, ‘village people’, ‘native people’ and ‘indigenes’ have been used by those antagonistic to the *neo-indigenismo*. Meyiwa and Ngubentombi (2010) and Goduka (2012) hint that the term has mistakenly been associated with poverty. On a similar note, concern with other authors is that IK remains a highly emotive concept with words like ‘transmogrification’, ‘subjugation’, ‘colonisation’ and ‘debilitating’ centralising the discussion (Smith, 1999; Odora-Hoppers, 2002; Maila & Loubser, 2003; Brook & McLachlan, 2008; Mapara, 2009; Mawere, 2010; Goduka, 2012).

3.2.3.1 What are indigenous knowledge systems?

Given this deluge of terminology and approaches, the lack of a universally accepted definition cannot be ruled out. Brook and McLachlan (2008:3502) opine that such heterogeneity is obvious “given the complexities of these knowledge systems, the diversity of environments and cultures that they reflect, and the myriad ways that they are viewed, documented, and used.” In general terms, the concept defines knowledge that is location specific, acquired in situ, through progressive study of the community’s interaction with the environment, and orally transferred intra-and inter-generationally. To IPCC, the problem in defining IKS lies with disputes in internationally recognised definition of the indigenous people themselves as cited in Box 3.2.

Box 3.2 Definition of indigenous people

No internationally accepted definition of indigenous peoples exists. Common characteristics often applied under international law, and by United Nations agencies to distinguish indigenous peoples include: residence within or attachment to geographically distinct traditional habitats, ancestral territories, and their natural resources; maintenance of cultural and social identities, and social, economic, cultural and political institutions separate from mainstream or dominant societies and cultures; descent from population groups present in a given area, most frequently before modern states or territories were created and current borders defined; and self-identification as being part of a distinct indigenous cultural group, and the desire to preserve that cultural identity.

Source: IPCC (2007b:876)

Mapara (2009:140) looks at the concept as “a body (bodies) of knowledge of the indigenous people of particular geographical areas that they have survived on for a very long time.” To Nakashima *et al* (2012) the term refers to “the knowledge and know-how accumulated across generations, and renewed by each new generation, which guide human societies in their innumerable interactions with their surrounding environment.” Orlove *et al* (2010) use the term to refer to the place-based knowledge that is rooted in local cultures and mostly associated with long-settled communities that have strong ties to their natural environments. Warren’s (1991) definition is very simple: wisdom of people for survival in their own environment.

What is key to these definitions is that they reveal the interconnectedness of humans to their environment, a linkage important in sustainable development pursuits discussed in this chapter. Specifically, Berkes *et al* (2000) opine that this knowledge is a unique attribute to a community group with historic continuity in a specific environment. When analysed in climate science, this means knowledge of the indigenous people can be harnessed not only to understand change and variability in the climate system, but also to propose strategies for understanding how society can reconnect with nature – aspects key in mitigation and adaptation.

The IPCC is also entangled in the *neo-indigenismo* mantra. The organisation cites Ajibade and Shokemi's (2003) definition of IK as the knowledge system developed by a community as opposed to the scientific knowledge generally referred to as modern knowledge. IPCC's contribution to this thought is presented in this chapter.

There is wide recognition that IK is housed with the elderly members of a community (Warren, 1991; Berkes, 1999; DFID, 1999; Kothari, 2002; Ajibade & Shokemi, 2003; World Bank, 2004; Briggs, 2005; Nyong *et al*., 2007; Mauro & McLachlan, 2008; Workineh *et al*., 2010; Lwoga *et al*., 2010; Sekine *et al*., 2009; Mkabela & Castiano, 2012; Jiyane & Ngulube; 2012; Leonard *et al*., 2013; among many others). For example, Leonard *et al* (2013) are of the view that even though the knowledge is collectively held within a community, its aspects are only known by specific members of a group such as specialists and elders.

Contrary to this, Ruddle (1993) and Grenier (1998) opine that all members of a community, that is, elders, women, men and children, possess this knowledge. For example, in an examination of traditional ecological knowledge in Venezuela and Polynesia, Ruddle (1993) observes that children as early as five years already had knowledge of names and characteristics of community biota. Grenier (1998:6-7) lists a number of factors that influence the quantity and quality of IK that these individuals possess; namely "education, gender, social and economic status, daily experiences, outside influences, roles and responsibilities in the home and community, profession, available time, aptitude and intellectual capability, level of curiosity and observation skills, ability to travel and degree of autonomy, and control over natural resources."

It is generally viewed that urbanisation, modernisation and globalisation are the major factors threatening IK perpetuity (Warren, 1991; Odora-Hoppers, 2002). Matshinyalo and Siebert (2010) confirm interference of strange practices as a major challenge exposing IK to natural erosion. In Chapter 2, it was discussed that these threats though in existence, have not completely weakened the cultural fabric characterising IKS in Muzarabani.

Threats to IK, however, are not without cost. The fear is that the usefulness of this knowledge system, particularly in addressing climate change, may be compromised too. Grenier (1998) cites an old African proverb, which says: “When a knowledgeable old person dies, a whole library disappears.” Odora-Hoppers (2002) even expresses that the erosion of peoples’ knowledge on natural resources is under greater threat than the erosion of natural resources themselves.

3.2.3.2 A Climate-oriented Definition of IKS

Fundamentally, the definitions examined here indicate that this knowledge is understood within a specific space. The knowledge is not separable from interaction with or studying the environment. When analysed in a climate change perspective, IK enables holders of the knowledge to understand their environment as they are in constant interaction with it for so many years. In this way, indigenous people are capable of observing and recording noticeable changes in the climate system. Nakashima *et al* (2012) opine that this observation generates knowledge that contributes to climate science by offering detailed interpretations and explanations at a much finer spatial scale, with considerable temporal depth beyond the consideration of climate scientists. In this study therefore, a climate-sensitive definition of IK is given as:

> *The reservoir of knowledge, skills, technologies and practices of a local indigenous community (a Science Academy) of elders (the scientists), about long-term noticeable change and variability in the climate system of their environment. The community is capable of sharing and utilising this knowledge to meet their livelihoods and survival needs.*

Three key points need to be understood about this definition. Firstly, the knowledge is understood collectively to include community skills, technologies and practices that give them a dual collective understanding; one, about how to observe and record the phenomenon; and two, how to review practices and respond to climate change. A focus on practices and response strategies is understood in mainstream climate discourse as mitigation and adaptation, respectively.

Secondly, the concept deployed here is holistic, empowering and participatory. This has commonly been referred to as community-based adaptation (CBA). Related to CBA, is the concept of climate governance – a new discourse about fairness, burden-sharing, inclusivity and participatory democracy in climate regimes (Chirisa & Chanza, 2009; Ensor, 2009; Backstrand & Loubrand, 2012). In Zimbabwe, CBA has been argued by Zvigadza and Mharadze (2010) as a crucial approach in dealing with climate change threats to the vulnerable populations. The concept embraces Agrawal's *neo-indigenismo*. Within this view, science is not the preserved field of mainstream pedagogy characterising technocracy. Here the community is viewed as a 'Science Academy' capable of generating useful knowledge in addressing climate change challenges. The community of elders are understood as 'scientists' whose long-term lived experiences have enabled them to give useful insights about the nature and magnitude of change and variability in their environments.

Thirdly, because they have been in close contact with their environment, it can be argued that these 'scientists' have unique knowledge and ingenuity unmatched with Western science since theirs give local precision, nuances, finer scale and more depth about noticeable change in the environment (Agrawal, 1995; Odora-Hoppers, 2002; Brook & McLachlan, 2008; Nakashima *et al.*, 2012).

3.2.3.3 Indigenous Knowledge and Conventional Knowledge Compared

The term IK can also be used to distinguish between knowledge systems developed by a community and a scientific knowledge system which is generally referred to as 'Western', 'conventional' or 'modern' knowledge. A distinction of the two sciences is provided in Table 3.2.

Table 3.2 Comparison between IK and conventional knowledge

Characteristic	Indigenous knowledge	Conventional knowledge
Mode of transmission	Orally	Documented texts
Level of application	Context-specific	Universal
Theoretical insight	Presuppositions	Definite theory
Procedure	Interpretation followed by construction	Construction followed by interpretation
View about the world	Closed system	Open system
Nature of knowledge	Scientific	Scientific
Ethical issues	Ethical free	Ridden with ethical issues
Method of generation	Cumulative and continually evolving	Cumulative and continually evolving
Nature of knowledge	Build on lived experiences	Empirical
Research paradigm	Qualitative	Quantitative

Source: Agrawal (1995); Grenier (1998); Morris (2005); Wallner (2005); Brook and McLachlan (2008)

Agrawal (1995) considers three key narratives that make the two knowledge forms distinctive. First, substantitive – there are differences in the subject matter and characteristics of indigenous versus Western knowledge. Second, methodological and epistemological – the two forms of knowledge employ different methods to investigate reality, and possess different worldviews. And, third, contextual – traditional and Western knowledge differ because traditional knowledge is more deeply rooted in its context.

Clearly, from the illustration in Table 3.2, some similarities and differences in the two knowledge dichotomies can be depicted. The difference between the two lies in the epistemological foundations. Morris (2005) and Walsh (2011) have commented on the idea of looking at Western knowledge as global. To them this is being romanticised since rarely do we see it as a truly global knowledge system. At the level of action and praxis, Morris argues that people invariably act locally. To Brook and McLachlan (2008) conventional knowledge readily incorporate technology and scientific discoveries where appropriate, such that the distinctions between the two sciences often become blurred. Agrawal (1995) and Grenier (1998) also write that the difference is rather artificial or closer than the dichotomy implies.

3.2.3.4 Is indigenous knowledge scientific?

The *neo-indigenistas* have not been immune to criticism. Labels like 'pseudo-science', 'anti-science', 'artefactual science' and 'primitive science' appear in some authorities (Briggs, 2005; Widdowson & Howard, 2008). As discussed in Chapter 4, the scientific community primarily prefers to deal with quantitative data rather than qualitative data that characterise IK studies. Because of this scientific bias, Grenier (1998) also reports that IK has been regarded as 'anecdotal', 'non-quantitative', 'out of date' and 'amethodological'. Clearly, what emerges from this analysis is that IK faces stigmatisation at the science front.

Briggs (2005) charges that use of IK in development is riddled with problems and challenges namely; focus on the (arte)factual; cleavage between Western science and indigenous science; the problem of differentiation and power relations; the romanticisation of IK; and the de-contextualisation of IK. However, the criticism by Briggs seems to lose substance when one considers that even Western science is also riddled with the problems of romanticism and tensions within the discipline itself (Wallner, 2005). Maila and Loubser (2003) are of the view that IK is of universal utility. They argue that traditional science is not static, but dynamic. Wallner (2005) adds that Western science can become 'very immoral' and 'very dangerous' since it lacks subjectivity. The power relations cited by Briggs are also inherent in conventional science that is understood as bureaucratic and egocentric.

Another criticism levelled against IK is from the book 'Disrobing the Aboriginal industry' by Widdowson and Howard (2008). The authors argue that definitions of IK concentrate on elements that are clear-cut from knowledge such as 'values', 'beliefs' and ‘practices’. In their line of reasoning the deployment of traditional knowledge infuses ancient culture into modernity with compatibility problems. However, Walsh (2011), citing other previous authors opposing the book, vehemently rejected Widdowson’s and Howard’s ideas. He stresses that the failure by Widdowson and Howard to gasp the fundamental aspects of IK generates serious problems. Walsh’s argument resonates with Simpson’s (2010) earlier criticism because the use of evolutionary arguments and the theory cited within their book is itself outdated and Neolithic anthropological theory. The two scholars actually dismissed Widdowson’s and Howard’s work as a colonial project.

Viewed within the perspective of climate science, IK requires some recognition. Looking at Western scientists as the super-observers of the climate system may be naïve in the face of local and global challenges posed by climate change. This study therefore looks at IK as legitimately scientific.

In support of this view, UNESCO’s Declaration on Science and the Science Agenda Framework calls for an inclusive agenda in science. It argues that given the serious global challenges confronting society, the task of science should be more accountable, more communicative and more dialogical. Such a framework can possibly better meet the needs and demands of society. From a closer analysis, the growing interest in the consideration of IK in environmental issues is a clear illumination of a revolution in academia – a paradigm towards democratising science.

3.2.4 Climate Change Mitigation

The concept of mitigation in climate theory and practice is one requiring clear definition. Generically, mitigation is understood as a proactive measure to prevent or minimise harm. Considering that climate change prevention is viewed from two main perspectives: focus on preventing the change from occurring, on the one hand; and focus on preventing the risk or hazard posed when the change occurs, on the other hand, the term needs to be properly conceptualised. A clear distinction is given by the IPCC as mitigation of disaster risk and disaster and mitigation of climate change.

The former is defined as "the lessening of the potential adverse impacts of physical hazards (including those that are human-induced) through actions that reduce hazard, exposure, and vulnerability." The latter is simply "a human intervention to reduce the sources or enhance the sinks of greenhouse gases" (IPCC, 2007c:818; IPCC, 2012:36, 561).

In this study therefore, the utility of IK can be seen in both viewpoints. In climate change mitigation, IK is potentially useful in the implementation of policies enhancing management of GHGs in agriculture, ecosystem and other forestry management projects. The challenge, however, could be the limited scale at which such projects can be implemented to cause significant sequestration of atmospheric GHGs. In disaster and risk management practices, IK can be harnessed in projects that reduce community vulnerability to the hazards posed by climate change extreme events such as drought, floods, hurricanes and thunderstorms. Throughout the study, the two distinct definitions of mitigation are accommodated in order to adequately understand the scope of IK in climate interventions. Lovell *et al* (2012) also view mitigation as a substantitive action that can be used in different contexts where reduction in existing specified conditions is required.

Other scholars classify mitigation into structural (technological) and unstructural (economic structure, societal organisation and individual behaviour) (Swart *et al*., 2003). Nyong *et al* (2007) indicate that employing mitigation strategies through indigenous natural resource conservation is an unstructural measure serving dual objectives: reducing GHG emissions from anthropogenic sources, and enhancing carbon assimilation. This study also examines the relevance of IK in climate mitigation. A twin concept with mitigation in climate change science is adaptation, which is described in the next section.

3.2.5 Climate Change Adaptation

In climate literature and practice, adaptation is a commonly used term. As such, the term has been defined differently and its typology is also various. Generally, the concept is seen as one of the policy options for reducing the negative impact of climate change (Berkes & Jolly, 2001; Adger *et al*., 2003; Sovacool, 2011). IPCC (2007:869) refers to it as "adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities." IPCC further distinguishes the following adaptation typologies:

- *Anticipatory (proactive) adaptation* – Adaptation that takes place before impacts of climate change are observed.

- *Autonomous (spontaneous) adaptation* – Adaptation that does not constitute a conscious response to climatic stimuli but is triggered by ecological changes in natural systems and by market or welfare changes in human systems.

- *Planned adaptation* – Adaptation that is the result of a deliberate policy decision, based on an awareness that conditions have changed or are about to change and that action is required.

These various adaptation interventions can be under private or public arrangements. The latter is more appropriate for the incorporation of IK, skills and ingenuity of local communities. The 2012 IPCC report makes a distinction of human systems adaptation from natural systems. In human systems, adaptation is defined as "the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities", while in natural systems, it refers to "the process of adjustment to actual climate and its effects, and human intervention may facilitate adjustment to expected climate" (IPCC, 2012:36). This distinction, the report argues, is necessary to avoid the implication that natural systems can adjust to anticipated climate stimuli. On another note, it is believed that opportunities for natural system adjustment to expected stimuli can be influenced by human action. The scope of this study is on human systems adaptation.

In this consideration therefore, the role of indigenous people cannot be dismissed. Lovell *et al* (2012) illuminate that disaster risk and occurrence are a function of hazard, exposure, vulnerability, capacity, resilience, and coping, which collectively are a reflection of societal contexts. Thus, it is action or inaction of society that explains its coping mechanism or adaptive capacity – response practices to capacitate a community whose propensity to climatic stimuli requires a toolbox of interventions to save lives and livelihoods.

Coping capacity and adaptive capacity have mostly been mistreated in literature (Berkes & Jolly, 2001; Lovell, *et al*., 2012). Some authorities therefore, deploy these terms interchangeably (UNISDR, 2008, 2009). While the distinction is rather vague, generally 'coping' focuses on the current circumstance while 'adapting' focuses into the future. The emphasis of the latter is to learn and reinvent following the experience with the circumstance (Berkes & Jolly, 2001; Sovacool, 2006; Lovell, *et al*., 2012). When considered at community level in the face of risks or hazards brought about by climate change, the praxis of these concepts utilises IK. Berkes and Jolly (2001) give a distinction between these concepts as summarised in Box 3.3.

Box 3.3 The relationship between coping capacity and adaptive capacity

Coping mechanisms are the bundle of short-term responses to situations that threaten livelihood systems, and they often take the form of emergency responses in abnormal seasons or years. Adaptive strategies, on the other hand, are the ways in which individuals, households, and communities change their productive activities and modify local rules and institutions to secure livelihoods. The two kinds of responses may overlap across the temporal scale, and coping mechanisms may develop into adaptive strategies over time. Coping mechanisms are more likely to emerge at the level of the individual and the household and at smaller spatial scales, whereas adaptive strategies, which are related to variables such as cultural values that change more slowly, are more likely to emerge at larger spatial scales.

(Source: Berkes and Jolly, 2001:2)

A key concept in climate adaptation is community-based adaptation. CBA – a bottom-up framework meant for effective adaptation through the central role of local people experiencing climatic phenomena – is now a preferred climate intervention strategy mostly by development practitioners (Ensor, 2009; Sekine*et al.*, 2009; Zvigadza & Mharadze, 2010). This framework can be ideal for meaningful incorporation of indigenous people through harnessing their knowledge, skills, experiences and experimentations in order to build climate-resilient communities.

3.2.6 Relationship between Mitigation and Adaptation

The complementary roles of mitigation and adaptation have been widely documented and are undoubtedly the focus of policy interventions (IPCC, 2001; IPCC, 2007; Nyong *et al.*, 2007; Wilbanks & Sathaye, 2007; Wilbanks *et al.*, 2007). Various reasons have been given for the integral role of mitigation and adaptation. Wilbanks and Sathaye (2007) have stressed that a highly adaptive society depends on the level of GHG stabilisation through mitigation. They argue that adaptation is difficult or even a futile if mitigation fails to minimise the magnitude of the costs to be handled. Figure 3.3 shows how the two concepts can be connected.

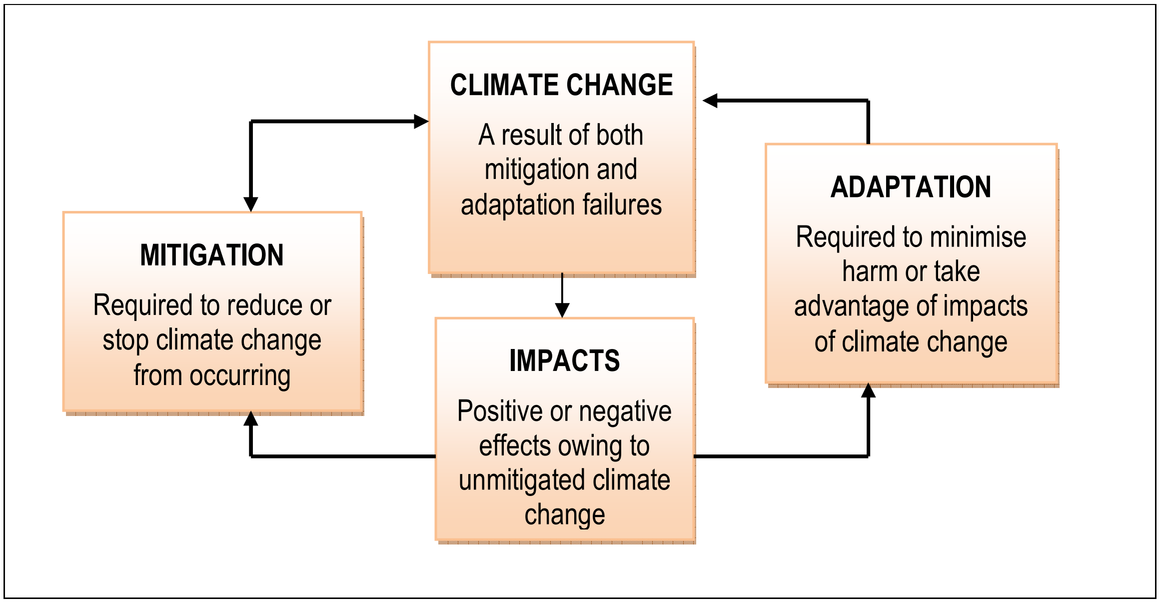

Figure 3.3 Adaptation and mitigation linkages

Wilbank *et al* (2007) add that mitigation is important in order to keep impacts under control. At the same time impacts cannot be avoided and globally mitigative progress has been very slow, calling for the need to complement with adaptive measures (IPCC, 2014b). This means in order to circumvent the limitation of each strategy both options are necessary. The IPCC has argued that despite the scale of mitigation measures adopted, adaptation is a prerequisite given the inertia in the climate system. This emphasises the mutual dependence of mitigation and adaptation. Furthermore, global developments characterising limited success with mitigation means immense challenges for adaptation (WMO, 2014).

When analysed in a sustainable development framework, Halsnaes *et al* (2007) express that both options are necessary, but are distinctive based on benefits that are global and long-term for mitigation, and local and shorter term for adaptation. This means adaptation can be a more preferred option for indigenous communities grappling with the devastating effects of climate change. The major distinction between the two concepts is actually the timing of the intervention. According to Wilbanks *et al* (2007), adaptation can be both reactive and proactive, while mitigation can mainly be proactive in avoiding or suppressing the phenomenon from occurring. Within this scope, therefore, it is necessary to understand what indigenous people can do to reduce, avoid or ameliorate the conditions of a changing climate. Box 3.4 explains in detail the merits associated with twinning mitigation and adaptation.

Box 3.4 Rationale for mitigation and adaptation integration

Mitigation and adaptation are also related in more action-specific ways. For instance, individual mitigation and adaptation actions often have the potential to interact with each other. In some cases, they offer alternatives; e.g., mitigation to reduce changes in precipitation patterns that would affect agriculture versus adaptive development of crop varieties resilient to a wider range of precipitation. In some cases, they reinforce each other: e.g., more efficient space cooling both reduces electricity consumption for space cooling (mitigation) and makes cooling more affordable for lower income groups (adaptation). In either case, the actions are also related to other aspects of sustainable development pathways as well.

Considering mitigation and adaptation as parts of an integrated portfolio of strategies, policies, and actions is complicated, however, by the fact that adaptation is in many ways more complex than mitigation - e.g., it can be both anticipatory and reactive and it often depends on a mosaic of local circumstances. More fundamentally, mitigation and adaptation actions often differ in their nature, their co-benefits, their limits, who decides, and who pays the price versus who benefits. For example, mitigation and adaptation measures tend to differ in the timing of the efforts (mitigation benefits are lagged in time, unlike some adaptation benefits), the geographical pattern of their effects (mitigation benefits are more global; adaptation benefits are more localized), and the sectoral focus of their responses (mitigation focuses on greenhouse gas emitters and sinks; adaptation focuses on sectors and activities sensitive to climate impacts).

(Source: Wilbanks *et al*., 2007:714)

Tol (2005) has a rather radical view on the mitigation and adaptation ‘marriage’. He argues for the need to treat them separately to avoid the impression of seeing adaptation as accepting defeat in mitigation. His viewpoint centres primarily on three arguments why isolation is necessary:

- Most adaptation is local implying that governments and international organisation have little to do with it;

- Adaptation cannot be readily compared to mitigation, because most adaptation is done by different people, at a different spatial and temporal scale than mitigation; and
- Mitigation takes resources away from adaptation. For instance, for infectious disease related impacts in poor countries, money is better spent on adaptation than on mitigation.

Tol's argument can be politically sound in the context of most African governments including Zimbabwe. In Chapter 1, it was stated that the motive behind Zimbabwe's attention to climate change is obviously from recognising the threats associated with the impacts and not from being a key driver of the problem. Thus, the country prefers an adaptation orientation. However, for the purposes of pedagogy, this study embraces both strategies in the prism of what IK can do in climate science. Additionally, the evidence about potential usefulness of IK in both mitigation and adaptation is a call for a broad examination on how the knowledge of indigenous people in Zimbabwe could also influence the mitigation and adaptation nexus. Besides, the current trajectory in climate science practice orients toward connecting mitigation with adaptation (IPCC, 2007c; Nyong *et al.*, 2007; IPCC, 2012; IPCC, 2014b).

3.4 A Conceptual Framework for Analysis

In the preceding analysis, it was revealed that IK is gaining phenomenal recognition as a concept in climate change interventions. The scientification of IK is undoubtedly occupying space on the climate science agenda. However, as Nyong *et al* (2007) point out, the challenge now is to translate this theoretical understanding into a conceptual praxis that guides IK operationalisation. A framework that guides understanding of IK in climate change science and interventions under the concepts of mitigation and adaptation is discussed here.

3.4.1 Linking IK with Mitigation and Adaptation

Action to respond to climate change should be understood through devising appropriate mitigation and adaptation measures in order to avert disasters potentiated by the phenomenon. Interventions should be holistic; that is, embracing both conventional knowledge and IK forms. Conventional knowledge is understood here as relating to mainstream scientific knowledge that is chiefly Western-based. Apparently, the knowledge that informs climate change interventions at policy level is mainly drawn from mainstream science (Du Toit, 2005; Berkes, 2009; Green & Raygorodetsky, 2010; Walsh, 2011; Cornell *et al*., 2013; Sorlin, 2013). Views of knowing of the indigenous people and the underlying systems have not been adequately addressed at the technocratic front. Paradoxically, the dominant conventional knowledge may either fail to precipitate down to the community experiencing the impacts of climate change, or face implementation challenges if they get to the community. The reality therefore is, at grassroots level, people adopt their own knowledge convenient to them.

In such a scenario, a vicious vulnerability cycle that further threatens the coping and adaptive capacities of communities facing climatic events would evidently manifest itself. In Zimbabwe, the resultant situation always attracts humanitarian interventions that are a peculiar arrangement in addressing deep-rooted causes of the vulnerability. In this framework therefore, the study opens democratic space for the integration of IK in climate science. This is referred to here as democratising science. Jasonoff (2005) conceptualises this notion as 'civic epistemology'. O'Brien *et al* (2013) and Solin (2013) view this as a transformative agenda to revolutionalise science which is necessary in addressing global environmental challenges. Related to this notion is the sustainability science concept currently attracting the attention of scholars and practitioners in climate change interventions (Welp, 2006; Kajikawa *et al.*, 2007; Kajikawa, 2008; Wilbanks & Wilbanks, 2010; Pahl-Wostl *et al.*, 2012; Thorton & Maciejewski, 2012; Cornell *et al.*, 2013; O'Brien *et al.*, 2013). Sustainability is now a central theme in climate change interventions (IPCC, 2012).

The rationale in this consideration is that climate change interventions – mitigation and adaptation – need to suit the context of community into which they are to be implemented. By so doing, the approach's impact can be two-fold: first, it can build community resilience against current and potential threats posed by climate change; and second, it creates latitude for understanding and enhancing community's adaptive capacities by using their local knowledge to get services from natural resources and ecosystems. This approach that serves both objectives of climate proofing and emission reduction through harnessing ecosystem services coupled with wise management of the same is understood as ecosystem-based adaptation (EBA) (Colls *et al.*, 2009; UNFCCC, 2012; Munang *et al.*, 2013).

Munang *et al* (2013:67) define EBA as "the use of natural capital by people to adapt to climate change impacts, which can also have multiple co-benefits for mitigation, protection of livelihoods and poverty alleviation." This framework owes allegiance to the sustainable livelihoods framework championed by the WCED (1987) and Chambers and Conway (1990). According to the United Kingdom's DFID, Department of International Development (1999) "a livelihood is sustainable when it can cope with and recover from shocks and stress and maintain and enhance its capabilities and assets both now and in the future, whilst not undermining the natural resource base."

The shocks and stress are brought about by climate and non-climate risks. Broadly, ecological sustainability can be realised if the natural resource base or the integrity of the environment is not undermined. Enhancement of environmental integrity is a necessary foundation for bridging the vulnerability gap and building the adaptive capacity of the community, with the ultimate goal of promoting a climate-resilient community.

Scholars like Mapara (2009) and Lavell *et al* (2012) underscore the imminent hazards associated with climatic events whose occurrence usual exceeds society's adaptive capacity, inevitably potentiating disasters. As pointed out in Chapter 2, this has been the case in Muzarabani including other parts of Zimbabwe. Given this poverty-climate change milieu, it is clear that climate change is adding to other entrenched drivers of unsustainability in most parts of Zimbabwe. Drawing from IK in designing mitigation and adaptation interventions can be one of the ways of addressing vulnerabilities of indigenous communities affected by climate change.

3.4.2 Climate Change and Sustainable Development Linkages

The climate change research community has largely embraced the concept of sustainable development following a realisation that the two are inseparable (IPCC, 2001; Robinson & Herbert, 2001; Munasinghe & Downing, 2003; Swart *et al.*, 2003; Bizikova *et al.*, 2007; IPCC, 2007b; Bizikova, 2012; IPCC, 2012). The major challenge cited by IPCC (2012), however, is that sustainable development and climate change linkages have largely remained theoretical and lacking empirical evidence. This challenge is possibly attributable to the inherent difficulties associated with practical implementation of sustainable development projects.

Downing (2003) and Bizikova (2012) present the nexus between sustainable development and climate change as illustrated in Figure 3.4. This framework can be useful if articulated at policy level. In essence, in a mutually-exclusive cause, sustainable development through ideal policies in social, economic, institutional and technological dimensions can curtail climate change on the one hand, while climate change policies through robust mitigation and adaptation policies can promote sustainable development on the other hand. Key in this view is that sustainability discourse should not be devoid of local input within which IK becomes pivotal.

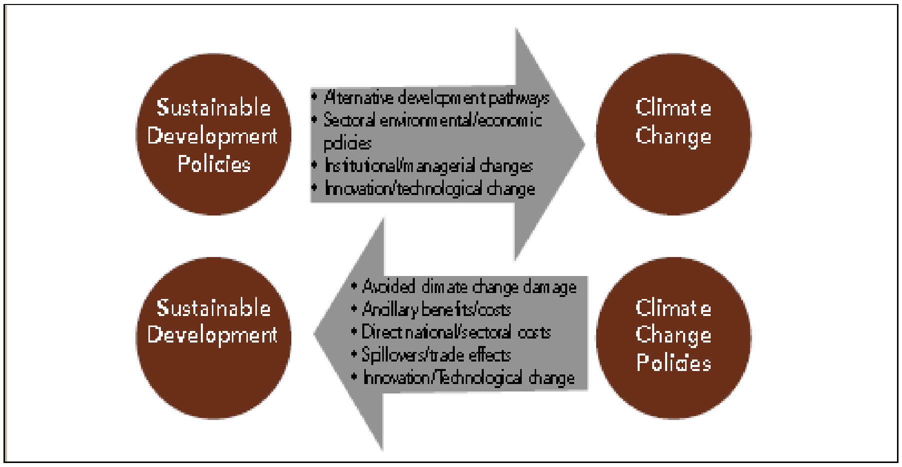

Figure 3.4 Linkages between climate change and sustainable development

(Source: Bizikova, 2012:217)

Emerging from this linkage is the fact that sustainable development paths through proper institutional, social, economic and technological arrangements collectively form a bundle of mitigation strategies necessary in addressing climate change. Depending on the scale and magnitude of climate impacts, communities can harness a variety of adaptation options from their bio-physical and socio-economic environment to position themselves on sustainable paths. Thus, mitigative and adaptive capacity is a measure of society's sustainability level in a mutually reinforcing mechanism between sustainable development policies and climate change policies. The opinion by Nyong *et al* (2007) is that society will get better results if both strategies are used as complements.

Conceptually expressed, sustainable development cannot be separated from climate change discourses. However, the challenge of climate change responses is to make them sustainable (Duerden, 2004; IPCC, 2007; Nyong *et al*., 2007; Bizikova, 2012). Adger *et al* (2005) and Thomkins and Adger (2005) argue that successful mitigation and adaptation can promote sustainable development. At policy level, the nexus between sustainable development and climate change deserves analytical and conceptual emphasis to avoid a bias towards the latter. Sathaye *et al* (2007) agree with Swart *et al* (2003) that climate policy alone will not address the climate problem. In essence, effects of climate change can adequately be curtailed through robust complementarity of sustainable development and climate change policies. Gorjestani (2000) shares a similar view with the World Bank (2004) that IK can be harnessed to advance the global development agenda. Therefore, given the evidence that climate change stymies development, the thesis advanced here is that IK has value in addressing the developmental challenges posed by the phenomenon.

3.4.3 Conventional Knowledge Interventions

The rush towards modernity in Africa has not been without challenges (Esteva, 1992; Hountondji, 1997; Odora-Hoppers, 2002). In Zimbabwe, of particular mention is that Western science has dominated development planning overall. However, as Odora-Hoppers (2002) points, Eurocentric-based models are not a perfect arrangement in problems besetting Africa in general. So far the challenge acknowledged by most scholars is that interventions have failed regardless of the scientific model adopted (Duerden 2004; Tompkins & Adger, 2005; Giddens, 2011; Lee *et al*., 2014).

A case in point is that by Salick and Byg (2007) who argue that even though climate change models generated by scientists can give insights into the consequences of the phenomenon, they remain poor in depicting local specific changes. Welp (2006) warns that where science is detached from the realities of society, it may remain purely academic with little social relevance. It is against this background that the sustainability science notion articulated in the next section can be useful in examining these gaps and proffering some solutions to climate change challenges. Specifically, when focusing on local disaster management initiatives, indigenous ideas can be a new debate requiring some attention given the limitations of conventional science in addressing climate change at community level. Clearly, in climate change considerations, there is need to look beyond the dictates of mainstream science in order to understand fully the phenomenon and how interventions can be crafted.

3.4.4 The Sustainability Notion in Climate Science

The challenge to climate change responses is to make them sustainable (Duerden, 2004; IPCC, 2007; Nyong *et al*., 2007; Bizikova, 2012). According to Nyong *et al* (2007) incorporation of IKS can be valuable in devising sustainable climate change mitigation and adaptation strategies that are formulated concurrently with the people. The philosophy behind the sustainability science approach is about promoting liveable human settlements through collective efforts of all stakeholders. The notion has its genesis from the concept of sustainable development promulgated by the World Commission on Environment and Development (WCED) in 1987. WCED also known as the Brundtland Commission, defines sustainable development as: “development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs.”

Komiyana and Takeuchi (2006), to make science accountable to society, have coined the term sustainability science. Sustainability science, according to Kajikawa (2008), is now a high priority on the research agenda owing to the growing number of environmental challenges that include climate change. Scholars like Kates (2000), Turner *et al* (2003) and Martens (2006) look at sustainability science as multidisciplinary and holistic in nature, incorporating many other dimensions of politics, natural sciences and sociology. According to Welp *et al* (2006), a major challenge facing the scientific community is how to make science sustainable. They advocated for the use of science-based stakeholder dialogues, a framework that attempts to link the scientific community and the generality of the public in seeking practical and sustainable solutions to environmental challenges. As shall be articulated further in Chapter 4, the study embraces this thinking in the methodological design for examining IK applications in climate science.

3.5 Developments in Indigenous Knowledge Recognition

The concept of IK in development policy and practice has a longevity spanning the past five decades. The genesis of its incorporation in sustainable development issues can be traced as early as the 1980s, albeit in existence in most indigenous communities since time immemorial. At global level, focus on the subject gathered momentum alongside the consideration of core values of sustainable development. These developments are summarised here. Grenier (1998) notes the following points about a sudden interest in IK:

- Demand by indigenous people on the right to be heard in development decisions;
- Issues of governance in natural resources management; and
- A quest for sustainable development and the sustainability science agenda.

As early as 1987, the WCED recognised that the global community has a lot to learn from the ingenuity of indigenous people in the management of complex ecological systems. The 1992 United Nations Conference on Environment and Development (UNCED), credited as a turning point for global embracement of sustainable development, recognises the significance of the diversity and role of indigenous communities in natural resources management for sustainable development. The Summit also culminated in the following five crucial documents related to climate issues:

1. Agenda 21
2. The Rio Declaration on Environment and Development
3. The Statement of Forest Principles
4. The United Nations Framework Convention on Climate Change (UNFCCC)
5. The United Nations Convention on Biological Diversity (CBD)

In these documents, aspects of IK and indigenous community participation feature. The CBD is the first international environmental law recognising IK in biodiversity. Its preamble says:

> *Recognizing the close and traditional dependence of many indigenous and local communities embodying traditional lifestyles on biological resources, and the desirability of sharing equitably benefits arising from the use of traditional knowledge, innovations and practices relevant to the conservation of biological diversity and the sustainable use of its components.*

Chapter 26 of Agenda 21 specifies the role of indigenous people in environment and development. Specifically, Article 26.1 states:

> *Indigenous people and their communities have an historical relationship with their lands (environments) and are generally descendants of the original inhabitants of such lands (environments)... They have developed over many generations a holistic traditional scientific knowledge of their lands, natural resources and environment. Indigenous people and their communities shall enjoy the full measure of human rights and fundamental freedoms without hindrance or discrimination. Their ability to participate fully in sustainable development practices on their lands has tended to be limited as a result of factors of an economic, social and historical nature. In view of the interrelationship between the natural environment and its sustainable development and the cultural, social, economic and physical well-being of indigenous people, national and international efforts to implement environmentally sound and sustainable development should recognize, accommodate, promote and strengthen the role of indigenous people and their communities.*

Recognition of IK in climate change science gathered impetus in 2007. In its AR4, IPCC acknowledges the crucial role of IKS in climate change mitigation and adaptation. Several cases drawn from Africa are documented in a separate section on IK. Cases cited by the report include utility of IK in weather forecasting and climate predictions in Burkina Faso, Nigeria and other parts of Africa; use of IK in building adaptive capacity of famers in Zimbabwe, including other parts of Africa drawing experiences in pest management, erosion control, fire and flood management; and IK used by pastoralists and agro-pastoralists in drought mitigation and adaptation (Boko *et al.*, 2007). In addition, the 2009 International Indigenous People's Forum on Climate Change held in Bankok went a step further to develop a policy paper that guides the inclusion of indigenous people in climate change agenda (IIPFCC, 2009).

Later in 2010, IPCC reaffirmed the significance of IK by incorporating it as a guiding principle for the Cancun Adaptation Framework adopted by Parties at the 2010 UNFCCC Conference in Cancun, Mexico (UNFCCC, 2010). In furtherance of the realisation of IK in climate change, the IPCC's Working Group II contribution to the AR5 includes local and traditional knowledge as a distinct topic under the section on rural areas (IPCC, 2014a).

Appropriately, Africa has also made some strides in institutionalising IKS. In 2002, a network of southern African universities and the University of Bergen of Norway culminated in the production of *Indilinga*: African Journal of Indigenous Knowledge Systems, an international academic forum for exchange of ideas and theory surrounding IK. This journal is published in South Africa. The move has been premised on the understanding that Africa is the continent richest in IKS. The UNEP (2008) also holds this view. Hitherto, *Indilinga* has published more than 250 articles on issues related to production, dissemination and recognition of IK. Part of this work has also been published in the same journal (see Chapter 4).

In Canada, Grenier (1998) reports that utilisation of IK has led to the following benefits:

- Improvement in scientific research
- Provision of environmental baseline data
- A tool in decision-making in environmental impact assessments (EIAs)
- Use in monitoring development impacts

In South Africa, the government, under the aegis of the National Research Foundation (NRF), has invested in this knowledge form. The embracive strategy is seen in the development of a broad and holistic policy framework guiding research, development, IK participation and institutionalisation of this knowledge form (Maila and Loubser, 2003).

Notwithstanding these developments, the situation in Zimbabwe is quite different. The country has no clear policy for IK in research and development although the existence of this knowledge form is generally appreciated. Current practices can best be described as segmented, undocumented, ad hoc and parochial. Furthermore, translating this theoretical recognition into practical research has not been a well-traded field by the climate science community in the country. Lack of a clear methodological praxis can be one of the challenges stymieing IK research in climate science. This study adopts a participatory research approach grounded in emancipatory theory, which is intended to make sure that the previously transmogrified indigenous 'scientists' are given adequate attention in climate research (see Chapter 4).

3.6 IK Applications in Environmental Issues

As a concept, IK is not new in the discipline of environmental geography. The current surge of interest in IK is evident over a range of environmental issues. This section approaches the concepts of IK and climate change by assessing scientific literature on cases that range from the application of IK in environmental issues in general to cases treating IK and climate change in particular. A review, by Brook and McLachlan (2008), shows that the *neo-indigenismo* wave has, of late, characterised the authorship of many scientific articles. This is seen from acknowledgements, community as co-authors, community member as co-author, to community member as senior author (Bizikova *et al*., 2007; Turner & Clifton, 2009).

The multidimensional nature of IKS (Williams & Muchena, 1991; Agrawal, 1995; Maila & Loubser, 2003; World Bank, 2004; Wallner, 2005; du Toit, 2005; IUCN, 2008; Berkes, 2009; Mapara, 2009; Peloquin & Berkes, 2009; Lefale, 2010; Mala *et al*., 2010; Mutshinyalo & Siebert, 2010; Nakapipi *et al*., 2011; Goduka, 2012; Jiyane & Ngulube, 2012; Larbode *et al*., 2012; and many others) is important in climate change science and disaster planning and management. Various areas of application include physical science and related technologies (climatology, ethnobotany, ethnoecology, medicine, engineering agriculture and irrigation), social sciences (politics, military, economics, sociology and ethnology) and humanities (communications). For instance, weather forecasting is important for community preparedness to climate aberrations like droughts and floods - to devise appropriate agricultural engineering and irrigation practices, while knowledge of defence is important for people to secure their crops, homes, livestock and other community assets against disasters. In climate theory and practise, the adoption of defensive strategies against climate change is called mitigation and adaptation.

Studies on the contribution of IK in ecology and environmental management have been widely documented. Maila and Loubser (2003) analyse the role of IK in environmental education in South Africa. Brook and McLachlan (2008) make a desk review of scholarly articles treating IK in ecology and environmental conservation.

Later, the topic was pursued by other authors such as Peloquin and Berkes (2009) in ecology of the James Bay in subarctic Canada; Reid *et al* (2009) in ecology of certain places in Kenya and Tanzania; and Mala *et al* (2010) in understanding the ecology of southern Cameroon. Cases on IK in environmental conservation and biodiversity are documented by du Toit (2005), Muhando (2005) and Matshinyalo and Siebert (2010) in some places in Africa. Application of IK in hydrological studies is covered by Larbode *et al* (2012) whose study focuses on Lake Como in Italy.

Other investigations by Larson (1998), Patt and Gwata (2001), Mararike (2001), Lwoga (2010) and Roos *et al* (2010) variously treat IK applications in agriculture and food security. The first three authorities base their studies in some rural communities in Zimbabwe. Other studies carried out by Mapara (2009) and Mawere (2010) were more generalised accounts on IK in the Zimbabwean society. From this collection, it is clear that the deployment of IK in climate change in Zimbabwe is an insufficiently studied topic.

3.6.1 IK Applications in Climate Change

The cases presented in this section, even though covering various issues of the environment, are philosophically very close to climate applications. The preceding analysis reveals the interconnectedness and crosscutting nature of IK applications. Therefore, compartmentalising its application has a tendency of overshadowing potential utility in climate science. When analysed in climate change, most of the presented cases apply to mitigation and adaptation as well. Specifically, cases cited here are in furtherance to the discussion of IK applications in climate change.

The climate research community has managed to advance ample evidence on the utility of IK in various fronts. Welp *et al* (2006) show that the knowledge is capable of prescribing practical solutions for mitigating against and adapting to global change. According to Duerden (2004) this is possibly made easier since the knowledge is well understood by the people. Berkes (2000) notes that IK builds ecological resilience at community level while Bollig and Schulte (1999) point out that oral accounts by the elders can be useful to unearth evidence of changes in the climate and associated disasters as they are understood by the locals. To Salick and Byg (2007), local people can devise appropriate adaptive mechanisms for coping with climate irregularities since they are keen observers of the phenomenon.

Enthusiasm in studies on IK and climate change, however, is a fairly recent practice. Typical cases available include Berkes and Jolly (2001) and Gearheard*et al* (2009), in Canada; Nyong *et al* (2007), in African Sahel; King *et al* (2008) and Berkes (2009), in New Zealand; Speranza *et al* (2009), in Kenya; Green and Raygorodetsky (2010) and Green *et al* (2010), in Australia; Lefale (2010), in South Pacific; Orlove *et al* (2010), in Uganda; and Nakashima (2012) in a UNESCO synthesis of cases drawn from across the world. Clearly, from sources available, it appears there is still a void in terms of documentation of IK practices and climate change specific to the Zimbabwean context. This gap has largely been the motivation behind the study.

Green *et al* (2010) discover that IK has potential value in observation and forecasting the impacts of climate change, including planning proactive adaptation activities. They explore the knowledge of Aborigines and Torres Strait Islanders of northern Australia who have a long history in their native environment. These groups have adapted well to a changing climate through various cultural practices such as use of indigenous seasonal weather calendars to record weather, plant and animal behaviour; language specific inferences to weather and climate; and indigenous astronomy to correlate between movements and patterns of stars and planets with changes in weather.

An examination of IK practices by King *et al* (2008) among the Maori of Aotearoa in New Zealand illuminates that through interaction with their environment for several years, the locals have developed a wealth of environmental knowledge useful in climate change. Their knowledge is found in various forms and expressions based on tribal histories, local geography, norms and practices. Their knowledge is also expressed in naming and classification of local weather and climate phenomena using local languages, oral recording of weather and climate based events and trends, and forecasting of weather and climate using environmental indicators (clouds, mist, lightning, rainbow, stars and planets). This knowledge is useful for the Maori people to adapt to climate variability and change through decisions about earning livelihoods from ocean and land-based resources.

In attempting to understand how local communities deal with climate change, Berkes and Jolly (2001) examine the indigenous practices of the Inuit of Sachs Harbour in Canada. The two researchers observe that both long-term adaptation and coping strategies through switching species and adjusting hunting practices are based on the community's detailed knowledge on the environment. Berkes *et al* (2007), in the same study area, intend to understand if IK can be used for monitoring environmental change. They show that community monitoring provides an extensive scan of environmental parameters based on signs and signals of environmental change developed from indigenous science. Later, Gearheard *et al* (2009) observe that the Inuit use environmental indicators like wind to observe weather and climate. They note that three aspects of wind have changed over the last decades namely wind variability, wind speed and wind direction. The Inuit observations could actually correspond to station data in the area.

Studies done in the Sahel, semi-arid and arid region of Africa covering Senegal, Gambia, Mauritania, Mali, Burkina Faso, Niger, Chad, Sudan, and South Sudan, reveal that local people have developed and implemented a range of methods that have enabled them to cope with a changing and variable climate system. To the amazement of many, it is even argued that some of these strategies go beyond those documented in mainstream science. Their mitigation ways range from emission reduction through zero tillage practices in cultivation, mulching and other soil management techniques; carbon sequestration through agroforestry and a fallow system which promotes the forestry development; to carbon substitution. In adaptation the populations here use their rich traditional knowledge for weather forecasting, vulnerability assessment and implementation of adaptation measures (Ajibade & Shokemi, 2003; Nyong *et al.*, 2007).

In a study of indigenous climate knowledge to determine the inter-annual variability in the timing of precipitation in Uganda, Orlove *et al* (2010) isolate four major components of the community's knowledge systems. These are: one, longstanding familiarity with the seasonal patterns of precipitation and temperature; two, a set of local traditional climate indicators; three, observation of meteorological events; and four, information about progress of the seasons elsewhere in the region. A number of indicators like clouds, sun, lightning thunder, wind and night temperature were isolated. They conclude that this system of IK empowers farmers to participate as agents as well as consumers in interventions that use modern climate science to plan for and adapt to climate change.

Speranza *et al* (2009) describe the IK held by agro-pastoralists in Makueni District, Kenya and how they use it to monitor, mitigate and adapt to drought. They identify various IK indicators of climate change and variability; namely animal, birds and insect behaviour and signs; local weather conditions and signs; rainfall patterns and amounts; signs from flora; astrological constellations; and signs from the local environment. These indicators are used to make seasonal climate projections and to understand changes in the local climate system.

3.6.2 Significance of Community-driven Interventions

Central to the knowledge informing climate change interventions is the analysis of community culture, customs and practices in order to understand the level of vulnerability and capacity to manage risks posed by climate phenomenon (McCaig, 2005; Alverez, 2006; Gwimbi, 2006; IFRCRCS, 2014). Disaster management literature has followed the logic of community action for disaster risk reduction and climate change mitigation and adaptation. For example, Satterthwaite (2011) argues that in as much as the success of post-disaster actions are determined largely by pre-disaster planning, awareness raising and readiness within government and civil society organisations, community action is necessary for effectiveness and sustainability of interventions. This argument is confirmed by the IFRCRCS's (2014) report that underscores the significance of local culture in the success of climate risk reduction programmes.

Experiences from community-driven approaches to climate change disaster in the Philippines have affirmed the effectiveness of community capital with concrete results. The challenge however, remains on mainstreaming these small-scale success stories to national strategies (Carcellar *et al*., 2011). Similarly, in the Zimbabwean context, the question of how to integrate local knowledge into mainstream climate change mitigation and adaptation strategies with the intention of building resilient society has to be addressed.

It is evident from the preceding review that IK-based strategies for responding to climate change have not been adequately documented in Zimbabwe. Given the case specificity in IK applications presented here, it is necessary to examine how this knowledge form is being used in a Zimbabwean case in order to bridge the existing knowledge gaps. The benefits of this focused study can help to inform grassroots climate interventions such as CBA and EBA discussed here.

3.7 Conclusion

Finally, the argument presented in this chapter is that conceptualisation of IK in climate change offers useful insights to mitigation and adaptation that not only potentially capture knowledge of the indigenous people, but also is necessary in sustainable development discourse. The discussion given here is also clear testimony that several researchers are increasingly recognising the contribution of IK in science. Jasanoff (2005) and Berkes (2009) further note growing acknowledgement on the limitations of conventional science among Western-based scientists where paradoxically, the knowledge is framed. Another key observation from this review is that studies on IK and climate change have tended to be dominated by non-indigenous researchers. While this may not be a problem, upon careful analysis, such a scramble to gather deep-rooted knowledge by external researchers may invoke serious ethical and intellectual property issues. This is sufficient call for a sound research methodology so as not to compromise both the contributors of the knowledge and the quality of the findings. Chapter 4 elaborately deals with these issues.

Clearly, the significance of IK in environmental issues like climate change is globally recognised. The World Bank (2004) decries under-utilisation of IK in the development process. What remains therefore, is the need to explore local-specific knowledge and practices that indigenous communities have in order to provide useful insights for climate change interventions. Since IK is a broad concept covering all forms of knowledge in a particular area, there is prudence in isolating the specific knowledge related to climate change, mitigation and adaptation. This logic is emphasised by the study.

Undoubtedly, faced with the challenge of climate change and the various risks it poses, whose severity and magnitude are largely unknown, a framework for constructive dialogue between indigenous scientists (local climate experts) and conventional scientists (mainstream scientists) is no longer an option but a requirement. However, the question that needs to be addressed is how such a framework should be instituted. Key in this focus is the design of appropriate epistemology, methodology and methods for analysing IK in climate change which are presented in the next chapter (Chapter 4).

CHAPTER 4

RESEARCH METHODOLOGY

Many of the challenges of IK research relate directly or indirectly to the difficulty of studying a subordinate knowledge system (that is, IK) using the dominant knowledge system (that is, Western science)

Grenier 1998:39.

The content of this chapter is primarily based on the following publication:

Chanza N and de Wit A (2013). Epistemological and methodological framework for indigenous knowledge in climate science. *Indilinga: African Journal of Indigenous Knowledge Systems*, 12 (2): 203-206.

4.1 Introduction

The field of environmental geography is so broad that it cannot be comprehensively studied by adopting natural science methodological purity. Thus, the research uses applied sciences to study the utility of IK in climate science. The departure from natural science to a social science methodology is an attempt to exploit the full value of IK's contribution in understanding climate change at community level. In social science, a strong orientation towards empirical research is established through acquiring knowledge from the people observing phenomena (Alvesson, 2011). In the context of climate change phenomena, researcher interactions with subjects through undertaking interviews and observations can reveal the reality of people's experiences and give a rich pool of participants' views about intervention strategies.

This chapter serves to illustrate the epistemological and methodological framework for studying IK and climate change. The chapter proceeds by first discussing the significance of an epistemology in IK methodology. This forms the methodological basis for adopting a qualitative enquiry. Drawing heavily from Alvesson's (2011) and Creswell's (2013) views on qualitative research, an elaborate explication of the research philosophy congruent to the theoretical underpinnings of IK enquiry discussed in Chapter 3 is pursued. Next, the main elements of the chapter: research design, methodology, methods of data gathering, and justification and selection of participants are given. The chapter then concludes by attending to the procedure of data analysis, which according to Rapley (2011) has been given little attention in most qualitative research scholarship.

4.2 A Methodological Paradigm for IK-Climate Research

It is necessary to understand that the motive behind choice of methodologies should not be solely judged by scientific allegiance. Rather, it should also be informed by the demands of the topic and the issue under investigation. Failure to consider this adequately might end up jeopardising the quality of the research findings, making science a custom to fulfil disciplinary requirements rather than a practice to address human developmental challenges. As put by Alvesson (2011), the challenge therefore is to demystify the dominant view within the natural science paradigm which casts doubts on any valid facts from the social worldview where interpretations of facts depend on meanings ascribed by the researcher.

In this study therefore, it is argued that the topic of IK can best be treated by espousing a social science methodological paradigm. The multifarious nature and complexities of social science methodologies have been adequately documented by several authors who caution about selection challenges (Struwig & Stead, 2001; Morse & Richards, 2002; Williams, 2003; Creswell, 2013). This means a qualitative researcher faces a quandary – what to do with numerous methodological options. To Huntington (2000), adopting a social scientific perspective in IK research requires appraisal of the utility and validity of the various approaches from the methodology toolbox. He stresses that methodological validity is measured by the ability to promote substantive interchange between local experts and outside scientists.

In a similar view, Nel (2005) emphasises the need to clarify the agenda in developing methodologies for IK research. From this perspective, the agenda for this research adopts a paradigm that views the people not as objects of research from which information is extracted, but equally as subjects in an empowering attempt. The research has been designed, as exposited in the next section, upon this basis.

4.3 Research Design for IK-Climate ChangeExploration

Analysis of IK in climate science requires a robust approach that examines the deeply embedded cultural values and practices of the people using this knowledge form. Thus, the research design deployed here bears allegiance to the emancipatory philosophy as a foundation for the engagement of indigenous people in research.

Gerring (2011) understands research design as the process by which data are generated. This process develops from either qualitative or quantitative approaches, or both. In this study, a qualitative research design is seen as the best approach to reflect on the indigenous understanding of climate change held by the Muzarabani people. Morse and Richards (2002) describe qualitative research as an attempt to make sense of our environment. In their words (5), "making sense involves organising the undisciplined confusion of events and experiences of those who participate in those events as they occur in natural settings." Creswell (2013) symbolises research design for qualitative study as being fabricated in very small threads with many colours, various textures and different blends of material. Accordingly, this makes research design very difficult to describe. Hence, there is growing interest in using theoretical frameworks and research paradigms in most descriptions (Morse & Richards, 2002; Williams, 2003; Carter & Little, 2007; Yin, 2009; Gerring, 2011; Creswell, 2013).

4.3.1 Rationale behind a Qualitative Research Design

Carter and Little (2007) look at qualitative research as that which utilises text data (not numerical one), analysed in their textual form (rather than converted to numbers for analysis), with the aim of understanding human action and behaviour. In this thesis, a departure from statistics has been preferred owing to the empirical demands of the topics – IK and climate change – that require not a hasty approach normally associated with quantitative enquiry, such as in a questionnaire survey. Creswell (20013:16) argues, "qualitative research is legitimate in its own right." This approach, according to Rapley (2011), increases knowability since it does not impose *a priori* theoretical positions on data but remains open to knowledge generation.

Furthermore, unlike quantitative research, which is restricted to artificially created phenomena, this research adopted a naturalistic perspective in order to remain faithful both to the knowledge generators and to the phenomenon investigated. This means the evidence of climate change had to be understood in a natural setting where participants who have witnessed the events associated with it are given room to openly and freely express themselves. Besides, environmental indicators of a changing and variable climate system that are used by the locals could, where possible, be observed and documented as evidence. In this view, qualitative research is a scientific enquiry that appreciates the complexity of IK practices that can adequately be captured through detailed narrations and descriptions given by the participants. As Morse and Richards (2002) and Creswell (2013) advise, it is important to note that the design expounded here has been chosen in line with the demands of the research questions listed in Chapter 1.

The argument driven by Le Grange (2009:193) that “conventional academic methods distort reality into apparent clarity” deserves attention here. To him, indigenous enquiry is guided by different assumptions to those of conventional research but the techniques for gathering data are similar. He further argues that a method cannot be universal and neutral, but rather contextually situated and performative. Tajudeen (2003) also emphasises that care must be taken in the design of methods of acquiring information on IK. Against this background, the description given in the next section is an attempt to meet the dual purposes of confirming to theoretical judiciousness about IK research and basic requirements of conventional research in the discipline of environmental geography. Grenier (1998) sees this as a mammoth task.

4.3.2 Description of Qualitative Research Design

An emergent research design methodology was adopted to incorporate the changes in circumstances and field work activities as the study progressed. For example, where engagement of participants was expected to follow a linear chain according to the administrative structures in the places studied (from the chief through the headman until getting to the elderly community members), this was not always the case as some headmen openly stated that their limited knowledge about the community's environmental history could jeopardise the research quality. Instead, these preferred to delegate the participation to those respondents they knew had a more in-depth account of events.

Also, where interviews were expected to be conducted at the participants' homes, this had to be adjusted so as to avoid interfering with their daily chores. This means some of the interviews ended up being held in the fields where the respondents were engaged. Apart from this, flexibility was also necessary in the recruitment of participants. Some aged respondents felt they could contribute well only if they were assisted by their spouses or elderly children who were also old enough to give detailed accounts of knowledge about past climate system in their community.

Unlike in quantitative research, there are no strictures in the design of a qualitative enquiry (Kvale, 1996; Thyer, 2001; Struwig & Stead, 2001; Warren, 2001; Osborne, 2008; Alvesson, 2011; Creswell, 2013). According to Kvale (1996), qualitative research design is not static but open-ended in the sense that it is attuned to the nature of the phenomenon being investigated and the behaviour of the participants. Thyer (2001) concurs that the method and procedure for investigation unfolds as one gets to the specific stages of the research. To Warren (2001), the reason for this fluidity in standard design strictures among qualitative researchers is attributable to concern with meaning making. Therefore, in this study, the research design described was not closely adhered to but remained amenable to the field circumstances and the behaviour of the participants.

The approach pursued here has seen extensive application in the field of environmental geography. Roos *et al* (2010) use qualitative research design to describe the experiences of drought and coping strategies by rural inhabitants in the North West province of South Africa. A similar design is used by Lwoga *et al* (2010) in studying the relevance of IK for small-scale farming in Tanzania. They justify that a qualitative approach is an effective design in understanding human action in natural settings.

It is also important to note that the domain of qualitative enquiry is riddled with numerous and complex choices (Richards & Morse, 2002; Holloway & Todres, 2003; Carter & Little, 2007; Starks & Brown-Trinidad, 2007; Le Grange, 2009; Creswell, 2013). To Creswell (2013) the process begins with a philosophical assumption central to the qualitative enquiry, then incorporation of some paradigms that bear allegiance to it, and lastly theoretical approaches guiding the study. He further mentions five philosophical assumptions that shape qualitative research: assumptions about ontology (about views on reality), epistemology (about knowledge generation), axiology (about values), rhetoric (about language), and methodology (about methods used in the process). Carter and Little (2007) synthesise these broad perspectives into three elements necessary in designing research. These are in the form of epistemologies (knowledge justification), methodologies (methods justification) and methods (action research).

According to Le Grange (2009), the distinction between methodology and method may be important for theoretical purposes only since in praxis, the two are inextricably interwoven. To Alvesson (2011), this theoretical stance is necessary for marginalising the limitations of interview research. This study adopted Carter and Little's approach in research design as illustrated in Figure 4.1.

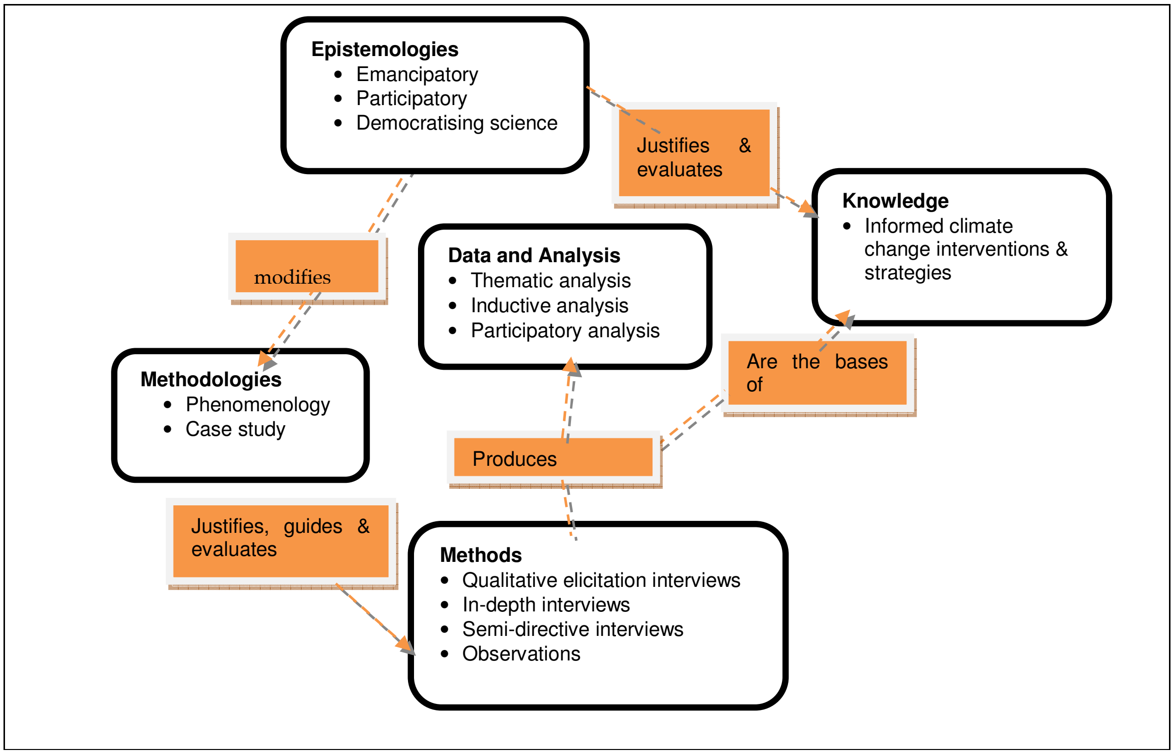

Figure 4.1 Research design schema

(Modified after Carter and Little, 2007:1317)

4.4 Epistemological Assumptions for Studying IK and Climate Change

As discussed by Morse and Richards (2002), Williams (2003) and Creswell (2013), the discourse of paradigms in qualitative research is diverse. Paradigms have been variously defined as: the incorporation of the researcher's "epistemological, ontological, and methodological premises" (Denzin & Lincoln, 1994:13) or "worldviews" (Creswell, 2013:37). Schwandt (2007) looks at them as the beliefs, assumptions, and values about the aim of enquiry or method shared by an investigator. Mertens (2003) summarises the paradigms into three broad categories: positivism or post-positivism, from which mainly quantitative research stems; interpretive or constructivism, which examines various truths based on the researcher's construction of reality; and a transformative or emancipatory paradigm, which besides examining multiple realities, also aims at critiquing discriminatory practices and promote change. An elaborate discussion of these paradigms is given by Creswell (2013).

This study adopted an emancipatory epistemic position presented by Mertens. The basic tenets of this position are participation, inclusivity and empowerment. As discussed in Chapter 3, the process of generating knowledge is not a preserved field of conventional scientists. Instead, all participants with an interest in the research and its findings ought to be included. It augurs well with the sustainability science notion and the *neo-indigenismo* agenda. The knowledge emerging from this research therefore, should be understood within this epistemic and philosophical stance.

Schwandt (2007:87) defines epistemology as “the study of the nature of knowledge and justification.” Carter and Little (2007:1317) simplify this definition as “justification of knowledge.” The epistemological position driving this study is an attempt to democratise science by taking science to the people. So what this study did, methodologically, was to establish a research protocol that is recognised as participatory and empowering, particularly to the people who are affected by climate change. The relevance of IK becomes central in this enquiry. As pointed out earlier, this entails adopting an emancipatory pedagogy that looks at the study area as a ‘Science Academy’ and the participants as ‘scientists’. Creswell (2013) refers to this paradigm as ‘advocacy’ and ‘transformative’.

Epistemologically, the study assumes that knowledge about meaningful climate change interventions can be generated at grassroots level by putting people at the centre of climate science in order to harness their IK. This was achieved through participatory interaction between the researcher and the community elders and other key informants. This epistemic position permitted proximity to the participants being studied in the form of a qualitative methodological praxis that captured the context in which the people are experiencing the phenomenon of climate change and climatic events. Smith (1999) and Fatnowna and Pickett (2002) hold this transformative view on IK enquiry pointing to the significance of its impact in a decolonising framework.

In recent years, interest in the emancipatory view in IK methodology for studying environmental change has grown phenomenally even though some authors do not clearly state their epistemological viewpoints. A good reference is that from Berkes and Jolly (2001) who report about a model of community research partnership involving local Inuvialuit people of the Canadian western Arctic region and the International Institute for Sustainable Development (IISD). They used a design based on participatory methodologies intended to promote collaborative research and gave a more detailed reflection of the community's observations and perspectives on adaptation to climate change. King *et al* (2008) used a Kaupapa Maori-based research methodology – a local theoretical paradigm within which local ethics and principles are recognised and applied when conducting research in the community. This approach, recognised by the New Zealand's Foundation for Research, Science and Technology, allows participation of marginalised groups in the design and control of research agendas.

Duerden (2004:206) argues that putting the affected community at the core of research aptly confirms to local-scale analysis since "…it incorporates a long, experience-based history and describes current and past geographies and landscapes in considerable detail."

4.5 Methodologies for Exploring IK in Climate Change

As Figure 4.1 reveals (also see Section 4.3.2), methodologies are related to epistemologies. The methodological theoretical roots presented here are traced from the emancipatory paradigm discussed in Section 4.4 above. Scholarship tackles three broad approaches: phenomenology, grounded theory and ethnography (Morse & Richards, 2002; Avis, 2003; Holloway & Todres, 2003). Creswell (2013) adds two other approaches to the list, namely narrative research and case study. The methodologies articulated here are drawn from Creswell's classification shown in Table 4.1.

Table 4.1 Methodological approaches in qualitative research

Characteristics	Narrative Research	Phenomenology	Grounded Theory	Ethnography	Case Study
Focus	Exploring the lifestyle of an individual	Understanding the essence of the experience	Developing a theory grounded in data from the field	Describing & interpreting a culture-sharing group	Developing an in-depth description & analysis of a case or multiple of cases
Type of problem best suited for design	Needing to tell stories of individual experiences	Needing to describe the essence of a lived phenomenon	Grounding a theory in the views of the participants	Describing & interpreting the shared pattern of culture of a group	Providing an in-depth understanding of case(s)
Unit of analysis	Studying one or more individuals	Studying several individuals who have shared the experience	Studying a process, an action, or an interaction involving many individuals	Studying a group that shares the same culture	Studying an event, a programme, an activity or more than one individual
Data collection	Using primarily interviews & documents	Primarily interviews with individuals, though documents, observation & art may also be considered	Using primarily interviews with 20-60 individuals	Primarily observations & interview, but perhaps collecting other sources during extended time in the field	Analysing data through description of the case & themes of the case as well as cross-case themes
Written report	Developing a narrative about the stories of the individual life	Describing the essence of the experience	Generating a theory illustrated in a figure	Describing how a culture sharing group works	Developing a detailed analysis of one or more cases

(Source: Creswell, 2013)

Methodologically, the study adopts phenomenology and case study as the main approaches in formulation of methods for data collection. In field application, however, the distinction given in Table 4.1 is not clear-cut. For instance, where participants were asked to narrate their individual experiences with phenomena like drought and flooding, they ended up detailing stories about their experiences, a tradition associated with narrative research. In addition, a detailed understanding of the contextual basis for IK practice would end up describing and interpreting the culture of the community being studied, a characteristic of ethnography. This means the research was not limited to phenomenology and case study, but also utilised narrative research and ethnography as methodological approaches. The methodological purity emphasis by Morse and Richards (2002) on short-term research (characterising doctoral thesis) was therefore deliberately ignored. Three major reasons informed this choice.

Firstly, the methodological boundaries stated by Creswell are not impervious, but porous (Holloway & Todres, 2003; Starks & Brown-Trinidad, 2007; Gerring, 2011). This implies that methodologies can be intermixed as long as they are congruent in responding to the study purpose and in answering research questions.

Secondly, the research attended to complex topics (IK and climate change) that demanded comprehensive and robust methodological strategies. As discussed in Chapter 3 research attention to IK has not been sympathetic to the sensitive demands of indigenous communities. Accordingly, methodologies should be designed to ensure substantial interaction with the research participants both to simplify the complexity associated with IK and to understand the indigenous people themselves. This view is also shared by Grange (2009) who advocates for distinctive IK methods of enquiry.

Thirdly, the difficulty in understanding climate change predominantly with mainstream science is not necessarily made easier by adopting an IK perspective. Instead, it may aggravate the intricacy unless driven by robust methodologies. This suggests that methodologies need to be complementary in attending to the complexities associated with these concepts. Williams (2003) refers to this blending as ‘methodological pluralism.’ With this view in mind, hybridising the methodologies proved very useful in articulating the indigenous perspectives of a changing and variable climate system in the study area. Each of the two primary approaches adopted is further elaborated here.

4.5.1 A Phenomenological Methodology for IK in Climate Change

According to Thyer (2001), qualitative research is primarily phenomenological. Miller and Brewer (2003:227) describe phenomenology as “…about bracketing off preconceived ideas about phenomena, through a process called phenomenological reduction, in order to achieve a state of pure knowledge and understanding uncontaminated by *a priori* beliefs.” Expressed differently, a phenomenological study according to Creswell (2013:57-58) describes the “meaning for a group of people of their lived experiences of a concept or a phenomenon.” In this study, the concept is IK, the phenomena are climate change, and the events associated with it. Phenomenology is used here to explore community’s experiences with climate change in order to come up with a richer description of the indigenous interpretation of climate change and community’s coping strategies.

Holloway and Todres (2003) state that within phenomenology, research questions can be formulated that ask respondents to narrate actual experiences that they have lived through. To Moustakas (1994) this description attempts to answer two questions of *what* and *how;* that is, what the community has experienced and how they have experienced it. Notwithstanding the extensive application of this approach in such fields as sociology, psychology, education and the nursing sciences (Morse & Richards, 2002; Creswell, 2013), literature is still limited in its application not only in the topic of climate change, but also in understanding the broad field of environmental geography.

A typical application of phenomenology is that employed by Nakapipi *et al* (2011) through the use of in-depth and unstructured interviews in studying IK in the use of the Dwarf Sage as a medicinal plant in Namibia. The authors remark that it is a strategy that permits deeper understanding of phenomenon, theory and practice. Mutema (2003) adds that phenomenology is best suitable for understanding the thought systems of African indigenous people.

4.5.2 A Case Study Methodology for Studying IK in Climate Change

To some scholars, a case study has been blended into other methodological approaches such as phenomenology, ethnography and grounded theory (Morse & Richards, 2002; Avis, 2003; Holloway & Todres, 2003). In a different view Denzin and Lincoln (2005), Yin (2009) and Creswell (2013) argue that a case study should be a stand-alone methodology. Creswell (2013:73) presents a case study as "a qualitative approach in which the investigator explores a case(s) over time through detailed, in-depth data collection involving multiple sources of information (observations, interviews, audio-visual material, documents and reports), and reports a case description and case-based themes." Yin (2009) cites definitional flaws characterising case studies as methodologies. Possibly, this is the reason why this approach tends to be conveniently ingrained into other methodologies. To him, a case study is an empirical enquiry that looks at the following (18):

- It investigates a contemporary phenomenon in depth and within its real life context especially when;
- The boundaries between phenomenon and context are not clearly evident.
- It copes with the technically distinctive situation in which there will be many more variables of interest than data points, and as one result;
- It relies on multiple sources of evidence, with data needing to converge in a triangulating fashion, and as another result; and
- It benefits from the prior development of theoretical propositions to guide data collection and analysis.

What is important about Yin's definition is that it provides logical considerations on research design, data collection and data analysis. Thus, a case study approach fits well within the framework of phenomenology. Consequently, the two methods were contemporaneously deployed as strategies for exploring the ideas of Muzarabani community in climate change science. A case study approach had its strengths in articulating the contemporary phenomenon of climate change in a well-defined context.

In addition, because it is best at addressing the 'how' and 'why' questions (Yin, 2009), requiring holism in the form of a greater range of data (Holmes, 2006), a case study provided an excellent opportunity for triangulating the methods presented in Section 4.6 below. In the same vein, climate change is a problematique – it demands a strategy that excavates deeper into the knowledge of subjects in seeking practical solutions to the problem. This detail could only be established by talking to the people who are experiencing climate change effects in a well-defined setting. Hence, the need to complement with a methodological lens that pieces through paraphernalia of practices, beliefs, technologies and systems of knowledge of the people in Muzarabani with the intention of bringing these to the analysis of climate change indicators and intervention strategies sought by the research.

4.6 Research Methods for Studying IK

Pursuant to the discussion on the study's philosophical and theoretical paradigms, the methods exposited here are selected within the emancipatory epistemological view and methodologies discussed in Section 4.4 and 4.5 above (also see Figure 4.1). This approach was intended to produce robust data that answer the research questions stated in Chapter 1.

Carter and Little (2007) define methods as the praxis that makes epistemologies and methodologies realisable. Le Grange (2009) defines them as techniques for gathering empirical evidence. Ascribing some theoretical allegiance expounded by Creswell (2013), the study triangulated qualitative in-depth interviews with observations to capture data on indigenous indicators of climate change and variability (Chapter 5), indigenous-based mitigation (Chapter 6) and adaptation strategies (Chapter 7), and consulted stakeholders of climate change interventions and IK applications to get independent insights and/or confirm some information given. In addition, a document review served to establish how data collected compared with known facts about climate change and IK applications.

Triangulation is defined here as a process of enhancing validity of research findings by subjecting data to various collection methods and sources. Collecting from multiple sources of information served as an approach to address issues of rigour, validity and quality of research findings. The methods of data collection used are detailed in the next sub-sections.

4.6.1 Qualitative Interview Techniques for Data Acquisition

The research utilised a multi-stage qualitative interviewing technique that started with unstructured exploratory interviews with the local influential leadership in Muzarabani. The subsequent stages of the elicitation interviewing technique were intended to adequately capture community knowledge about climate change in the study area. At the level of understating IK institution and challenges and opportunities in IK applications in Zimbabwe, the study used key informant interviews with officials drawn from government, academia and the policy-making divide. Government and non-governmental officials were also drawn to understand their experiences with climate events in the study area. The selection procedure for these participants is detailed in the subsequent sub-sections. The questions asked throughout the interview process were open-ended. These questions allowed the researcher and the participants to discuss the topics in detail. Where necessary, a probing technique was employed to seek clarity and to elicit more information. The detailed procedure for data acquisition is further exposited hereunder.

4.6.1.1 Techniques & Procedure for Eliciting Participants' Climate Knowledge

In order to document IK's utility in climate change, an exploratory-explanatory mechanism was crucial. The elicitation interview method was chosen because of its strengths in addressing challenges characterising basic interviewing techniques and procedures. Traditional interviewing, according to Johnson and Weller (2001), is constrained by challenges of rapport, personal style, the manner in which questions are framed and interview instruments. These challenges demanded a more robust approach to enhance data validity and reliability.

Therefore, adopting elicitation interviewing methods served not only to capture unarticulated informant knowledge on tacit issues on IK, but also created space to fit well into the community structures so as to understand the context in which this knowledge is understood at different structural levels of society. Thus, the methods were applied to depict descriptive and explanatory models of tacit knowledge in order to understand how IK are shared and structured in the community. The approach was meant to extract expert knowledge as it was applied to elicit subjective understandings within the domain of traditional knowledge on climate change. Figure 4.2 collates this procedure.

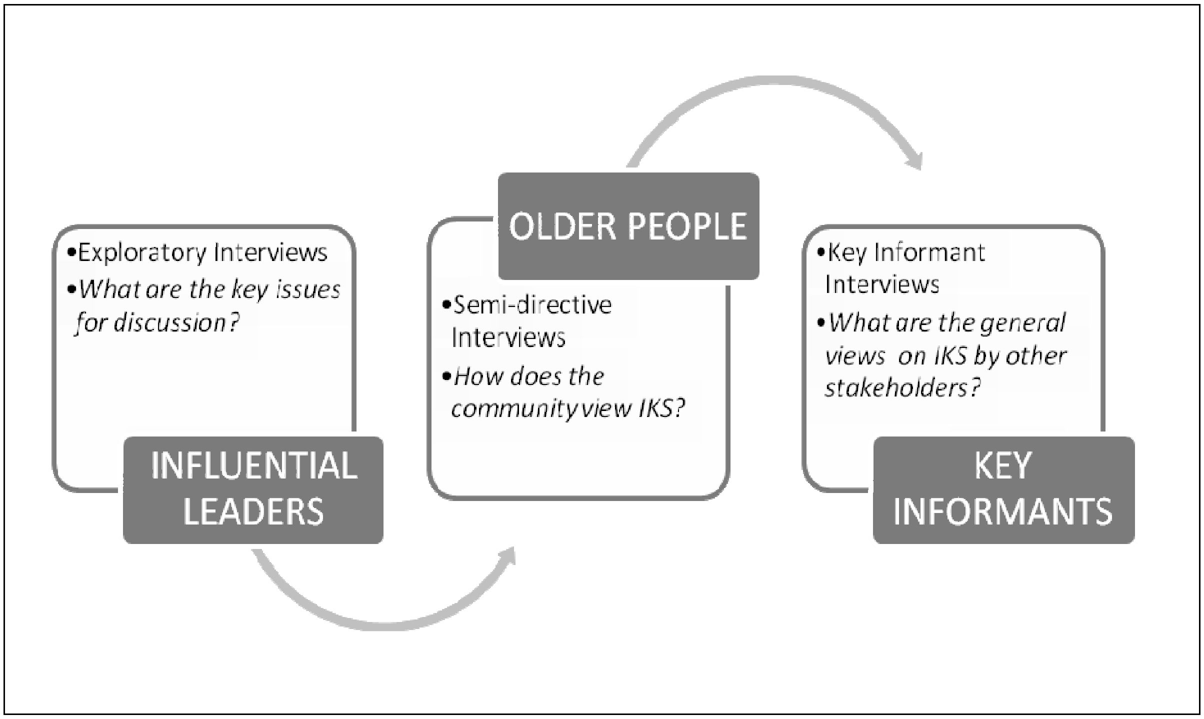

Figure 4.2 The elicitation interviewing process

As Figure 4.2 reveals, the elicitation-interviewing technique embraces both bottom-up and top-down approaches in data acquisition. The first stage in this method entailed use of unstructured interviews to learn the subjective contours of IK practices in the study area. In Johnson's and Weller's (2001) illumination, this is a bottom-up approach whereby issues central to the discussion emerge from the grassroots level and the researcher is assumed to be ignorant about the issues. Here items in the domain of IK and climate change, which guide the next stages of elicitation, are substantially documented. Thus, an initial discussion that used in-depth conversations with selected community leaders (mainly chiefs and their advisors) helped to bring to the fore, key issues characterising IKS in the area. With this clarification and general description given, a good knowledge about the area's political system, spirituality, economy and culture was established.

The subsequent stage of in-depth interviews, now resembling the form of a top-down approach, proceeded from the established acquaintance about the community's culture. This contextual understanding enabled subsequent development of probing questions to understand how the participants view their environment and climate system. Later, engagement of other key informants external to the community enabled the elicitation of independent views about how IKS has been generally understood, including its applications to the subject of climate change. The detailed stages followed are described here.

a) *Use of Exploratory Interviews*

Exploratory interviews marked the first stage of elicitation. In order to tap the scientific, social, economic and technological views and practices of the people of Muzarabani vis-à-vis climate change, informal conversations with chiefs and the MP for Muzarabani North Constituency were held. As stated in Chapter 2, there are three chiefs (two full sworn-in chiefs and one sub-chief) in Muzarabani. Two of them appointed their senior advisors whom they felt had a profound knowledge requisite to the study. Primarily, their engagement facilitated the acquisition of general information about the area.

At this stage, the purpose of the study was explained to these participants who also served as gatekeepers (see Appendix 1, 4a and 4b). The identity of the researcher and the purpose of the study, including the timeframe expected to carry out field work in the area were clearly given. It was also necessary to specify the type of people expected to participate in the study and how they would be selected. The researcher also introduced the two topics that frame the investigation; that is, IK and climate change. Johnson and Weller (2001) have advised that the researcher needs to assume the role of a student who orients towards learning from the informants to avoid the impression that the researcher would know everything about the topic. This stage was very crucial and served the following purposes:

- To have the blessings of the community leaders who would then sanction conducting of the research that examined their culture and IK;
- To create a good initiative to building rapport so that the researcher could not be treated with suspicion;

- To adequately get acquainted to the community’s way of life, political and social administrative structure;
- To form a good base to frame interview questions and design the research procedure; and
- To get leads about the potential participants who were knowledgeable enough to give a good account about their environment and climate system.

b) *Use of In-depth Interviews with the Elderly*

In order to explore further IK and its validity in climate change interventions, in-depth interviews were conducted with the community elderly. In this study, the term elderly is used to refer to participants above fifty years with both a long history of residing in the area and knowledge about their environment. Participants were guided throughout the discussions by the interviewer, the latter being mindful of the idea that the direction and scope of the interview should follow the participants’ train of thoughts. This means during the interview process, respondents had to be guided so that the information they provided remained within the scope of topics under investigation. Use of focused probes was therefore a necessity. A list of topics pulled from earlier elicitation was used to prompt further discussions. The interviews lasted between one to two hours each. Typical questions asked at this stage covered areas including but not limited to the following:

- Detailed accountsof environmental conditions in this area;
- Descriptions of noticeable changes experienced over the past 20 years or more;
- Reasons for experiencing such changes;
- Indigenous ways of coping with the changes identified;
- Views about the effectiveness of these countermeasures; and
- Indigenous strategies for the management of natural resources.

It is crucial to emphasise here that the domain of topics stated here are only meant to be illustrative. As such, the question listed in Appendix 2 only served as guides. Essentially, during the interview sessions questions would be crafted randomly around these topics, or as follow-ups to the issues raised by the participants. Alvesson (2011) also emphasises that direct or previously crafted questions are not necessary in this type of interviewing. In the observation of Huntington (2000) this method is more a conversation than a question-and-answer session. Generally, participants were asked to give guided narratives of their environmental history and how it had been shaped by their IK. At this stage, it was necessary to emphasise that the description of their lived experiences should be traced from a period of at least 30 years back. The IPCC uses a period of at least 20 years as a reference point in climate assessments (IPCC, 2013). Since the age criterion was primarily used for engaging the participants, most of them could give accounts starting from as early as 1930, which was a good reference period for showing significant climatic events in their area.

In Figure 4.3, a general framework guiding the interviewing process, from which questions were generated is also shown.

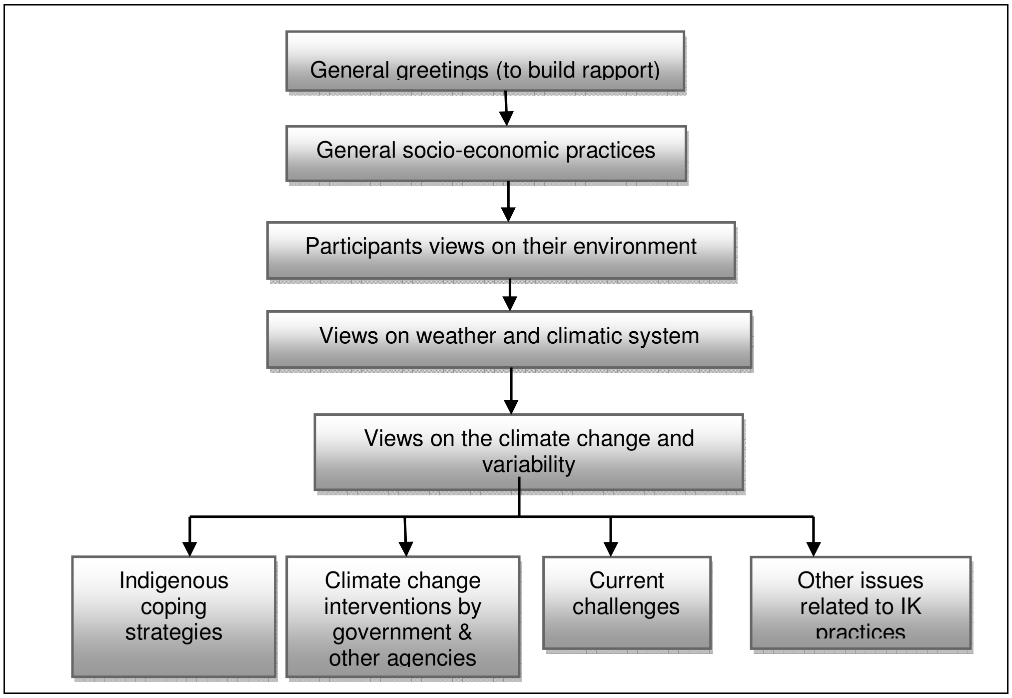

Figure 4.3 Framework guiding the generation of interview questions

Initially, it was necessary to build rapport with the participants. The local practice and form of greetings that are characterised by a rhythmic clapping of hands accompanied by chanting pleasantries had to be followed. As an outsider not well versed with the local culture, the company of research assistants not only simplified the exercise, but also made it enjoyable. This was then followed by a brief discussion on the general socio-economic situation in the area, which at the time of research were mostly characterised by the recent political development in the country. Subsequently, the conversations had to narrow down to the specific topics of environmental change and changes in the climate system over time.

The robustness of this method lies in capturing all other useful information that could have been missed in the earlier discussions with the chiefs and their senior advisors. By triangulating respondents based on their insightful knowledge about their environment, this method was potentially useful in enhancing the validity of data provided. Peloquin and Berkes (2009) also used in-depth conservations with selected local hunters to understand ecological complexity in a changing climate in sub-Arctic Canada. Tajudeen (2003) expresses that interview method allows lengthy informal conversation with local people. This approach correctly resonates with Grenier's (1998) view that the long time spent while talking to the local experts legitimises qualitative studies.

c) *Use of In-depth Interviews with other Key Informants*

This was the final stage of the elicitation process. Aside from further extracting knowledge on IK practices in Zimbabwe in general, in-depth interviews were also intended to understand current climate change interventions from the perspectives of knowledgeable persons. As described by Johnson (2001:104), in-depth interviews involve "one-on-one, face-to-face interaction between participants", mainly an interviewer and respondent, "after building intimacy intended for mutual self-disclosure." In this study, the technique was intended to elicit deep information from the views of other stakeholders in order to enhance understanding of the topics investigated. The method intended to solicit views of different groups namely, practitioners of development interventions from both government and humanitarian agencies, climate change experts in government and research institutions and other community leaders. Creswell (2013) asserts that phenomenological studies involving in-depth interviews need to be supplemented by gathering information from depictions of the experience outside the context of the studied case.

Throughout the interviewing process, the procedure embraced Warren's (2001) idea of a higher degree of flexibility and diligence in extracting meanings. To him, this may invalidate previously designed questions in light of new contexts of meaning. Rubin and Rubin (1995), who specify three kinds of questions that direct in-depth interviews, also acknowledge this view: main questions that begin and guide the discussion; probes to clarify answers; and follow-up questions that seek clarifications of responses to main questions. Questions asked intended to understand the respondents' experiences with climate change in the study area, including their views on IK. So, like in interviews with the elderly respondents, questions asked were not prescriptive. Those stated in Appendix 3 only served as a guide.

Views generated from these informants were useful in understanding the multidimensional nature of IK in climate science applications. Johnson (2001) and Alvesson (2011) recommend the use of in-depth interviews in qualitative research as they tend to be more focused on specific probes and verify what has been learnt from previous techniques. This means the method was also useful in enhancing the rigour of research findings. In a similar approach, Olove *et al* (2009) complement data obtained from focus group interviews and observation with open-ended interviews with district officials, community leaders, agricultural technicians and NGO field agencies to obtain additional information on indigenous climate knowledge in southern Uganda.

The list of officials who participated in the interviews and their respective institutions is given in Appendix 5.

4.6.1.2 Key Lessons Drawn from Conducting Interview Research

Important lessons were drawn from the process of interviewing the elderly participants about their lived experiences with climate change as influenced by their IK. The eight issues that unfolded during the data collection process can be summarised thus: researcher as an instrument, dealing with a politically-sensitive environment, scepticism of participants, the problem of 'over-researched' cases, dealing with an emotive topic, knowledge as power and the problem of exclusion, issues of gender-sensitivity, and the nature of research assistants.

a) Researcher as an instrument

Unlike in quantitative studies where a researcher makes use of a pre-designed instrument such as a set of questions to be asked to the interviewees such as a questionnaire, qualitative interviews proceed differently. Here the researcher is the instrument. This technique, also cited by Alvesson (2011) and Mararike (2011), should start from how the researcher builds rapport. Initially, the issue of building rapport is highly crucial especially when the researcher is an outsider. Considerable amount of time needs to be taken to establish rapport. The help of research assistants who are insiders in the area investigated is therefore useful in the topic of IK. Local people can treat outsider researchers with suspicion and contempt if they fail to confirm to the cultural forms of local greetings. Therefore discipline, humility and patience are key qualities that the outside researcher should have.

b) A politically-sensitive environment

During the time of field work, there were recent political developments in Zimbabwe where the ruling party, ZANU-PF had just won national elections. So the victory of ZANU-PF was topical and most interviews proceeded after congratulatory messages were given by the participants, which was indicative of their allegiance to the party. Consequently, the research team had to appropriately reciprocate. This does not necessary mean that the researcher should take political sides, but remain apolitical throughout the research process. The main objective was to make sure that the researcher fits into the study context to attract the full liberty and participation of the participants engaged. Care should also be taken so that the researcher would not end up being embroiled into political discussions with the participants. Furthermore, the participants may belong to different political parties and their concerns about such political developments also need not be underestimated. To address this tricky situation, the research team only shared the congratulatory message after the participants themselves introduced it.

c) Scepticism of participants

Some local elders feared that certain aspects of their IK could be misinterpreted and/or misused. Kvale (1996) and Grenier (1998) have also noted concern about willingness of participants to share knowledge with outsiders. The observation by Wenger (2001) that interviewing older people invites some unique challenges was also experienced in this study. The fear of misinterpretation was addressed by assuring the participants that information synthesised after the data collection process would be availed back for their verification and validation. Besides, willing respondents were also asked to participate at a later stage of group preliminary data analysis. Scepticism about misuse of extracted information was addressed by patiently explaining to them the objectives of the study and how it was supposed to benefit the community (as specified in Appendix 1). The engagement of locally-based mature research assistants also assisted in the trust-building exercise. After trust was established, participants were passionately co-operative in sharing their knowledge. Meyiwa and Ngubentombi (2010) also found that respondents were enthusiastically generous about sharing their experiences with phenomena. They opine that such co-operation is an indication of the richness in knowledge ingrained within indigenous communities.

d) The problem of over-researched cases

In communities like Muzarabani, which usually attract research attention because of the propensity to climatic hazards, some local citizens feel that their area has been ‘over-researched’. So a typical challenge emerges on how to address this perception held by the people. It is therefore necessary to adequately communicate about the purpose of the study, its uniqueness, the existing knowledge gaps, the role of participants in the investigation, and how it is expected to benefit them or contribute in transforming the community. This means knowledge about previous studies and the gaps thereof has to be known by the investigator. Such a challenge can be fully tackled by establishing a good rapport with support from the community gatekeepers who are mostly quick in appreciating the potential role of research as a tool for community development.

e) Indigenous knowledge as an emotive topic

Driven by the enthusiasm about and interest in the topic of IK, some participants may see it as an opportunity to express their deep feelings about the failure by other members in the community or the government to adequately protect their indigenous beliefs and culture. Therefore, IK can be an emotive subject. This requires careful handling of the interview process so that the respondent is allowed to openly express his/her thought and at the same time remaining within the scope of key issues under investigation. One way of doing this would be to allow the respondent to say whatever (s)he feels is necessary to share with the researcher and thereafter re-focus into the trail of the key topic

f) Knowledge as power and the problem of exclusion

Some community members would want to assume superiority and unmatched knowledge about their environment. This could happen when one feels that s(he) is the most senior citizen in the area. If not handled properly, such participants would end up excluding other potential respondents who could also contribute meaningfully in the research. Mararike's (2011) argument that knowledge is power can be used to explain this situation. A good way of addressing this challenge would be to request the respondent to name other potential people who could share a similar or closer account of the details already provided. Another way could be to ask for a respondent of different sex with the view that other details could be gender specific.

g) Addressing gender-sensitivity

Qualitative interviews embrace gender-sensitivity. Some respondents felt that they could account better the details of their lived experiences about climatic events when their spouses assisted them. Such a practice could enrich the information given by addressing the problem of loss of memory on some key periodic events that deserve detailed narration.

h) The nature of research assistants

A common pitfall that may affect the research process is the nature of field assistants and the manner in which they are recruited. If research concerned with understanding IK is to be successful, the issue of ownership and buy-in from the community is highly crucial. This means researchers should not impose themselves into the community with their outside research teams. In such rural research settings, this pitfall is viewed by the citizens as an 'urban bias syndrome'. Therefore, research in this manner needs to be interpreted as a collaborative effort between the external investigator and the community under study. Research assistants who happen to be members of the researched area should represent the latter. This approach has numerous advantages that are detailed in Section 4.7 below. The two research assistants employed were identified from the study area.

4.6.2 Use of Observation to Complement Interview Data

In order to get a richer picture of the context of IK practices in Muzarabani, the direct observation method was used. This technique was also meant as confirmatory evidence of data obtained from interviews and served to enhance the rigour of research findings (Sagarin & Pauchard, 2012). In this study, observation is defined as a qualitative research technique of obtaining data about the phenomenon of climate change through contact with the evidence indicated by respondents. The evidence observed was in the form of environmental indicators of climate change and coping and adaptive strategies used by the people in the studied area. Where such evidence had to be observed, guided field tours to the sites of interest were executed with the help of respondents and research assistants. In some cases, objects or features of interest could be observed at the participants' homes or in their fields.

The method fits well within the naturalism focus of qualitative research in which the participant ought to be observed in their natural state (Morse & Richards, 2002). Creswell (2013) sees observation as a continuum from passive to participant observation, with active observation wedged in between these extremes. Given that the researcher was actively engaged in the community while administering interviews, observations were done concurrently with interviews without influencing the naturally occurring behaviours and practices of the people. As Rapley (2011) states, this method was very useful as it could give room for the researcher to act as an insider in terms of documenting evidence given by the participants. The significance of this method in a study to explore indigenous ways of understanding changes in the climate system deserves emphasis. In the views of Murphy *et al* (1998), relying on what people say, without observing what they do can be a piecemeal effort to understand social reality. Therefore, unlike in survey research, the method adopted here strengthened the validity of interview data.

4.6.3 Document Review Technique for Data Collection

The topics of climate change and IK can be adequately understood by extending the scope of data collection to include review of secondary data. Reference to secondary data served three main purposes, namely to:

- Gather information on how IK has generally been treated in the topic of climate change;
- Understand existing strategies in climate change interventions in Zimbabwe; and
- Compare research findings with those existing in literature which is a strategy to enhance the strengths and comparability of research results.

Information was accessed from government publications, internet websites and print media. At the level of understanding existing knowledge about climate change in Zimbabwe for example, the study reviewed the 1998 Initial National Communication to the UNFCCC, the 2012 Second National Communication to the UNFCCC, the 2013 National Climate Change Response Strategy (NCCRS) draft document and conference proceedings made at the June 2013 FCCSZ (The researcher also participated at this symposium). Specifically, this review helped in understanding how the issues of IK feature in climate change discussions and interventions in Zimbabwe. Other reports were accessed from climate change related projects supported by the UNDP, UNEP and other NGOs. Alvesson (2011) also stresses that complementing methods is vital in capturing what is outside participants' experiences and worldview.

4.7 Field Reconnaissance and Identification of Research Assistants

As stated in Chapter 2, rural communities in Zimbabwe have a dual administrative system: the RDCs and the customary leadership involving chiefs, kraal heads and headmen. The political leadership in the area is another influential group in Zimbabwe's rural areas. This means all these groups had to be consulted about the intention of the study. Therefore, familiarity with the study area began with engaging these gatekeepers. The first day involved interaction with various stakeholders in the study area. The MP for Muzarabani North Constituency assisted with the identification of desired field assistants shown in Table 4.2. A ward boundaries map of the district including names of the respective Councillors was provided by the Chief Executive Officer of Muzarabani RDC. The district programme officers of World Vision International and Zimbabwe Red Cross shared their programme experiences in the area.

Table 4.2 Profile and roles of research assistants

Name[1]	Sex	Age (yrs)	Profile	Main Task
Tendai Gudu - Sithole	Female	36	Born in Muzarabani, grew up here and did her primary and secondary education in the same area. She also got married in the community. Mrs Sithole had a good traceable record of community engagement from her seven years of interaction with Muzarabani farmers as a cotton buyer agent. Since she was well known in the area, coupled with her experience with farmers, her involvement was useful for easier identification and locating of respondents and exchanging customary greetings.	Writing field notes
Hondo Muzanenhamo	Male	35	Born in Murewa, but raised in Muzarabani. He did his primary and secondary education in the study area. Mr Muzanenhamo is a trained community volunteer under the Zimbabwe Red Cross. He once participated in other research projects in the same area: the Disaster Risk Reduction project and other vulnerability assessment surveys conducted by the ZRC. As such his wealth of experience assisted in navigating throughout the area.	Giving introductions & introducing the researcher to the participants

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[1]Consent was sought from the research assistants to disclose their names and profiles

The gatekeepers required some information about the research such as the motivation for choosing the study area, the type of information sought from the respondents, the amount of time to be spent in the area, the major activities to be undertaken while interacting with the participants, and the envisioned benefits of the research findings to the community.

The engagement of assistant researchers was necessary in order to smooth field work activities. The study engaged two research assistants: a male and a female to assist with the data collection procedure and field logistics. A gender perspective was adopted in order to facilitate easier entry into the community in case some respondents might have been uncomfortable with a completely male-constituted research team. It is important to note that the identification of these research assistants was done with the assistance from the MP of the area. This was done after clearly specifying the attributes of the people expected. The second day was used to acquaint the assistants to the study. This was a training exercise to enable them to understand the research purpose and the type of participants targeted. Table 4.2 summarises the profile of the research assistants and their roles. Key lessons drawn from engaging research assistants in qualitative IK-based research of this nature are reported here.

Dealing with the topic of IK requires the recruitment of field assistants who are native to the area being investigated. They should be well-dignified mature people who are known and respected in the area. Their knowledge about the community's culture, administrative structure and physical layout is also important. In addition, research assistants should be willing to learn, trainable and efficient in understanding the research process. This is because in IK qualitative enquiry, they form the research team whose quality and attributes help to facilitate the whole research process from research design, selection of participants, navigating through the researched area, and observing the traditional protocols to data analysis.

Unlike in questionnaire-aided quantitative studies where the trainees repeatedly go over a list of questions with emphasis on how they are to be administered, here the process is highly participatory. It embraces both top-down and bottom-up approaches in terms of input from the investigator and the assistants, respectively. The researcher only introduces the topic of study but input on how and where to start may also come from these community members following their appreciation of the research. They should actively be involved in the design of the study. At this point, it is also necessary to assign specific role(s) that each research assistant is expected to perform, although flexibility in these tasks is also important during the interview process (see Table 4.2).

Engagement of community members in the research team was intended to serve the following purposes:

- building trust between the researcher (external to the community) and the respondents;
- promoting freedom, comfort and enthusiasm on the part of the participants to openly express themselves;
- Resolving unanticipated problems that arose during the research process quickly (for example, some respondents demanded assurance that the researcher was not a journalist camouflaged to assess the post-election environment in the area);
- Making use of persons from the community, who have a wealth of information to facilitate field logistics and navigability in the study area;
- Clarifiying some of the issues that the researcher wanted to know about regarding the culture and other practices in the community;
- Interpretation of local terms, concepts and language that the researcher could not easily understand; and

- Allowing room for the researcher to conveniently and comfortably conduct the field work under the guidance of people known in the community (This is part of ethical issues covered later in Section 4.11).

4.8 Sampling Techniques and Procedures

Execution of the aforesaid research methods is clarified by specifying the sampling methods, plan for interview schedules, and procedures used to identify participants.

4.8.1 Sampling Techniques

Non-probability sampling was the main procedure used in selecting research participants. This type of sampling, as Creswell (2013) puts it, is not probability sampling where statistical inferences are made. Instead, it is an approach where one can best study the problem under examination. DeCuir-Gunby (2008:129) describes sampling as "…the manner in which participants are accessed as well as the number of participants needed."

In all the methods outlined in Section 4.6.1 above, it was necessary to select participants who were knowledgeable and who would provide balanced perspectives on IK and climate change. The study adopted purposeful sampling both for choosing key informants and for identifying participants in the elicitation interviewing techniques described earlier. In this approach, once an informant is located, (s)he would identify initial participants in a practice of chain referrals. The initial participants would also lead to other knowledgeable or key person(s). This technique is also named snowball sampling (Huntington, 2000; Starks & Brown-Trinidad; DeCuir-Gunby, 2008). There is no definite size of respondents in this approach. It is generally agreed that respondents are chosen until the level of saturation – where no new issues will be emerging. Johnson (2001) and Starks and Brown-Trinidad (2007) describe this level as 'theoretical saturation'.

In interview conversations with participants in Muzarabani, theoretical saturation was reached after the fifteenth participant. Two more respondents, to give a total number of 17 interviewees, were added to confirm if indeed no more new issues would emerge. Creswell (2013) hints that 10 subjects would represent a reasonable sample size in phenomenological studies involving long in-depth interviews. The breakdown of participants is illustrated in Table 4.3.

Table 4.3 Breakdown of participants

Category	No. of Interviews	Description
Chiefs	1	Out of the 3 chiefs, 1 participated and 2 delegated the interviews to their advisors. All of them were males.
Chief advisors	2	Appointed by the other 2 chiefs for in-depth discussions. Both were males, but 1 was assisted by his wife.
Headmen	6	All males, 2 of them requested joint interviews with other village elders (a maximum of 3 participants was sought).
Other elderly people	8	3 were assisted by their spouses while 3 were exclusively held with female respondents.
Sub-Total	***17***	*Total number of indigenous participants in Muzarabani*
Government/Agencies	4	3 drawn from head offices in Harare& 1 local RDC
Academia	2	University of Zimbabwe & Independent consultant
NGOs	6	3 were with field personnel in Muzarabani and the remainder were in Harare
Parliamentarians	1	MP for Muzarabani North
Sub-Total	*13*	*Total number of key informants*
TOTAL	**30**	

With key informant in-depth interviews, theoretical sampling of respondents was also utilised. Starks and Brown-Trinidad (2007:1375) define theoretical sampling as "recruiting participants with differing experiences of the phenomenon so as to explore multiple dimensions of the social processes under study." A total of 13 key informant interviews were held with various groups shown in Table 4.3. Overall, 30 interviews were conducted in this study.

4.8.2 Procedure for Choosing Participants in Muzarabani

The choice of participants had to observe the administrative protocols stated in Section 4.7. The chiefs were the first people to be engaged in exploratory interviews described in sub-Section 4.6.1.1. The chiefs would then appoint their advisor(s) and/or headmen who had a long and rich history about the area. These participants would in turn identify other people whom they knew would contribute meaningfully to the information sought by the study. In some cases, the participants would then refer to other knowledgeable members even those outside their immediate areas or villages. In other cases, the gatekeepers (chiefs) would even suggest some potential respondents under their jurisdictions. This is the practice of chain-referrals previously described. Since the input of these participants was also sought at the level of confirming synthesised collected information, it was also important to request their participation at a later stage.

4.8.3 Procedure for Choosing Key Informants

As shown in Table 4.3, individuals were drawn from pre-determined groups such as government agencies, NGOs, academia and parliamentarians. A list of personnel and their respective institutions is provided in Appendix 4. These respondents were approached after initial contacts (mainly through phoning) to book appointments for the interviews.

While accessing the key informants was relatively straightforward as compared to that of indigenous respondents in Muzarabani, the procedure had some challenges owing to a number of reasons given here.

Some officials could only be accessible after repeated visits or several phone calls owing to their work commitments. Therefore, it was necessary to be very patient until such a time they would be accommodating. In extreme cases, this would take up to a month of persistent follow-ups. Another challenge encountered was the length of time taken for authorisation owing to the bureaucratic labyrinth in some government ministries. In worst cases, this took up to three months, probably because of re-merging of some ministries and government departments after formation of a new cabinet following the July 2013 national elections. Again, there was need to patiently wait until such a time when clearance would be granted. The use of official letters from the university, supported by the researcher's business card attached to the letters, however, facilitated the process (see Appendix 5 for one of the letters).

4.9 Methods and Procedures for Recording and Storing Data

The data capturing process in social geography generates contention (McKether *et al.*, 2009; Meyer & Avery, 2009; Alvesson, 2011; DeCuir-Gunby, 2011). Alvesson (2011) posits that the procedure should be a non-technical view where there is no single recipe for doing it. In this study, unstructured, open-ended conversations with indigenous people were audiotaped and later transcribed. This method was supplemented by taking interview notes in notebooks, in case the audio recording would give problems.

The people in the study area use Shona as a vernacular. This means Shona was the language of communication in conducting field interviews, including capturing and recording interview statements. In order to manage the difficulty of simultaneously asking questions and writing responses, one of the research assistants was assigned the responsibility to write down the notes. This was intended to make sure that all the statements were accurately captured and at the same time facilitate the interview process. Even though audio-taping conversations could be conducted with relative ease, certain aspects of the interview process such as non-verbal expressions and post-interview comments could be missed. Therefore, the idea of writing complementary notes that also captures non-verbal expressions deserves emphasis.

Descriptive notes were also recorded about the interview setting and expressions that were equally useful yet could not be captured by the audiotape. The advice given by Murphy *et al* (1998) on the need to also record field notes on comments made by informants once the audio recorder is switched off was also embraced. At the end of some interview sessions, notes were read out to the participants to verify if all statements had been accurately captured. This procedure also ensured more insights to be given (where necessary) as the respondents reviewed and analysed what they had stated.

Data from observations were captured in the form of field notes, descriptions of sites and features of interest. Where appropriate, photographs were also taken to complement observation notes. These photos were later used to illustrate some important practices and features. It was also necessary to take descriptive notes on experiences, hunches and lessons learnt during the observation protocols.

With key informant in-depth interviews, data were captured as audio-taped transcriptions. Quickly inscribed short notes were used where necessary. These could then be used for focused probes. Unlike the practice with field interviews, spoken texts and transcriptions were in English since all the informants were able to fluently speak the language.

Creswell (2013) bemoans the little attention given in literature about storing qualitative data. In this study, the filing system of the digital voice recorder (Olympus Digital Voice Recorder, VN-7600 with 1GB storage space and 573 hours recording time) was utilised. Each recorded audio transcript was saved as a unique file in a specific folder and was identifiable by a file number, recording time and date. This information was also written down in a notebook. Handwritten interview notes (after some translations) and observation notes were later typed and stored as word files in a computer. Then, each transcription was merged with the respective written notes so that the same data source identity would be maintained during analysis. Each interview had its own file with backup copies of computer files to ensure adequate security of collected data.

4.10 Data Analysis and Interpretation

Concerning data analysis, the qualitative worldview has seen some metamorphosis (Murphy *et al*., 1998; Morse & Richards, 2002; Lofland *et al*., 2006; Gibbs, 2007; Meyer & Avery, 2008; Basurto & Speer, 2012; Creswell, 2013). These changes have developed from manual analytic procedures to computer-aided qualitative data analysis softwares (CAQDAS). Creswell (2013) says that interest in methodological discussions on qualitative data analysis is a fairly recent practice where previously, details about execution of the methods were mostly shrouded in mystery.

Unlike in quantitative data where one can stick to some clear conventions, in qualitative data an analyst faces a quandary (Fairclough, 2002; McKee, 2003). In this study, the analysis involved working with voluminous unstructured texts that needed to be carefully interpreted in order to provide valid conclusions to scientific audiences, while remaining faithful to the generators of the knowledge.

Lofland *et al* (2006) and Creswell (2013) list the computer programmes available, including their utilities. Like the statistical packages mostly used with quantitative data, the CAQDAS have increased rigour in the analysis of qualitative data (Lofland *et al*., 2006; Gibbs, 2007; Basurto & Speer, 2012; Creswell, 2013). These capabilities include good data storage and organisation, ability to generate queries, flexibility in coding and generating themes, measurement of relationships among segments, hierarchical analysis, concept mapping and generation of templates within various methodologies.

However, some desiderata need to be made before deciding on whether to go mechanical or manual. In an appraisal of CAQDAS, Murphy *et al* (1998:145-146) note the following issues:

- Misapplication of a computer package can cause problems with the quality of research findings;

- Premature theoretical closure;
- Analytic madness – emphasis on quantity whilst sacrificing quality;
- Epistemological problems – assumptions that phenomena being coded are actually out there in the world;
- Mismatch between primarily holistic aims of qualitative research and coding strategies employed by many CADQAS packages;
- Chunking and coding also tend to discourage reflexivity – another hallmark of qualitative research; and
- False sense of security over analysis, instead of remaining close or immersed in the data.

In this study therefore, a manual approach was preferred to counteract the limitations of CAQDAS. This decision was arrived at after careful consideration of the tenets of IK enquiry where, for instance, indigenous generators of knowledge should also play a key participatory role in the research process (Berkes & Jolly, 2001; King *et al.*, 2008; Grange, 2009; Peloquin & Berkes, 2009).

Murphy *et al* (1998), Fairclough (2002) and McKee (2003) argue that the central analytic task in qualitative research is the understanding of meanings of text. To them, texts cannot be computerised and the analytic process of generating meanings of texts is not an algorithmic one. In dealing with views and knowledge generated by indigenous people therefore, the submissions given should not be manipulated by the need to dovetail into a pre-designed computer package.

Likewise, Creswell (2013) has stressed that clarity is needed of actions during the coding procedure, as the computer is not capable of making informed decisions. Furthermore, in a manual approach an analyst remains in control of the data and the knowledge about the topic under investigation grows through the analytic process.

Additional insights from Murphy *et al* (1998) reveal that the process of handling data after collection has been given confusing terminology: analysing, interpreting, transforming, or making sense of data. Wolcott (1994) uses the term data management to mean a systematic procedure of efficiently handling data to produce identifiable features and relationships. In this study, the term 'data analysis and interpretation' is preferred as it tends to encapsulate all the meanings.

In an argument about the best approach to handling and analysing qualitative data, Morse and Richard (2002) advance that a good technique should be congruent with a fit among research question, method, data and analytic strategy. Espousing this viewpoint, the study attends to an *ex ante* other than *ex post* procedure for data analysis. The former emphasises tracing the data generating process while the latter looks at the method of data analysis. Coffey and Atkinson (1996) and Creswell (2013) also support this stance. Thus, the data analysis procedure stated here was an ongoing process infused in the elements of the research design illustrated in Figure 4.1. This means the data analysis process effectively began as a participatory exercise with the generators of the knowledge about climate change.

The exercise of reading out the gathered interview notes to the participants was part of the participatory data analysis. As specified in Section 4.9, this activity was meant to verify and validate the data given. The data analysis process was also enhanced by taking back synthesised analysed data and sharing them with a group of selected participants who had to verify if their contributions were adequately captured in the study without some distortions.

Data interpretation in science and indeed in qualitative research is also shrouded in controversies (Morse & Richards, 2002; Williams, 2003). The most commonly held view is that interpretation requires reflexivity (Williams, 2003; Yin, 2003; Alvesson, 2011; Creswell, 2013), a declaration of the investigator's position in relation to the subject being studied. In order to marginalise the shortcomings of interviews, reflexive pragmatism was adopted in interpreting interview data. Alvesson (2011) states that theory building is necessary to have a good idea about what to do with interview accounts. The epistemological assumption stated in Section 4.4 that generators of knowledge about climate change in Muzarabani are in their own right scientists capable of contributing to understanding climate change was also embraced in this analysis framework.

Interpretation in qualitative studies is an attempt to understand what the data mean (Lillejord & Soreide, 2003; Rapley, 2011). Here, the analyst starts with many words, pictures, sounds that are all meaningful. Nevertheless, as previously stated, these need to be interpreted in a way that is both faithful to the participants and their settings, while at the same time informing and explaining these accounts to the readership. Lillejord and Soreide (2003) preferred the use of narratives in order to address this concern about retaining meaning of IK collections.

The study used an inductive analytic method to analyse interview and observation data. Thomas (2006) defines this approach as a systematic procedure for analysing qualitative data where the analysis is guided by specified objectives. In qualitative analysis, the approach enables the analyst to organise and deduce meaning from large amounts of data. Nakapipi *et al* (2011) opine that this method can be appropriately deployed in phenomenological methodological designs. To them, data can be analysed inductively where the focus will be to allow meanings to emerge from the interviews. They examined statements from the interviews by clustering them to form common themes that enable understanding of meanings attached to the data.

In this analysis also, the descriptive analysis method formed the core of treating observation field notes and photographs.

Thomas (2006) states the purposes of inductive analysis which are inherent in other qualitative approaches as thus:

- to condense extensive and varied raw text data into a brief, summary format;

- to establish clear links between the research objectives and the summary findings derived from the raw data; and
- to develop a model or theory about the underlying structure of experiences or processes which are evident in the raw data.

Therefore, inductive analytic approaches serve to aid understanding of meaning in complex data through the development of summary themes or categories from the raw data. This approach is called data reduction, a practice common with quantitative data analytic procedures (Thomas, 2006; Creswell, 2013). The next description details the procedure that was taken to analyse data.

Many scholars agree that the practices of a perfect and adequate analytic approach of qualitative data can never be best summed up by a list of specific steps that have been undertaken (Murphy *et al.*, 1998; Fairclough, 2002; Thomas, 2006; Alvesson, 2011; Rapley, 2011). Alvesson (2011) opines that the researchers craft each study differently, using analytic procedures that evolve in the field through learning by doing. Clearly, no consensus exists. Drawing heavily from Thomas's (2006) inductive analytic procedure, basic steps adopted in this analysis are given here.

a) Sorting the database

The database consisted of raw data from interview transcripts, field notes and photographs. The raw data files were sorted into common format in Microsoft Word files. These files were then printed as separate files for each interview. This phase also involved general review of all the data: observational field notes, interview transcriptions and notes about photographs. Thomas refers to this stage as data cleaning.

b) Careful reading of texts

This stage involved reading and re-reading through all the data files to obtain a sense of the overall data. The technique proceeded by looking closely at the words used by participants such as metaphors, symbols and figures of speech. Thomas stresses that one needs to read in detail so as to gain familiarity with the content and understanding of the themes and details in the text. This stage was accompanied by writing findings in the form of reflexive notes in line with the research questions.

c) Coding and Categorising

This is the process of identifying and defining categories or themes. Taylor and Gibbs (2010) define coding as the process of marking passages of text whose meanings are similar in content. According to Carley (1993), the analyst has many choices for coding qualitative data. In this analysis, categories that are more general were derived broadly from the research objectives (that is, indigenous indictors of climate change and indigenous-based mitigation and adaptive strategies). Specific categories were then generated from within these broad categories after re-examining the text files. Texts, statements and paragraphs that meant the same thing were given codes. Where a theme could not fit the codes already assigned, a new code was then assigned.

d) Dealing with overlapping coding and uncoded text

Text segments that were coded into more than one category and those not assigned to any category were re-examined to check if they were still relevant to the research objectives. Creswell (2002) calls this stage winnowing the data since not all information will be used and some may be discarded. Alvesson (2011) looks at it as the process of reducing the data.

e) Continuous revision and refinement of category system

This final stage entailed searching for sub-topics within each category, including contradictory points of view and new insights. Appropriate quotes that convey the core theme or essence of a category were also selected. Thomas urges that these categories may be combined or linked under a superordinate category where the meanings are similar.

Clearly, it can be learnt that making sense out of large volumes of qualitative data is an overwhelming task requiring careful thought and practice. As Creswell (2002) and Taylor and Gibbs (2010) express it, one engages in a process of swinging in analytic circles rather than a fixed linear approach. When dealing with IK therefore, it is always important to remember that the participatory input and review by generators of the knowledge is highly crucial since the respondents are at the heart of the enquiry.

4.11 Ethical Considerations

This study embraced appropriate ethical principles meant to protect and respect the rights of the community studied and individuals. In interview research, Johnson (2001) says that ethical issues are meant to protect the interests and rights of both the researcher and the respondents. Human geography related research invokes some critical ethical issues particularly when the topic of IK is incorporated (Smith, 1999). This study was subjected to rigorous scrutiny by the Sub-Committee for Ethics in the Faculty of Science at Nelson Mandela Metropolitan University (NMMU) (Ethics clearance reference number H2013-SCI-GEO-01) before commencement of field work (see Appendix 6).

It was necessary to get the informed consent of the participants before they would be involved in the research. Before participants would consent to the interviews, an adequate judicious disclosure on these issues was given: who was carrying out the research; the nature of the research, that is, what was being researched on; why participants were required to express their knowledge and views; and what the researcher intended to do with the information provided (also see Appendix 1).

During the interviewing process respondents were also informed at the outset that they had the liberty of withdrawing from participating at any moment whenever they deemed it expedient. Confidentiality of information and anonymity was assured in which the identities of the participants were not disclosed and would not be linked to the views expressed. With key informants, however, participants agreed to the disclosure of their identities. Research assistants recruited into the study also expressed willingness to identity disclosure and the study followed that.

Finally, the full identity and contact details of the researcher was given to all participants. It was specified that the researcher was a doctoral candidate registered with the Department of Geosciences of the NMMU in South Africa. This was meant to facilitate the process of contacting the researcher in the event that they would wish to do so. The use of name cards or business cards bearing the researcher's name, contact details and name of the university was highly useful in revealing the details of the researcher without doubt.

4.12 Conclusion

A qualitative research paradigm adopted in this study is seen as the best strategy for addressing community driven knowledge in climate change discourse. This strategy allowed flexible approaches capable of tapping out the experiences and perspectives of the community being studied in order to get a richer description of the context in which IK is practised. Furthermore, the qualitative potpourri allowed capturing of salient and new ideas useful in informing appropriate climate change interventions in Zimbabwe. To study these topics, open-ended questions were asked in order to gather as much as possible the views and perspectives of the participants. The elicitation interviewing process has strengths in reflecting on an increased understanding of the idiosyncrasies of IKS at various community structures.

Broadly, qualitative research was also intended to empower the people in devising sustainable interventions through capturing their stories into climate change directions. A case study methodology was necessary to understand the context in which IK is shaped and how the local people view and respond to disasters brought about by change and variability in climate. The approach was also intended to complement mainstream quantitative research through enriching explanations in causal theories and models of climate change and climate risk management interventions.

Apparently, interventions lack the pragmatism that drives successful results of climate strategies, leading to policy rhetoric. Thus, deep-rooted ideologies and behaviours stymieing success of community-targeted interventions, yet ignored by the dictates of technocracy usual remain unexplained. So the methodology presented here excavated through these salient issues, tapping them to inform a scientific framework crucial in guiding pragmatic strategy for climate change interventions.

An exploration of IKS in climate science would arguably require an expanded geographic coverage in terms of data collection to map practices across the country in order to generalise research findings. However, Muzarabani being the epicentre of climate change impacts is a reliable case to document knowledge and experiences of indigenous people witnessing climate events. Furthermore, participation of key informants external to the study setting managed to draw independent insights from those outside the study area.

Finally, a mixed research design blending qualitative and quantitative paradigms would also give another dimension possibly, through empirical justifications of facts and techniques. Nevertheless, the adoption of a mixed qualitative methodology that utilised triangulated research methods and the elicitation interviewing techniques enhanced the robustness of the study and rigour in research findings that are presented in the next chapters.

CHAPTER 5

INDIGENOUS INDICATORS OF CLIMATE CHANGE

When a knowledgeable old person dies, a whole library disappears

An African proverb

Part of this chapter is based on the following publication:

Chanza N and de Wit A (2014). Rediscovering Indigenous Climate Knowledge for better Responses to Climate Change: Insights from Muzarabani. *The International Journal of Climate Change: Impacts & Responses.*

5.1 Introduction

A range of community environmental assets that serve as signs of change in the climate system were identified from interactive conversations with an elderly indigenous group in Muzarabani. These markers can also be used to understand impacts of climate change. Key to the understanding of these indicators is the centrality of customary arrangements that shape IK practices in the area. It should also be emphasised from the philosophical stance of this thesis that information was sought from a group of an elderly knowledgeable community whose religious attention to the environmental landscape qualified them into a category of community 'scientists' capable of giving insightful leads on processes and changes in the local climate system.

The purpose of this chapter is to document evidence of change and variability in the climate system as understood by the indigenous people from their proximity to and constant study of the environment. As shall be seen throughout the chapter, most of the indicators reported here are those widely understood in mainstream climate science. These include elements of the climate system, notably, rainfall, temperature, wind, clouds, thunderstorms and lightning. Environmental indicators of ecological aspects (biodiversity, forests and trees), hydrological features (rivers, pools, ponds and wetlands), physical features (mountains), and pests and diseases were also identified.

Essentially, some of the indicators reported in this chapter have not been adequately understood at the level of national and regional climate studies, possibly because the methods used for analysis do not adequately capture the details about the nature and impacts of climate change experienced at localised levels. The chapter shall zero in on this finer analysis. It is also necessary to first discuss the indigenous thinking about the phenomenon of climate change. A discussion of specific types of indigenous indicators useful in understanding nature and the magnitude of change in the climate system is later presented. The chapter concludes by highlighting the challenges of and strengths in the use of these indicators in understanding climate change.

5.2 Indigenous People's Perception of Climate Change

The local people in Muzarabani blame the change and variability in the climate system on failure to observe traditional customs. They see the environment as spiritually connected to their ancestry. Their actions or inactions on it can either please or dismay the spirits. In the latter case, they believe that if the environment is disturbed by their actions or the actions of others, the spirits will punish them by destabilising the climate system. To them, climate events such as drought and violent storms are signs used by the spirits to register their distress and objection (see Box 5.1). This observation is analogous to that gathered by Turner and Clifton (2009) where the local people in British Columbia, Canada also see climate change as an outcome of disrespectful practices and violations of taboos.

Box 5.1: Indigenous people's views about climate change

"We have inherited a Western culture that disregards our beliefs as a people. The present generations have been exposed to the English way of doing things that they see as a civilised culture. Now talking about these traditional ceremonies and their significance is a laughable thing to the young ones and the Christian community.

"A place where Mbuya Nehanda (VaMazviona) is buried in Tsokoto – a thick forest near Chadereka - used to be routinely visited by some elders for spiritual consultations. Even President Mugabe himself is aware of this. This is no longer the practice. Sacred places where you could not just fetch water with anything unless with a *mukombe* (a specially prepared traditional vessel) are now tampered with. Metal items like cups, plates or pots were not permitted at these sites. We are no longer closely following *chisi* (holy days set aside for honouring the spirits so that they would bless us with good rains). Those who prepared traditional beers were old women who were off child-bearing ages. These would spent up to 14 days in sacred forests – playing a special dance called *mapfuwe*. The 14th day was always associated with the onset of rains signifying that the spirits were happy and had heard their prayers. This happened regardless of the time of the season. Even during this spring, rains would come.

"Now mermaids, snakes and lions that take care of us have been disturbed and are now powerless, hence these omens like droughts and floods. So these changes we are talking about are caused by violations of these myths and taboos."

On the contrary, it is on record that the forcing behind global climate change is attributable to global warming mainly by anthropogenic GHG-emissions. For example, the AR5 by the IPCC reinforced findings from earlier reports on atmospheric instability largely from unsustainable energy consumption, pollutants from the transport sector and poor land-use practices (IPCC, 2013).

There is a sharp contrast existing between indigenous people of the study area and mainstream scientists about the physics of climate change. While the views of the indigenous people may appear unscientific and cause this divergence, the factors behind the causes of change are the same, that is change. Instead, the indigenous people rush to associate this process with the reaction of the spirits. Notwithstanding this dearth of scientific attribution to causation, bemoaned by Unganai (2013 *interview*) and also cited by the IPCC (2014a), the knowledge commonly held by the indigenous people about ecosystem disturbances leading to environmental changes remain purely scientific. The next sections further interrogate the IK-climate change linkage by looking at how the local customs can be useful in enhancing climate knowledge.

5.3 Customary Practices and Climate Change

In Chapter 2, it was shown that customary arrangement systems in Muzarabani have buoyantly fitted alongside main or conventional law. The limitations of the latter in sustainable natural resource management at the level of communities who are in daily contact with the resources have been widely adumbrated in various studies (du Toit, 2005; Muhando, 2005; Brook & McLachlan, 2008; Peloquin & Berkes, 2009; Reid *et al*., 2009; Mala *et al*., 2010; Andrade & Rhodes, 2012). Thus, under IKS, communities use their customs to manage the environment. Such a practice has merit in climate science. In this study, the centrality of customary practices as a driver of IK has been noted in the concept of sacredness.

This section examines the notion of sacredness as a conservation strategy that has promoted giant stands of forests, pools, and certain trees and animal species to remain in some places where adherence to customs is still being practised. It is shown here that in the science of climate change the concept serves a dual purpose. Firstly, mitigation against GHGs that is given by forestry resources and, secondly, helping in identifying a range of terrestrial and aquatic species that can be used as environmental inventories to understand how they respond to climate change. The significance of sacredness in climate mitigation is discussed further in Chapter 6.

5.3.1 Sacredness and Climate Change Indicators

The Oxford English dictionary defines sacredness as that associated with great respect and reverence by a group of people. In other words, the concept relates to something considered holy and too important to be tampered with. When applied to the environment, certain aspects and resources are understood by the people as valuable and sacrosanct. Thus, sacredness encapsulates a conservation ethos that enforces nature conservation. Indigenous people in Muzarabani have evolved customs governing their environment for many years. In their own definition, sacredness means a belief and practice in which some aspects, features and places of the environment are considered as sanctified and inviolable, and violations will upset the spirits that not only protect them, but also give them a good climate. These environmentally specific norms do not exist in an institutional vacuum; instead they are profoundly embedded within the indigenous governance systems of traditional leadership. To the locals in Muzarabani, the environment is not an asset to be tampered with and as such helps them to understand their local climate system. A range of sacred sites and features listed in Table 5.1 were identified.

Table 5.1 Types of sacred sites and features in Muzarabani

Site/Feature of sacredness	Description
Forests	Giant forests like Tsokoto are known to be inhabited by the spirits. They are habitats for a range of sacred animals.
Mountain ranges	The giant Mavhuradinha range is important for traditional shrines and rain-making influences.
Trees	Tree species such as the Baobab, Tamarind, Fig, Marula, etc are places where the spirits (Mhondoro) rest.
Rivers	Rivers such as Musengezi are unique in supporting riverine and aquatic biodiversity.
Pools	Deep pools such as Chikambo and Ngwandongwando are known as dark deep pools important in traditional ceremonies and are infested by crocodiles.
Ponds	Several surface depressions that collect and store water and are known for their unique aquatic biodiversity.
Springs	Kapatamukombe which is known for housing diverse unique aquatic species. Water from this spring can only be tapped using a specially designed traditional vessel called *mukombe* in the local language.
Animals	Lions, elephants, snakes, pangolins

(Source: Field Interviews, 2013)

The sacred sites, tree and animal species presented in Table 5.1 can also be used as resource inventories for measuring the nature and magnitude of change in the climate system. In Muzarabani, certain pools, ponds, springs and vleis are understood as sacred. Their waters are known to be inhabited by the spirits that guide the people. For example, large animals like crocodiles and snakes are found there. When undisturbed, these hydrological features keep water throughout the year. As shall be seen later, a trend towards drying up of these features is indicative of a drier climate currently experienced in Zimbabwe and the whole of Southern Africa. To protect these waters, certain practices are not allowed. Metals objects or vessels should not be used for collecting water. Only a traditional gourd container is allowed. Washing with soap is considered a taboo. The water should not be extracted for agricultural reasons unless after appropriate consultation to get the blessings of the spirits. Use of this water is often confined to some special ceremonies such as the *Huruwa* ceremony, a rain-making event held at the end of the dry season in October to enlist the favours of the ancestral spirits in bringing good rains.

Some of the main indicators of climate change have been measured in the water and forestry sector. However, while the behaviour within climate change of catchment areas, rivers and forests have been recorded in the country, little is known about specific tree and animal species and other hydrological features like pools and ponds, including the biodiversity they preserve. Indigenous people in the study area are capable of locating certain trees such as *Adansonia digitata, Hyphaene petersiana, Sclerocarya birrea, Kirkia acuminate, Tamarindus indica* and *Ficus* sp which serve as witness species for understanding the past, present and future climate system (see Table 5.2). Specific studies to understand the resilience of ecosystems and behaviour of these species in the context of temperature and rainfall changes, for example, can be carried out by climate scientists or ecologists.

Table 5.2 Sacred trees that can be used as indicators of climate change

Local name	English name[a]	Scientific Name[a]	Use value by the locals
Murara/Mugoma	Palm	*Hyphaene petersiana*	Fruits are used as food especially during drought periods
Muuyu	Baobab	*Adansonia digitata*	The fruits are eaten by people and can be used to make porridge during the times of drought
Musomo	Marula	*Sclerocarya birrea*	A sacred tree species whose fruits are highly valued by people and animals
Mubvumira	White seringa	*Kirkia acuminata*	A sacred tree species
Muonde/Mukuyu	Fig	*Ficus sp*	A sacred tree species associated with presence of spring water and its fruits are highly favoured by birds
Mutowo	Rock fig	*Ficus glumosa*	A sacred tree species used for customary courts
Musika	Tamarind	*Tamarindus indica*	A sacred tree species

(Source: Field Interview, 2013; [a] Hyde *et al*., 2014)

Apart from this, the impact of change in the climate system can also be understood by measuring changes in sacred vleis, pools and ponds. Respondents' knowledge about the behaviour of these hydrological features pointed to a trend towards shrinkage and reduced periods of water retention. There is evidence of desiccation of vleis, pools and ponds that used to hold water and support a variety of plant and animal species. Sacred snakes like the python are no longer visible following drying up of their habitats. This ecological knowledge, that disturbances in habitats have far reaching implications in ecosystems is known by the locals. In essence, climate change is leading to loss in biodiversity with some species being lost. The indigenous people have knowledge of identifying these species. As shall be discussed later in this chapter, facts about the impact of climate change on local ecosystems and local hydrology as understood and observed by the indigenous people can be discerned.

The Mavhuradonha range is a stretch of sacred mountains whose influence on the local climate is adequately understood by the local people. The mountains regulate wind flow, wind speed, clouds formation, river flow, precipitation and temperature. To the locals, the mountains are used as a weather or climate observation site. The respondents gave detailed narratives on the history of Mavhuradonha in influencing the setting and strength of local precipitation that they receive. Besides, it is home to a variety of tree and animal species whose resilience to change and variability in climate can also be understood.

Later in this chapter, the usefulness of Mavhuradonha mountain range in interpreting elements of the climate system will be examined. Therefore, emerging from this analysis is that by utilising the knowledge of local indigenous people, climate scientists can effectively understand changes in the climate system by performing an inventory of the available species and compare the results with the list and abundance of species recorded many years ago. Limited ecosystem damage that is necessary to separate from anthropogenic related disturbances is guaranteed through customary observations on sacredness. The major barriers to the perpetual continuation of customary regimes are discussed in the next section.

5.3.2 Threats to Customary Beliefs and Practices

Concerns about threats to the value and continuity of customs were well expressed by the respondents. In Muzarabani such pressures are associated with the influx of migrant populations, Western-based education, modernisation and Christianity, including death of custodians of IKS, that is, spirit mediums, *madunzvi* and *homwe* (see Table 5.3 for the detailed descriptions). This means places formally regarded as sacred are also under threat with subsequent disturbances on ecosystems and local climate.

Table 5.3 Terms associated with the spirit mediums

Term	Description
masvikiro	Spirit mediums
mudzimu	Ancestral spirit
homwe	Person possessed by the spirit medium
dunzvi	Person who used to travel with spirit mediums and remains a focal person for giving directions on traditional ceremonies
mhondoro	Spirit lion

(Source: Field Interview, 2013)

The complaints expressed by some of the participants are testimony to this fear on the threat to customary rules in Muzarabani. Box 5.2 captures these local fears about the sustainability of their cultural beliefs and practices.

Box 5.2 Concerns about threats to customary practices

"We lost it all when some chiefs and headmen just received people from all over the country, including those coming from Mozambique, Zambia and Malawi. The other problem is that we have lost a generation of the elderly who knew how to religiously appease the spirits. The remaining ones is just a generation of kids who do not understand our tradition," says one respondent.

Another participant weighed in: "*Masvikiro* are now involved in strange practices that make them lose strength. We see them fighting with young boys over beer, women or snatching other men's wives. Chivere, a *homwe* (one possessed by spirit medium) was beaten by the youths just recently, yet long back these people used to be very respected."

Another participant attributed the problem to the Shona terminology like *chivanhu* (tradition): *some people especially the youth are ashamed of being associated with chivanhu. As a result, we are witnessing a continuous onslaught of these practices and we need urgent interventions to address this. We are now working with the chief's office to address this problem of cultural erosion*. Viewed from the lens of the modernised world, the new generation looks at these customs as primitive, backward or uncivilised, and in worst cases evil. Such cases are not a good reflection on the interests of maintaining the local customs for safeguarding the local environment and its resources (Mararike, 2013 *interview*).

Breakdown of traditional belief systems alongside rapid socio-economic changes, and its antecedent threats on sacred environmental assets have also been reported elsewhere in Africa. For instance, Nganso *et al* (2012) complain about the disappearance of sacred groves owing to human pressure in Ghana, while Matshinyalo and Siebert (2010) observe threat on biodiversity in sacred places among the Vavhenda community in South Africa. They attribute this to the failure to observe traditional myths and taboos. However, it should be known that there are some places that have remained resilient to these threats and the customary observations are still strongly obeyed. The sacredness of these places if allowed to persist can serve to meet the conservation purposes specified earlier in this discussion, which in turn can offer opportunities for enhancing understanding of the local climate system.

5.4 Indicators Associated with Elements of the Climate System

Several indicators of elements of the climate system were captured from narrations given by participants. Such indicators as seasonal changes in precipitation, temperature, wind, clouds, thunderstorms and lightning are congruent with those considered in mainstream climate discourse. It should also be known here that these indicators can also be deployed to understand impacts of climate change in Muzarabani. Even though some of these indicators lack precision in their applications, a notable strength of indigenous indicators is their detailed refinement in describing the extent of change experienced at local level. In this section, a description of each of these climate elements is given.

5.4.1 Seasonal Changes

Changes in the rainy season are one of the distinct indicators of climate change that is understood by the locals. Climate change is causing growing seasons to be shorter than before. This observation is generally the trend throughout the country (MENRM, 2012a). The people interviewed traced a good reference period where before the 1970s, the rainy season would start from October/November stretching up to April. This means there was a period amounting to six full months when they used to receive substantial amounts of rainfall for supporting quality agriculture. The seasonal interpretation used by the locals covers a period from the time of receiving the first rains to the time of the last rains. A pre-1970 period, according to them, had the first rains being received in October/November and the last rains received in April/May, depending on the locality. A post-1970 period is reported to have marked a gradual shift towards shorter rainy seasons. During the period covering the two decades from the 1970s to 1980s, the first rains shifted to November or early December, with the season stretching up to March/April. The post-1980 period is regarded as the shortest seasons in their records. The seasons have been effectively reduced to about ninety days stretching from December to February. A participatory conceptualisation of the changes in the length of the rainy season with the participants produced an illustration shown Figure 5.1.

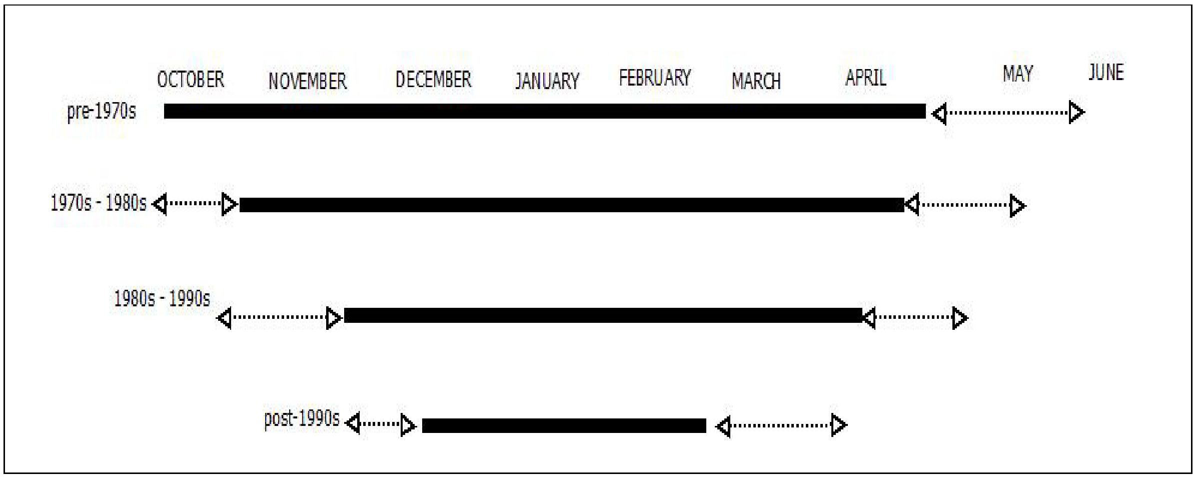

Figure 5.1 Changes in the length of the rainy season

(Produced from participatory analysis with selected respondents: the solid line represents the definite mean length while the broken arrows show some seasonal variations)

It should be noted that the shortening in the rainfall season reported is not distinctive throughout the given periods and months. These changes are gradual and not clear cut. By looking back over the past four or five decades, indigenous people are able to trace this gradual trend towards shorter growing seasons. Within these periods there are some seasons also recorded in mainstream climate data as anomalous seasons (IPCC, 2007b; Parry *et al*., 2007; Mutasa, 2008; Aguilar *et al*., 2009; Mugandani *et al*., 2012). These seasons can either be shorter or longer than the mean seasonal lengths. Most of the anomalies recorded in Muzarabani are those associated with very short seasons and they tend to be recent events. Significant shifts were recorded starting in the post-2000 period to present. The following narration given by one of the respondents is a good testimony:

Now if the rains start in November/December then chances are high that these will be good and effective rains, but if the rains start in October then the likelihood of drought cannot be ruled out. One of the peculiar seasons in mind is when we planted on the 5th of January and amazingly we got very good yields. Also, in 2010 we planted on the 28th of January and some of us obtained good yields after the rainfall ended up being well spread throughout the reason.

Another notable characteristic of the current seasons is their variability in terms of reliability and effectiveness of rainfall received. The comment cited here can give more evidence to these changes:

Long back the season would span from November until April, starting as heavy downpours in November and ending as light showers in April. These years we are now experiencing rainfall from December to February. The rains are just sporadic, in one season we can get some little harvest, in another season it is just nothing.

Attention to seasonal changes is a crucial aspect defining the agricultural livelihoods of the community. Cropping choices are related to the registered changes in seasonal characteristics. Evidence of a gradual shift towards shorter seasons is found in the crop varieties adopted by the peasant farmers. Before the noted seasonal changes, farmers would grow long season crop varieties that would take up to six months to mature. For example, there was a sorghum variety called *Mudyandararama*, whose growth would take six full months under rain-fed conditions. Another late season maize variety they planted was called *Machingamvura*.

These local names have a deeper meaning that can shed more light about the climatic conditions under which the crops were grown. *Mudyandararama*, when loosely translated means relates to a longer time required before the farmer enjoys the crop yield. *Machingamvura* denotes a crop that would be planted late in February but was guaranteed to complete its life cycle to give good yields to the farmer under quality rains that were received until the end of the season. Implictly, such crops were once grown over a longer wet season. The current climate experienced is no longer able to support these crop varieties. On a closer analysis, this is also indicative of a once wetter climate associated with the area. Evidence gathered from key informants working in drought mitigation projects in the area also point to focus on shorter season crop varieties that government and NGO extension officers are promoting. As shall be discussed in Chapter 7, the current climate in Muzarabani largely impacts on agriculture and food security and the situation prompts the locals to adapt accordingly.

5.4.2 Changes in Rainfall Characteristics

The rainfall pattern, amounts and distribution have also become irregular and unpredictable. Generally, a trend towards drying or rainfall deficits has been noted. This trend is also observed both at national and regional levels (Brown *et al*., 2012; Mugandani *et al*., 2012; Gukurume, 2013). Of particular mention is that the strength in IK observation and interpretation of these changes is made finer in a locally richer contextual analysis. Rainfall is a key climate variable that shapes the mainstay of the local community. As such, its characteristics over the past decades have been studied with much interest by the villagers. In this section, the seasonal changes discussed earlier are further examined in terms of observed changes in the pattern, amounts and distribution of rainfall received.

Indigenous people in Muzarabani use rainfall names to understand their climate system and seasons. As shown in Table 5.4, use of these names is key to determineing any significant changes in the climate system.

Table 5.4 Local rainfall typologies and their climate meanings

Rainfall name	Period	Description
Bumharutsva	October	First rains for clearing burnt ash
Gukurahundi	October/ November	These usually fall after *Bumharutsva* and are meant to clear away chuffs
Nhuruka	November	Signify the onset of proper planting season
Gumbura	February	Devastating rains received late in the season
Tupfunhambuya	April	Light showers towards the end of the season
Mavhurachando	May/June	Usually the last rains marking the beginning of the winter season

(Source: Field information from participatory analysis, 2013)

The local names used to describe the types of rainfall received and the months that they are received are a good indicator in understanding changes in rainfall amounts and distribution throughout the seasons. The first rain usually received in October called *Bumharutsva*, is meant to clear the ash from the dry season burning that would have occurred. It is also referred to as *Bvumiramutondo*, meaning tree species such as *Julbernardia globiflora* would start shooting their leaves after receiving the rains. *Gukurahundi* is commonly received in mid-October. The name means this rainfall type is capable of clearing away chaff from previous harvests. Farmers could use these rains to start land preparation. *Nhuruka*, usually received in November, means the onset of the proper rainfall season, informing farmers to plant their crops. *Gumbura* would later be received around February and this rain is blamed for causing crop damages as most crops would have matured. In April, the people would also receive light showers called *Tupfunhambuya*. In the local understanding, these showers would fall onto grannies while they are scanning the fields for some last produce to give to their grandchildren. The last rain is called *Mavhurachando*. This would be received in May or early June marking the start of the winter season.

Emerging from these rainfall typologies is the understanding that the trend has totally changed. The setting of the rains has changed drastically. For example, *Bumharutsva* and *Gukurahundi* are no longer definite and distinctive. Of late the villagers only start receiving *Nhuruka* but *Mavhurachando* is no more. The practice of giving names to rainfall types is since gone. To them, the previously understood sequence that defined these rainfall types is now a thing of the past. This is clear evidence of changes in the rainfall characteristics. One respondent has this to say about the change in rainfall:

> *Hahaha…my son….(laughter followed by change in voice tone, perhaps to emphasis a point). Now we no longer give names to the rainfall. Yet long back we knew very well that the first rains to come were Bumharutsva followed by Gukurahundi. Now if you give rainfall names you will certainly die of hunger. Any rains we receive now should be put to good use, or else there will be no farming to talk about (respondent ends statement shaking his head in despair).*

Another key characteristic of deviation in rainfall is the variation in amounts received over the season. There is an observation that much of the rainfall is now concentrated in the shorter rainy season. This situation is now seen in violent storms received in December/January with potential to cause a trail of crop damages, including destruction of buildings if the storms are accompanied by high winds. Long back, the people understood that effective rains usually falling mid-season in January/February would last for up to seven days as drizzle. Cessation in these rains is blamed for the drying up of rivers, wetlands and ponds as shall be discussed later in this chapter. The current irregular pattern from October throughout April is understood as a recent phenomenon. As a result people have lost predictive knowledge of rainfall as they used to do some decades ago. Loss of predictive capacity on the pattern and distribution of seasonal rainfall is also clear evidence that the climate have changed. Consequently, such a situation becomes a major threat to community's adaptive capacity as reported in Chapter 7.

It is also a fact that the shortening of the growing season described above is a result of periodic changes in the rainfall received. Late season months of March/April were once associated with some rains that the community relied upon for late season planting. For example, crops like beans could be planted under rain-fed conditions during that period. Of late, the crops will just wilt before completing their life cycles due to water stress. Furthermore, it is reported that farmers would take advantage of the late season rains for easier harvesting of groundnuts. The use of hoes to harvest groundnuts owing to dry soils created has replaced the accustomed manual uprooting over the past many years. The latter was only possible when the soil was moist from late season rainfall once received. This is also evidence of the temporal variations towards drier late seasons.

Aside from variations in temporal distribution, changes have also been noted in the spatial distribution of rainfall. Rainfall is now received in patches over the valley. For instance, areas within a five-kilometre radius now largely receive rainfall differently. Respondents reported that such irregularities were not known over twenty to thirty years ago. More amounts of rainfall are now mainly confined to the two extreme ends of the valley: the area at the foot of Mavhuradonha mountains, probably mainly receiving relief rainfall and the area further north close to Mozambique, the direction from which most of the rainfall received comes from. In-between, villagers just get patches of rainfall during most rainfall seasons. To them, such spatial variabilities in rainfall were not so distinctive over the past decades. In a study of climate change impacts in Zimbabwe, Unganai (1996) and Mutasa (2008) also report some irregularities in spatial rainfall distribution across the country.

5.4.3 Changes in Temperature

Temperature is a cardinal climate variable used to explain changes in the climate system. The trend in temperature changes experienced in Muzarabani is mainly localised. This finer analysis reveals mixed facts beyond the general trend of warmer winters documented in the MENRM (2012a) report. Such a peculiar situation, according to the participants, can be attributable to the remarkable changes in the land cover and land use practices that have occurred in the area since the 1970s. While a robust explanation would require substantiation in quantitative terms, the qualitative explanations given here can serve to understand the experiences of the local people with temperature changes over time. What has emerged from interactions with the participants is the understanding that the temperature they now experience is different from what they used to have previously. Apart from their own observation on the behaviour of animals and trees as they respond to the new environment, evidence of change in temperature is also seen in the people's adaptive behaviour. Therefore, two important facts need to be known about temperature changes in the area, that is, increased duration of hotter days and a strange trend towards cooling experienced mainly in winter.

Of late, the people in Muzarabani have witnessed an increased duration of hotter days. Long ago, high temperatures reported were mostly felt in the months of September/October/November and the period was synchronised with the setting of rainfall. Because of the delays in rainfall characterising the current climate, the duration of hot days have actually lengthened. This has seen hotter days starting in mid-August and spreading to late December. Consequently, hotter days coupled with excessive drying is now a common experience in the area. Such observation is in line with documented evidence of an increase in hot days throughout the country (Low, 2005; Kahinda *et al.*, 2007; Ungani & Murwira, 2010).

This development is causing animals like birds and kudu to succumb to the high temperatures. For example, sentiments that even young children could easily capture kudu with bare hands if temperatures become excessively high, is an indication of greatest impact on fauna. The dying of animals owing to high temperatures and its impact on biodiversity is another indicator of climate change presented later in this chapter. The situation is now worsened by erratic and very little rainfall supposed to replenish soil moisture for vegetation growth, which then provides forage, and food for animals and birds in ecosystems.

Another important observation is that October was known to be the hottest month in the memories of the people. But given the increased duration of hotter days marked by delays in rainfall, it is a possibility that the average hottest days are now spread across the months of October/November/December. An account of changes in temperature characteristics is reflected in the statements collated in Box 5.3.

Box 5.3 Evidence of changes in temperature over years

"Hah, Dande used to be very hot long back. No one could dare walk in the heat with bare feet during the day. This means temperatures were very high. But the hottest period was even shorter than it is now. We could not even follow the months, whether we were in June (winter) or out of winter. We could tell that hot days signify the onset of the rain season with good predictability. It was so hot that people could not cover themselves with blankets during the night. We could not put on jerseys as we are doing now. This could only be experienced over a shorter period mainly in the month of October/November followed by clouds and thunderstorms thereafter. Nowadays we just see clouds without rainfall."

Another respondent added, "Everyone who lived in this community during that period would tell this. You couldn't sleep inside the house in October. It was very hot. During the day, the sun would brightly reflect while heating the ground surface, as if it was fire burning. Now the situation has completely changed, it can be very cold in the morning and very hot during the daytime. People used to sleep outdoors because of heat during the night. This is now outdated. Now you can't sleep without a quality blanket during winter. Everyone is now buying blankets for warmth."

The study area is known to be associated with a hot climate. Notwithstanding, the high temperatures experienced, the general observation among the people is that the current winter season climate is now cooler than before. Temperature data of the 1960s show that the area was relatively warmer even in winter (see Table 5.5 for Chirundu temperature data that is used as proxy owing to absence of specific data for Muzarabani during that period).

An increase in wind activity due to land clearance is probably the reason explaining this scenario. Important in this analysis is the observation that the local people are capable of understanding the science of the relationship between temperature and wind. The reason behind cooler temperatures noted are attributed to the significant land clearance that have characterised the area as more people attracted to the then agricultural productive valley opened up land for farming. So, more winds received of late have probably led to the cooling effect experienced. This means, over time land clearance has an influence on local climate. In Muzarabani therefore, opening up of woodlands have made the area cooler despite a general trend towards higher temperatures that is recorded throughout the country. This trend towards cooling is mostly associated with the winter seasons.

Table 5.5 Monthly mean, average maximum and average minimum temperatures for Chirundu – 1960 to 1969

	Jan.	**Feb.**	**March**	**April**	**May**	**June**
Mean temp.	26.5	26.4	26.1	25.4	22.8	19.8
Ave. max	31.3	31.0	31.7	32.0	30.6	28.0
Ave. min	21.7	21.9	20.6	18.8	15.0	11.6
	July	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**
Mean temp.	19.6	22.3	26.5	30.0	29.2	27.2
Ave. max	28.5	31.1	34.3	37.2	35.3	32.3
Ave. min	11.0	13.6	18.8	22.8	23.1	22.1

(Source: TILCOR, 1972)

Winter seasons were characteristically hotter than they are now. An examination of climate records of Chirundu (the nearby weather station during the 1960s) by TILCOR (1972) shows that the area had warmer winters with no risk of frost (see Table 5.5 above). Since the incidence of frost is closely related to minimum temperature, with minima of 11.6^{0}C in June and 11.0^{0}C in July, winters used to be warmer as reported by the participants.

Evidence that the area is becoming cooler particularly during winter nights is also exhibited in the people's behaviour. The respondents reported that they now require blankets and jerseys to keep them warmer in winter. Previously, at night they used to sleep outdoors during the hottest months of September/October/November. Nowadays, the locals are keeping indoors during the same months of the year that they used to spend their nights in the open. These changes are described in the following comment given by one of the respondents: *This Dande area is now uniquely becoming cooler. Long back we could not specify the seasons, whether we were in June (winter) or in summer. For example, for the past 10 years winters are now cooler. You can now see people clad in heavy jerseys. People are buying even thick 2-in-1 blankets, yet long back blankets were not necessary.*

A note from this quotation is that the temperatures experienced several years ago made it difficult to clearly delimit the winter seasons. This is more evidence of significant changes in temperature that is evidenced in clear cut seasonal boundaries separating winters from springs and summers.

Probably, the reduced blocking effect of the woodlands and forests has given room for wind activity. It is the cooling effect of the wind that has tended to make the area cooler albeit more hotter days are being experienced. A study of temperature data could give more insights into the facts discussed here. However, absence of temperature data for the specific area is largely a constraint. This means experiences with indigenous people can be used to guide some understanding toward changes in temperature in such places as Muzarabani which are not covered by meteorological stations.

5.4.4 Changes in Wind Characteristics

A characteristic phenomenon of the study area narrated by the people is that the Dande Valley is known to be windy. Previously, forests and woodlands would play a significant role in regulating wind activity. The respondents' line of argument is standard: the clearing up of land described earlier has led to some changes in the local climate as seen from wind activity. Important lessons about changes in wind activity have been noted over the past decades. The local people have a good knowledge of changes related to wind frequency, pattern, duration and strength.

Table 5.6 reveals four types of winds identified by the locals, which are useful in understanding wind activity in Muzarabani.

Table 5.6 Types and characteristics of wind in Muzarabani

Type	Description
Easterly flows	Are dry violent winds coming from the east, mainly experienced from August to December
Westerly flows	Are often violent winds experienced during the rainy season. If they build in March, they become highly devastating leading to crop damages. They are often blamed for bringing diseases around the same period
Northerly flows	Are relatively calm and moist winds that are mainly associated with good rains
Southerly flows	Are mainly triggered by the giant Mavhuradonha range and can also be highly destructive to villages situated along the foot of the mountain.

The northerly and southerly flows are usually accompanied by rainfall even though the increased frequency of the latter is now blamed for destroying houses and crops particularly in the villages located along the foot of the Mavhuradonha Mountain. The northerly winds would usually be experienced starting from November and the locals knew very well that such winds would be accompanied by good rainy days marking the start of the growing season. In the local Shona language, the northern direction is called *Maodzanyemba.* Literally, this term means a direction associated with heavy rains that can cause crops to rot. These winds are becoming less frequent and irregular. Consequently, the villagers are experiencing increased frequencies of the other two groups of destructive winds: one from the East and the other from the West. Winds coming from the East are regarded as the most devastating, usually very violent leading to uprooting of trees and destruction of buildings and other structures. Evidence of the destructive effects of the winds experienced in Muzarabani can be read in the images shown in Plate 5.1.

Plate 5.1 Structural damages caused by violent winds in Muzarabani

(Top left, Chadereka School damaged by winds; top right and bottom left, Hoya School damaged by wind; and bottom right, a shop at Kapembere Business Centre with damaged rooftop)

The effect of westerly winds is now largely felt in March when crops would have matured. This means these winds would lead to severe crop damages. The participants also relate the occurrences of these winds to the increased incidences of diseases. The reason for such a relationship is not known. A typical expression associated with the increased wind intensity given by one elderly respondent is worth noting:

> *We have seen some significant change in terms of damages and threats from wind. Long back, we used to have trees blocking the strength of the wind. The winds are now excessively violent. In 2010, a child from Tsiga family died when the house fell from excessive winds that started around 4pm lasting the whole night. We knew for sure that we would wake up to hear something bad.*

To the locals, the increased severity of these winds is in synchrony with the dry spells. Respondents explained that these winds have a tendency of dispersing away rainy clouds leading to no rainfall being received. For example, they refer to the winds coming from the east as *chisero chinopepeta mvura*, suggesting that the winds just dissipate rain clouds. If rains are accompanied by these winds they are always associated with violent thunderstorms and lightning. The rising incidences of thunderstorm and lightning activities are presented later in the next section.

Another notable characteristic of the wind regime is the unpredictability of the times of the year the winds are experienced. Previously it was definite that the month of August, locally known as *Nyamavhuvhu,* was the windiest month. In the local Shona language, *Nyamavhuvhu* means a windy month. The strength and frequency of wind has shifted from August to September/October/November/December. Wind pattern is also increasingly becoming irregular.

The science of wind is fairly understood by the community elders. Their knowledge reveals that such winds were previously felt but their impact could be suppressed by the thick forests and woodlands. Therefore, local people are able to study the wind system in their area which is essential in understanding changes in the climate system. It can be concluded from these observations that the present climate is now associated with increased incidences of violent winds and their pattern is also highly irregular.

5.4.5 Clouds, Thunderstorms and Lightning

An understanding of the local climate system by the indigenous people also reveals some important knowledge pointing to atmospheric changes as assessed in the occurrence of clouds, thunderstorms and lightning. Increased incidences of thunderstorms and lightning reported could be related to violent winds and excessive heating discussed earlier. The current climate experienced is now characterised by thunderous and violent storms. Previously, thunderstorms were mainly witnessed in

October/November after being triggered by very high temperatures associated with these months. The characteristic spread of the hotter days discussed earlier could also be the major reason behind increased incidences of thunderstorms and lightning which are now spread until the month of February. In other scenarios, instead of receiving rains as they used to experience, they have seen intensification in afternoon clouds that are devoid of the much anticipated rains during most period of the growing season. Cases of people struck by lightning are on the increase in the area. For example, in January 2014, three school children were struck by lightning on their way to school (Mufunga, *pers. comm.*) and some people were left homeless when five homesteads were struck by lightning during the same period (Bulawayo.24news, 2014). Earlier in the 2009/10 season, 54 families were also left homeless after devastating hailstorms (Herald, 30/12/2009).

In terms of cloud events, the people reported that they are now observing more cloud days. However, these clouds reportedly fail to bring any rains for most of the time. For example, instead of getting Mavhurachando rains in May/June, the people are now experiencing clouds accompanied by a cool breeze. One of the respondents expressed this: *There was a thick and dark rainfall cloud that used to set from the north. This signalled the coming of heavy downpours where people were strongly encouraged to keep indoors or risk being affected by these rains. This is now irregular and cannot be tracked.*

From the captured narratives, the usual development of rainfall clouds from the north would be synchronised by thick mist setting over Mavhuradonha to the south. Locals would use this knowledge to understand the quality of their rainfall season. This phenomenon is no more. Reportedly, they just observe mist building up over Mavhuradonha Mountains with little or no rainfall being received. The villagers also reported observed changes in the types of the clouds. They understand that during the rainfall season thicker clouds extending deeper into the atmosphere would characterise the rainy season. To them, the thickness and height of the clouds especially those stretching from lower levels getting high into the atmosphere are the ones that would bring some rains. They now mostly find scattered clouds, which rarely bring any substantial rains. This is also evidence of marked variability in the local climate.

5.5 Experiences with Climate Phenomena

A discussion of climate change without reference to events such as drought and floods would not adequately reveal the nature and gravity of change in areas like Muzarabani. In this study, the phenomena of droughts and floods featured prominently in the discussions to understand evidence of change in the climate system. These experiences are discussed in separate sections below.

5.5.1 Experiences with Drought

Drought is a phenomenon associated with little or no rainfall. To the locals in Muzarabani, the event is understood as a diminishing in the length of the growing season as a result of delays in the onset of first rains coupled by early termination of rainfall before the crops mature. In a worst case scenario, the progressively shorter season is also punctuated by mid-season droughts. Since agriculture is the mainstay of their agrarian-based livelihoods, the villagers closely monitor the drought events in their community. The following changes have been reported as evidencing the occurrence of drought:

- Shifting dates in planting crops owing to delays in the onset of effective rains;
- Increased incidences of crop wilting at different times of the growing season owing to mid-season droughts;
- Excessive wilting of crops such as during tasseling and silking of corn marked by complete crop loss;
- A trend towards poor crop harvests;
- Lack of pastures for livestock grazing with subsequent livestock death owing to little or no rainfall;

- Excessive drying of water points leading to limited access to portable water and livestock death; and
- The cumulative result leads to socio-economic drought.

Thus, four types of drought have been identified in Muzarabani and can best be illustrated in Figure 5.1.

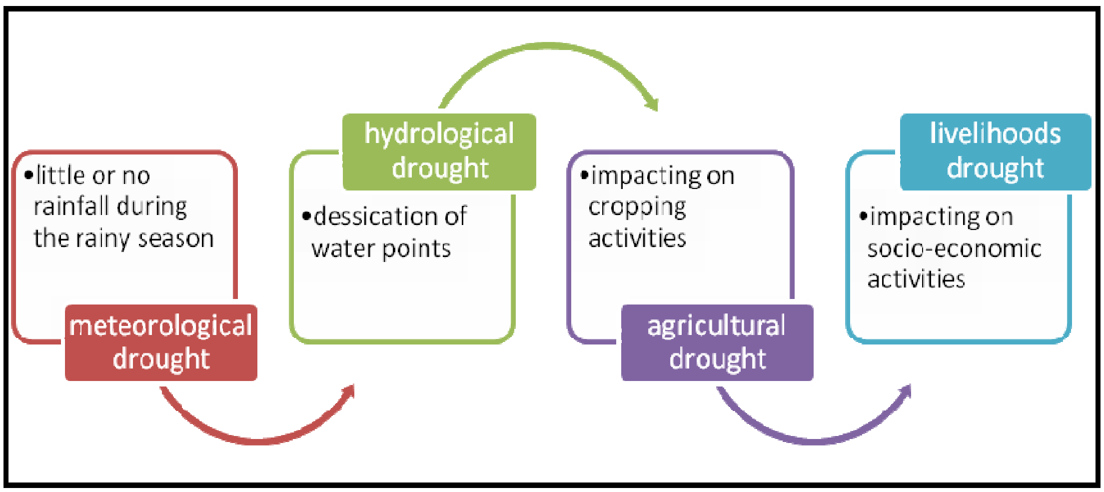

Figure 5.2 Four types of drought experienced in Muzarabani

(Source: Andreadis and Lettenmaier, 2006)

Climate change is leading to meteorological droughts that are associated with little or no rainfall during the rainy season. To the locals, this type of drought can be further categorised into three forms: a) early season (when effective rains are not received in the months of October/November/December leading to delays in planting), b) mid-season (absence of rainfall in January/February leading to wilting of crops before or at flowering stages), and late season (wilting of crops before complete maturity owing to absence of rains in February/March). Persistence of dry weather conditions over the rainy season will lead to hydrological droughts that cause desiccation of water sources in the area. Consequently, this will trigger agricultural drought associated with crop failure and livestock death owing to water stress. The cumulative impact of this scenario is the occurrence of livelihoods drought where the means of survival of the people will be interrupted. Because of severe famine, people will be left with no choice but to sell their livestock and other assets to avert famine and food insecurity disaster leading to a vicious cycle of poverty that affects them socio-economically.

It should be known here that little or no rainfall induced by climate change is the major force behind these droughts. Much of what is known about climate-induced droughts in the country has been that occurring mid-season and late-season. The evidence given here is that indigenous people start to trace the meteorological droughts early in the season when the normal times of receiving planting rains have shifted. These delays are reported to occur between November and early January. What is also important here is that the people have capacity to narrate the exact period at which they experience the dry spells since they would be closely and constantly studying how crops would be responding to water scarcity. A continous spell of dry days during the rainfall season leads to drought. The cumulative impact of these scenarios is seen in recurrent famine in the area. For example one of the respondents had this to say about the incidence of drought: *Look at this crib we use for stacking maize. It used to be filled up with maize but we are now stuffing it with cattle fodder. Even if you invest all your effort in production nothing will come out. The crops just wilt because of excessive dryness. This has caused serious famine in our area.*

Conventional assessments consider dry spells of ten days or longer to relate to meteorological drought. Adopting this treatment to the situation experienced in Muzarabani, the locals pointed out two scenarios associated with dry spells: a) increase in frequency, and b) lengthening of the dry spells. Table 5.7a and 5.7b show data on dry spells recorded during the 1960s. To the locals, what is significantly changing here is the duration of each dry spell. It was revealed that dry spells are now extending for up to thirty or more days because of climate change. This evidence can be read in one of the statements shared with participants: *Dry spells are now very long. The whole of February can be very dry without even a single drop of rainfall*.

Table 5.7a Total number of dry spells of 10 days or longer recorded in Muzarabani during the 1960s

Period	Musengezi	Gutsa[2]
1966/67	3	2
1967/68	2	1
1968/69	2	1

(Source: TILCOR, 1972)

Table 5.7b Average length of dry spells of 10 days or longer for Chirundu[3] between 1959 and 1969

Month	Length of dry spell (days)	Total evaporation (mm)	Average/day
Nov/Dec	17	149.8	8.8
Nov/Dec	15	171.6	11.4
Dec	11	69.9	8.4
Dec/Jan	12	66.0	5.5
Jan	12	81.5	6.8
Jan	11	68.4	6.3
Feb/Mar	15	92.7	5.8
Feb/Mar	14	79.5	5.9
Feb/Mar	12	72.5	6.0

(Source: TILCOR, 1972)

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[2] Fewer dry spells were recorded for Gutsa probably because of the influence of orographic rainfall since the area is closer to Mavhuradonha Mountains than Musengezi.

[3] Proxy data is used to understand the situation in Muzarabani during that time.

Clearly, Muzarabani is now characterised by a drier climate. This evidence is also indicative of the general trend of increase in drought incidences recorded in the country (Low, 2005; Chamaillé-Jammes*et al*., 2007; Brown *et al*., 2012) and in southern Africa (IPCC, 2014). The locals understand that when the land becomes excessively dry, much rainfall will be lost. They argue that rains will just fall on dry land and instead of infiltrating into the ground; the water is lost as runoff. It is also argued that the drying of the land's surface coupled with increased incidences of heavy thunderstorms are the major factors contributing to flush floods in the area. This event is presented in the next section.

5.5.2 Experiences with Floods

Climate change is blamed for increasing frequencies and worsening the severity of floods. The locals understand flooding as an event occurring when water excessively flows over land. Two types of floods were identified in the area: flash floods and riverine flooding. Because of the low-lying nature of the area, flash floods, related to intense storms of comparatively short duration that produce high volumes of flowing water, are regarded as the most devastating. They associate riverine flooding as a phenomenon occurring where the flow in a river channel exceeds the holding capacity of its banks leading to bank overflows and inundation of adjacent floodplains.

Evidence that the threat of flooding is afairly recent event is collated in the following expression given by one of the respondents:

> *People were enjoying life in this part of the community and there were hardly any problems. The floods couldn't cause any threat to our survival here. Early during the 1940s, 1950s and 1960s we cloud happily catch wild animals trapped in floods and the floods were not a problem. We knew our floodplains would be richer and moist for dual-season cropping. The situation significantly reversed*

in 1999/00 after receiving heavy cyclones that widened the channel and changed the course of Musengezi River. Now the river no longer holds much water because of siltation. Serious flooding has become an annual threat.

A key strength of IK applications in understanding flooding is the finer details and richer descriptions given by those witnessing the event. The locals narrated that the area is sitting in very complex hydrological and topographical systems. Most places towards the far north are surrounded by large rivers that of late have seen bursting of river banks and water overflowing their channels during the rainfall season. The participants' point of explanation is similar: At the far east there is a river called Hoya which usually gets full and overflows. Another river, Nzoumvunda also gets filled up and empties into Hoya River. Hoya subsequently empties into Musengezi, which eventually empties into Zambezi River. Other tributaries leading to bursting and overflowing of Musengezi are Kadzurure, Mayo, Nyatsengwa, Sapa, Utete and Mukorodzi. At the confluence of these rivers there is a backflow of water, which viciously overflows the river banks and spreads all over cropping lands and settlement areas. The backflow from Caborabassa in Mozambique also worsens the situation with heavy floods damaging crops and properties, and in worst case scenarios, killing livestock and people (see Plate 5.2).

Plate 5.2 Structural damages by floods in Muzarabani

(Left, bridge linking Dambakurima and Chaderaka damaged and right, temporary road cutting into a river bed which can only be accessed during the dry season)

Apart from this, the locals are also capable of tracing the occurrence of the phenomenon over time, including the specific period of the year the floods are experienced. The vivid experiences that were reported occurred in the seasons 1999/00, 2005/06, 2007/08, 2009/10 and just recently in 2013/14. A closer look at these times clearly affirms the fact that the floods are a recent event related to changes in the climate system. These floods are reported to occur mostly between the period from late December to late February. Furthermore, because the floods affect them, the local people are able to assess the level of damage over time. From the evidence gathered, it can therefore be concluded that floods are increasing in both frequency and severity in Muzarabani. Such evidence has also been documented in some studies (OCHA, 2011; MENRM, 2012a), including wide coverage in various media reports (Herald, 15/12/2007; Herald, 11/12/2009; Sunday Mail, 18/12/2011; Herald, 09/01/2012; Newsday, 27/02/2014).

5.6 Hydrological Features

An assessment of hydrological features such as rivers, pools, ponds and vleis also serve as a good pointer of climate change in Muzarabani. These changes are variously noted through desiccation of ponds, wells and vleis, intermittent river and stream flows, alterations in flow regimes and discharges over time, deeper watertables and diversions in river courses caused by channel flooding and silt deposition.

The community's knowledge about the location of these hydrological features, coupled with constant study on their behaviour in response to aridity and temperature changes can be useful in understanding how these features are impacted by changes in the climate system. A trend towards desiccation of these water sources has been noted.

In Muzarabani, ponds are large depressions on the ground's surface that collect and hold rain water. These vary in size from relatively small pans to large hydrological pans capable of supporting unique plant and animal biodiversity within them or their boundaries. As shall be seen later in this chapter, drying up of these features also induces a threat to the biodiversity they support. The locals now see the desiccation of ponds as a fairly recent phenomenon. Long ago the ponds would hold water throughout the year. It is reported that the ponds now only hold water after the rainy season replenishment, which would only last up to May/June. Thereafter, most of these ponds would dry up. The illustration given in Plate 5.3 serves to compare significant seasonal changes associated with the drying of ponds because of climate change.

Plate 5.3 Seasonal hydrological changes in ponds in Muzarabani

(*left, a dry Dambatura pond during the dry season and right, the same pond filled with water during rainy season*)

There are also changes in hydrological flow regimes. Rivers that used to be perennial have become intermittent. For example, some respondents identified such big rivers as Musengezi, Hoya and Utete that have become seasonal. In Musengezi alone, water is now confined to the pools during the dry season. Other rivers like the Boore that used to have permanent annual discharges, are now characterised by disappearance and re-emergence of water alongthe course of their channels. The desiccation of vleis also affect river and stream discharges. This is because the spongy-like nature of wetlands is known to hold water during the rainy season and slowly releasing it to continuously replenish rivers and streams even during the dry spells. Increased livestock population and siltation of rivers, however, have also worsened this situation. For example, siltation can be the main reason for the reported reduced velocity in river flows. Nevertheless, other national and regional studies isolate climate change as the major force behind interruptions in river flows (Milly *et al*., 2005; IPCC, 2008; Beilfuss, 2012; Kusangaya *et al*., 2013).

The following testimony by one of the participants can shed more light on the hydrological situation in Muzarabani:

> *We cannot even explain the changes to our children because they won't believe us. Nyahwanga spring that used to have numerous water creatures has since dried up in the 1980s. This Boore River you crossed over when coming this side used to have water flowing throughout the year. But, did you see any water there? The same applies to Utete River where water flows only during the rainy season. We don't even know how we are going to survive here since our cattle no longer have water to drink.*

The flooding events reported earlier are also blamed for changes in river flows. This is seen in two main ways, that is, diversion of river courses and widening of river channels. The situation is worsened by excessive evaporation during the dry season which would impair river discharges.

Increased water scarcity is also understood in the levels of groundwater. The common understanding is that watertables are becoming deeper. Where they used to easily access water through wells, they now need to dig deeper to tap up the water. This is clear evidence that the groundwater is getting depleted owing to a drier climate. A report by the IPCC (2008) confirms that rural communities relying on low-cost dug wells and boreholes are now exposed to serious water stress owing to interruptions in recharges resulting from drought.

Essentially, it can also be noted that the period marked by desiccation of these hydrological features coincides with significant changes in rainfall or drought. The locals refer to the post-1990 era as the time they started witnessing such changes. This indication can be useful in providing a reference point for modelling future changes in the hydrological system especially where data is scanty or unavailable. It can be understood in this analysis that closeness to the hydrological assets like rivers, pools and ponds enhances the community's ability to give some indications as to the nature and extent of climate change on water resources.

5.7 Incidences of Pests and Diseases

There are some indication that change in the environment brought about by a changing climate system is also influencing the ecology of pests and diseases. The climate change situation in Muzarabani is understood as either creating conditions favourable for the prevalence of certain pests and diseases or constraining the existence of other pests and vectors on the other hand. Thus, the evidence given here reveals that climate change impacts on both species richness and species abundance. The former relates to the diversity of the various species in an ecosystem, while the latter defines the increase in population of the same species.

5.7.1 Experiences with Pests

With regard to pests, the respondents' understanding is that certain species are increasing in abundance. They identified the increase in such pests as termites, armoured crickets, Quelea birds, armyworm and ticks.

Prevalence of Termites

Termites are known for depleting vegetation biomass in the area. The climatic conditions in Africa are known to favour a rich termite fauna with over 664 known species recorded (Bale *et al*., 2002; Ahmed *et al*., 2011; Sawadogo *et al*., 2011). Sawadogo *et al*. (2011) further point out that these insects constitute 61% of the total macroinvertebrate abundance in African savannas. In Muzarabani, two groups of termites are distinctive. Small termites, which the respondents pointed out are less threatening than large termites. This problematic group is known locally as *manheza*. Their knowledge resonates with that of Ahmed *et al.* (2011) who classified African termites into lower termites which include the families Kalotermitidae, Termopsidae, Rhinotermitidae and Hodotermitidae, and higher termites all belonging to the family Termitidae.

Samples taken for laboratory analysis (at the Entomology Section, Biological Sciences Department of the University of Zimbabwe) identified the most abundant termite species as *Macrotermes sp,* belonging to the Order Isoptera and Family Termitidae. This group is understood as the most notorious for degradation of wood and vegetable biomass (Ahmed *et al.,* 2011), a problem that the respondents argued is seriously threatening their farming activities.

The local people revealed that around October/November each year, there would virtually be no crop residues or biomass left. They reported that the intensification of termites started in the early 1990s when the locals started to see a significant decline in rainfall. This suggests that drought induced by climate change has led to termite abundance in the area. The respondents were high in confidence that termite proliferation is induced by moisture stress. In wetter years, they reported that the prevalence of these species will be suppressed. Furthermore, abundance of the species tends to decline as one moves from drier land towards wetter riverines. It can be argued that the termites would want to establish their colonies and mounds without disturbances from moist conditions. With more rains, the termites recede deeper into the ground and will be finding drier areas to inhabit.

The influence of climate change on termite ecology is still a poorly researched field (Ahmed *et al*., 2011; Sawadogo *et al*., 2011). The evidence given here suggests that water stress induced by a drier climate leads to increased colonisation with subsequent expansion of termite territory size. Lee and Chon (2011) also show behavioural and physiological changes of termites due to temperature changes.

To the locals in Muzarabani the knowledge generated from studying termite activities can also be used to understand the nature of seasons. For example, the following narration, given by one of the respondents, is key in the prediction of seasons*: If we see the termites breaking vegetation biomass and channelling it into their mounds, including many termite mounds around, then we know very well that the season will be wetter.*

Another respondent added: *The problem is fairly a recent one: We have seen intensification of termites since 1992 and its devastation on crops worsens during the dry spell. A week or two without rains invites trouble. We are even forced to prematurely harvest our maize to circumvent damage by the termites.*

This evidence denotes an increasing problem in the pestiferous nature of termites on crop and livestock production. Such understanding can be tapped into mainstream science to enhance ecological knowledge of termites including their feeding behaviour in a changing climatic environment. In climate science therefore, these leads given by indigenous people can help to construct hypothesis on whether aridity caused by an increasingly drier climate has an influence on termite ecology. This is a clear demonstration that locals use their IK to understand the ecology of termites and their effects on both crop and vegetation biomass. The question that will need to be investigated further is: Is the prevalence of termites in Muzarabani and other places related to aridity caused by climate change?

According to Sawadogo *et al* (2011), the other relationship between termites and climate change is understood in the release of carbon-dioxide and methane as metabolic end products from degradation of vegetable organic matter. The liberation of these GHG gases is believed to increase with increases in temperature. Quantities of up to 2% global terrestrial carbon-dioxide and 40% methane releases from terrestrial arthropods reported by Bale *et al* (2002) are likely to increase as termites expand their habitats. This will reinforce climate change owing to worsening global warming reported by IPCC (2014).

Prevalence of Quelea birds

Quelea birds, *Quelea quelea* are a highly gregarious migratory bird species capable of inhabiting most regions (Jones *et al.*, 2000). Even though the locals understand the weavers as being endemic in Muzarabani, of late they have been considered a problematic pest. In the local language, the birds are known as *ujiri*, a name suggesting that they are found in very large numbers. The people link the high prevalence of the pest to the change in the climatic system. From their long time observations, they reported that previously these birds were not as abundant as they are now and were not a threat to their subsistence farming. Two possibilities related to climate change may explain the unfolding situation: 1) the increasing growing of smaller grains as a drought adaptation measure, and 2) the rainfall migration model cited by Oschadleus (2005).

In an investigation of the primary moult and migration pattern of the *Q. quelea*, Oschadleus (2005) argues that the behaviour of these species is influenced by food and rainfall variability which are both climate related. The narrations given by the respondents reveal that the birds are highly prevalent between February and May, a period coinciding with abundant moisture and food for successful breeding. Another important revelation given is that of the variability in incidences of Quelea birds over the years. One of the respondents has this to say: *We can't really tell whether the birds will be coming this year or not. In 2011 and 2012, they were a menace but this year (2013) the birds were not a problem.* This means movements of the birds can be random as influenced by the variability in the pattern of rainfall in Southern Africa that is reported by Mugandani *et al* (2012) and IPCC (2014).

Emerging from this analysis is the understanding that agricultural activities and cropping choices preferring smaller grains, mainly sorghum and millet, which are drought tolerant crops, have also modified the movement pattern of the weavers. As shall be discussed in Chapter 6, these adjustments in farming activities are necessitated by changes in the climate system. So, the knowledge about the feeding and breeding behaviour and migration patterns of the birds that the locals have can be useful in understanding climate change, including understanding how such species respond to environmental changes.

Prevalence of armoured crickets

Armoured crickets, *Acanthoplus discoidalis* are locally known as *mamunye* or *matagutapadare*. These local names mean that the creatures are highly devastating on crops. The threat posed by the crickets is expressed by one of the respondents: *Matagutapadare are a curse to us. They feed on everything, day and night. You can't control them*. Indeed the crickets are a dangerous pest whose prevalence could be attributable to changes in climate. Representatives of organisations working in the area also confirmed in interviews that the crickets are indeed a notorious species to the farming activities of the villagers.

There are three plausible explanations given by the locals on the prevalence of the crickets and their associated crop damages; namely, transition from bush toilet system to sanitary Blair toilets, lands clearance and drought.

First, the shift from bush toilet system to Blair toilets gathered prominence around the 1990s following moves toward improvement in rural health and sanitation in the whole country. Before this development, it is believed that the crickets' impact on crops was minimal, as the arthropods would feed on human faeces that were deposited in the bushes. This assertion has mixed interpretations since the period in point tends to coincide with the other two explanations given below, which are climate related.

Second, as shall be seen in Chapter 7, the clearance of woodlands and grasslands to open up land for farming is a climate change adaptation strategy. This practice, however, has seen migration of species like crickets into crop lands as they also adapt to the new conditions. Therefore, it can be seen here that land clearance disturbs both the habitat and feeding of the armoured crickets. Thus, the reported trend towards invasion of crop fields by *A. discoidalis* is likely to be a survival strategy against the effects of climate change.

Third, drought is now an overriding phenomenon that worsens the situation. Because of worsening aridity, livestock also end up degrading grazing lands leaving virtually nothing for the crickets to feed on. As a result the *A. discoidalis* are left with no option but to survive on crops. This explains why the community is now reporting worsening devastation on crops by these pests. The people argue that previous wetter conditions would suppress the breeding of the crickets. For example, rainfall would wash away the eggs of the crickets before they hatch, thus significantly minimising the species populations. Studies by Mosupi (2003) and Mviha *et al* (2003) show that the crickets are known to favour dry habitats.

Mosupi (2003) also identified two other factors favouring the prevalence of crickets. One, the availability of *A. discoidalis* has been associated with *Acacia* bushes surrounding crop fields. Two, *A. discoidalis* is also common in areas where pearl millet and sorghum are widely cultivated. These two conditions are also true in Muzarabani. For instance, the increasing encroachment of *Acacia* tree species is a recent phenomenon attributable to seed dispersal by an increasing livestock population (see Plate 5.4). Elsewhere, Turner and Clifton (2009) relate to the study of species life cycle and their behaviour as a form of traditional ecological knowledge known as traditional phonological knowledge (TPK). In such studies, IK can aid in the understanding of how certain species respond to change and variability in the climate system.

Plate 5.4 Colonisation of land by Acacia woodlands

5.7.2 Experiences with Diseases

With regard to diseases, there are indications that certain diseases affecting humans, like malaria and diarrhoea, are declining, while new ailments never known before are increasing in prevalence. Reasons cited for the decline in common diseases affecting humans are related to climate change and health related interventions in water and sanitation programmes. The projected incidences of disease vectors like mosquitoes and tsetse flies reported in some parts of the country by Hartmann *et al* (2002) and Matawa and Murwira (2013) are not likely to be a problem in Muzarabani owing to evidence given here. However, these vectors were previously reported to be a health problem in the area.

In the case of water related diseases, it can be argued that the desiccation of wetlands and ponds that previously harboured vectors and acted as breeding grounds for mosquitoes has significantly reduced disease incidences. In this regard threfore, climate change can be understood as of merit to the local community. Drought has also led to serious water scarcities prompting the government and other development partners to sink boreholes in order to improve access to portable water. This means people can now easily access portable water, which previously they could not. In this thinking therefore, climate change is arguably an opportunity for community development through interventions to improve water and sanitation.

From a social perspective, these interventions have also impacted on the gender dimension of the community. Women and girls who used to travel long distances to access water are now travelling less owing to proximity and improved access of portable water from boreholes drilled in their villages. On the contrary, boys and young men who are assigned to look after cattle are now made to travel longer distances to enable their cattle to access drinking water which is increasingly becoming scarce owing to excessive dry season scarcity. In such communities as Muzarabani, these gender aspects and other social effects of climate change have not been adequately investigated and would need further studies to understand underlying challenges and opportunities.

Clearly, these revelations prompt further enquiry on the impact of health management interventions like malaria control in such places as Muzarabani. Local health information points to a significant decrease in malaria cases in the area (Matsongoni, 2013, *interview*). But the question that needs to be understood further is what exactly is credited for significant reduction in malaria infections. Is it malaria control interventions through occasional spraying and use of mosquito nets, or are reductions credited to climate change impacting on the ecology of the mosquito?

5.8 Report on Biodiversity

The environment in Muzarabani is ideal for supporting a rich biological diversity of plants and animals. However, climate change has not been sympathetic to the perpetual existence of this biodiversity. Drought coupled with desiccation of wetlands, ponds and rivers means riparian species that were commonly found in these habitats are also under threat. In trying to cope with climate change impacts, humans are exerting pressure on wetland, riverine and terrestrial ecosystems with a subsequent impact on the biodiversity that are supported in them. In aquatic ecosystems, fish, crocodiles and other species are reportedly disappearing owing to drought and desiccation of rivers, pools and ponds.

It was reported that desiccation of vleis has led to plant succession, replacing the once prevalent marsh and shrub vegetation by large Mopane woodland tree species. Previously, the dominant *Colophospermun mopane* and *Julbernadia globiflora* species were interspersed by vlei vegetation. The disappearance of the latter is also threatening fauna species it used to support.

The locals are also able to understand floral biodiversity, including the wild fruits they gather especially during the drought periods. A collection of fruits listed include *matamba, hwakwa, nhunguru (Flacourtia indica), matohwe (Azanza garckeana), mauyu (Adansonia digitata), masau (Ziziphus mauritiana) and nhengeni (Ximenia caffra).* These used to be plenty, but are becoming fewer owing to population growth and its pressure on land clearance and commercialisation to avert hunger and famine caused by drought and floods. Apart from contributing to the decline of these tree species, the locals argue that drought is also affecting the productivity of these fruit trees.

Despite the observed anthropogenic pressures on biodiversity, the combination of CAMPFIRE and customary restrictions have at least managed to maintain some stands of forests and woodlands which can serve as species inventories in monitoring change in the climate system. The impact of these strategies is seen in the maintenance of a variety of mammals like kudu, impala, zebra, buffaloes, elephants, hares, lions, leopards, and various reptiles especially crocodiles and snakes. For instance, elephants are known to move along some forest and woodland corridors between Mavhuradonha Mountains and the Zambezi River. These giant mammals are also found around villages where they get attracted to stands of *Ziziphus mauritiana* (masawi) fruits and riverine crops during the growing season. As shall be discussed in Chapter 6, the indigenous understanding in the protection of forests and woodlands is important in climate mitigation.

Lessons drawn here are that climate change, either directly or indirectly, affects biological diversity in Muzarabani. Directly, some tree and animal species are dying owing to drought coupled with desiccation of vleis and aquatic habitats. Indirectly, unsustainable coping and adaptive measures are also threatening biodiversity. This means climate change is significantly affecting species richness and species abundance. From the evidence gathered here, species abundance of certain species like birds, termites and crickets is increasingly becoming noticeable.

5.9 Conclusion

Emerging from this discussion is that communities through their IK are capable of monitoring change in the climate system using a variety of environmental parameters. An important tool they use for managing their environment is a customary management system. In this chapter, it was shown that the philosophy of sacredness – a commonly shared thinking held by the indigenous populations – drives environmental management and conservation. It is from this protectionist belief that changes in their environment can adequately be monitored and identified. A number of opportunities exist for utilising IK in enhancing understanding of changes in the climate system:

a) Capability to identify and study elements of the climate system such as seasonal changes, temperature, rainfall, wind, clouds, thunderstorms and lightning which are also considered as key elements in mainstream climate science.

b) Capability to identify and study some ecological and hydrological indicators such as biodiversity, forests, woodlands, tree and animal species, rivers, pools and ponds, and vleis. This can guide adequate understanding of the nature and extent of impact on local ecosystems.

c) Capacity to enhance in-depth understanding of socio-economic impacts associated with climate events such as drought and floods, including the social dimension of climate change on gender, food security, water accessibility, human health and social conflicts related to resource pressure.

Overall, the analysis presented here has managed to unravel the untold story about opportunities created by climate change on community development. Previous studies have tended to dwell much on droughts and floods as disastrous events always inflicting harm on communities experiencing them, without comprehensively reporting on opportunities associated with climate change. A participatory review of the developments in Muzarabani from the people's religious attention to the environment over the past five decades have shown some evidence toward reduction in disease incidences owing to changes in vector ecology, including improvements in water and sanitation as development agencies make interventions to address the challenges of climate change. Notwithstanding these observations, there is still need to critically appraise the situation in terms of the community's adaptive capacities. This shall be attended to in Chapter 7.

Given a milieu of limited documentation of climate change impacts in Africa, the results discussed here reveal that knowledge of the local people is potentially useful both as leads and a baseline for future empirical work on the effects and processes of climate change. Typical examples of avenues worth exploring include the remotely or partially investigated influence of climate change on terrestrial and aquatic ecosystems, and the epidemiological aspect of the phenomenon. The highlights emerging in this IK enquiry could serve as hypothetical stances requiring the refinement of conventional climate science. The next chapter treats IK capabilities from the perspective of climate mitigation.

CHAPTER 6

INDIGENOUS-BASED MITIGATION

Trees are our relatives

Elderly participant in Muzarabani

6.1 Introduction

Chapter 3 dealt with mitigation and adaptation as key concepts underpinning climate change strategies. It can be emphasised here that mitigation, from the viewpoint of being a substantive action against potential harm, serves a dual purpose: averting the magnitude and severity of destabilisation in the climate system and reducing risks associated with the phenomenon. Therefore, the need to understand opportunities associated with IK applications from these twin perspectives is pursued in this chapter. Essentially, the chapter serves to document existing scientific, cultural and technological practices of indigenous people, which are relevant in climate change mitigation. The utility of IK is explored both from the viewpoint of enhancing GHG sinks and that of reducing vulnerability to hazards posed by extreme climatic events on the Muzarabani community at risk.

Opportunities available for enhancing assimilation of GHGs through forestry management practices under indigenous arrangements are first presented here. Later, the chapter dwells on strategies in place that the community can use to minimise their exposure to hazardous events potentiated by climate change. An attempt is made to relate the indigenous ways of observing climate change (presented in Chapter 5) to the mitigative strategies of the community.

6.2 Indigenous Knowledge and Climate Mitigation

The indigenous ways of mitigating against climate change and its impacts are mainly understood in a system of customs and practices by the local community. This section presents the opportunities available for enhancing GHG sinks under the customary arrangements of the people. Strategies meant for reducing vulnerabilities to extreme climatic events are also presented. However, as shall be discussed later in this chapter, indigenous disaster risk reduction (DRR) strategies tend to fall under strategies for enhancing adaptive capacity and the two practices are difficult to separate.

6.2.1 Indigenous-Based Climate Change Mitigation

Stands of sacred forests and trees, together with sacred wetlands and the shrub and floral biodiversity they support, presented earlier in Chapter 5, are an important contribution in climate change mitigation. Mitigation is a key strategy for suppressing the severity of climate change by enhancing CO_2 sinks and minimising GHG emissions mainly from the energy, transport and agriculture sector (IPCC, 2014b). One way of enhancing carbon sequestration would be through promoting sustainable forestry conservation practices. Thus, it is a fact that customary environmental management practices defined by IKS under the notion of sacredness and other community-based strategies exposited later in this section are essential strategies toward climate regulation.

With sacred forests and trees, the local leaders enforce that these should neither be burnt nor cut down because they house the spirits. Cutting them down is believed to inflict misfortunes on society. The *mhondoro*, understood as the spirit lion among the local Shona people, represents connectedness to the ancestral spirits who guide and protect the people. It is common thinking in the area that people are not detached from the environment. As such, this belief has managed to preserve giant forestry resources in places like Tsokoto, where the common Shona spirit medium, Mbuya Nehanda, is buried. Rukonde Forest along the Musengezi River, for example, is one of these highly valued forests. Its width extends some kilometres across the river and its length is tracked several kilometres along the river into Mozambique.

Mohamed-Katerere (2002) shares a similar view that conservation strategies are inter-woven in cultural beliefs through this notion of sacredness. This connection between environment and people is evidenced in the words of one of the respondents: *Miti ihama yemunhu (Trees are our relatives).* A closer analysis of this expression denotes a good appreciation of a fine balance between environmental integrity and social well-being within customary practice – an aspect of sustainability. It demonstrates understanding of the intrinsic bond between humans and their environment – a belief system where nature is linked to the supernatural. To the locals, this knowledge means their survival is dependent on the preservation of forests and trees and harming these assets will end up negatively affecting them too. Therefore, they look at forests as an inviolable resource. This philosophy is understood in environmental studies as kincentric ecology. In this view, Turner and Clifton (2009) opine that other forms of the environment are regarded as generous relatives who commit themselves so that human beings can exist. Within this environment-spiritual connection, Mohamed-Katerere (2002) identifies two rules that characterise this bond. One, there are rules that link abuse of resources to spiritual sanctions and, two, spiritual rules that restrict use and condemn unsustainable exploitation. The people thus have a moral obligation to prudently use the environment.

When examined in the science of climate change mitigation, these sites can serve as sinks for carbon sequestration and climate regulation. In mainstream climate discourse, opportunities exist for tapping from this concept to enhance mitigation programmes. There are two major mitigation interventions targeting the forestry sector in developing countries; namely, the programme on Reducing Emissions from Deforestation and Forest Degradation (REDD+) and that on Land Use, Land Use Changes and Forestry (LULUCF). It is argued here that IK can offer opportunities for the success of these interventions.

6.2.1.1 IK and REDD+ Linkages

REDD+ is a collaborative initiative in developing countries created in response to the UNFCCC at the 2007 13th Conference of Parties (COP 13) in Bali (UNFCCC, 2007). It is a carbon-based compensation mechanism for projects that reduce carbon emissions or enhance carbon sinks (Danielsen *et al.*, 2011). Makhado *et al* (2011) argue that it is no longer just understood as a highly specific mechanism to tackle deforestation and degradation, but has shifted towards a broader inclusion of efforts to mitigate carbon. It defines the contribution of forests to emission reduction while contributing to economic development, making it relevant to indigenous communities if they can wisely manage their environment.

Hitherto, there is only one REDD+ project in Zimbabwe – the Kariba REDD+ Project covering four RDCs of Mbire, Nyaminyami, Binga and Hurungwe – upstream of the study area. This privately-funded project is an initiative by a United Kingdom-based firm called Carbon Green Africa. Already there is reported outcry over governance, transparency and accountability issues since its implementation in 2009 (Herald, 27/10/2014). It can be argued here that adequate engagement of indigenous communities in the project cycle can be a solution to these problems.

Overall, a number of stumbling blocks towards the full-scale adoption of REDD+ in the country have been identified. These include limited awareness and understanding of REDD+ among stakeholders, limited capacity building and stakeholder engagement, poor governance, deforestation resulting mainly from tobacco curing, domestic energy use and open cast mining operations, and unwillingness by donors to provide bi-lateral funding (Makhado *et al*., 2011; Jiri *et al*., 2013). Therefore, IK, under the guidance of customary leadership arrangements, can be an opportunity to successfully implement REDD+ projects to address climate change and rural poverty in such communities as Muzarabani. Sekine *et al* (2009) advise that when adopting such forest management projects, the system must be harmonious with local social rules and systems to avoid conflicts between local government and communities living alongside the forest resources.

6.2.1.2 IK and LULUCF Linkages

Concerning LULUCF, the Kyoto Protocol identifies changes in carbon stocks and GHG emissions by sources and removals by sinks related to direct anthropogenic landuse change and forestry activities (UNFCCC, 2006). Globally, about 17% of GHG emissions come from land use and landuse change (Olivier *et al*., 2005), and IPCC’s AR5 highlights the significant role played by this sector in the overall atmospheric carbon stabilisation (IPCC, 2014b).

Human activities such as land clearance and cultivation, livestock grazing, and forest fires by the villagers have an influence on the carbon cycle dynamics between terrestrial ecosystems and atmospheric concentrations, though on a limited scale. Under their IK, these activities are regulated. For example, land allocations for cultivation, settlement and livestock grazing are done with guidance from the chiefs and headmen who are the custodians of local customs. People are not allowed to burn forests or indiscriminately cut down trees unless they get permission from the traditional leaders. The locals believe that burning the forests disturbs the *mhondoro* who reside in them. Thus, as previously mentioned, some forests, trees and other sites are considered sacred. However, a potential threat to the continuity of such practices mainly comes from land pressure associated with agricultural-based livelihood activities and the influx of the migrant population discussed in Chapter 2. Furthermore, climate change itself may force the locals to devise unsustainable adaptation practices that end up threatening local ecosystems. Apart from this, the gradual loss of IK in the community could also be a major hindrance.

The participants believe that the continued threat to sacred forestry has more to do with human pressure, a situation that could not go unchecked during the past decades. They argued that during this period, the spirits had their own way of punishing offenders, even if the traditional monitors did not notice the culprits. A clear testimony by one of the respondents shown in Box 6.1 exhibits this view.

Box 6.1 Complaints about ecosystem disturbances

"Most of these violators are the immigrants that came from other places. Violators are punished by the chiefs with various fines ranging from chickens, goats or cattle, depending on the gravity of the offence. This is meant to deter others from unsanctioned practices. For example, we have a case of a man called Chiwayawaya who was bruised by a lion after secretively eating a pangolin which traditionally is reserved for chiefs only. Also, a long time ago two whites who failed to observe the traditional strictures mysteriously died at Sohwe Falls, a sacred place in Mavhuradonha mountains and their bodies were picked by a helicopter. In 1974, a baobab tree that was felled down by bulldozers to open up land for ARDA estates against our tradition was heard crying with human voices. This tree was known to be home for the spirits and their instruments.

"Another interesting incidence happened in 1963. A man in this community accidentally ensnared a lion. During the day lions would come to his courtyard, roaring fiercely. We knew for certain that something was wrong. This man was later summoned by the chief and elders who advised him to consult the spirits. The problem only ceased after he was asked to pay compensation under strict spiritual guidelines."

Elsewhere, in most rural areas, it is a fact that the state of Zimbabwe's forests is under pressure from unsustainable landuse practices and energy consumption (MENRM, 2012b). Overall, forests in the country cover 16.80 million ha with eight major forest and woodland types of Miombo, Teak, Acacia, Mopane, Savannah, Combretum/terminalia, Montane and Exotic plantations (Murwira *et al*., 2013). In rural areas, communities exploit the resources at varying levels for energy, food, construction and grazing for their livestock among other livelihood uses. Therefore, in such places as Muzarabani, villagers can derive meaningful benefits from sustainable natural resources management defined by their customs. More benefits can be realised if these strategies are integrated with the ongoing CAMPFIRE initiative mentioned in Chapter 2. In the current mantra of climate change mitigation, such communities can benefit from ecosystem-based mitigation strategies such as REDD+ and LULUCF. IPCC (2012) reports that REDD+-based mitigation generates co-benefits for adaptation through mediating run-off and reducing flood risk. Such opportunities can be harnessed for enhancing DRR and adaptation strategies against climate-related disasters like floods.

6.2.2 Indigenous-Based Disaster Risk Management

Through their IK, the locals have devised a range of mitigatory strategies against drought, violent storms and floods. IPCC (2012:558) defines disaster risk management (DRM) as "processes for designing, implementing, and evaluating strategies, policies, and measures to improve the understanding of disaster risk, foster disaster risk reduction and transfer, and promote continuous improvement in disaster preparedness, response, and recovery practices, with the explicit purpose of increasing human security, well-being, quality of life, and sustainable development." The intention, as explained by Wilbanks *et al* (2007), is to keep climate change impacts as low as possible. In this conceptualisation therefore, the role of IK in DRR is pursued.

As earlier reported in Chapter 2, community development interventions in the study area can best be described as an assortment of technocratic efforts by various government agencies, NGOs and faith-based organisations, making the purity of indigenous practices disputable. However, an attempt is made to distinguish indigenous-based DRR strategies from conventional ones. Where evidence of interactive practices is found, the significance of the former is also stressed.

6.2.2.1 Disaster Risk Management against Drought

The recurrent droughts in Muzarabani have called for appropriate DRM strategies by the local community. It can be understood here that DRM entails a toolbox of interventions to enhance human security against disastrous events. From this analysis, strategies deployed by the Muzarabani community in addressing the problem of drought were identified. Worth noting is that these practices are ingrained in the people's customary practices as listed in Table 6.1.

Table 6.1 Indigenous disaster risk management strategies

Strategy	Description
Zunde raMambo	A rural project for enhancing social nets of disadvantaged members of a community involving setting aside farming land under the supervision of a chief.
Rain-making ceremonies	These are meant to enlist the intercession of *mhondoro* to bring rainfall especially before the onset of rainfall season or during mid-season dry spells. Various names such as Huruwa, Mukwerera and Makoto are given to these ceremonies in rural Zimbabwe.
Nhimbe	A term from the Shona people of Zimbabwe entailing collective community effort where people pull their resources together for some field work or any other community task.

The Zunde raMambo Strategy

According to the participants' descriptions, the main purpose of the Zunde raMambo project is to enhance social protection against such problems as famine particularly to the vulnerable members of society. Mararike's (2001) analysis shows that the strategy has a long history as a traditional social welfare practice in rural Zimbabwe (see Box 6.2). As such, it is important in addressing food insecurity threats resulting from drought and crop damages by floods and hailstorms.

Box 6.2 A description of the Zunde raMambo project

Zunde is a Shona word that may mean a large gathering of people taking part in a common activity or may refer to plenty of grain stored for future use by people in a particular community. However, *Zunde* normally means an informal, in-built social, economic and political mechanism. Its primary aim was to ensure that a particular community had adequate food reserves that could be used in times of food shortage. The *Zunde* practice ensured that food security for a village or villages was guaranteed at all times. A Chief designated a piece of land for cultivation by his subjects. The yield from this land was stored in granaries (*Zunde raMambo*) at the Chief's compound. The food was also used to feed the Chief's soldiers, subjects awaiting trial, the Chief's advisors, and the destitute, as well as travellers who stopped in the village for the night. Village ceremonies such as burials also benefited from the *Zunde raMambo* food reserves. The main beneficiaries were, however, the villagers themselves during times of food shortages.

Zunde was perceived not only as a crop production activity whose main objective was to address food shortages, but was also regarded as a social, economic and political rallying mechanism. The chief to control his people and to ensure their safety used it. Participation in the *Zunde raMambo* was an expression of oneness and carried with it social and moral obligations. Food was perceived not only as a means of meeting nutritional requirements, but also as a social tool which brought people together to share their successes and/or failures.

(Source: Mararike, 2001:54-55)

In Muzarabani, like in many parts of the country, this practice is being strengthened to increase food production with the long-term intention of decreasing dependence on the state for food so that state welfare and food security interventions are shifted to the grassroots levels. These observations resonate with Kaseke’s (2006) findings that the practice is increasingly appreciated as a security mechanism designed to address the contingency of drought and famine. The resources required in the implementation of this strategy include land, labour, agricultural inputs (fertilisers and seeds) and implements. The village labour is required in cultivation, planting, weeding, harvesting and building of granaries for keeping the harvests. Inputs in the form of seeds and fertilisers, including advisory services of late, come from government, extension service staff and NGOs. This means even though the current implementation gets the full support of external development interventions, the genesis of this strategy is unarguably indigenous.

The Zunde strategy, however, is not without implementation challenges that tend to haunt its effectiveness. For example, the respondents complained that inputs released by governments rarely get to the community in time. One participant pointed out the challenges associated with late disbursement of the inputs: *It becomes very difficult to plan for the project when seeds and fertilisers come late in the season such as in January. Honestly, what will the people do in such situations?* Also, beneficiaries from the food reserves are prioritised as older persons, the sick, widows, orphans and persons with disabilities. Of late, however, the recurrent droughts caused by climate change have exerted much pressure on the limited reserves since almost everyone would need a share of the grains when famine strikes. In order to address some of these challenges, participants were of the view that the project could be decentralised from the chief to the headman so as to increase food reserves to meet the increasing challenges of food security in Muzarabani.

Indeed, the Zunde raMambo as a platform for collective action by community members is a home-grown mechanism with merits in DRM. Its significance in this regard deserves emphasis against climate change risks and the weakening of national social security schemes attributed to resource constraints, erratic food relief supply chains and politicisation of food aid reported by Mapfumo *et al* (2010).

Rain-Making Ceremonies

Traditional practices through rain-making ceremonies have a long history not only in Zimbabwe (Vijfhuizen, 1997; Mararike, 2011), but also in many parts of Africa (Muhando, 2005) and in the Middle East (Dafni, 2011). In Muzarabani, the ceremonies can be understood as a strategy to reduce the risks posed by drought by soliciting the help of ancestral spirits whom they believe have power to bring rain if appeased or keep away it whenever they are angry. In fact, the locals refer to failure to adhere to the strictures demanded by these ceremonies as the reason behind drought in the area. This thinking is insistent, from respondent to respondent. For instance, one of the participants explained this:

> *We have our own traditional ways of getting rains through traditional beers. If we religiously adhere to the requirements those who visit Dendemaro would hardly get back home without rains pouring on them. Long ago Mbuya Nehanda and Sekuru Mupfudzi were the rainmakers. These would go with a snuffbox to Mutota, who would then pass it to Chingovo, then to Musumha. Musumha was a mhondoro whose forehead could be seen shining when it was time for rain. The problem nowadays is that some people are no longer interested in these ceremonies and view them as archaic, primitive and anti-Christian.*

When asked about the continuation of such practices, the respondent's face fell (perhaps being worried about the manner in which the ceremonies are treated these days) before bravely gathering some pride about the rituals: *We follow the advice that we get from these government extension officers, but mikweverera yedu hatiregi (we won't abandon our rain ceremonies).* Clearly, the insistence shown here emphasisies that the community has a strong faith in the rain-making ceremonies which they see not only as a survival strategy against drought, but also a religious practice to keep ties with their ancestry.

Under these ceremonies, each community member is expected to contribute some grains for preparing traditional beers at the *Dendemaro* (sacred shrine). This beer is prepared by old women who are beyond fertility age and no longer sexually active. Sometimes the services of young girls can also be sought, though of late, it is has been criticised for violating children's rights. For example, one participant complained: *The practice requires that we take a girl from each household. But it is now difficult because some families believe that their girls will become heathens.It is a pity that we cannot give instructions to our own children. The girls can just scoff at you.*

Water used in brewing the beer is taken from sacred pools or sacred wells. This practice is done annually and can be repeated within a year whenever the custodians of the *Huruwa* deem it expedient, especially in the event of mid-season droughts. The occasion is always co-ordinated by rainmakers (usually the *svikiros*) or traditional leaders. In their worshipping, these elders would also report on such problems bedevilling the community as droughts, floods, crop pests and diseases or lightning bolts striking people. It is also reported that the custodians of *Huruwa* would also apologise for society's *zvimina* (taboos or sins) such as fornication, murder, rape, *juju* or any other unsanctioned act that upsets the spirits. However, the elders in the community believe that shortcomings in the way these rituals are held are the reasons why rains sometimes may fail. This observation resonates with Vijfhuizen's (1997) findings that the Mutema and Musikavanhu people of Chipinge in southeastern Zimbabwe associate drought with community conflicts and taboos.

The Nhimbe Strategy

This scheme, involving mutual aid through collective sharing of resources by members of a community, is an indigenous move towards alleviation of environmental problems such as drought. According to the participants, this co-operation ideology fosters responsibility by countering a dependency syndrome that has captivated a donor dependent Zimbabwean society in general. Here, the host who calls for a *Nhimbe* is not a passive bystander during the process. His or her effort put to the task is demonstrated from contributing food and drinks such as beer and *maheu* (a form of traditional beer not containing any alcohol) to active involvement during the work. The invited guests would come with such resources as labour, expertise, ploughs, hoes and draught power (cattle and donkeys), depending on the nature of the task – ranging from ploughing, planting, weeding, harvesting, threshing or construction work. As such, the idea is about enhancing food security in the community.

In this strategy therefore, the collective work ensures that activities are done speedily and timeously. When viewed from a disaster management perspective, the concept serves to strengthen the social nets of the community against the risk posed by climatic events such as droughts and floods. In addition, it can also be understood as a strategy to minimise the devastating effects of pests like birds, crickets and termites.

There are many aspects of Nhimbe that resonate with DRR of climate related events. For instance, the practice has a multifunctional role. Firstly, it is intended to share expertise, skills, experiences and ideas about how to address drought. Secondly, it is a matchmaking practice, obviously intended to boost morale of participants, where people eat and drink during and at the end of work. By so doing, it creates opportunities for networking – sharing problem solving knowledge and skills. Thirdly, it harnesses resources, which are always limited in such rural communities as Muzarabani. The collective pull of local capital is necessary to build community resilience against climate shocks like drought, instead of waiting for outside intervention. Fourthly, the major underpinnings of the ideology described by the participants as solidarity, co-operation, trust, honesty, respect, allegiance and reciprocity, are necessary in strengthening social nets against a background of worsening climatic perturbations. Evidence that such interventions are taken seriously by the community members is given in the comment by one of the participants: *If you can't mourn with others, why should they come to mourn with you when disaster strikes?*

The three strategies presented here embrace the significance of community networking, participation, collective responsibility, response and continuous improvement, elements that commonly feature in disaster management scholarship (UNEP, 2008; UNISDR, 2008; Gwimbi, 2009; IFRCRCS, 2010; Carcellar *et al.*, 2011; Satterthwaite, 2011; IPCC, 2012; Lavell, 2012). For instance, community networking through sharing experiences, knowledge and problem solving skills is also an important aspect of indigenous-based DRM strategies discussed here. This strategy has been treated by other scholars as social capital (Woolcock & Narayan, 2000; Castle, 2002; Johnston & Percy-Smith, 2003; Sekine *et al.*, 2009; Chanza, 2011). Woolcock and Narayan (2000:3) define it as "the norms and networks that enable people to act collectively." From a disaster management standpoint, the concept constitutes a vital asset that can be leveraged on as a strategy for climate proofing.

Sekine *et al* (2009) argue that social capital itself tends to influence the success of climate interventions targeting local communities. In a similar emphasis, the IFRCRCS (2014) advises on the need to consider cultural issues like religion and local beliefs as an entry point for disaster risk reduction.

6.2.2.2 Disaster Risk Management against Floods and Violent Storms

Experiences with floods and storms by the Muzarabani community have also enabled it to develop a collection of disaster management strategies using their IK (see Figure 6.1). Two important observations need to be emphasised about these interventions before their operationalisation is unpacked. First, practices like *Zunde raMambo, Nhimbe* and cultural ceremonies discussed in the preceding section relating to DRM for drought are also employed to manage floods. Accordingly, their detailed application will not be repeated here. Second, from the definition of DRM given earlier, it can be learnt that the specific activities detailed in Figure 6.1 reverberate with some of the adaptive strategies presented later in Chapter 7. This means some DRM and adaptation measures deployed by the indigenous people are overlapping and complementary. In addition, these strategies are not mutually exclusive, but can be deployed synchronously to reinforce one another depending on the community's exposure to specific climatic risk.

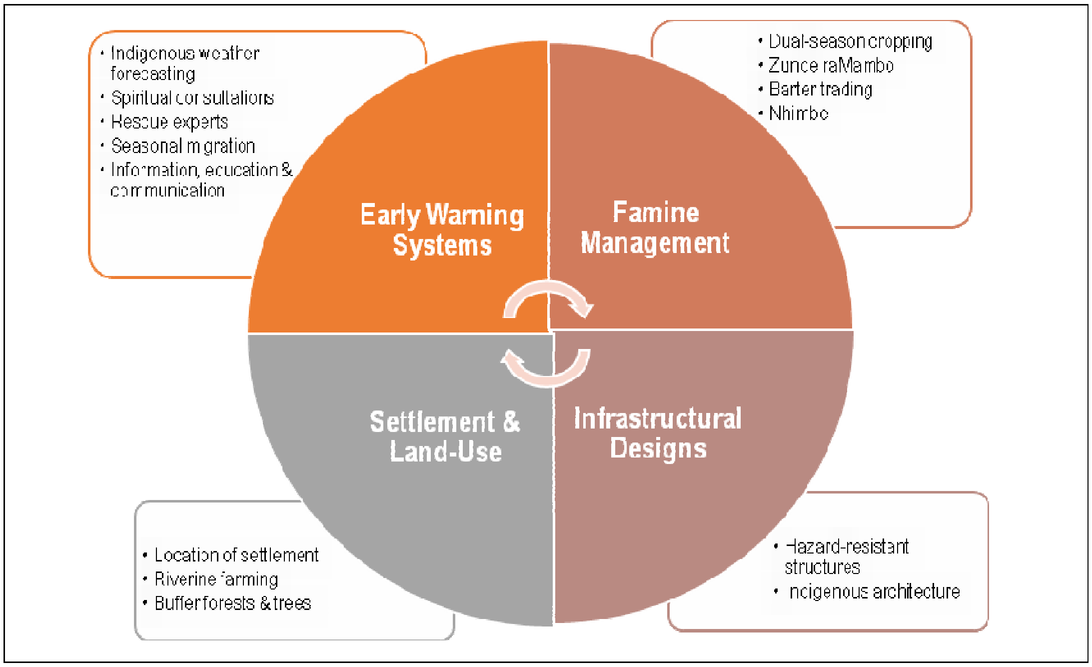

Figure 6.1 Indigenous strategies for managing flood-related disasters

Indigenous Early Warning Systems

Early warning systems (EWS) used by the indigenous people consist of indigenous seasonal forecasts, spiritual consultations, and information, education and communication (IEC) strategies. Important to note here is that the EWS are also supported by early action involving seasonal migrations and rescue operation plans. For example, participants reported studying the behaviour of migratory birds (locally referred to as *Mashuramurove*) and certain tree species such as *Hwakwa* to predict events like floods. One respondent explained: *If we see Mashuramurove hovering in the atmosphere around November/December, or if there are many of the Hwakwa fruits that season, we can tell that there will be much rain with the potential of causing floods. So people are then warned to leave riverines as soon as we start to receive torrential rains*.

Information on EWS is also passed on to the villagers after consulting the spirits. There is a strong belief among the people that the *mhondoro* have accurate forecasts on the occurrence of floods, droughts, or any other events like hailstorms, and severe thunderstorms and lightning better than conventional meteorologists. As such, special elders such as *madunzvi* and *masvikiro* routinely visit the holy shrines for advice before the villagers are asked to take some appropriate action. In the event of anticipated flooding for example, early action would involve human migration to safer areas, shifting livestock grazing to less vulnerable places and stocking food coupled with safekeeping of other assets. Another intervention in the event of people marooned by floods involves rescue operations as explained by one of the experts in thefollowing testimonial:

> *We can use indigenous boats made from barks of trees that we call Hwato. We use these to sail across the flooded rivers so as to rescue people who would have been trapped on the other side of the river. If anyone gets drowned in the waters we can even get there with our ropes. But the operation needs very brave men since the waters will be so powerful that you risk being swayed away yourself. These ropes are tied around the victim's waist before carefully dragging him/her for safety.*

Of particular mention in this analysis is that the strategies presented here exhibit a clear practical application of EWS and early action. The purpose of an EWS from the viewpoint of the IFRCRCS (2009) is to put in place systems for action before the occurrence of the disastrous event. In this regard, the utility of the indigenous-based EWS presented here deserves emphasis against a backdrop of challenges in early warning communication and early action by responsible authorities in Zimbabwe that were also cited by Gwimbi (2009). Facts substantiating the effectiveness of local rescue operations can be read in a declaration by one of the interviewees: *Our community rescue strategy works very well. The Army helicopters brought by the Department of Civil Protection will only reach here after the waters have vanished. By that time, we would since have rescued our people.*

An assessment of the capacity of disaster management institutions in Zimbabwe is beyond the focus of this thesis. However, it is clear from the insights given here that such institutions have a limited impact on addressing disaster management issues in the broad Zimbabwean landscape. On a similar note, a study by Gwimbi (2009) laments poor linkages between EWS and early action as stymieing DRM operations in the country. As discussed earlier in Chapter 2, these challenges also relate to geographic barriers, deprivation and remoteness of such places as Muzarabani.

Other early action strategies entail activities for addressing famine, land `use and settlement arrangements, and housing architecture as elaborated below.

Strategies to manage famine

According to the information gathered from the participants, the devastating effects of floods are seen mainly in crop damages, livestock losses and destruction of structures such as granaries used for stocking food. This would lead to food scarcity in the area. In response, they make use of EWS to devise strategies for famine management. Thus, the locals can also make use of the IEC strategies to strengthen interventions for famine management. A toolbox of famine management strategies used includes dual-season cropping, barter-trading, *Zunde raMambo* and *Nhimbe*.

Plans for barter-trading their livestock with grains from other communities as far as Mozambique are put in place as soon as the villagers realise the impending threat on crop production posed by floods. While this may seem an innovative idea against famine, the prudence of such a practice remains questionable particularly when it involves exchanges with livestock. This is because cattle are seen as an important livelihood asset that requires careful thought before it is easily traded away. In a crisis like famine, however, the vulnerable people would end up losing this valuable asset to save lives. As shall be discussed later in Chapter 7, this practice tends to weaken the community's adaptive capacity in the long term.

Dual-season cropping is a strategy that people living in flood-prone villages adopt to benefit from the rich alluvium deposits and moisture brought about by riverine flooding. Actually, this is one of the merits that the locals tend to enjoy from the increased frequency of flooding. One of the respondents proudly expressed: *We are mostly worried about food security and not the threat of floods. The floods are actually good to us in this era of recurrent droughts. Even if we fail to get anyyields from the main cropping season (December – March), we are certain that following some floods we are able to get something after re-planting in April.*

Structural designs

Indigenous architecture is seen in the design of structures like houses, granaries and fodder racks. These are raised to a height of at least one metre above ground as a defence mechanism against floods (see Plate 6.1). The tiers are made up of very strong wood or can also be supported by a combination of hard wood and large rocks to enhance the durability of the structure. All household valuables like food, clothes and blankets are kept in this house they locally refer to as *hozi*.

Plate 6.1 Defensive indigenous technology to withstand flood damage

(*Left, a house suspended a metre above ground, and right, a rack for storing crop yields seen here where children are standing underneath it*)

Settlement and land-use

Another defensive strategy meant to minimise harm posed by floods is seen in the settlement pattern and landuse practices. In terms of landuse arrangements, the Korekore people exhibit a sophisticated way of allocating land according to its best use, where plots are distinctively set aside for settlement, farming, livestock grazing and forestry. Walls of trees or woodlands usually demarcate these landuse types. For example, a wall of trees is left around a homestead to act as windbreaks against violent storms. Riverine trees are also not allowed to be cut down so that they can serve as a buffer zone to minimise the severity of flooding (see Plate 6.2). Evidently, it can be understood here that these plans and practices are a vital DRR strategy for minimising the threat posed by climatic events such as floods and violent storms.

Plate 6.2 Defensive mechanism of woodland and trees

(Left, riverine trees, and right woodland patches)

6.3 Conclusion

This chapter detailed some indigenous-based mitigation strategies ranging from those that are capable of enhancing GHG sinks to those that aim at DRR. Other factors like interventions from exogenous-based development agencies and their ideas, a dual administrative arrangement involving customary leadership alongside statutory established administration under the auspices of RDCs, and the scale of impact caused by climate change also have an influence in the utilisation of IK. Consequently, it can safely be concluded that some of the strategies targeting DRR may overlap with technocratic-based ones rendering the purity of IK contestable. However, the purpose of this thesis is not to label IK as a 'Messiah' to climate strategies, but to understand how the knowledge can be used to complement mainstream thinking about climate science. In this regard, an attempt was made to examine the nature and relevance of these indigenous interventions in climate change mitigation.

Furthermore, the treatment of mitigation as separate from adaptation is not necessarily in negation to the well-established evidence of the complementary roles of the two concepts as presented in Chapter 3, but is for illustrative purposes only. As in various mitigation and adaptation literature (Wilbanks & Sathaye, 2007; IPCC, 2014a; IPCC, 2014b), climate change impacts cannot be evaded. This means the indigenous-based mitigative practices presented in this chapter cannot be a panacea to the local threats posed by climatic events and would always need to be supported by adaptation. A range of adaptive strategies to respond to climate change impacts identified in Muzarabani are presented in the next chapter (Chapter 7).

CHAPTER 7

INDIGENEOUS-BASED ADAPTATION

Some content of this chapter is based on a conference proceeding paper presented at the East & Southern Africa CBA and Resilience Learning Conference, ILRI Campus, Addis Ababa - Ethiopia; 1-4 September 2014. This paper is to appear in the publication as:

Chanza N (2014). Harnessing Indigenous Knowledge for Enhancing CBA and resilience in Muzarabani dryland, Zimbabwe. *Joto Afrika, ALIN.*

7.1 Introduction

In conceptualising climate change adaptation in Chapter 3, it was understood that as a concept, adaptation serves to respond to some climate stimuli so as to minimise harm or enhance the benefits brought about by climatic conditions or events. In this treatment therefore, it is necessary from the lens of IK enquiry to identify those measures that are used by indigenous people in Muzarabani. It is also essential to understand how the knowledge and practices of indigenous people influence their adaptive capacity.

This chapter details some coping and adaptive options and practices of the people to some specific identifiable climatic stimuli. Throughout the discussion, an attempt is made to relate the indigenous ways of observing climate change (presented in Chapter 5) to the adaptive practices of the people. This is intended to investigate the extent to which these response mechanisms are able to minimise harm and/or harness opportunities created by climate change. As in adaptation scholarship, the chapter also concludes that there are limits to adaptation from the IK perspective. The forces behind these barriers are not only endogenous, but also emanate from the shortfalls of exogenous interventions (mainly by government and development agencies) exacerbated by the growing risks potentiated by change and variability in the climate system. The risk of mal-adaptation prompted by lack of congruence between indigenous-based adaptation and top-down based adaptation interventions is also highlighted.

7.2 Indigenous-Based Adaptation Strategies

As the people get exposed to climatic challenges, they do not just watch in passivity. Instead, wittingly and mostly collectively, they develop knowledge to act appropriately to the new challenges. This knowledge, jointly framed and developed by the people themselves from their own experience with climatic events, and the actions or inactions taken to suit the new challenges is deployed here as 'indigenous-based adaptation'. The emphasis here is that the reactions and practices by the community experiencing the events are endogenous and not externally-driven. The challenge in this analysis, however, is to distinguish these indigenous responses from interventions brought by outsiders or conventional players. In this regard therefore, the discussion presented here shall attempt to clarify this dichotomy and highlight areas where some overlapping exist.

Given the threats posed by climate change, the locals in Muzarabani have devised a toolbox of response mechanisms to save lives and livelihoods. Chapter 15 of the IPCCC's AR5 notes a marked transition from a phase of awareness to the construction of actual strategies and plans (IPCC, 2014a). This is also a true observation in the study area where the motivation behind coming up with responsive actions is largely from the knowledge that the environment in which they inhabit has been characterised by uncertainties and irregularities that compel them to adopt appropriate coping and adaptive strategies.

Coping capacity and adaptive capacity have been analysed in Chapter 3 as complementary concepts where the former looks at short-term emergency responses, while the latter places emphasis on learning about appropriate reactions to the same event to institute some better responses in the future. The unfolding discussion isolates the main climatic experiences presented in Chapter 5 and draws attention to the respective coping and/or adaptive interventions deployed by the locals to specific climatic stimulus. A scheme of these intervention typologies gathered from participatory analysis with the respondents is shown in Figure 7.1.

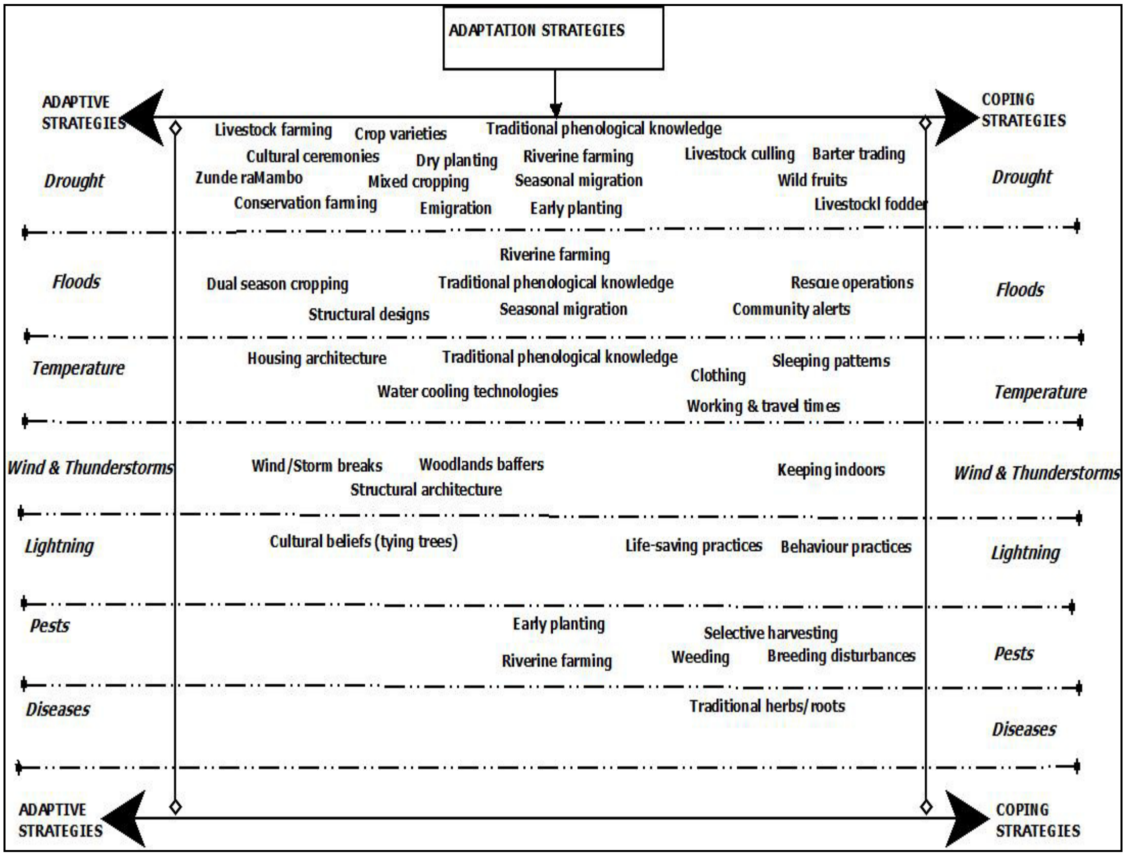

Figure 7.1 A toolbox of indigenous-based adaptation practices

(Jointly drafted through participatory analysis with the respondents)

It can be gathered here that numerous adaptation interventions to events like droughts, floods, temperature changes, excessive winds, lightning, thunderstorms, pests and diseases do exist. The task of sorting the practices into coping (short-term) and adaptive (long-term) strategies is not an easy one, but a challenge. Neither could it be simplified by participatory analysis involving the indigenous people themselves. Emerging from this observation is that there is a gradation of measures from coping capacity to adaptive capacity characterising indigenous-based adaptation interventions of local communities. Furthermore, some long-term strategies like *Zunde raMambo* and cultural ceremonies (identified in Chapter 6 as DRR measures) also feature here as adaptation measures. Consequently, a reiteration of these strategies is not necessary in this chapter. The following sections advance the analysis further by examining not only the type of intervention made, but also the extent to which the measure can enhance the adaptive capacity of the community at risk.

7.2.1 Adaptation to drought

Chapter 5 presented various typologies of drought experienced in Muzarabani (see Section 5.4.1), prompting the locals to devise respective coping and adaptive measures. Mechanisms used by the villagers to react to drought events are numerous but well co-ordinated. Aside from grouping these interventions into short-term, medium-term and long-term responses (see Table 7.1), this section also evaluates the extent to which they can contribute in enhancing the resilience of the affected community. It is also critical to note before the discussion unfolds that the distinction given in Table 7.1 is only illustrative since in praxis, the adaptation choices are more of a continuum from reactive to proactive measures.

Table 7.1 Drought adaptation choices in Muzarabani

Nature of Adaptive Strategy		
Long-term	***Intermediate***	***Short-term***
Choice of crop varieties	TPK	Cattle drinking & stocking schedules
Livestock production	Early planting	Wild fruit exploitation
Dry planting	Riverine farming	Livestock culling & trading
Conservation farming	Seasonal migration	Barter trading
Stacking animal fodder	Mixed cropping	
emigration		

7.2.1.1 Drought coping strategies

In the face of drought risk posed by climate change, locals in Muzarabani have a bundle of short-term responses that enable them to cope with drought or famine (see Table 7.1).

The practice of barter-trading, apart from being a drought reduction measure, serves to avert food scarcity following crop failure. The locals use their networks to identify other places, mostly outside the valley where they can exchange their livestock for grains. In some cases they can also sell their cattle in order to raise money to buy food. The challenge with this practice is that it further predisposes the people to poverty as they end up losing their most vital livelihood asset – livestock. A closer analysis, however, sees the benefits of this practice in reducing the cattle herd to a sizeable number that they can manage given lack of forage and drinking water caused by hydrological droughts. The villagers do not just randomly cull the cattle, but they use their knowledge to selectively take out those they see to be weaker, sick, thin or less productive. This practice is commonly referred to as 'culling'. Here, it is used by the people to withstand drought caused by climate change.

Knowledge of wild fruits and the procedure of processing them also serve as a coping mechanism in the event of drought or famine. A range of tree species they utilise include: *maungu* (*Landolphia buchananii* fruits), *shumha* (*Diospyros mespiliformis* fruits), *masau* (*Ziziphus* spp fruits), *mauyu* (*Adansonia digitata* fruits) and *magoma*. *Masau* and *mauyu*, for example, are regarded as the most important food sources in drought situations. The knowledge about how to process these fruits for food is also of higher importance than the fruits themselves as this enables the people to realise more food value. Some detailed descriptions of indigenous-based food processing are given in Box 7.1.

Box 7.1 Indigenous food processing of wild fruits

Masau fruits are harvested between June and September. These can naturally be dried in the sun and carefully stored in the granaries. In the event of famine or food scarcity, the fruits are pounded to prepare *masau maheu*, a liquid which is instantly made through mixing the pounded materials with water. Unlike the common *maheu* – a liquid made from fermented small grains (sorghum or millet) malt that is usually prepared overnight and drank on the following day, what is amazing about the *masau maheu* is its instant preparation. This makes the drink unique and a strategic food source that the locals can rely on in the event of famine.

Mauyu are also used to make porridge. The white powder from the fruits is shortly immersed in water to make it soft before it is sieved. The collected powder is then mixed with water and heated to make porridge. *Magoma* are also used to make porridge and the method of preparation is more or less similar to that used in the preparation of *mauuyu* porridge.

(Source: Participants' description, 2013)

One of the respondents pompously expressed (while chewing the *masau* berries in her mouth before extending a bowl full of the fruits to the research team): *This berry is highly crucial to us in this valley. In the 1991/2 season drought that led to severe famine in the whole country, people here could have starved to death had it not been the availability of masau*.

The major constraint, however, is the increasing pressure exerted on these fruits from both humans and wild animals. For example, *masau* fruits are increasingly harvested for commercialisation by people coming from as far as Harare, depriving the locals who manage and conserve the fruits. The crisis is worsened by elephants and baboons that compete with the people over the berries. These challenges tend to weaken the people's coping capacity. Exploitation of ecosystem services as a coping measure by communities vulnerable to drought has also been documented elsewhere. Specific cases are those given by GoZ-UNDP/GEF (2009b) on subsistence farmers in Chiredzi District in Zimbabwe, Brockhaus *et al* (2013) on communities around Lake Faguibine in Mali, and Turner and Clifton (2009) on indigenous citizens of Hartley Bay in British Columbia in Canada.

Water scarcity problems caused by drought also demand that the locals devise appropriate coping mechanisms by planning for cattle drinking schedules, for example. Boys and young men who usually look after the cattle are expected to take the herds to places where water would be available during the dry spells. The challenge is the long distances of up to 25km travelled to access the water points in worst cases. This would end up forcing the people to shift the daily drinking schedules to once in every two days, instead of the usual daily routines. Villagers also devise seasonal migration schedules where the livestock are temporary taken to suitable places for easily accessing drinking water. The suitability of this intervention is questionable since the cattle population would end up concentrated in smaller areas with a subsequent threat to the land's carrying capacity. The resultant overstocking can worsen desiccation of water points and lead to environmental degradation. In a worst case scenario, the people are forced to pump water from boreholes drilled by government and other development partners. This intervention, however, is not purely indigenous but blended with externally driven extension services and community support mechanisms from government and NGOs.

7.2.1.2 Drought adaptive strategies

With regards to adaptive capacity, the Muzarabani community exhibits a portfolio of strategies seen mainly in farming choices and practices (see Table 7.1).

Cropping choices

Drought has forced the villagers to shift from long-season to short-season varieties of maize and small grains. Adaptation crops grown include an assortment of sorghum (*mapfunde*), bulrush millet (*mhunga*), grain millet (*rukweza*), cowpeas (*nyemba*), together with cotton – a cash crop. Some indigenous maize and sorghum varieties they used to grow can no longer withstand the current climate. This necessitates the locals to plant modern varieties they get through the assistance from government, NGOs.

Accordingly, the people's agricultural knowledge about selection of crops and timing of planting in the face of rainfall deficits characterising the current climatic system has been diluted by the knowledge and skills of agricultural extension officers from both government and development partners. The latter includes organisations like World Vision International (WVI), HELP from Germany, Zimbabwe Red Cross Society (ZRCS). These interventions are, however, constrained by the threats of pests such as birds and crickets (discussed earlier in Chapter 5). One of the participants complained: *The Marcia sorghum variety that we receive from HELP is seriously attacked by Quelea birds. In the 2012/13 farming season, some people decided not to grow it. Surprisingly, the attack by the birds was minimum and those who had planted it actually got very good yields*.

Another respondent cited the challenge of lack of interest in the small grains by the young generation: *Our children give us a headache. You give them sadza rezviyo (a thickened porridge made from sorghum or millet flour), they just dislike it. They don't know that this type of sadza is actually the best both for health reasons and for keeping one energetic in these days of hunger.* Clearly, it remains a challenge to convince the young generation who think that this type of staple meal is inferior. Consequently, the adaptive option of shifting to small grains is constrained by the negative perceptions and attitudes of the young generation.

Cotton is a fairly recent drought tolerant and economic crop introduced into the valley during the late 1970s. Therefore, the knowledge about its cultivation and production is certainly non-indigenous. Due to the economic value attached to it, this crop has greatly contributed towards enhancing the livelihoods of the locals. The people would use the cotton revenue to buy cattle and agricultural implements like scotch carts, ploughs and cultivators. This would enable them to increase hectarage and maximise land utilisation. When evaluated in the context of climate change, the introduction of the cotton crop has indeed contributed to enhancing the community's adaptive capacity. Nevertheless, the participants exhibited mixed reactions about cotton farming. While some fully acknowledge its socio-economic contribution, others are of the view that the crop's lucrativeness attracted an influx of immigrants who ended up competing with the native people over limited land resources. The extreme critique levelled against cotton farming is that its production requires chemicals that would end up contaminating their rivers. In this argument, reservations raised by one of the respondent are worth noting:

> *This cotton business has brought more harm than good. It used to be a profitable venture some years ago. Yes, some people can boast about enlarging their cattle herds from the cotton income. But nowadays the cattle risk dying of drought. As headmen, we have failed to control an army of migrant people invading our villages. All our rivers are now highly polluted by fertilisers and pesticides. The contamination is killing snakes and fish that used to be plenty in the rivers. So the spirits are now upset. We are now being punished for our own sins. Mhondoro have decided to withhold their rains as a sign of anger. Consequently, the cotton is now affected by drought.*

Overall, the challenges of cotton production in Zimbabwe's landscape have attracted the attention of researchers, politicians, business people and the media. For example, media reports cite the problems as associated with poor cotton pricing, poor agricultural policies and depreciating global market prices (Herald, 24/12/2013; Sunday Mail, 29/09/2013; Newsday, 27/02/2014), while researchers add that drought associated with climate change tends to aggravate the crisis (Mutasa, 2008; Unganai and Murwira, 2010; Brown *et al*., 2012; Murwira *et al*., 2013). The local subsistence farmers gave a detailed testimony about this problem (see Box 7.2).

Box 7.2 The cotton farming crisis in Muzarabani

Cotton used to be a golden crop in this valley. No family could resist its attractiveness. As a drought resistant crop, it once helped us to raise our standards of living. We could use the cash to buy everything from cattle, food, fertilisers, seeds, scotch carts, ploughs, cultivators and to send our children to school. Most young men here raised the *lobola* (dowry) through cotton farming. Even if maize would be ravaged by drought, we couldn't lose sleep because cotton would do well. Now the situation has changed. Cotton can't withstand drought anymore. If the crop is subjected to dry spell for a long time the cotton balls will fall off and the crop will be stunted leading to poor yields.

As if the drought infliction is not enough, our government is neglecting us. Even our own MP and councillors are proving to be incompetent. As farmers, we get agricultural inputs under credit schemes (a practice commonly known as contract farming). So the contractors in return ask for collateral security in the form of livestock, ploughs, cultivators and scotch carts. This means if the crop succumbs to drought, or if the pricing system is poor, we will not be able to repay the loans. The contractors are just merciless, they will just grab everything from chicken to cattle, including the same implements that we should use for farming.

(Source: Participant's narration about cotton farming in Muzarabani, 2013)

From the perspective of adaptive capacity assessment, the situation presented here reveals that poor yields resulting from drought, coupled with a poor cotton policy, expose the villagers to serious poverty as they end up losing their livelihood assets to the creditors. This means the transition to cotton as a drought tolerant crop faces formidable challenges which end up compromising the people's adaptive capacity.

Livestock production and feeding systems

With regard to livestock production, the participants expressed that they have actually shifted much of their attention to it in the face of frequent droughts and crop failures. Animals like cattle, donkeys, goats, sheep and pigs are commonly domesticated. The people are confident that livestock rearing is a better option despite the threats of drought. As previously indicated in Chapter 2, the soil and climatic conditions of Muzarabani favour livestock farming. This suggests that livestock can be an alternative adaptation livelihood mechanism as long as the practice can resiliently withstand the droughts posed by climate change. However, the threat to adaptive capacity cannot be ruled out since drought leads to loss of grazing pastures and desiccation of water points. Nonetheless, the locals have learnt some mechanisms to save their livestock from drought, notably through devising cattle grazing and drinking schedules explained earlier.

In addition, the villagers also prepare cattle fodder that they would feed the animals during the dry spell. According to the respondents, this practice has a long history in the community and is being seriously considered as an adaptation strategy. The fodder is commonly collected from crop residues soon after each harvest and would be given to the animals in critical times when pastures dry up (see Plate 7.1).

Plate 7.1 Cattle fodder stacks

(*The stacks are raised at least 3 metres above the ground both as a defence measure against damage by termites and to make sure that the cattle will not tamper with the fodder*)

Conservation farming

Conservation farming, known as *timbaugute* in the local language**,** is seen as a traditional Korekore practice used to enhance food security. Under this innovation, which entails digging planting holes with minimum soil disturbance, the respondents emphasised three main advantages associated with it: conservation of soil against erosion which also keeps soil nutrients, keeping of soil moisture, and limited labour and time requirements. Mainstream agronomists also state that this strategy, alternatively referred to as minimum tillage, leverages on natural ecological processes to conserve moisture, enhance soil fertility and improve soil structure (FAO, undated). Apparently, development extension work in Zimbabwe's agricultural sector has revitalised the concept to promote food security in the whole country. In the agricultural community, conservation farming is understood as part of a broader concept commonly referred to as 'conservation agriculture'. The Food and Agricultural Organisation (FAO) defines it as: "…a way of farming that conserves, improves, and makes more efficient use of natural resources through integrated management of the available resources combined with external inputs" (http://www.fao.org/ag/ca/).

When examined in the context of drought and excessive evapotranspiration rates associated with temperature increases, the significance of the strategy in enhancing the community's adaptive capacity deserves emphasis. Participants expressed that they always obtain higher yields from pieces of land where this practice is applied. This position was also confirmed by officials involved in development work in the studied villages. A survey conducted by the Zimbabwe Conservation Agriculture Taskforce during the 2010/11 farming season has noted a dramatic increase in the adoption of conservation agriculture in the country (MAMID, 2012).

Dry planting

The strategy of dry planting, locally known as *kuparira*, is also adopted to suit the increasingly dry climate. To the locals, this practice holds several merits extending beyond just being a drought cover to other benefits like early crop maturity, and addressing labour challenges and threats from pests. Under this practice, farmers would start sowing their seeds before the onset of rainfall so that by the time the rainy season starts, the seeds would fully utilise all the available moisture for fast germination and plant growth. Put concisely, the practice enables the crop to fully harness all the rainfall received throughout its life cycle. In addition, respondents expressed that through *kuparira*, the effects of crop damage by pests are reduced. For example, one of the participants commented: *Earlier maturity of crops would* *ensure that we can quickly pick up the crops. Around that time, birds would be concentrating in wetter areas up the Zambezi where they suck juices from riverine plants. When they finally migrate down here most crops would be mature or harvestable and the damage becomes minimal.*

Riverine farming

In responding to an increasingly dry climate, locals in Muzarabani are shifting their attention towards cultivating in riverines and stream banks. These places are preferred because they are known to be highly fertile with a good moisture retention capacity that in some places can even support crop farming all year round. The locals identify this practice as *kurima kurukova* or *kurima kumatimba*. As reported in Chapter 6, villagers living in flood prone areas actually harness this practice to allow dual-season farming. The practice is also complemented by choice of crops grown. The people understand that crops such as maize require too much moisture compared to drought tolerant crops like sorghum. One respondent clearly specified: …..*kurwizi (in riverines) we grow maize and vegetables, while kunze (further away from the rivers) we spare the land for sorghum.*

Even if some villagers realise good yields to cushion themselves against drought, the sustainability of this practice remains questionable. This is because riverines are marginal ecosystems highly prone to environmental degradation. Competition over such land, coupled with poor enforcement of environmental laws and their own customary laws will exert more pressure on these fragile ecosystems. One of the headmen acknowledged weakening compliance to traditional strictures that are supposed to regulate such practices: …*munhu kana aine nzara haatongeki (it is difficult to enforce our conservation laws if people are hungry).* The ecological threats associated with competition over riverine farming can be viewed in Plate 7.2.

Plate 7.2 Ecological threat associated with land clearance in riverines

Migration

There are two forms of migration characterising adaption strategies of the people in Muzarabani namely, permanent outmigration from the valley and seasonal migration within the valley. The latter, characterised by temporary relocations to and from riverines, is also deployed as a flood adaptive measure except that the direction of movement reverses. Temporarily, some families in dry places relocate to the moist flood plains in order to escape drought. In flood hit villages, the movement will be seasonal and in the opposite direction. Seasonal migration to exploit riverine moisture is however, restricted to long-time citizens who have access to the riparian land.

Drought challenges experienced in the community also force some households to migrate to other places outside the valley. Evidence gathered points. out that this strategy tends to be the last preferred option from the adaptation toolbox. Furthermore, this practice is selective as not everyone is willing to leave the area. Reports by the participants indicate that mostly those immigrants who had actually moved into the area mainly since the 1980s are the ones characterised by this strategy. In a study to understand the motivation behind population movement in response to climate-related hazards in rural communities of Bangladesh, Penning-Rowsell *et al* (2013) also observe that migration tends to be the last resort after the vulnerable citizens would have explored all other possible options. Even though the impact of the practice in receiving regions call for further investigation, in Muzarabani this can help to decongest the area and ultimately reduce pressure on the environment in the long term. Plate 7.3 shows homesteads that have been abandoned by some emigrants from the area.

Plate 7.3 Abandoned homesteads in Muzarabani

The migration practices to suit changing environments in and outside the valley are understood as a form of long-term adaptation which has helped the community to withstand the climatic vagaries to this day. According to Chikozho-Mazarire (2009) the Korekore people's attraction to this geographically challenged valley can be traced from successive Mutapa rulers (the founding kings) who occasionally moved their settlements in and out of the valley. The strategy of migration to cope with changing environmental conditions is not new in climate adaptation literature, but has also been cited by scholars like Turner and Clifton (2009) and Black *et al* (2013).

Traditional phonological knowledge

Indigenous people in Muzarabani also keenly study the life cycle of certain trees and animals which they use to predict events in the climate system ranging from seasonal changes, drought, temperature changes, wind to floods. For example, they believe that if the *munanga* (*Acacia nigrescens)* tree blossoms in early September, then the rainy season would be expected to start earlier. The abundance of termite colonies seen collecting plant biomass into their mounds, the appearance of migratory birds and the abundance of Christmas beetle (*Anoplognathus* spp.) are all believed to be associated with a normal or above normal rainfall season with potential to cause flooding. The application of this TPK is highly valued in Muzarabani and can contribute towards enhancing the community's adaptive capacity especially against a background of limitations in official climate assessments and poor dissemination of seasonal forecast information also cited by Patt and Gwata (2002).

7.2.2 Adaptation to floods

Floods bring mixed fortunes to the villagers in Muzarabani. The main adaptive mechanisms to floods include structural designs, temporary migration and dual season cropping. These have been explained earlier in Chapter 6 (see Section 6.2.2.2) and it is not necessary to repeat the detailed expositions here. Worth mentioning, however, is the deployment of dual season cropping, a strategy that enables the locals to harness opportunities associated with flooding. In addition, villagers also apply TPK through studying the behaviour of migratory birds (*mashuramurove*) and the flowering pattern of certain tree species to predict the occurrence of floods. They use the information to enhance their traditional early warning systems which are also supported by early action. Some early action interventions include temporary migration from riverines, transferring cattle to safer grazing sites and sorting of some valuable household assets.

Overall, it can be noted that as long as the villagers are able to appropriately adapt to floods, the benefits they realise tend to override the risks posed by them. This makes the villagers reluctant to permanently move out from the flood-prone areas despite the flood hazards. Grothmann and Reusswing (2006) also observe that communities at risk of flooding devise heterogeneous options for self-protection that would reduce their vulnerability. In a similar observation, Penning-Rowsell *et al* (2013) observe that the capability of the affected people to exploit various adaptation options enhances their resilience against climate-related hazards and would consider migration as a last resort.

Emerging from this analysis is that the strategies for reducing flood disaster risks are also part of the adaptation toolbox. This means from the perspective of IK practice, DRR and adaption strategies are not clearly distinctive. Evidently, from the generic definition of mitigation and adaptation given in Chapter 3 (see Section 3.2.4 and 3.2.5), a common purpose of these concepts is to minimise harm from a phenomenon. It can also be concluded here that the complementarity of mitigation and adaptation appears to be closer in practice than in theory. Perhaps this justifies why climate science theory and practice prefer to treat them as compementary.

7.2.3 Adaptation to temperature changes

Experiences with temperature changes have also created appropriate adaptation strategies and cognitive action. These range from behaviour changes to the design of requisite structural materials. In the traditional Korekore culture, housing design was done in such a way that the people could withstand the hot climate. Houses were built of wood without dagga and the roofs were thatched. The houses used for sleeping, locally known as *gero* and *nhanga* for men and women respectively, had floors suspended about a metre above the ground, supported by very strong wooden poles and/or rocks. These features would ensure adequate natural ventilation necessary to keep the rooms cooler. However, these traditional houses have failed to stand the test of modernity. There is a common view among the locals that traditional houses are now archaic and in worst cases, considered as just rudimentary. Of late, the majority are seemingly shifting towards modern houses made of bricks and asbestos or corrugated roofs. Those who cannot afford the modern houses still maintain the wooden huts, but the walls are now mostly filled with dagga.

In terms of technological innovations, the Muzarabani people have come up with indigenous ways of adjusting to the new climate. This can be seen in local technology for cooling water they use for drinking. The water is put in a large clay pot called *chirongo*. Once filled with water, the *chirongo* is placed in a well-ventilated shade to allow natural cooling. Alternatively, the water is put in plastic containers and covered with a thick moist sack before it is suspended onto a tree to keep it cool (see Plate 7.4). Scientists have also validated that earthen pots are capable of cooling water because they keep the water temperature below ambient temperature, a process called evaporative cooling (Olorunmaiye, 1996; Mittal *et al.*, 2006).

Plate 7.4 Indigenous water cooling technology

(Water-filled plastic containers wrapped with a moist thick sack is hanging onto a tree to allow natural cooling before the water is drunk)

During the hotter months, people used to sleep outdoors but the reported falling night temperatures force them to keep indoors. In some villages, they also minimise day-time travels especially when they plan long distances, or when working in the fields in order to minimise exposure to the high day temperatures. This is done mainly in the hottest period of the year stretching from August to December. While this may seem a convenient adaptation option, the gender dimension of it may need to be examined since in such rural villages, the laborious tasks of young girls and women usually demand that they always work most of the time during the day. It is also reported that some years back, they would use their own convenient routes around the edges of forests to avoid direct exposure in the sun. Unlike measures to adjust to drought and floods that appear to be well-co-ordinated, it can be noted here that modifications to adjust to the changing temperatures are just spontaneous activities. The people would just act at random depending on the circumstance. Deressa *et al* (2009) also observe that adaptation action can be highly heterogeneous in societies facing a climatic stimulus.

7.2.4 Adaptation to storms, thunderstorms and lightning

Indigenous architecture, housing designs and wind breaks are some of the adaptation options exploited by the locals in the face of increasing violent winds and thunderstorms. To enhance the durability of their houses, the locals use poles from certain indigenous tree species they know to be highly resistant against strong winds. Periodically, the structures are also assessed to check if they are still intact and would be repaired if need arises. Ashes can also be applied to treat the poles against damage by fungi or pests which are reported to weaken the walls of houses or other structures. The houses are also designed in such a way that doors and windows would not face the direction of the violent winds.

The locals also leave a wall of trees around their compounds to buffer against potentially damaging winds. They also believe that tying fibrous leaves taken from a certain palm tree around the breast height of the trees (*Hyphaene petersiana*) protects them from lightning bolts (see Plate 7.5). In some cases, their homesteads are seen interspersed with virgin woodlands which they make sure should not be cleared up so as to provide the defensive mechanism against violent storms. As previously pointed out, the challenge with this adaptive measure is that it is constrained by competition over land use from an increasing human and livestock population.

Plate 7.5 Trees serving as a defence mechanism against storms

(The trees are left as stormbreaks around homesteads. The trunk circumference is seen here tied with rods of palm leaves to protect from lightning strikes)

In order to cope with lightning, the locals also observe that trees around the compounds are not cut down. In addition, the knowledge that people are advised to keep indoors and minimise movements during thunderstorms and lightning is also commonly applied. It is also important to note that they have acquired indigenous life-saving mechanisms from their own experiences with lightning strikes. One of the elders described the skills in the following way:

When a person is striken by a lightning bolt (mheni), one needs to gently pull out the tongue of the patient. This is done to ensure that the mheni gets out. We also press the stomach or give much cold water so that the person vomits and releases out the mheni. The problem now is that very few people still have this knowledge. You can hardly find people with such skills in most villages.

Inferring from this description, it is clear that the strength of this practice does not lie in just knowing what the people should do following an incident of lightning strike, but how the procedure is skilfully done to save life. While this practice would contribute towards building the indigenous coping capacity of the community against a background of a poor health delivery system cited in Chapter 2, the key challenge however, is the natural loss of skilled people capable of applying this knowledge.

7.2.5 Adaptation to pests and diseases

Chapter 5 identified pests of economic importance in the study area as termites, birds and crickets. This section examines the range of strategies that are deployed to adapt to the challenges posed by these pests. It should also be known that the centrality of the community's relationship with the spiritual world tends to characterise the exploitation of available options for adaptation. For example, it is in their view that unsanctioned pest eradication methods are likely to upset the spirits and would end up worsening the problem instead of ameliorating it.

In order to adjust to the increasing threat of termites on crops, the subsistence farmers in Muzarabani are encroaching into riverine land where they know that the pest's effect is minimal. Here it should be emphasised that the exploitation of riverine woodlands is done selectively since other areas are considered sacred. There is a well-known case demonstrating the dangers of opening up sacred land in the area. One of the participants confirmed:

In 1987, a man who had decided to expand his land into a sacred woodland in Sohwe area ended up inviting the wrath of the spirits. Amazingly but terrifyingly, just after planting his crops on the previous day, the next day people woke up to find the whole field full of readly harvestable maize and pumpkins. It was a clear sign to the people that the spirits were angry and until now, that area is not tampered with.

It can thus be inferred from this quotation that even though the invasion of riverine woodlands is not a sustainable adaptation venture, not all places are opened up because of the spiritual value attached to them. In a related conviction, the people also use cultural beliefs to consult their spirits whenever they face the devastating effects of pests, regardless of whether the intervention is effective or not. The practice of seeking the intercession of *mhondoro* is also done whenever they encounter unfamiliar diseases affecting both humans and livestock. This actually confirms traces of very ancient coping strategies which village people continue to use. In a study of survival strategies of communities in selected villages of Buhera District in Zimbabwe, Mararike (2011) also identifies the perpetual existence of pre-colonial coping mechanisms which have evolved with the indigenous people.

Another coping measure involves selective harvesting of ready crops from the fields, instead of waiting for all the crops to reach the maturity stage. This will minimise damage by Quelea birds, termites or crickets. It can also be understood here that this strategy calls for adjustments in the division of labour. More time is actually spent scouting the fields to selectively pick out crops at their different stages of harvestibility. In addition, as previously reported, termites degrade the vegetation biomass with serious effects on livestock grazing particularly during the dry spell. Accordingly, the people stack cattle fodder collected from crop residues to ensure a secure food supply throughout the year.

Studying the ecology of the termites also enables them to predict the state of the seasons, whose information can subsequently be used to adjust planting times and crop varieties. Early crop planting is also adopted to evade late season damage of small grains by birds. The success of this practice, however, rests with the onset of the first rains. If the rains come too late, crop planting is delayed and the risk of attack by birds is high. But if the rains are received earlier, the people would use this opportunity to put in their first crops which would be expected to mature earlier before they are seriously attacked by birds. In worst case situations, some people may even end up disturbing the breeding cycle of the weavers by physically destroying their nests or cutting down the *Mupangara (Dichrostachys cinerea)* trees that reportedly harbour the *Quelea quelea*. The latter practice is inarguably improper from the viewpoint of ecological sustainability.

In villages that experience floods, the people usually look at the natural ways of cricket eradication. It was reported that at times the timing of the floods especially in mid-January would destroy all the cricket eggs before they are hatched. When this happens, the people know cricket damage on crops would be minimal. Experiences with these arthropods have also enabled the locals to understand their ecology. They reported that keeping the fields weed-free would also minimise damage by crickets.

The reported desiccation of wetlands that significantly reduced breeding sites for vectors and the exogenous health interventions are arguably beneficial to the people. Thus, from the perspective of disease management, the new conditions created can be an opportunity for enhancing a community's adaptive capacity and climate change has actually created opportunities to the villagers.

7.3 Conclusion

The acknowledgement of noticeable environmental irregularities and the risks caused by climate change have been seen as a major driver to harness coping and adaptive strategies in order to reduce vulnerability to climatic stimuli. A portfolio of autonomous and anticipatory adaptation strategies which are driven by IK exists in the study area. While most of the proactive strategies appear to be well-coordinated in the community, reactive coping options are highly spontaneous and tend to be influenced by the gravity of exposure to the climatic events. Coping and adaptive strategies discussed in this chapter are rather blurred. There appears to be a continuum from reactive to proactive adaptation options utilised by the indigenous people studied.

With regard to adaptive capacity, long-time residents who have more access to land resources tend to have learnt better coping and adaptive capabilities for resilience using their IK. This has been explained by a skewed emigration pattern where new immigrants are the ones permanently leaving the valley. Where effective deployment of indigenous-based adaptation strategies and activities exist, villagers cognitively exploit the new conditions to suit themselves. In this view, IK has potential not only in the exploitation of climate change opportunities, but also in enhancing community resilience against climatic hazards. However, like in many instances where adaptation capacity is assessed, the application of IK to adjust to climate change is riddled with many barriers that tend to constrain local adaptive capacity.

Emerging from this analysis is the revelation that indigenous people are not passive observers of the climate system; instead they have developed their own coping and adaptive strategies that are mainly driven by their IK. The application of IK, such as that relating to TPK in crafting adaptation options deserves emphasis against a background of poorly implemented early warning systems by mainstream disaster management practitioners. The risks posed by climate change on the community clearly show that adaptation is not just an option but an urgent requirement. The major challenge, however, is that the increased uncertainties in the climate system coupled with climate-sensitive livelihoods render indigenous-based adaptation ineffective without the support of outside interventions. This development obviously requires support from mainstream adaptation policy and practice. Apparently, lack of adaptation finance is reportedly undermining adaptive capacity in most developing countries (UNEP, 2014). Essentially, most of the indigenous adaptation options presented here may require minimum or none external funding for their enhanced adoption. It is therefore necessary to realise that outside interventions would need to learn from these locally available coping and adaptive options to avoid conflict with local practices and beliefs that can potentially lead to maladaptation.

CHAPTER 8

SUMMARY, RESEARCH AND POLICY DIRECTIONS

What counts in life is not the mere fact that we have lived. It is what difference we have made to the lives of others…

Nelson Mandela

8.1 Introduction

The philosophical stance of this study centred on an attempt to excavate the knowledge of indigenous people to the attention of mainstream climate science discourse. It was extensively argued that indigenous communities (mainly those in Africa) occupy an inferior position both in causing climate change and in the imperative global agenda to study and contain the phenomenon. The evidence documented throughout this thesis is that current climate research, policy and practice are now increasingly drawing from the knowledge and experiences of indigenous people. Perhaps, this is from the growing realisation of the potential significance of IK applications in informing the same.

A summary of the major insights on IK-climate linkages is presented in this chapter. These major highlights are used to identify some areas for future research in IK-climate applications, including broadly in the field of climate change. From these insights, the thesis then gives policy directions for framing current and future climate interventions.

8.2 Major Reflections from Muzarabani

In this section, key research messages are considered. These insights are gathered after examining the research questions and they also draw closely from the objectives listed in Chapter 1. The themes and sub-themes summarised here are mainly centred on the IK-climate change relationships that guided the thesis.

8.2.1 Significance of the Study Area in IK-Climate Connections

Muzarabani has a rich cultural geography that is fertile for IK applications in climate science. The IKS in the study area has resiliently defied the known threats of modernisation, globalisation, Christianity and Western culture reported by Smith (1999), Mohamed-Katerere (2002), Mawere (2010) and Mararike (2011). Therefore, experiences of climate change in a setting of culturally embedded IKS that mainly exist in customary regimes helped to draw closely from the IK-climate interactions. Notable threats to IK continuity were mainly from immigrants who tend to take advantage of a combination of poorly defined roles of traditional leaders in statutory provisions and incapacities of the local leaders to enforce customary standards in their jurisdictions.

The people in the study area survive mainly on climate-sensitive livelihoods, which are continuously constrained by a physiographically and climatically challenged environment. In this regard, the experiences of climate change and the measures adopted to respond to climatic stimuli are a good reflection shaping current discourse on adaptation in poverty-stricken arid places. The poverty situation exacerbated by climate change deserves emphasis and these observations should help to frame climate change developmental interventions. Drawing on this information, the following facts emerge:

- Floodplain areas experiencing frequent floods apart from threatening lives, infrastructure and livelihood security, also provide fertile soils that support an assortment of crop faming activities, and luxuriant growth of pastures for livestock production. The latter conditions are beneficial in building adaptive capacity through food security enhancement in communities exploiting floodplains.

- Decisions on floodplain landuse practices are mainly driven by IK under the guidance of traditional leaders. However, depending on the magnitude of risk posed by climatic events (such as floods and droughts), governing and regulating landuse activities under customary arrangements is usually dogged by challenges. If not properly regulated, for example, the situation can lead to environmental degradation that subsequently threatens the community's adaptive capacity.

8.2.2 Deployment of IK in Climate Science

Another key message emerging from this study is that at its front, the mainstream climate science community is undergoing a fundamental metamorphosis described here as a move to democratise science or to make science more accountable to communities facing growing environmental challenges such as climate change. This notion was considered here as sustainability science. In IK-environmental applications, it can be highlighted that researchers are becoming less arrogant about science. The previously rigid frontiers of science are becoming inflated or perforated to accommodate other sciences such as indigenous-based knowledge or the philosophies of long-time witnesses of climatic phenomenon. The deployment of IK in climate change exhibited by an extensive geographical scale of empirical applications (presented in Chapter 3) bears enough testimony. In such a treatment therefore, the following facts are worth noting:

- The growing recognition of IK in climate change is not only a scientific revolution, but also an opportunity to enhance understanding of our environment by drawing from the knowledge and experiences of people witnessing climate phenomena and events. This phenomenal growth is against a background of inaccuracies in climate models owing to uncertainty about climate change as cited by Salick and Byg (2007), Hallegatte (2009) and Lee *et al* (2014).

- Despite varying levels of confidence in the detection and attribution to climate change of global and regional trends cited by IPCC (2014a), IK is useful in examining finer details of change and variability in the local climate system. In areas such as Muzarabani, these details have not been adequately captured by previous studies. From this evidence, the study confirms the observation of Nakashima *et al* (2012) that the local precision, finer scale and deeper facts provided by IK can even be richer than those given by mainstream scientists.

- IK is a broad concept covering numerous applications in environmental studies. Consequently, with regard to climate applications, there is need to specifically isolate knowledge that is applicable to climate change indicators, impacts, mitigation and adaptation. This refinement can best be done through active engagement of selected knowledgeable participants in communities experiencing climatic phenomena.

- The intricacies of the topic of climate change cannot be simplified by adopting an IK-based enquiry. In actual fact, the complexities may be aggravated by dichotomous worldviews existing between indigenous scientists and mainstream scientists. Notwithstanding this cleavage in paradigmatic stances, the two knowledge forms have many features in common which can be listed thus:

    a. An understanding that environmental disturbances can cause climatic destabilisations;

    b. Human actions or inactions are largely to blame for causing climate change;

    c. Unless urgent actions are taken to address climate change, events such as droughts, floods and violent storms are most likely to worsen in magnitude and severity; and

    d. Reversing the situation requires the urgent intervention by humanity, notably behaviour changes in human-environmental interactions and sustainable livelihood coping strategies. From an IK perspective, however, the spiritual-environmental interaction is given more emphasis.

- As Chanza and de Wit (2013) put it, there is need to frame the IK-climate linkages within appropriate epistemologies and methodologies; failure to do this puts IK at risk of being dismissed as unscientific and the knowledge itself would lie largely untapped. In such a development, indigenous scientists are likely to be disempowered to meaningfully contribute to climate science and policy discourse.

8.2.3 Participatory Research with Indigenous People

Participatory engagement of subjects throughout the research process, that is, from designing the research procedure, choosing interview respondents, framing research themes to data analysis, is beneficial in addressing an idiosyncratic topic such as IK. In terms of contribution to climate knowledge, indigenous people are scientific experts in their own right. Their willingness to engage in the research process, including its results are key elements that can enhance the robustness of a scientific investigation. Chapter 3 already gave the major highlights of facts worth considering in such a type of enquiry. The following points are worth emphasising:

- The participants should be treated as research subjects and not objects from which data are just extracted without a clear definition of the respondents' roles and their significance.

- Researchers need the support of all the community gatekeepers in the research setting so as to circumvent stymieing the research process that possibly emanates from political, religious, institutional or cultural collision. There are various groups of gatekeepers in rural Zimbabwe, each with their own roles and interests. As specified in Chapter 2, some of these roles overlap with the possibility of igniting conflicts. Against this background, a proactive research approach that adequately consults each of these groups and solicits their open support throughout the study is a requirement.

- The robustness, rigour and smooth flow of the investigation that profoundly probes community culture, beliefs and practices (or people's IKS) is greatly influenced by the level of support obtaining from both participants and non-participants, that is, the generality of members in the studied area. One of the prudent measures that can guarantee this buy-in is the engagement of local research assistants. Gender sensitiveness in the choice of research aides is also an additional factor.

8.2.4 Indigenous-based Climate Change Indicators

From the perspectives of IK generators who have a traceable history of direct interaction with the environment over climate reference periods spanning periods of up to six decades, a rich toolbox of climate change indicators were identified. Essentially, most of these indicators relate to those commonly adopted in mainstream climate change discussions. The indigenous-based climate change indicators used by the Muzararabani community are listed as:

a. Meteorological indicators (consisting of seasonal changes, frequencies and severity of droughts, frequencies and intensities of floods, rainfall variabilities, temperature changes, changes in wind characteristics, and changes in incidences of thunderstorms and lightning).

b. Hydrological indicators (explained by the progressive desiccation of water bodies such as rivers, streams, pools, ponds and vleis).

c. Biological indicators (these are marked by changes in biodiversity of plant and animal species, including forests).

d. Incidences of crop pests (notably, crickets, termites and birds).

e. Incidences of diseases (notably reduction in vector-borne and water-borne diseases such as malaria and diarrheal diseases in some places and an upsurge of other unfamiliar diseases in areas experiencing flooding).

In addition, the people also make use of physical structures like mountains to study changes in clouds formation, wind patterns and directions, and precipitation.

It can also be highlighted here that an analysis of these indigenous climate indicators can be deployed to get a finer understanding of climate change impacts. For example, the following facts can be drawn about the nature of change and variability impacting the studied area:

- Climate change is leading to progressively shorter growing seasons which, depending on the capacity of villagers to cope, severely influence household food security.

- Increased incidences of droughts also lead to food insecurity owing to crop failures and desiccation of grazing lands and water bodies for livestock.

- The area is getting drier because of irregularities in rainfall and frequent droughts punctuating the rainfall season. Rainfall, for example, is increasingly received in patches with some places receiving diminishing amounts in the same season.

- Thunderstorms and lightning incidences are increasing in frequency and severity and this could be explained by temperature and evapotranspiration increases.

- The people are registering distinctive seasons unknown before, particularly winters which are reported to be cooler than they were in the past.

- Flood events have now increased in frequency and severity than the situation recorded over the past two or more decades ago.

- Wind speed and violent storms are now on the increase, with an associated increase in the duration of the storms experienced.

- There is a marked desiccation of water bodies such as rivers, streams, pools, ponds and vleis, with a registered decline in plant and animal biodiversity that is supported by these aquatic habitats.

- The drying up of hydrological features is believed to have contributed towards reduction in vector-borne and water-borne diseases. However, increased incidences in diarrheal diseases reported in some places could be associated with higher frequencies of flooding.

- There is a noted prevalence in crop pests such as *Macrotermes* spp, *Q. quelea* and *A. discoidalis*. This is attributed to a drier climate favouring the ecological proliferation of these pests.

- Patches of forests and some trees are under threat owing to increased pressure and competition from human beings and their livestock as they attempt to cope with the drier climatic conditions and drought.

The major limitations cited here are that descriptions and explanations given are based on past and present experiences, which unlike predictions made by climate models about the future climate scenarios fall short of giving such forecasts. Furthermore, unless rigorously verified, the robustness and reliability of data and information given may be questioned since much of it is not documented and reliance is made on the memory and quality of the respondents chosen. In addition, generators of the knowledge sought are not always easily accessible over space and their availability is not always guaranteed. Despite these setbacks, the richness and finer level of analysis given by IK-based information is capable of complementing current and future understanding about climate change.

8.2.5 Indigenous-based Mitigation

From an IK-based lens of scientific enquiry, the concept of mitigation is understood as one which looks both at averting magnitude and severity of destabilisation in the climate system and reducing risks associated with a climate phenomenon. Opportunities associated with IK deployment in climate mitigation from the viewpoint of enhancing GHG sinks and that of reducing vulnerability to extreme climatic events, were recorded thus:

- Enhancing GHG sequestration through forestry and land-use management initiatives under traditional institutional regimes. Within such arrangements, two familiar interventions are opportunities worth exploiting:

    a. IK-REDD+ linkages, which are a framework to contribute towards local socio-economic development through sustainable forestry management.

    b. IK-LULUCF linkages, for atmospheric carbon stabilisation through regulated activities in local land-use planning, land allocation for cultivation, settlement, forestry and grasslands, and livestock grazing.

- An assortment of indigenous-based DRM strategies can be put into the following categories:

    a. Drought management (notably, in form of Zunde raMambo, *nhimbe* and rain-making ceremonies).

    b. Containment of floods and violent storms (mainly through EWS, which are in the form of indigenous weather forecasting and spiritual consultations).

    c. Famine management (done through measures such as dual-season cropping, Zunde raMambo, barter trading and *nhimbe*).

    d. Settlement and land-use initiatives (strategic locations, riverine farming, buffer trees and forests).

    e. Infrastructural designs (in the form of hazard tolerant structures and indigenous architecture).

The centrality of customary regimes in perpetuating these IK strategies deserves consideration. Embedded in this understanding is the notion of sacredness, which the locals interpret as a belief system, held on the sanctity and reverence of the environment in which violations would upset the spirits who are capable of causing a bad climate as a way of registering their displeasure. As a concept, sacredness when applied to climate science primarily serves to:

a. Mitigate against destabilisation of the climate system through sequestration of GHGs offered by sacred forests and wetland resources.

b. Provide inventories of sacred forests, certain tree and animal species, rivers, pools, ponds and vleis, which can be used to understand how they respond to climate change and variability.

8.2.6 Indigenous-based Adaptation

Growing risks posed by climate change challenges the people in Muzarabani to devise strategies to respond to climate stimuli with the intention of minimising harm and/or enhancing the benefits brought about by the same. Therefore, a portfolio of IK-based adaptation strategies, ranging from short-term coping practices to long-term adaptive strategies was identified. The study observed that these strategies are not necessarily clear-cut, but are best described as a spectrum from reactive to proactive interventions. The following highlights can be noted:

- For responding to drought, an attempt was made to classify the strategies into short-term (i.e., exploitation of wild fruits, livestock schedules, livestock culling and barter trading); intermediate (i.e., TPK, early planting, riverine farming and seasonal migration); and long-term response packages (i.e., cropping choices and varieties, livestock production, dry planting, conservation farming, stacking of livestock fodder and emigration).

- In order to respond to floods, measures used consist of structural designs, dual-season cropping and temporary migration to and from flood-prone places.

- Defence mechanisms against storms are mainly proactively done through indigenous housing architectural designs and indigenous EWS.

- Adjustments to temperature changes are mainly through indigenous water cooling technologies and housing designs. In addition, other responses are seen through behaviour changes such as changing the dress code and travel times during the hot seasons.

8.2.7 IK-Adaptive Capacity Relationships

Largely, it can be noted here that acknowledgement of progressive and rapid environmental changes triggered by climate change and variability motivates the locals in Muzarabani to devise coping and adaptive strategies mainly guided by their IK. From an adaptive capacity assessment, IK influences the development and choice of adaptation options. In the milieu of limited climate services and deprivation resulting from poor development planning in most parts of rural Zimbabwe therefore, the locals' preference and prioritisation of IK-based strategies deserves emphasis. In some cases, overlaps occur between endogenously- and exogenously-based interventions. Where there is a lack of congruence between these two forms, the fear of maladaptation cannot be ruled out.

8.3 Policy Directions

The growing risks potentiated by climatic events and the increasing incapacities to adequately tackle them are emerging development and policy challenges not only in Zimbabwe, but also in other places experiencing the same. CBA – a concept where the technocratic community engages people experiencing climate change to jointly craft adaptation management plans to make interventions more effective – is a viable option. In societies with a rich account of IK, it is important to note that indigenous-based knowledge, science, practices, skills and experimentation are potential avenues to accelerate CBA initiatives. This means in such rural places as Muzarabani, the success of CBA is strongly influenced by IK.

Also, the inferior position accorded to indigenous people and their knowledge is an invitation to call for reconsideration particularly in the current dispensation where climate governance is increasingly occupying local, regional and international policy space. The issues of indigenous people's rights, knowledge, concerns and interests, and their active engagement in decisions to choose mitigation and adaptation projects are paramount in climate regimes. It is therefore important to advance the global agenda for climate governance by meaningfully engaging and building from local indigenous people where local climate governance can first be realised.

Home-grown indigenous coping and adaptive strategies that have helped indigenous people to be resilient against the vagaries associated with climatic events need to be recognised in current and future policy formulation. Government agencies and development partners need to interactively engage indigenous people in crafting adaptation interventions. When doing so, they also need to learn from the experiences and knowledge of the locals, including helping them to prioritise strategies from a toolbox of coping and adaptive options used by the indigenous people.

Locally, decisions to design and implement climate programmes such as REDD+ need to incorporate views and knowledge of indigenous people so as to ensure that they are successful and the local people benefit. The centrality of customary environmental management systems in driving such initiatives means that any policy designed to manage environmental assets such as local forestry resources should not ignore the role of traditional leaders and their IK. The concept of sacredness should not be ignored in shaping locally-based forestry management interventions that aim at boosting the carbon sequestration stock. Figure 8.1 illustrates the framework for integrating this notion in local climate change strategies.

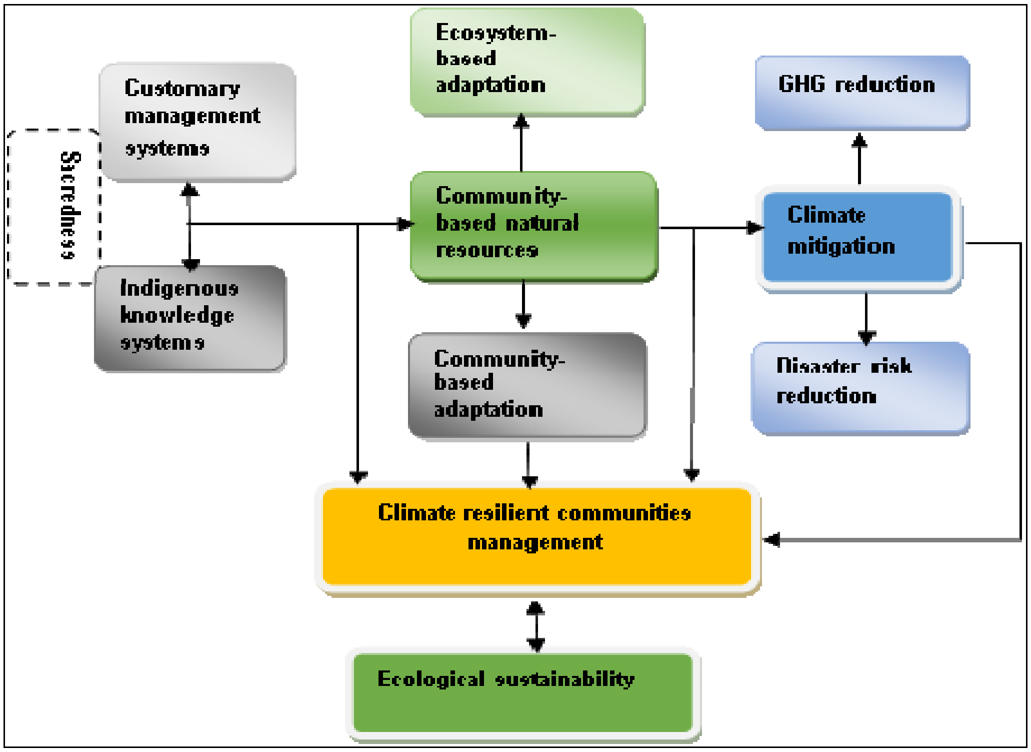

Figure 8.1 A framework for locally-based climate change strategies

It can be seen here that sacredness is the central notion underpinning customary resource management schemes and IKS. These jointly inform community-based environmental management systems from which CBA, ecosystem-based adaptation and climate mitigation stem. The purpose is to build climate resilient communities who should continuously get forestry services as they move towards ecological sustainability. Lessons derived from these local-level climate customary management initiatives, which are related to climate change interventions, can actually be up-scaled to other places with the advice of indigenous people themselves.

8.4 Directions for Future Research

It has been proven here that IK is capable of filling knowledge gaps and validating scientific understanding about climate change at local levels where mainstream studies tend to give rough-grained analysis. This means IK should also occupy space in impact assessments, mitigation studies and adaptation analysis. One of the crucial areas that this study did not cover, but potentially useful for enhancing climate knowledge, is a methodological deployment of multi-stakeholder science dialogue meant to share experiences and knowledge between indigenous scientists and conventional scientists. A methodology for future studies on IK-climate applications would need to proceed from this premise in order to adequately complement the two sciences and to operationalise their relationships.

This study did not view IK as a superior knowledge form in climate science; neither did it regard IK as occupying the peripheries of climate knowledge. This means it would be naïve to disregard its usefulness or to consider it as a replacement to the well-established conventional knowledge. A key message to the climate research community therefore, is that IK is useful both as leads and baseline knowledge for future work on the impacts of change and variability in the climate system, and in the assessment of climate interventions. The thesis thus recommends further research on the following areas:

- Two dominant factors seem to explain reduction in malaria disease incidences in Muzarabani: (a) desiccation of water bodies and wetlands owing to climate change that could have significantly reduced vector breeding sites, and (b) health interventions by government and development partners. Of these two, there is a need to investigate which one explains the situation properly. Or can it be safely concluded that climate change led to reduction in malaria in the area?

- Are the spatial distribution and abundance of *Macrotermes* spp, *Q. quelea* and *A. discoidalis* in Muzarabani related to climate change?

- How can REDD+ initiatives be effectively downscaled to benefit indigenous communities who use their customary regimes to manage forestry resources?

- What are the key drivers of and constraints to successful CBA under IKS of the communities practising them?

- What are the constraints and strengths of jointly conducting an inventory of climate change indicators by indigenous and mainstream scientists?

8.5 Conclusion

Overall, it can be emphasised here that indigenous people are capable of monitoring changes in the local climate system using a range of environmental parameters. Most of these are recorded as qualitative descriptions and explanations of conditions and events in the local environment. The major barriers to IK acquisition emanate from lack of documentation of the data and information, including the spatial and temporal haphazardness of the IK generators coupled with the challenge of accessing them.

Clearly, the complementary role of indigenous-based knowledge cannot be disputed given the demonstrated range of applications from identifying several indicators of change and variability in the climate system, examination of climate change impacts, to identification and assessment of mitigation and adaptation options. What is remaining, therefore, is to formulate a framework of constructive dialogue between indigenous scientists and conventional scientists so as to make sure that the complementary benefits of the two knowledge forms are adequately harnessed. The key question that should be addressed by the climate change community is how to integrate local knowledge generated by indigenous players into mainstream climate regimes with the purposes of both enhancing climate knowledge and community resilience against the perturbations caused by climate change, or for harnessing the benefits brought about by the same. One of the mechanisms suggested here would be to make an inventory of indigenous scientists in various localities who would then partner with mainstream scientists in advancing the climate research agenda.

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www.wmo.int

Appendices

APPENDIX 1: ORAL INFORMATION GIVEN TO PARTICIPANTS PRIOR TO PARTICIPATION

My name is **Nelson Chanza**, a doctoral student registered with **Nelson Mandela Metropolitan University**. I am conducting a study intended to understand how local people in this area use their indigenous knowledge to cope with climate change. As such the study targets elderly members whose lived experiences are important in understanding how they have been monitoring change and variability in the climate systems, including devising traditional response mechanisms, for so many years they have been in this area. The information that you share with me can be useful in order to complement climate change interventions by government and other organisations working in this district.

Your participation in this research is voluntary. Confidentiality of information and anonymity is assured in which the identities of the participants are not be disclosed and are not linked to the views expressed. However, should you wish to disclose your identity, it will be treated as such. This discussion may take a considerable amount of your time (at least 1 hour). Throughout our conversation, I will be recording the interview or writing down your responses in a note book in order to make sure that everything you have said is captured. At the end of the discussion, I will also read out everything that I have written down to ensure that all your contributions have been correctly recorded. I will also seek your voluntary participation at a later stage for group-based data analysis to ensure that all your views and interpretations are adequately covered.

However, should you feel that you are no longer comfortable during the interview process, you are free to say so and the discussion will just stop there. Again, should you get uncomfortable in answering some of the questions, you are also open to say so.

I will be very grateful if you are interested in sharing your views with me. In addition, you are kindly requested to express as openly as possible these views as other participants in this community have also been selected for participation. In the event that you will require to contact me after this interview or research, I am free to leave my contact details (*to give business card if requested*).

May I proceed?

APPENDIX 2: INTERVIEW QUESTION GUIDES FOR ELDERLY RESPONDENTS

Introduction

To be given orally as read in Appendix 1.

1. Greetings (in the local traditional way)
2. Generally how are you coping in this community?
3. What is your view about the environment in this community?
4. Have you witnessing any change in the climate system during the past 30 years or so?
5. What are your experiences in this regard?
6. How would you describe these changes in the climate?
7. What do you think are the major causes of these changes?
8. What situations (IKS) have typically influenced your experiences of the phenomenon?
9. What indigenous knowledge systems characterise your response to the phenomenon?
10. How do you view the usefulness of your traditional knowledge in understanding and responding to changes in climate?
11. Any other view you can share with me on climate change and your indigenous practices?

Thank you for your views and for taking your time in this interview.

APPENDIX 3: KEY INFORMANT INTERVIEW QUESTION GUIDE

Introduction

My name is **Nelson Chanza**. I am a student from **Nelson Mandela Metropolitan University** studying for a doctoral degree in Environmental Geography. I am carrying out a study to understand the utility of indigenous knowledge systems (IKS) in climate change (CC) interventions in Zimbabwe. Your institution is key in providing such information. However, you are free to express your own personal opinion which may not necessarily reflect the position of your organisation. This information is purely for educational purposes. Your views will thus help to give some useful insights on how IKS can be incorporated in CC policy strategies. So, your participation in this exercise is highly crucial.

Institution____

Department____

Position (may also give name) __________________________________

1. What is your organisation’s or personal view on indigenous knowledge (IK) utility in Zimbabwe?
2. Do you think IK can be useful in CC e.g., from understanding the phenomenon to formulation of response strategies?
3. In your organisation’s interventions, do you make use of or engage traditional views and knowledge of the people?
4. Do you think government is doing enough in recognising IK applications in climate change? What do you think should be done?
5. What are the major threats (if any) to IK existence in Zimbabwe?
6. What do you think needs to be done to ensure maximum usefulness of IK in CC interventions?
7. What challenges of and/or opportunities for IK application in CC interventions can you think of?
8. In what way(s) can IK enhance current or future CC interventions?
9. Any other view you can share with me on IK and CC?

Thank you for your views and for taking your time in this interview.

APPENDIX 4: LIST OF KEY INFORMANTS

NAME	ORGANISATION	POSITION
Prof. CG Mararike	University of Zimbabwe	Professor of Sociology
Dr L Unganai	EMA/GEF/UNDP	Project Manager
Mr W Zhakata	Climate Change Office – Zimbabwe	Coordinator
Hon. AMufunga	House of Assembly	MP – Muzarabani North
Mrs E Gwachiwa	Muzarabani RDC	Chief Executive Officer
Mr C Sakuhuni	Min. of Environment, Water & Climate	Chief Hydrologist
MsT Wutaunashe	GEF/UNDP	National Coordinator
Ms. D Mukarakate	UNDP	Senior Environmental Officer
Mr S Zvigadza	Regional Environmental Organisation – ZERO	Director
Mr K Karise	Zimbabwe Red Cross	District Project Officer
Mr A Matsongoni	World Vision International	District Program Manager
Ms R Nhongonhema	Min. of Agriculture, Irrigation Development & Mechanisation	AGRITEX Officer
Anonymous	HELP – Germany	Field Officer

APPENDIX 5: SAMPLE OF LETTER WRITTEN TO GOVERNMENT AUTHORITIES

Department of Geosciences
Summerstrand Campus (South)
3rd Floor, Building 13
Tel : +27 41 504 2325
Fax: +27 41 5042340

• PO Box 77000 • Nelson MandelaMetropolitanUniversity
• Port Elizabeth • 6031
• South Africa
• www.nmmu.ac.za

Nelson Mandela Metropolitan University

for tomorrow

05 August 2013

The Honorable Member of Parliament

Muzarabani Constituency

Dear Sir

RE: AUTHORITY TO CARRY OUT A STUDY IN MUZARABANI CONSTITUENCY

The above request refers.

This serves to express my sincere request for permission to conduct a study in Muzarabani constituency titled:

INDIGENOUS KNOWLEDGE AND CLIMATE CHANGE: REFLECTIONS FROM MUZARABANI

I am a doctoral candidate registered with Nelson Mandela Metropolitan University (NMMU) under the supervision of Dr Anton de Wit. The study seeks to understand the indigenous knowledge and practices of communities affected by climate change in Muzarabani. Results from the study can be used in the formulation of climate change response strategies that incorporate community experiences and practices. This will help in enhancing the effectiveness of disaster risk reduction projects in the district.

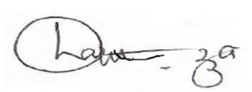
This study is going engage the participation of rural district council (RDC) officials, chiefs, village heads, councillors and selected community elders through face to face in-depth interviews intended to understand individual views on the subject. At the end of these personal interviews, a community meeting with these participants is planned at a central local school in order to share more insights and to discuss how these views can be incorporated in national climate change policy strategies. In this regard, your views as the constituency Member of Parliament is also sought.

It is envisaged that the field work activities will cover a period on four months from July to October, 2013. In order to facilitate community movement and accessing of respondents, two research assistants will be recruited from the community. All the requisite procedures that involve approaching such community gatekeepers as RDC officials, chiefs and village heads will be observed. Furthermore, the study religiously complies with the ethical issues of engaging human subjects and will meet the requirements of the Research Ethics Committee (Human) of the NMMU.

In the event that you require to be furnished with any other information about this study, please feel free to contact the undersigned supervisor.

Your kindest cooperation in this regard will be greatly appreciated.

Yours sincerely



Nelson Chanza
Researcher
NMMU

Dr Anton de Wit
Promoter
NMMU

APPENDIX 6: ETHICS CLEARANCE LETTER

Faculty RTI Committee (Faculty of Science)
Tel: +27 (0) 41 5042268
E-mail: lynette.roodt@nmmu.ac.za

Ref: H2013-SCI-GEO-01

Contact person: Mrs L Roodt

Student No: 213332744

Date: 13 June 2013

Mr Nelson Chanza
c/o Department of Geosciences
NMMU, South Campus
Port Elizabeth
6001

Dear Mr Chanza

TITLE OF PROJECT: INDIGENOUS KNOWLEDGE IN CLIMATE CHANGE: REFLECTIONS FROM MUZARABANI, ZIMBABWE

Your above-entitled application was considered and approved by the Sub-Committee for Ethics in the Faculty of Science on 13 June 2013.

The Ethics clearance reference number is **H2013-SCI-GEO-01**, and is valid for three years. Please inform the Committee, via your faculty officer, if any changes (particularly in the methodology) occur during this time.

An annual affirmation to the effect that the protocols in use are still those, for which approval was granted, will be required from you. You will be reminded timeously of this responsibility, and will receive the necessary documentation well in advance of any deadline.

We wish you well with the project. Please inform your co-investigators of the outcome, and convey our best wishes.

Yours sincerely

LRoodt

Lynette Roodt
Manager: Faculty Administrator
Faculty of Science