



**UNIVERSITY OF
KWAZULU-NATAL**

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**THE ROLE OF ENVIRONMENTAL EDUCATION IN CLIMATE
CHANGE MITIGATION AND ADAPTATION: THE CASE OF GWANDA
RURAL DISTRICT, ZIMBABWE**

by

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Supervisor: Prof. Sadhana Manik

DEDICATION

With genuine gratitude and warm regard, I dedicate this study to my mother (Simakaling Ndlovu), family members, and friends for their unwavering support, inspiration, and assistance, which they granted me while pursuing my PhD study.

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- The Environmental Management Agency (EMA), Gwanda rural district council and Agriculture and Extension Services Department (AGRITEX) (Gwanda district) for granting me the opportunity to carry out my research.
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- Finally, I acknowledge the power of the Almighty God (*Molimo eamatla 'ohle*) that kept me going at all times.

DECLARATION - PLAGIARISM


I, Arorisoe Sibanda (219093949), declare that:

1. The research reported in this thesis is my original research, except where otherwise indicated.
2. This thesis has not been submitted for any degree or examination at any other university.
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I Prof. Sadhana Manik, as the candidate's supervisor, I agree to the submission of this thesis

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ABSTRACT

The purpose of this research was centred on the role of Environmental Education (EE) in climate change mitigation and adaptation. The study sought to explore the successes and challenges of EE efforts in climate change mitigation and adaptation among the communities of Gwanda rural district in Zimbabwe. An interpretive qualitative case study research approach was used to explore EE efforts in the rural drought-prone area in Zimbabwe. The participants comprised farmers whose livelihoods are dependent on natural resources and government support officials such as the Agriculture and Extension Services Department (AGTRITEX) and the Environmental Management Agency (EMA) officials). Data generation tools included semi-structured interviews, focus group discussions and document analysis. A sample of 38 research participants from two wards of Gwanda rural district were used, and there were 19 research participants per ward. The Sustainable Rural Livelihoods (SRL) Framework and the Nested model of sustainability guided the study. The findings indicate a myriad of EE efforts by the government and Non-Governmental Organisations (NGOs) that require local innovations in their implementation. The research indicated that there are numerous climate change mitigation and adaptation strategies being implemented in the Gwanda rural district. Some of these strategies are ineffective, whilst some are successful. There were inconsistencies and a lack of coordination in some climate change mitigation and adaptation strategies which are being implemented. The research indicated *cultural resistance* by some farmers who are not implementing mitigation and adaptation strategies that have proved to be successful in the district due to traditional beliefs and practices. Therefore, there is a need to embark on EE programmes to address issues that hinder the adoption of successful climate change mitigation and adaptation strategies. All cultural beliefs and practices that hinder the implementation of successful climate change mitigation and adaptation strategies should be addressed through the engagement of traditional leaders. The study revealed that for EE programmes to be effective, they have to focus on harnessing local expertise that is collaborative efforts between extension agents and communities to craft EE programmes for local use.

The research also indicated that a 'one size fits all' approach will not lead to successful implementation of climate change mitigation and adaptation strategies because there are *situated vulnerabilities*. COVID-19 has also worsened *situated vulnerabilities* in Gwanda rural district mainly due to recurring national lockdowns which inhibit the local communities' access to treated seeds from local towns. Also, the retrenchment of workers has worsened the vulnerabilities of

communities because a loss of income negatively affects capital assets which compromises *generative resilience*. Thus, the study advocates for the use of indigenous seeds that avoid inconveniences during national lockdowns because communities will be using locally available seeds which are well adapted to the local conditions. Two models were developed in this study towards this end, to illustrate the roles of EE in enhancing **generative resilience** and reducing *situated vulnerability* in Gwanda. The models developed are EE for Rural Sustainable Livelihoods (EERSL) and the Box Model for Rural Sustainable Livelihoods (BMRS�). The models were developed focussing on different levels of intervention: the micro, meso, and macro levels whilst extrapolating concepts of SRLF and the Nested model of sustainability. They illustrate that the key determinants of sustainable livelihoods in the context of Gwanda, are EE and financial funding. As a result, the study found that EE and capital assets are critical in reducing the vulnerability of communities in drought-prone areas. They also enhance resilience, environmental stewardship and promote sustainable livelihoods. The study suggests exploring African solutions to African problems and the harnessing of indigenous knowledge systems in developing local solutions to local problems. The data from the study can be utilised in EE programmes to boost the resilience of rural communities, which are vulnerable to climate change in Gwanda rural district, Zimbabwe.

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LIST OF ABBREVIATIONS/ ACRONYMS

AGRITEX-	Agriculture and Extension Services Department
BMRS-	Box Model for Rural Sustainable Livelihoods
CMS-	Carbon Monitoring System
EE-	Environmental Education
EERSL-	Environmental Education for Rural Sustainable Livelihoods
ERF-	Emissions Reductions Fund
EMA-	Environmental Management Agency
EPA-	Environmental Protection Agency
ESD-	Education for Sustainable Education
GoZ -	Government of Zimbabwe
NEPP-	National Energy Productivity Plan
NGOs-	Non-Governmental Organizations
SADC -	Southern African Development Community
SD-	Sustainable Development
SRL-	Sustainable Rural Livelihoods
SSA-	Sub-Saharan Africa
UNDP -	United Nations Development Programme
ZIMSTAT -	Zimbabwe National Statistics Agency

CHAPTER ONE

BACKGROUND TO THE STUDY

1.1 Introduction

According to the IPCC (2014), climate change is one of the greatest threats of the 21st century. In the same vein, it has been articulated by others that climate change is a significant threat affecting humanity in recent years (Government of Zimbabwe [GoZ], 2016; Pihl et al., 2021). It is argued that climate change adversely impacts the Zimbabwean economy because it is generally agriculture-based, with at least 70 per cent of the population being rural dwellers and dependent on livelihoods such as crop production that are sensitive to climate change (Manatsa & Gadzirai, 2010; Mburu et al., 2014; Moyo et al., 2012). Communities should know the impacts of climate change to mitigate and successfully adapt (Bryan et al., 2009; Egbe et al., 2014; Lee, 2004; Manatsa & Mukwada, 2017). It is indicated by many studies that communities' awareness of climate change can be promoted through EE (Klein & Mohner, 2014; Monroe et al., 2019; Reid, 2019). According to Mburu et al. (2015), the lack of EE can result in complacency by communal farmers leading to their vulnerability to the negative effects of climate change. This section is divided into three sections: EE for climate mitigation and adaptation at the global, regional, and national levels.

1.1.1 EE for climate change mitigation and adaptation at global level.

It is reported that climate change mitigation and adaptation are contemporary issues at the global level. Australia, Canada, and the United Kingdom appear to be willing to give up their materialistic lifestyles for the sake of the global environment (Downes & Roberts, 2018; Eisenack et al., 2012; Reid, 2019). As a result, EE programmes in the Global North have proven to be highly effective in promoting climate change mitigation and adaptation (Monroe et al., 2019; Palmer, 2002; Scott & Vare, 2018). According to Klein and Mohner (2014), few studies have focused on EE concerning climate change globally. For example, Downes and Roberts (2018) focused on a systematic review concerning the staffing criteria in Australian schools that are rural and remote between 2004 and 2016. Their research was primarily concerned with EE in schools. As a result, there is a research gap in EE in communities other than schools. The purpose of this research is to add to our understanding of the role of EE in climate change mitigation and adaptation in rural

communal farming. In chapter two, detailed information about EE for climate change mitigation and adaptation at the global level will be discussed in depth.

1.1.2 EE for climate change mitigation and adaptation at the regional level

It is argued that countries in Sub-Saharan Africa are forced to degrade their environment in order to earn a living due to poverty and technological backwardness (Dube et al., 2016; FAO, 2016; Mukute et al., 2012). As a result, their EE programmes are less effective and have a lower likelihood of achieving climate change mitigation and adaptation goals (Masipa, 2017; Wynes & Nicholas, 2017). It has been asserted that experiences in Southern Africa over the past few decades are characterised by severe climate extremes such as droughts and floods that pose threats to the ability of communities to adapt (IPCC, 2014; Loison, 2015). However, Smith's (2013) research in climate change has revealed that adaptation strategies being implemented successfully reduce the negative effects of climate change. Hence, it is contended that there is an urgent need to improve EE programmes in order to mitigate and adapt to climate change (Bryan et al., 2009; Chanza & Gundu-Jakarasi, 2020; Ncube et al., 2016). This will help avoid more significant economic losses and aid in the recovery or rebuilding of the economy and promote sustainable livelihoods of rural dwellers. It is argued that incorporating EE in climate change mitigation and adaptation ensures effective adaptation, resulting in favourable economic returns, with estimates of approximately 2–10 times the investments in EE (Pihl et al., 2019). The second chapter will discuss climate change mitigation and adaptation in detail.

1.1.3 EE for climate change mitigation and adaptation at the national level

It is reported that climate change mitigation and adaptation in Zimbabwe can be traced back to three decades ago, particularly in 1992, when the country experienced major developments in implementing climate change initiatives after signing and ratifying the United Nations Framework Convention on Climate Change (UNFCCC) (United Nations Development Programme, 2018). However, it is argued that climate change continues to negatively affect the nation despite the developments experienced some decades ago (Chanza & Gundu-Jakarasi, 2020). Farmers in rural Zimbabwe who are dependent on largely rain-fed agricultural production are vulnerable to droughts associated with climate change (Ndlovu et al., 2020; Phiri et al., 2019). This research explores EE efforts in climate change that seek to advance solutions to low adaptive capacity. This was the first case study to explore EE efforts in climate change mitigation and adaptation in

Gwanda rural district, Zimbabwe. Gwanda District was chosen as a case study because it is an arid region of Zimbabwe severely affected by climate change (Chanza, 2018; Dube, et al., 2018). Detailed information about the vulnerability and evidence of climate change in Gwanda rural district is given in Chapter 3 (3.2 Context of Study). This information justifies choosing this district as the case study of this study.

This study examines the role of EE in improving mitigating and adapting to climate change in communities of Gwanda rural district. A study undertaken in Zimbabwe that had a similar focus to this current study was carried out by Makoni in 2013, and the study focused on EE in secondary schools. However, the study mainly focused on EE in the school curriculum, and there is thus a research gap both globally and nationally regarding EE efforts in rural communities.

Furthermore, a better understanding of the successes and challenges of EE efforts in climate change mitigation and adaptation is important to inform policies meant to promote sustainability in the agricultural sector. Consistent with calls for understanding climate variability in farming regions (Bryan et al., 2009), this study adopts a case study approach. This study acknowledges that the communal farmers are better positioned to implement climate change mitigation and adaptation strategies. The case study approach allows for a holistic consideration in the local management of the complex issue of mitigating and adapting to climate change. It also provides information about how these experiences may assist in supporting other rural communities in their mitigation and adaptation to climate change. Thus, this research can provide insights into the ability of current EE efforts to enhance climate change mitigation and adaptation. The research findings could assist in the design and implementation of effective EE in promoting communities' resilience to the effects of climate change.

1.2 Statement of the problem

It is argued that the climate is changing, as is evidenced by the reduced mean annual rainfall and increasing mean temperature even though people are working tirelessly to adapt to climate change (Gaughan & Cawdell-Smith, 2017; Ncube et al., 2016; Phiri et al., 2019). Although climate change continues to be a significant challenge in achieving sustainable livelihoods (IPCC, 2014), it is contended that climate change is a highly contested concept both globally and locally. There are numerous narratives on climate change (Bryan et al., 2009; Reid, 2019). For example, some religious groups say climate change marks the last days, and some politicians say it is a conspiracy,

while others say it is a moneymaking hoax (Dunlap & Brulle, 2020). Despite the various contrasting views, people who believe the science are trying to reduce the impact of climate change and adapt; hence research should keep abreast with communities' efforts in mitigation and adaptation.

At the global level, the Paris Agreement targets limiting global temperature rise to below 2°C and aiming for 1.5°C by 2100 (UNFCCC, 2015). This implies an urgent need for climate change action to meet the target, and a call for all nations to commit themselves to achieving the Paris agreement target. An influence on the researcher to conduct this study derives from the IPCC report on global warming of 1.5°C (IPCC, 2018) which states that the pathways concerning the current mitigation efforts agreed to in the Paris agreement would not limit global warming to 1.5°C implying that the estimate was conservative. Hence, there is a need to do research that will explore the strategies for climate change mitigation and adaptation to contribute at a local level towards achieving the targets set by the Paris agreement in 2015, especially now that the COVID-19 pandemic has set back the world in attempts to achieve targets such as the SDGs (UNESCO, 2017b; Usman et al., 2021; Tian et al., 2020). As the need to mitigate and adapt to climate change became a priority worldwide before the pandemic, the nations' strategies for climate change action through EE efforts in developing countries have become more pronounced (Fazey et al., 2018; Myers, et al., 2012; O'Brien et al., 2013) in the hope of turning the tide.

It is argued that climate change projections indicate that the African continent is at risk, and it is reported that the planet will heat up more than double the global temperature average (Gemedo & Sima, 2015; IPCC, 2014), hence the need to explore climate change action strategies (such as mitigation and adaptation) and to identify the gaps that need to be addressed through EE. Within the African continent, Sub-Saharan Africa (SSA) is one of the most vulnerable regions to climate change due to what is described as low mitigation and adaptive capacity (IPCC, 2014; United Nations Development Programme, 2018). This study identified the gaps in climate change mitigation and adaptation to facilitate better climate change action through EE. This study explored EE opportunities and it highlights the gaps in climate change mitigation and adaptation in one of the most drought-prone communities in Zimbabwe.

The study was conducted in Zimbabwe for three main reasons; the nation is drought-prone, making the communities more vulnerable to climate change, economic instability constrains climate

action, and there is an overdependence on rain-fed agriculture. The country is experiencing higher temperatures and reduced rainfall (Chanza & De Wit, 2016; Dube et al., 2018). Economic activities, mainly farming, are negatively affected by climate change (Ncube et al., 2016). Gwanda rural district was chosen, and it is located in region five, which is the driest region in the country. The annual rainfall is less than 450 mm and it is also erratic thus making it more vulnerable than other regions (FAO, 2018). Furthermore, it is argued that rural communities in Zimbabwe continue to suffer from climate change-related impacts and risks such as prolonged dry spells, floods and agricultural losses. Thus, the need to explore EE opportunities, challenges and gaps in climate change mitigation and adaptation efforts among rural communities is of paramount importance towards achieving sustainable livelihoods for communities.

The role of EE in climate change mitigation and adaptation needs to be addressed for its value to sustainability, which is the overarching aim of this current research. Exploring climate change mitigation and adaptation through the lens of EE is significant in designing and implementing EE efforts that can enhance climate action concerning mitigating and adapting to climate change for this district.

1.3 Aim of the study

The main aim of this study was to explore the role of EE through unpacking the successes and challenges of EE efforts in climate change mitigation and adaptation among the communities of Gwanda rural district in Zimbabwe. The study aimed to ascertain from EMA officers, AGRITEX officers, and communal farmers what are the achievements and challenges of climate change mitigation and adaptation strategies. This could then be used to design suitable EE efforts for improved climate action in the district.

1.4 Objectives of the study

The main objectives of this study were as follows:

- To identify the successful strategies for mitigation and adaptation to climate change in Gwanda rural district and to identify why they are successful for EE programmes.
- To explore the challenges for climate change mitigation and adaptation in the study area and to explore how EE programmes can address these challenges.
- To examine the role of EE in the mitigation and adaptation to climate change in the study area.

- To develop models for EE to enhance the understanding of climate change mitigation and adaptation in the study area.

1.5 Critical research questions

Specifically, the study sought answers to the following critical research questions:

- What are successful strategies for mitigation and adaptation to climate change in Gwanda rural district and why are they successful for EE programmes?
- What are the climate change mitigation and adaptation challenges in the study area, and how can EE programmes address these challenges?
- What is the role of EE in mitigation and adaptation to climate change in the study area?
- What models for EE can be developed to enhance the understanding of climate change mitigation and adaptation in the study area

1.6 The rationale of the study

The rationale for the study is dealt with under the following subheadings: geographical context, personal and professional.

1.6.1 Personal rationale

My rural background, having spent my childhood in Gwanda rural district and having seen farmers struggling to attain harvests to sustain their livelihoods, also necessitated the study. Therefore, I believe that there is a need for research on the successes and challenges of EE efforts in climate change mitigation and adaptation among the communities of Gwanda rural district in Zimbabwe. People are currently surviving through food aid from non-governmental organisations such as World Vision that prompts the need for research aiming at self-reliance in the future (Dube et al., 2018). However, World Vision and other NGOs do not provide food aid to the whole population. They only choose a limited number of households to support, and due to nepotism and corruption, some people who require assistance are left out of the donor funding. Thus, I believe that there is a need for building resilience through empowering the community via EE efforts to effectively mitigate and adapt to climate change for self-reliance and sustainability.

1.6.2 Professional rationale

As a geography teacher, I have noticed that EE in climate change mitigation and adaptation has been overlooked, particularly in rural areas of Zimbabwe. Thus, the research was necessitated by the need to explore the role of EE in climate change mitigation and adaptation so that the resilience

of rural communities can be developed, especially those who are currently vulnerable to climate change and if they can be brought into focus. It is my view that their livelihoods could be ensured, and their lives could improve in time if EE efforts are deepened in Gwanda rural district.

1.6.3 Geographical Context rationale

The impact of climate change has influenced the decision to embark on this study to explore the EE opportunities and gaps in climate change mitigation and adaptation among the communities in Gwanda rural district, Zimbabwe. The area is characterised by poor rainfall distribution, delays in the onset of rains, high incidences of flash floods, which are the main indicators of climate change (Ndlovu et al., 2020). There are also recurring droughts, extreme temperatures, and the prevalence of pests and outbreaks of diseases, which indicate climate change (Dube et al., 2018; Mbereko, et al., 2018; Ncube et al., 2016). The context of study will be discussed in detail in the following section.

1.7 Context of the study

The study was conducted in Gwanda rural district in Matabeleland South Province Mzingwane sub-catchment area of Limpopo basin in Zimbabwe. Figure 3.1 shows the location of the two study sites, wards 12 and 16. These communal lands are agro-ecologically unfavourable, and it is claimed that the majority of people rely on agriculture for a living; however, frequent drought cycles result in poor harvests (Chitongo, 2019; Thebe, 2012). According to Chitongo (2019), the rural areas in Africa depend on local natural resources such as forests, land, and water for survival. Similarly, people's livelihoods in Gwanda rural district are intricately dependent on forests, land, and water for agricultural activities. Historically rural districts in Zimbabwe were created as communal areas for Africans during the colonial era. Gwanda rural district is one location amongst the overpopulated communal lands in Zimbabwe; hence, there is limited land for arable and pastoral farming. Chagumbura et al. (2016) argue that overpopulation and poor environmental management practices promote overgrazing and monoculture, which exacerbates ecological degradation in the rural areas of Zimbabwe. The main economic activity in Gwanda rural district is farming and each household has a farming field and livestock.

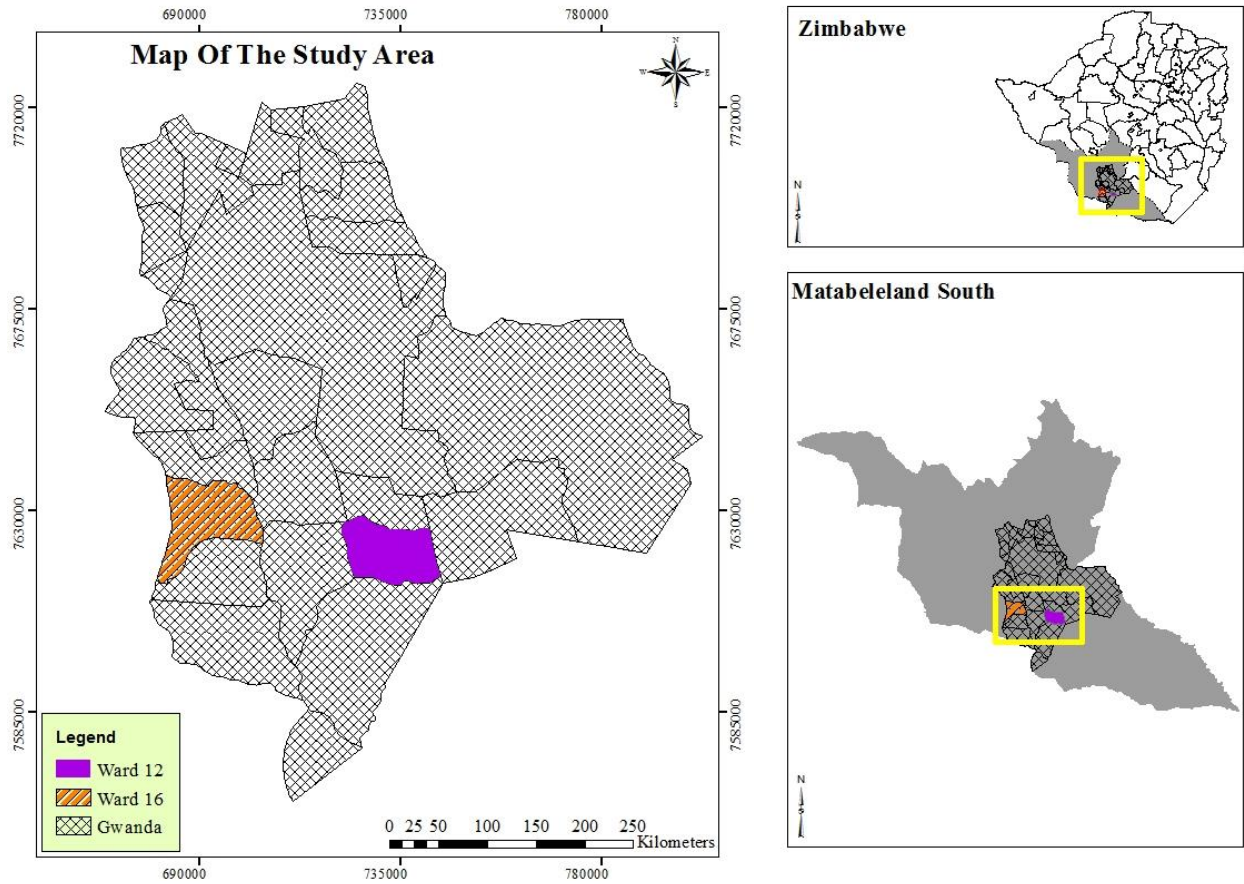


Figure 1.1 Map for the study sites (Source: own, using QGIS)

Gwanda rural district is one of Zimbabwe's driest regions situated in sub-Saharan Africa and is experiencing negative impacts of climate change in the form of droughts that cripple some of the communities' efforts to ensure food security and poverty alleviation (FAO, 2018; Unganai, 1996; World Bank, 2011). Gwanda district lies in Natural Region V that typically receives rainfall in one season from mid-October to March. Natural region V, on average, receives an annual rainfall of less than 500 mm/annum and high temperature in summer (Government of Zimbabwe, 2016; Unganai & Murwira, 2010). The area is characterized by poor rainfall distribution, a delay in the onset of rains, and increased flash floods, the leading indicators of climate change. There are also recurrent droughts, winter and summer temperature extremes, and increased pest and disease incidences for crops and livestock that indicate the impact of climate change.

1.8 Significance of the study

This study explored the gaps and suggested a way forward to improve mitigation and adaptation for climate change through EE to contribute to the Paris Agreement (2015). The research

contributes to knowledge on the capacity of rural communities to mitigate and adapt to the adverse impacts of climate change. The study sets the stage for understanding EE as a significant tool towards promoting mitigation and adaptation strategies employed by rural people in Gwanda rural district. This knowledge provides insights on improving the capacity of local people to mitigate and effectively adapt to climate change.

In addition, the significance to explore mitigation and adaptation strategies at the local level is reported by Howden et al. (2007). They argue that agricultural research initiatives for mitigating and adapting help decision-makers and policymakers to make strategic plans for sustainable agriculture. This research provides recommendations on improving climate change mitigation and adaptation through EE efforts as the effects of climate variability persist. It also provides suggestions on how EE can be enhanced to promote effective climate change mitigation and adaptation strategies to improve the livelihoods of people who live in dry climates and who are generally vulnerable to climate variability and change. Thus, the study provides significant policy recommendations for Gwanda as a rural district that can help towards achieving national goals for addressing the adverse impacts of climate change in other similar rural contexts.

1.9 Assumptions

The study assumed that the researcher would be given the requisite permission to carry out the research, and all the responsible authorities granted the permission. The other assumption was that the research participants would willingly consent to participate in the study and cooperate in providing correct information, thus helping the researcher achieve the research targets timeously. The study assumes that the research participants would provide honest responses without bias. In addition, the other assumption was that the researcher would have enough time and resources to do data generation by making use of the weekends, evenings, and spare time to do the research.

1.10 Delimitations of the study

This study was located in a context where addressing the challenges of climate change adaptation appear to be in vain, as communities in Sub-Saharan Africa continue to be threatened by the effects of climate change (Arora, 2019; Donatti et al., 2019; Ombogoh et al., 2018). The focus of the study was limited to the phenomenon of EE in climate change mitigation and adaptation among communities in semi-arid regions of Gwanda district. The study is thus the case of Gwanda rural

district, Zimbabwe only. Gwanda rural district was the selected area of study as it is one of the most drought-prone areas with very high temperatures and unreliable rainfall in Zimbabwe (Chanza, 2018; Ndlovu et al., 2020).

There were delimitations also in terms of the research design and methodology. The study was qualitative, utilising a small sample although I mined deep in terms of data generation. The sample was limited to the communities of Gwanda rural district in Zimbabwe that is villagers, AGRITEX, and EMA officers in this region. Thus, although a representative sample was drawn for conducting semi-structured interviews and focus group discussions, the data sets were qualitative in nature as it was a small-scale study. The secondary data for this study was mainly generated from EMA and AGRITEX annual reports and not any other documents in Zimbabwe, for a more localised approach.

1.11 Critical concepts related to the study

Some concepts require an understanding of their meaning in terms of this study. This section covers the critical concepts related to the study. Eight critical concepts have been discussed below: climate change, climate change mitigation, climate change adaptation, adaptive capacity, EE, EE approaches, the challenges of EE implementation, and the effectiveness of EE efforts.

1.11.1 Climate change

Climate change refers to long-term shifts in temperatures and weather patterns (IPCC, 2007). Climate change is one of the most complex issues involving many dimensions and it is a global problem but felt locally. Climate change is one of the biggest threats facing communal farmers in Zimbabwe (GoZ, 2016). The adverse effects of climate change are becoming more evident with increased incidences of droughts, floods, hailstorms, and heatwaves in many countries (Adger et al., 2009). Bryan et al. (2009) argue that climate change is expected to reduce the production of essential staple foods, including maize, sorghum, millet, and groundnut, especially in rainfall-dependent farming systems of Africa. The Intergovernmental Panel on Climate Change (IPCC) fourth assessment report concluded that in the coming decades, there would be a decrease in the size of arable land, the length of growing seasons, and yield potential, particularly in semi-arid and arid areas of Africa (IPCC, 2007). This would further increase food insecurity and exacerbate malnutrition in the African continent. The IPCC is the United Nations agency in charge of analyzing climate change science. It publishes comprehensive Assessment Reports on the state of

scientific, technical, and socioeconomic knowledge on climate change, its impacts, and future threats, as well as ideas for slowing down climate change's rate (IPCC, 2018).

According to Gaughan and Cawdell-Smith (2017), Southern Africa is experiencing hotter and fewer cold days than before due to climate change. The sub-region's annual mean surface temperature has warmed by about 0.40C from 1900 to 2000 (Jury, 2012). The period from 1980 has been the warmest in Zimbabwe. The timing and amount of rainfall received are becoming increasingly uncertain (GoZ, 2016). According to Mukwada and Manatsa (2013), the length and frequency of dry spells during the rainy season have increased while the frequency of rain days has declined. This situation cripples the primarily agriculture-based economy, with over 70% of the population living in rural areas and dependent on climate-sensitive livelihoods such as animal and crop production (IPCC, 2018).

1.11.2 Climate change mitigation

The IPCC defines mitigation as an anthropogenic intervention to reduce the sources or enhance the sinks of greenhouse gases (Klein et al., 2007; UNFCCC, 2015). It is about reducing greenhouse gas emissions from human activities by reducing sources of these gases and it also includes the process of enhancing the “sinks” that absorb carbon dioxide by planting trees (Dow et al., 2013; UNFCCC, 2011).

The mitigation goal is to avoid significant human interference with the climate system and stabilise greenhouse gas levels in a timeframe sufficient to allow ecosystems to adapt naturally to climate change, thereby ensuring that food production is not threatened and enabling economic development to proceed sustainably.

According to Fawzy et al. (2020, p. 5), “there are three main climate change mitigation approaches discussed throughout the literature. First, conventional mitigation efforts employ decarbonization technologies and techniques that reduce CO₂ emissions, such as renewable energy, fuel switching, nuclear power, and carbon capture storage and utilization. A second route constitutes a new set of technologies and methods that have been recently proposed. These techniques are potentially deployed to capture and sequester CO₂ from the atmosphere and are termed negative emissions technologies, also referred to as carbon dioxide removal methods. Finally, a third route revolves around the principle of altering the earth’s radiation balance through the management of solar and

terrestrial radiation.” As a result, mitigation entails preserving existing carbon pools to avoid emissions to the atmosphere, increasing carbon uptake in trees (sequestration), and employing substitutes for fossil fuels (Adger et al., 2013; Bustreo, 2019; Palmer, 2019; Ricke, 2017). Mitigation can be achieved at many different levels: governments and national institutions trying to fulfil their national commitments to the Paris agreement.

The mitigation benefits are typically viewed in a global, long-term perspective, given the time lag between greenhouse gas emission reductions and the achievement of equilibrium in the atmosphere's concentration. Furthermore, climate change mitigation is a global issue with generally good public characteristics, and therefore, it does not matter where greenhouse gas emission reductions or sink enhancements occur (Ackerman et al., 2009; Palmer, 2019; Watkiss et al., 2015).

1.11.3 Climate change adaptation

According to Chanza (2018), the concept of adaptation has a diverse and conflicting scholarly treatment in climate science, and as such, competing definitions abound. The commonly used definition of climate change adaptation is given by the IPCC (2014) as planned adjustments in ecological, social, or economic systems in response to actual or expected climatic stimuli and associated impacts. Climate change adaptation is about preparing for the current and future impacts of climate change by changing activities and decisions to reduce the negative impacts of climate change and becoming more resilient. In the same view, Bryan et al. (2009) define adaptation as the attempts made to cope and build long-term resilience to the negative impacts of climate change.

According to Gaughan and Cawsell-Smith (2015), climate change adaptations are significant for countries such as Zimbabwe, where the poverty rate is above 76 per cent, while about 70 per cent of the population depends on rain-fed agriculture for their livelihood. In Zimbabwe, there is a need for robust climate change adaptation strategies among many rural communities (Chanza, 2014; Manatsa & Mukwada, 2017). Furthermore, Forino et al. (2014) define adaptation as adjusting natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates potential damages or takes advantage of beneficial opportunities. Moser and Ekstrom (2010) deviated from these views by arguing that adaptation must not consider climate change alone, but it may be initiated or undertaken in a set-up of non-climatic windows of opportunity. From the perspective of exploring the successes and challenges of EE efforts in climate change

mitigation and adaptation that this study pursues, the view of the IPCC (2014), which defines climate change as planned adjustments in ecological, social, or economic systems in response to actual or expected climatic stimuli and associated impacts, deserves closer attention.

In agro-based economies, adaptation is needed to improve the resilience of the farming system, protect the livelihoods of the poor and ensure food security. The adaptive capacity of communities is strongly dependent on their access to resources. Thus, adaptation to climate change at the national level will require large-scale investments in environmental programmes, irrigation infrastructure, farming technology, drought-tolerant varieties, social protection programmes, and integrated strategies to reduce livelihood risks (Bryan et al., 2009).

Furthermore, at the community level, adaptation to climate change can include changes in crops, livestock, land use management practices and other livelihood strategies. According to Mburu et al. (2015), crop management practices that may require changes include a choice of crop varieties, fields, and planting dates. Livestock management practices to be considered in line with changes in climatic conditions include the choice of livestock to the rear and their feeding programmes (Bryan et al., 2009). The land use and management practices to be considered include the following: irrigation and water harvesting, soil and water conservation measures, tillage practices, and soil fertility management (Dube et al., 2018; Mburu et al., 2015; Phiri, 2019).

1.11.4 Adaptive capacity

It has been asserted that Africa remains vulnerable to climate variability and change partly due to multiple stresses and low adaptive capacity (IPCC 2007). The vulnerability of a socio-economic and environmental system to climate change is conceptualised as a function of a system's exposure to climate change effects and its adaptive capacity to deal with those effects. The more exposed a system is to a particular climate stimulus, the greater the system vulnerability; conversely, the greater the adaptive capacity of the system to a given climate event, the lower its vulnerability. It has been contended that the emergence of the vulnerabilities approach coincides with realising that experiences and lessons learned building resilience to existing climate stresses are important prerequisites for future adaptation (Sarker, 2019). Several research studies on indicators of adaptive capacity related to climate change have attempted to provide a conceptual framework and operational method to measure adaptive capacity. Smit et al. (2001) identified six determinants of

adaptive capacity in the context of climate change as a contribution to the third assessment report for the Intergovernmental Panel on Climate Change. The six determinants are presented overleaf.

Table 1.1: Determinants of adaptive capacity

Determinant	Rationale
Economic resources	<ul style="list-style-type: none"> ➤ Greater economic resources increase adaptive capacity. ➤ Lack of financial resources limits adaptation options.
Technology	<ul style="list-style-type: none"> ➤ Lack of technology limits the range of potential adaptation options. ➤ Less technologically advanced regions are less likely to develop and implement technological adaptations.
Information and skills	<ul style="list-style-type: none"> ➤ Greater access to information increases the likelihood of timely and appropriate adaptation. ➤ Lack of informed, skilled, and trained personnel reduces adaptive capacity.
Infrastructure	<ul style="list-style-type: none"> ➤ A greater variety of infrastructure can enhance adaptive capacity since it provides more options. ➤ The characteristics and location of infrastructure also affect adaptive capacity.
Institutions	<ul style="list-style-type: none"> ➤ Well-developed social institutions help to reduce impacts of climate-related risks and therefore increase adaptive capacity. ➤ Policies and regulations may constrain or enhance adaptive capacity.
Equity	<ul style="list-style-type: none"> ➤ The equitable distribution of resources increases adaptive capacity. ➤ The availability and entitlement to resources are important.

Source: Smit et al. (as cited in Abah, 2017, p. 1007)

Table 1.1 shows different indicators of adaptive capacity. This conceptual framework provides a basis for analysing the indicators of vulnerability and adaptive capacity. It helps researchers to

identify aspects that would assist farmers in adapting to challenging climatic conditions. These six determinants of adaptive capacity were crucial for this study because they provided a lens for exploring the successes and challenges of climate change mitigation and adaptation.

1.11.5 EE

EE refers to the process that involves exploring environmental issues, engaging in problem-solving and taking action to improve the environment (Ghiurca et al., 2015; Manyatsi, 2011; Shutaleva et al., 2020; UNFCCC, 2018). It helps people to develop a deeper understanding of environmental issues and have the skills to make informed and responsible decisions. According to Knight (2000), EE mainly aims to develop environmental awareness and skills in identifying, monitoring, and evaluating environmental issues, solving environmental problems, and developing positive attitudes and values.

According to Manyatsi (2015), Sustainable Development (SD) is an aspect of EE that teaches, amongst other things, how to identify and solve environmental problems and develop positive attitudes and values. Thus, EE is about knowledge, skills, and values about the environment, and SD is about the nature of development (UNFCCC, 2012). This definition for EE will be employed in this research in understanding how EE can be used as a tool for addressing the problems of climate change. The Paris agreement UN (2015, p. 83) emphasised the "importance of education, training, public awareness, public participation, public access to information and cooperation at all levels." The article explains the importance of each country to incorporate EE at all levels to avail necessary information for climate change mitigation and adaptation in communities.

Integrating quality EE into existing education systems represents immediate and longer-term challenges for responding to climate change. The challenging task for responding to climate change is to include climate change adaptation knowledge and skills in educational systems, while the longer and more difficult task is to develop education systems for climate change mitigation that equip learners with the necessary skills, knowledge, and attributes to deal with future challenges (Bangay & Blum, 2010).

Educational responses to climate change range from the short-term measures that equip learners and communities with knowledge for adaptation to long-term measures that equip learners with knowledge for mitigation which is important in addressing the adverse impacts of climate change.

These educational responses to climate change show the significant role of EE in climate change mitigation and adaptation. Table 1.2 provides a generalised chronological view of the possible sequencing of educational responses (Bangay & Blum, 2010).

Table 1.2: Theoretical framework for educational responses to climate change mitigation and adaptation

Short	Medium	Long
<ul style="list-style-type: none"> • Communities risk assessment • Climate 'proofed' school design • Adapting to weather extremes such as heat waves and floods • Disaster preparedness capacity e.g., to respond to climate-related weather hazards such as heat waves, droughts, cyclones, etc. • Increased 'scientific literacy' e.g., higher education capacity to facilitate technological transfer 	<ul style="list-style-type: none"> • Capacity to respond to new migration and adaptation streams • Demand-side interventions e.g., conditional cash transfers • Integrated climate change education interventions that promote environmental stewardship and resilience to climate change • Climate change education projects, assessment, education reforms e.g., integration of climate change education with Indigenous Knowledge Systems (IKS) • Issuing attendance certificates as well as merit certificates to individuals who get involved in education CCE short courses and workshops • Research, innovation, and invention 	<ul style="list-style-type: none"> • CCE programmes that promote climate change mitigation and adaptation in support of sustainable livelihoods • Orientation towards new 'low carbon' technologies & sustainable futures
Adaptation		Mitigation

Educational responses to climate change mitigation and adaptation (Adapted from Bangay & Blum, 2010).

Table 1.2 shows a holistic approach for educational responses to climate change that helps understand the role of EE in mitigation and adaptation. Educational responses to climate change address the adverse impacts of climate change and support wider goals for mitigation and

adaptation through the provision of curriculum content approaches to pedagogy, curricula, assessment frameworks, and learning environments that support quality learning about the protection and sustainable utilisation of the environment (Bangay & Blum, 2010). Thus, EE efforts are valuable as they support knowledge and skills for mitigation and adaptation that promote communities' capacity to deal with future climate uncertainty.

1.12 Outline of the chapters of the thesis

This thesis is composed of six chapters.

Chapter 1: Background of the study

Chapter 1 gives an overview of the study, that is, the statement of the problem and rationale of the study, aim of the study, objectives, and critical research questions. The chapter highlighted the significance of the study, the reasons for the choice of Gwanda rural district as the study area, and a summary of some of the key theoretical insights that guided the study.

Chapter 2: Literature review and detailed theoretical underpinnings for the study

Chapter 2 provides the literature related to the role of EE in climate change mitigation and adaptation: the case of Gwanda rural district, Zimbabwe. EE in climate change mitigation and adaptation are discussed under global, regional, and national contexts. The chapter discusses the rural experiences of EE in mitigation and adaptation. The challenges of EE in rural areas of selected countries are also explored. The chapter also discusses two models that guide this study, and they include the Sustainable Rural Livelihoods (SRL) Framework (Carney, 1998; Scoones, 2015) and the Nested model of sustainability (Department of Environmental Affairs (DEA), 2012).

Chapter 3: Methodology

Chapter 3 discusses the methodology employed in the generation of data for the study. It also explains that qualitative research methods were employed, using semi-structured interviews, focus group discussions and analysis of key documents. The participants in the study were the Environmental Management Agency (EMA), Agriculture and Extension Services Department (AGRITEX), and community members. Also included in this chapter is an explanation of the data generation and analysis procedures and ethical issues.

Chapter 4: Data Presentation, Analysis and Discussion

Chapter 4 gives an overview of the findings of the study. These include the experiences of EMA, AGRITEX, and community members about successful mitigation and adaptation strategies for climate change that can be used in EE programmes, the challenges faced in mitigation and adaptation for climate change in Gwanda rural district, and how EE programmes can address these challenges. The chapter also provides a discussion of the findings and their links to the literature reviewed. There is also an in-depth discussion of the role of EE in climate change mitigation and adaptation. The successes and challenges of EE efforts in climate change mitigation and adaptation are also discussed.

Chapter 5: Theorisation

Chapter 5 presents an outline of the key theoretical aspects and insights that emerged from the study after discussing the findings together with the available literature. The chapter presents two models developed from the discussion of research findings. The models were used to illustrate the role of EE in climate change mitigation and adaptation. In addition, the models illustrated EE's role in enhancing resilience and reducing vulnerability. Thus, theorisation was based on the successes and challenges for climate change mitigation and adaptation in Gwanda rural district.

Chapter 6: Summary, Conclusions and Recommendations

This chapter summarises the whole study and conclusions concerning the critical research questions guiding this study. There are recommendations for the government of Zimbabwe, agricultural extension officers, NGOs, and community members in drought-prone areas with specific reference to the role of climate change mitigation and adaptation. Possible areas for further research are also outlined.

The next chapter (two) provides a review of the literature relevant to the study and the theoretical underpinnings of the study.

1.13 Conclusion

Chapter 1 gave an overview of the study, that is, the statement of the problem and rationale of the study. The aim of the study, objectives and critical research questions were also presented. The significance of the study was then highlighted, as well as the reasons for the choice of Gwanda

rural district as the case study area. The chapter concluded with an outline of the contents of each of the chapters in the thesis.

CHAPTER TWO

LITERATURE REVIEW AND THEORETICAL UNDERPINNINGS

2.1 Introduction

This chapter presents a review of the literature and the theoretical lenses used in the study. The study aimed at exploring the role of EE in climate change mitigation and adaptation amongst farmers in Gwanda rural district. Thus, the successes and challenges to EE efforts in climate change mitigation and adaptation in the Gwanda rural district are also explored for the insights into the phenomenon. The chapter discusses EE, climate change mitigation, and adaptation on a global, regional, and national scale. With the exception of the introduction and conclusion, the rest of this chapter is divided into five sections. The first section is the introduction, which provides an overview and outline of the chapter. The second section deals with climate change interventions in the Global North under the following subsections: mitigation, adaptation, and EE. In this section, the concept of EE in climate change mitigation and adaptation is elucidated in four developed countries (Australia, Canada, UK, and the USA). The third section overviews climate change interventions in the Global South under the following subsections: mitigation, adaptation and EE. The case studies selected from countries in the Global South include Bangladesh, Brazil, and Mexico.

The fourth section is about climate change interventions in Sub-Saharan Africa under the following subsections: mitigation, adaptation and EE. This section focused on three Southern African countries: South Africa, Botswana, and Mozambique. The fifth section elucidates the climate change interventions in Zimbabwe. The sixth section focuses on the theoretical lenses underpinning the study, and two models are discussed. These models include the Sustainable Rural Livelihoods (SRL) Framework (Carney, 1998; Scoones, 2015) and the Nested model of sustainability (Department of Environmental Affairs (DEA), 2012). Section seven constitutes the last section, and it presents the conclusion of this chapter.

2.2. Climate change interventions in the Global North: mitigation, adaptation, and EE

This section discusses climate change mitigation, adaptation, and EE in the Global North. It is reported that countries in the Global North that have signed the Paris Agreement should continue to establish absolute emission reduction targets for their entire economies (UN, 2015). Four global superpowers, namely: Australia, Canada, the UK, and the USA, were selected as case studies to explore mitigation, adaptation, and EE efforts in the context of climate change. Australia was

selected because it is one of the world's biggest per-capita emitters of greenhouse gas, and there has been a long-running debate about the country's approach to climate change (BBC Reality Check, 2020). According to the International Energy Agency, BBC Reality Check (2020), Australia was the fourth-largest coal producer in 2017. It is among the world's largest exporters of fossil fuels such as iron ore, uranium, coal, and natural gas.

2.2.1 Climate change mitigation in the Global North

In Australia, Canada, the United Kingdom, and the United States, the government and non-governmental organizations use a variety of mitigation strategies to address the negative effects of climate change. Strategies for climate change mitigation will be discussed under five headings; international agreements on climate change, the establishment of policies for climate change mitigation, use of renewable energy sources, use of energy savers and enhancing carbon sinks. The subsections are as follows:

a) International agreements on climate change

The nations selected have committed to international agreements and are signatories to the Kyoto Protocol and the Paris Agreement. Australia, Canada, the United Kingdom, and the United States signed the Kyoto Protocol, which aimed to reduce greenhouse gas emissions by 5% below 2000 levels by 2020, and the Paris Agreement, which aimed to reduce greenhouse gas emissions by 26-28 percent below 2005 levels by 2030 (UNFCCC, 2015). To meet the targets of these international climate agreements, governments have implemented measures to reduce emissions in various sectors of their countries, and governments publish regular quarterly reports on greenhouse gas emissions from various sectors such as mining, transportation, and metal manufacturing, among others.

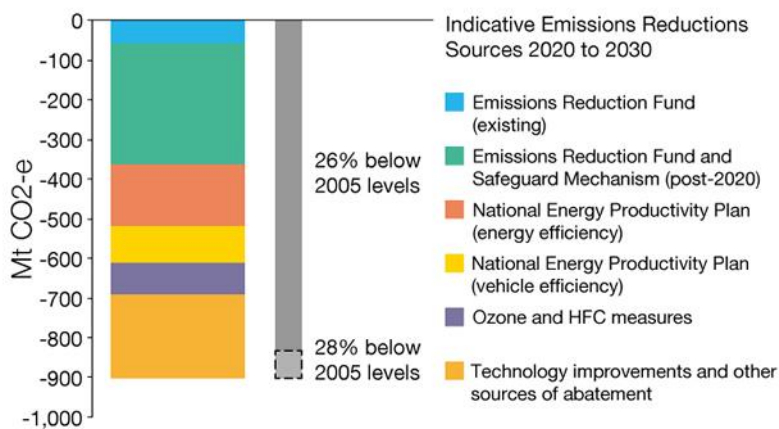
b) Establishment of policies for climate change mitigation

The selected countries have established policies and strategies to mitigate climate change. To begin with, Australia has several national policies and strategies that are earmarked to mitigate climate change. According to the BBC Reality Check news report (2020), the Australian government maintains that it has policies to meet its 2030 targets for mitigating climate change by reducing carbon emissions. The report quoted the Australian Prime Minister Scott Morrison, who stated, "Our climate policy settings are to meet and beat the emissions reduction targets," According to Australian projections published in December 2019, carbon emissions will be only 16% lower than 2005 levels in 2030 (BBC Reality Check, 2020). Thus, the Australian government

is investing in national environmental programmes and policies to mitigate climate change. Australia's Long-term Emissions Reduction Strategy is being developed. The Australian government will present the strategy to the 26th United Nations Framework Convention on Climate Change (UNFCCC) at a climate summit held in Glasgow in 2021 (Alt, 2016).

Furthermore, the Government of Australia has several national policies to reduce greenhouse gas emissions and meet the 2030 target for mitigating climate change. The Australian national policies are generally designed to reduce emissions, increase energy productivity, and boost the use of renewable energy (Talberg et al., 2016). Australia's policies for mitigating climate change are illustrated in the Figure below.

Figure 2.1: Australia's policies for mitigating climate change



Source: Parliamentary Library Briefing Book 45th Parliament: August 2016

The Emissions Reductions Fund (ERF) is a voluntary scheme designed to provide financial incentives for businesses, landholders, and communities to reduce emissions in Australia. Under the ERF, the government purchases greenhouse gas reduction, quantified by Australian Carbon Credit Units through an auction process administered by the Clean Energy Regulator. Many projects to reduce emissions have been funded under the ERF. These include projects to replace Melbourne streetlights with more energy-efficient light bulbs, native forest and vegetation growing projects, and the use of gas from waste to create energy (Alt, 2016).

According to the Alt (2016), the Australian government has established the National Energy Productivity Plan (NEPP), which aims to enhance energy productivity by 40% between 2015 and 2030. Energy productivity combines traditional energy efficiency measures with new technology

such as solar power. Mitigation strategies listed in the NEPP include improved vehicle efficiency and improved residential building energy ratings and disclosure.

Furthermore, the rural areas in the Global North have mitigation strategies that they employ to reduce the impacts of climate change. It is reported that rural communities have shifted to production practices that release fewer carbon emissions. For instance, the responsible departments such as agriculture in the Global North are promoting low carbon emissions by ensuring that farmers have a "social license to farm" before embarking on farming activities (Bustreo, 2019; Iglesias & Garrote, 2015; Sharma et al., 2016). This means that farmers in the Global North must demonstrate their environmental responsibility as a pre-condition to being allowed to carry out their preferred farming practices. Martin and Williams (2011, p. 202) state that "embracing the social license challenge positively may be the most effective way to ensure continued support from the community." The "social license challenge" refers to farmers' obligation to apply for licenses before starting their farming. The application should show that the farmers are committed to emitting fewer greenhouse gases. Thus, the agricultural sector is working with rural communities to reduce carbon emissions, which mitigate climate change. Wind and solar farms benefit rural areas by using green fuels that do not produce greenhouse gases.

Furthermore, Canada has national policies and strategies that are earmarked to mitigate climate change. In Canada, the primary form of climate change mitigation is the development of environmental policies that achieve real environmental benefits while reducing greenhouse emissions in accordance with the international focus on green growth. The government has implemented measures targeting greenhouse-emitting sectors in Canada such as transportation, electricity generation, oil drilling, drilling of gas, and industrial activity (Monroe et al., 2019). In the year 2000, federal, provincial, and territorial energy and environment ministers approved a National Strategy on Climate Change in Canada. The strategy emphasizes lowering greenhouse gas emissions.

The United Kingdom has a number of national policies and strategies in place to combat climate change. According to Monroe et al. (2019), the United Kingdom's government mitigates climate change by requiring students to participate in mitigation programmes through their curriculum. Students can make a significant difference in lowering their school's energy consumption. According to the findings of the study, students are involved in learning about energy resources, data collection, monitoring energy use in schools, and implementing appropriate action projects

within the school. These student-led projects have reduced electrical usage in schools by approximately 35%. Furthermore, policies exist in the UK that are driving a 25% reduction in emissions from 1990 levels by 2050 (Greater London Authority, 2017; Lorenzoni et al., 2007). As a result, decarbonization of energy grids and other measures will be required in accordance with policies aimed at achieving zero-carbon UK carbon budgets. The process of reducing carbon dioxide emissions, with the long-term goal of eliminating them, is referred to as decarbonisation. This is consistent with the 2015 Paris Agreement, which set a goal of limiting global warming to 1.5°C above pre-industrial levels by 2050, to achieve net carbon neutrality or low carbon emissions (IPCC, 2018).

The USA has several national policies and strategies in place to mitigate climate change. The USA's government employs cutting-edge technology to combat climate change. According to Talberg et al. (2016), NASA's Carbon Monitoring System (CMS) was introduced in 2010 as a US government-directed initiative. The CMS is working to improve global carbon stock and flux monitoring. The carbon stock is the amount of carbon stored in forests as biomass, soil, deadwood, and litter (Kunkle & Monroe, 2019; Petrokofsky et al., 2012; Vieira et al., 2008). A carbon flux is the amount of carbon exchanged between Earth's carbon pools, which include the oceans, atmosphere, land, and living things (Dilling & Berggren, 2015; Melieres & Marechal, 2015). According to Zhou et al. (2021, p. 1) "Accurate quantification of forest carbon stocks and fluxes over regions is needed to monitor forest resources as they respond to changes in climate, disturbance and management, and also to evaluate contributions of the forest sector to the regional and global carbon balances". As such, the primary goal of CMS is to make significant advances in quantifying, understanding, and predicting how global carbon sources and sinks change.

c) Use of renewable energy sources

According to government reports from the four countries used as case studies, nations in the Global North are encouraging the use of renewable energy sources to combat climate change. Climate change mitigation strategies include the standard set of alternatives to reduce fossil fuel consumption, lowering energy use in general, and using energy more efficiently (Jeong & Ko, 2021; Talberg et al., 2016). Households are also turning to renewable energy to reduce expenses and become self-sufficient. Households have access to cost-effective off-grid renewable energy systems, which reduce or replace reliance on diesel with a greener option.

Households in the Global North are implementing a variety of climate-change mitigation strategies. The majority of families use renewable energy sources such as solar energy (Jeong & Ko, 2021). The use of natural gas also continues to play an important role in the transition to a low-carbon economy in the short and medium term. Households use natural gas-generated electricity, which helps to mitigate climate change. Local energy generation and communal heating networks in the United Kingdom, for example, generate renewable energy such as solar and wind (Great London Authority, 2017). As such, households in the Global North have eco-friendly energy sources for heating, lighting, and cooking, among other things.

d) Use of energy savers

Households in the Global North are implementing a variety of climate-change mitigation strategies. To reduce pollution, environmentally safe paints and cleaning products are used in homes. Furthermore, households are conserving electricity by using thermostat-controlled appliances, which help reduce electricity waste and indirectly reduce carbon emissions associated with electricity generation (Matson et al., 2016). Households are also prioritizing climate change mitigation by purchasing and using home appliances with the ENERGY STAR label. ENERGY STAR certified gadgets are built to meet energy efficiency standards, lowering energy consumption without compromising performance. Thus, decisions made about the use of gadgets at the individual and household levels play a significant role in regulating greenhouse gas emissions.

e) Enhancing carbon sinks

Good forest management improves carbon sinks by limiting deforestation and lowering GHG emissions. It is one of the most widely used strategies for mitigating climate change in the Global North. There are effective forest management strategies in the Global North, as evidenced by minimizing tree disturbance during harvesting activities, narrowing road widths, and assisting trees to re-establish more quickly after harvest (Alt, 2016). Communities, particularly in rural areas of the Global North, are said to be establishing more forests through afforestation programs. Furthermore, by reducing forest exploitation, they promote the growth of existing forests. Afforestation and reforestation programmes aid in the establishment of new forests on abandoned agricultural land and in other areas where there were previously no forests. Forest maintenance

protects both newly planted trees and trees that existed before the afforestation program. The governments of the four selected Global North countries have established committees to spearhead afforestation programmes (Lang & Ryder, 2016; Matson et al., 2016). Furthermore, people plant trees in their farms to provide shade for their livestock, and this also increases carbon dioxide uptake from the atmosphere because trees act as carbon sinks. Farmers have currently adopted the best fertilizer application practice, which reduces nitrous oxide emissions and thus greenhouse gas emissions.

Furthermore, countries in the Global North, particularly Australia, Canada, the United Kingdom, and the United States of America, are establishing more forests through afforestation and encouraging the growth of existing forests. These strategies have proven to be the most effective at mitigating and adapting to climate change by increasing forest carbon sinks. The four countries are investing in national climate change mitigation and adaptation programmes and policies. These countries have ratified the United Nations Framework Convention on Climate Change (UNFCCC). Furthermore, it has been reported that communities in the Global North are reducing greenhouse gas emissions and limiting deforestation during their economic activities. Mitigation strategies for forestry management include establishing narrow roads and planting trees along roadsides. There is a research gap on the role of EE in enhancing climate action, which this study aims to address.

2.2.2 Climate change adaptation in the Global North

In Australia, Canada, the United Kingdom, and the United States, governments and non-governmental organizations use a variety of adaptation strategies to address the negative effects of climate change. The common climate change adaptation strategies will be discussed under three headings: national programme establishment, climate-smart agriculture, and livelihood transformations. The subsections are as follows;

a) Establishment of national programs

All four countries used as case studies have national climate change adaptation plans in place. To begin, Australia has several national policies and strategies in place to deal with the effects of climate change. Climate change adaptation is a priority for the Australian government, which began incorporating it into the national budget in 2004. A National Climate Change Adaptation Programme is funded in the national budget. The National Climate Change Adaptation

Programme, established in 2015, had the goals of supporting and preparing industries and communities for the effects of climate change, as well as sponsoring coping strategies. According to Pearce et al. (2018), the Commonwealth Scientific Industry and Research Organization (CSIRO) established the Climate Adaptation Flagship in Australia in 2007. This programme was established to provide practical and effective adaptation options to policymakers, industries, and communities. Australia regularly publishes national climate change communications, which cover a wide range of adaptation strategies and policies in the country (Pearce et al., 2018; Pearce et al., 2010). As a result, the Australian government has put in place national programmes to assist people in adapting to climate change.

Furthermore, Canada has many national climate change policies and strategies in place. In addition, in May 2002, ministers approved the creation of a national Framework for Adaptation. Programmes are being developed to help citizens cope with the negative effects of climate change. For example, the Government of Canada's Climate Change Impacts and Adaptation Programme has funded some projects that assess the vulnerability of infrastructure to climate change. The Canadian Environment Assessment Act establishes guidelines for environmental assessments for all projects. The Act, for example, requires the design of a sewer distribution project to account for the effects of projected future precipitation and wet weather flows.

In addition, Canada's Climate Change Impacts and Adaptation Programme assists coastal communities in dealing with sea-level rise. It also increases the resilience of northern communities to permafrost degradation. This is accomplished by providing a best practice guide for incorporating climate change and adaptation effects into land-use planning.

Furthermore, the UK has several national policies and strategies in place to address climate change. The Climate Change Act, enacted by the UK government in 2008, is intended to assess and manage the risks associated with climate change in the UK. In addition, the UK government launched the UK Climate Change Risk Assessment (CCRA) and the National Adaptation Programme, both of which aim to promote climate change adaptation in the country. Some policies were put in place such as adaptation frameworks and plans in Scotland and Wales, the Localism Act (2011), and the National Planning Policy Framework. Climate change adaptation organizations such as Defra, Devolved Administrations, and the Environment Agency have also been established by the government. These organizations work together to promote climate change adaptation across the UK.

Furthermore, the United States has several national climate change policies and strategies in place. The adaptation strategies provided by the United States government are intended to inform and assist citizens in identifying potential alternatives to dealing with the negative effects of climate change. The government of the United States of America has national projects that are illustrative and are being implemented to assist citizens in adopting measures to address current and anticipated future climate threats. Thus, governments in the Global North play an important leadership role in establishing policies that affect the actions of all sectors of society in terms of climate change mitigation and adaptation.

b) Climate-smart agriculture

It is reported that communities in the Global North have implemented adaptation strategies to deal with climate change (Lawson, 2016; Pearce et al., 2018). Furthermore, dryland farmers are experimenting with various crops, growing methods, and farming techniques. The Birchip Cropping Group (BCG), for example, was critical in providing locally based and technologically advanced support for the dry land farming sector in Australia (Alt, 2016). Farmers also observe that during a drought, this type of adaptation is accelerated because survival is at stake. As a result, households in the Global North are implementing a variety of climate change adaptation strategies. Adaptation to climate change is already underway in the agricultural sector of the Global North. For example, selected countries in the Global North have adopted the use of new crop varieties and animal breeds that are resistant to harsh conditions. In addition, they have adjusted their sowing and harvesting dates to cope with the changing climate. The breeding of heat-tolerant sheep breeds like the Dorper and tick-resistant cattle like the zebu (Stokes & Howden, 2008). People are also shifting from dry land to irrigation production systems. Rainfall in Australia is unreliable, so farmers have turned to irrigation to supplement low rainfall.

c) Livelihood transformations

Adaptation strategies in the four selected case studies in the Global North include changing the crops planted during drought conditions and looking for off-farm work to diversify income sources. Furthermore, hunters in the Arctic have increased their use of GIS and remote sensing by employing GPS technology to aid navigation in unpredictable and challenging weather. According to the Great London Authority (2017), local governments identify specific opportunities for promoting climate change adaptation, such as a greater emphasis on localism,

local nature partnerships, neighbourhood planning, and funding mechanisms like the Community Infrastructure Levy. According to a study conducted by Brisley et al. (2012), local governments in the Global North are working to embed adaptation across all services and production systems. According to reports, the government departments have gone a step further by incorporating adaptation into the council decision-making processes. As a result, governments in the Global North play an important role in maximizing adaptation to climate change. Furthermore, according to a study conducted by the Green Alliance (2011), addressing climate change remains a top priority for local governments in the United Kingdom and other developed countries.

In addition, governments in the Global North have enacted ordinances governing the ventilation of residential dwellings in communities (Matson et al., 2016). This is done to prepare for the effects of storm-related power outages caused by climate change. The local authorities' recommendations and approvals for building designs seek to improve proper ventilation and maintain acceptable thermal conditions. Thus, adaptation strategies for climate change have been put in place and this current study seeks to identify the ways in which EE can be utilised to enhance climate change mitigation and adaptation.

2.2.3 EE in the Global North

To address the negative effects of climate change, governments and non-governmental organizations in the Global North implement numerous EE programs. EE will be discussed in four sections: policies, the school curriculum, the tertiary curriculum, and non-formal education. The section also discusses the challenges associated with EE in the Global North. The subsections are presented below

a) EE policies

EE for climate change mitigation and adaptation has made remarkable progress in the Global North. According to Downes and Roberts (2018), EE experienced a boost in the 1980s as it became more highly organized internally with the formation of its national professional association, which has grown from strength to strength with a significant presence in each state and territory. For instance, the Australian Association for EE has established an environment conducive to the development of positive environmental attitudes. EE, according to Alt (2016), has a promising future because it promotes environmental awareness among ordinary citizens.

This directly affects behaviour change, which is the primary goal of EE. International conventions were held in the 1970s to raise public awareness of EE issues (UNFCCC, 2015).

Furthermore, in the 1980s, Canadians affiliated with the North American Association for EE, which was based in the United States of America. The Network for EE and Communication in Canada was established in the 1990s. This initiative raised public awareness and interest in EE. Furthermore, the Canadian government established the Green Plan, which refers to a significant national commitment to protect the nation's entire environment and promote public interest in EE. The National and Provincial Round Tables on the Economy and the Environment (NRTEE) were established in 1993 to promote the nation's EE (Smithers & Palmer, 2001).

According to Palmer (1998), the European Community (EC) adopted EE as an integral and necessary part of the upbringing of every European citizen in 1988. Thus, communities in the Global North are exposed to EE programs, which equip them with knowledge about environmental issues and skills to implement practices in their own lives which are environment friendly.

b) School curriculum

The case studies from the Global North show that the school curriculum is used to teach students about climate change mitigation and adaptation strategies. For example, the UK government promotes climate change mitigation and adaptation through a compressed school curriculum. The knowledge and skills acquired by students at school benefit communities as well (Monroe et al., 2019). As such, communities have benefited from energy conservation education programmes in which students conserve energy at home and share mitigation strategies with their parents. As a result, these programs, which aim to equip citizens with climate change mitigation skills, are also benefiting rural areas in the Global North. In addition, EE has been embraced in the Australian school curriculum because it has been centralized while not ignoring the local needs of each school or state. According to Eilks (2015), the Australian EE Programme recognizes that educating about environmental issues necessitates the inclusion of EE in the school curriculum. Furthermore, EE in Australia extends beyond ecological concerns to include cultural, social, political, ethical, moral, emotional, philosophical, and economic aspects (Smithers & Palmer, 2001). As a result, it has gained international recognition.

The Canadian government has made significant strides in the advancement of EE. EE in Canada began in the 1960s, when subjects such as nature study, natural history, conservation education,

and outdoor education were taught in schools. Another development in Canada that promotes EE is the establishment of the EE Programme in 1993, which provided learners in primary and secondary school with EE training. Thus, the Canadian government's support for EE dates back to 1993, when it was incorporated into the curriculum. Furthermore, the majority of provinces provide guidelines for incorporating EE into existing curricula. This encourages environmental research, preparing citizens to cope with and address environmental issues such as climate change. It is reported that during the 1980s, governments in the Global North consolidated the national curriculum for schools to include EE (Williams, 2005; Zhou et al., 2021). For example, by 1987, the government of the United Kingdom had already endorsed the Tbilisi Convention's principles for an updated national curriculum. Formal education, according to Williams (2005), promoted the protection of human health and the preservation of an ecological balance. After finishing primary and secondary school, students are expected to use natural resources in a sustainable manner (Ford et al., 2010; Monroe et al., 2019). As a result, EE in schools prepared each individual to change behaviour and contribute to environmental protection through climate change adaptation and mitigation. The United Kingdom is combating climate change through school projects and a locally based school curriculum that equips students with the knowledge and practical skills for climate mitigation and adaptation (Porter et al., 2014). Learners are taught how to care for the environment while exploiting resources through the curriculum.

The National EE Act was the first piece of EE legislation passed by the federal government of the United States in 1970. This Act became a rallying point for parties interested in EE. The Act was repealed in the 1980s, and EE programmes had to thrive without government funding. This development compelled local communities to become self-sufficient, and EE gained widespread acceptance in mainstream educational circles. In 1990, the USA reversed the situation by enacting the new National EE Act, and government funding was reinstated (UNESCO, 2017). The EE programme of the United States influences the programmes of other countries, and they drafted their EE programmes using it as a model. The United States Environmental Protection Agency (EPA) (<https://www.epa.gov>) is the official website of the USA government that provides EE for adapting to and mitigating climate change.

Teachers and students can find environmental and science-based lesson plans, activities, and ideas on the Environmental Protection Agency's website. For example, EPA scientists created the "Generate! Game" which is a fun interactive board game. It allows students to learn about energy

choices and the environment while also "energizing" them through friendly competition (Environmental Protection Agency, 2021, August 25). The game is a teaching tool that can be used to learn about the costs and benefits of different energy options, as well as what will happen if the energy mix changes in the future and what energy choices mean for the climate, air, water, and overall environmental quality.

There's also the Climate Change, Wildlife, and Wildlands Toolkit, which is a collection of resources for both formal and informal educators (Environmental Protection Agency, 2021, August 25). The EPA developed a kit for use when talking with the public about how climate change is affecting our nation's wildlife and public lands on this platform. EPA developed this toolkit in collaboration with the National Park Service and with input from the US Fish and Wildlife Service.

Furthermore, the EPA created NASA's Climate Kids, a multimedia-rich website aimed at students that use games, humorous illustrations, and animations (Environmental Protection Agency, 2021, August 25). This website helps students to break down the important issue of climate change, particularly for students in grades K-12.

According to the Environmental Protection Agency (2021, August 25), there is the NOAA Education Resources Website provides teachers with information, activities, and background information on how to teach students about weather, climate change, and oceans, with a focus on grades 6 through 12. Finally, the NOAA's Discover Your Changing World Activity Book is available. This free activity book will teach students about the fundamentals of climate science and what they can do to help protect the environment.

c) Tertiary curriculum

Tertiary institutions have participated in the education of students at various levels of higher education. Some universities provide post-graduate degrees (Master's and PhDs) in EE and environmental science (Downes and Roberts, 2018; Matson et al., 2016). Australia has also produced internationally renowned researchers whose contributions have been critical in the development and conceptualization of EE at the national and global levels. Among them are John Fien (Griffith University), Ian Robottom (Deakin University), David Yencken (University of Melbourne), Roy Ballantyne (Queensland University of Technology), and Rob Walker (Deakin University), according to Smithers and Palmer (2001). EE has evolved, and it piqued the public's

interest in the 1980s and 1990s. This is demonstrated by the curriculum of Canadian tertiary institutions, which introduced several courses promoting public awareness in EE (Monroe et al., 2019). Bachelor programmes in Environmental Studies in Canada, for example, include Bachelor of Environmental Arts and Justice, Bachelor of Environmental Design, Bachelor of Science in Land Reclamation, Bachelor of Environmental Science / Studies, Bachelor of Sustainable Environmental Management, and so on. These degree programmes provide university students with the knowledge and skills necessary to mitigate and adapt to climate change, biodiversity loss, and other environmental issues.

d) Non-Formal education

The selected Global North countries have non-formal education initiatives which equip citizens with EE. To begin, the USA government, through the Environmental Protection Agency (EPA), is empowering local governments to be decision-makers by developing a package of information tailored to their needs, in which people can find information about the risks posed by climate change to the issues they are concerned about, as well as relevant adaptation strategies (EPA, 2021; Schild, 2016). Households in Australia are launching a variety of EE initiatives to adapt to climate change. Parents' interactions with their children at home promote EE by cultivating an environmentally conscious culture. Parents encourage children's resourcefulness in a variety of domestic activities and interactions while restricting children's availability or access to consumer/material goods. Households in the Global North use recycled and handmade play equipment in conjunction with manufactured resources, such as recycled milk bottles for sand scoops, discarded pots and pans for home corners and dramatic play areas, and cards, bottle tops, and old Compact Discs to make mobiles to hang in trees. Reusing items teaches children the value of recycling and encourages them to come up with new ways to use everyday household items. Thus, EE in Australia is passed down through generations through the use of stories, dance, and ceremonies, as well as the establishment of a network of sacred places.

Furthermore, Canadians have fish tanks and pot plants, which encourage children to become interested in environmental elements (Jones, 2014; Monroe et al., 2019). Some homesteads have planted vegetable gardens, worm farms, and native bird feeders, promoting a variety of experiences and learning opportunities for sustainable living practices and livelihoods.

According to Monroe et al. (2019), UK students in their homes have participated in community projects that have allowed them to communicate climate change concepts to other members of

society. As a result, environmental projects assist students in sharing EE with members of the community in rural areas. Households in the UK are embarking on various EE efforts to adapt to climate change. For craft activities, families collect and donate items such as old magazines, greeting cards, bottle tops, cardboard boxes, cardboard tubes, and metal waste. Upcycling these unwanted household items into valuable art pieces provides children with a multifaceted learning experience that is required to mitigate and adapt to climate change.

In rural areas, the Nature Conservancy serves as a tool for implementing EE. Students learn how trees replenish the air supply by absorbing carbon dioxide and producing oxygen, as well as how they purify the air by filtering out dust and greenhouse gases. This teaches students the value of trees, which act as carbon sinks and absorb carbon dioxide. Households in the Global North are embarking on a variety of EE initiatives to adapt to climate change. Games are being used as exciting and fun ways to engage people of all ages in the Global North. Children develop skills and knowledge about EE while having fun. The use of games in EE is advantageous because it aids in the communication of complex concepts and relationships found in ecosystems. Players can enter a game with varying levels of knowledge. It is reported that the governments have curated a selection of games suitable for both formal and informal settings through its urgencies. Aside from games, parents teach their children about waste management both directly and indirectly. The government teaches citizens how to compost yard waste and food scraps. When waste is converted into compost, children and their parents learn about waste management, which promotes EE. Food scraps and yard waste account for approximately 30% of household waste, according to the Environmental Protection Agency (EPA). As a result, EE is visible at the household level, where children are engaged in games and part-time composting.

To conclude, countries in the Global North have EE programmes that are primarily incorporated into the school curriculum. EE has been integrated into the school curriculum in the Global North (Matson et al., 2016). EE Programmes in the Global North include the incorporation of EE into the tertiary curriculum (Stein, 2019; Eilks, 2015). Furthermore, in these four case studies, EE encompasses all forms of learning, both formal and informal. Schools and home learning experiences are critical in disseminating EE to children and the general public. Governments and Non-Governmental Organizations (NGOs), as presented in this section, are establishing EE, climate change mitigation, and adaptation strategies.

2.2.4. Challenges to climate change mitigation, adaptation, and EE in selected case studies for the Global North.

Although countries in the Global North have a greater capacity to manage the negative effects of climate change, this capacity does not always translate into climate change mitigation and adaptation options. This section discusses major challenges to climate change mitigation, adaptation, and EE in the Global North. These challenges include the costs of mitigation, adaptation, and EE programs, increased vulnerability to extreme weather events, conflicting ideas about climate change issues, and a lack of commitment and consistency on the part of the government and individuals.

a) The cost of mitigation, adaptation and EE programmes

Climate change mitigation and adaptation initiatives face challenges that limit their effectiveness. To begin, there are challenges with the use of gas, particularly in the home. According to the Great London Authority (2017), gas for heating water is prohibitively expensive for some households. The continued use of gas exposes the United Kingdom to energy security concerns as well as price volatility (Pelling, 2011). Furthermore, London's homes are inefficient in terms of energy efficiency, which contributes to greenhouse gas emissions (Porter et al., 2014). Climate change mitigation in the United Kingdom is also hampered by a lack of capacity to identify and implement appropriate energy-saving measures to reduce emissions in workplaces and homes. Furthermore, the cost of combating climate change through the installation of air conditioning is very high and few rural households in the UK and other countries in the Global North are embarking on proactive adaptation strategies. Households are primarily engaged in low-cost and quickly implementable strategies such as changing diets and clothing. For instance, reducing the overconsumption of high-impact foods (meat) and recycling and purchasing used clothing. As a result, households are limited in their ability to engage in more proactive adaptation due to financial constraints, as some adaptation strategies are costly.

Furthermore, it is argued that significant reductions in greenhouse gas emissions are costly and necessitate transformative changes, such as increased funding for water and other natural resource management. As a result, climate change mitigation is hampered by a lack of funds and technology to effect significant changes in consumer preferences, travel behaviour, and other individual and household-level decisions that can reduce greenhouse gas emissions. Significant changes are required in the design of buildings, infrastructure, and industries (Huai, 2016; Jones, 2014).

According to Kragt et al. (2013), more funds are required, as is extensive EE in the Global North since it is reported that a lack of funds limits climate action.

b) Increased vulnerability to extreme weather events

Climate change exacerbates already-existing climate-related risks, which pose potential hardships, particularly for resource-dependent communities. Flooding, heat waves, bushfires, extreme storms, and droughts are all linked to climate change, and they all destroy infrastructure and crops. Because people are concerned with livelihood strategies at the expense of climate action, these unfavourable climatic conditions jeopardize mitigation, adaptation, and EE strategies. As a result, the process of climate change adaptation faces numerous challenges (Biesbroek et al., 2013). According to reports, extreme weather events that destroy existing and newly planted trees pose a critical challenge to climate change mitigation and adaptation. These extreme weather events exacerbate existing vulnerabilities and risks associated with climate change, making it difficult for communities to implement mitigation, adaptation, and EE programmes (Jeong & Ko, 2021).

c) Conflicting ideas concerning climate change issues

It is reported that policymakers face challenges in mitigating and adapting to climate change due to a lack of agreement among climate experts on the precise effects of changing concentrations of GHG emissions on global weather patterns (Cushing et al., 2018). Uncertainty creates an aversion to concrete action, especially when economic interests are at stake.

Furthermore, some climate action strategies, such as afforestation and reforestation, raise other issues. The main challenge with these strategies is the cost of forest maintenance, which is argued to be prohibitively expensive. Another issue is that many of the costs of afforestation must be paid for upfront before any reduction in greenhouse gas emissions can be observed. It is argued that afforestation is primarily a government burden because it is not always economically attractive to the private sector. Furthermore, the lack of irrigation facilities limits climate change mitigation and adaptation. Afforestation programmes consume vast tracts of land that could otherwise be used for other economic activities such as farming. Farmers are being forced to use more energy-intensive agricultural practices to meet production demand on a smaller land area while reducing greenhouse gas emissions.

One of the major challenges of climate change mitigation, adaptation, and EE in the Global North, is conflicting views on the causes of climate change. Farmers in the United Kingdom, for example, disagree on whether local climatic changes are caused by natural or anthropogenic factors. Similarly, Cushing et al. (2018), explained that rural industry stakeholders had negative reactions to climate change due to entrenched scepticism about the cause and existence of the phenomenon. Farmers' willingness to act on climate change is hampered by uncertainty and conflicting views on the causes of climate change, a lack of clear information, and the perception that climate change is a natural event that will inevitably return to normal. As a result, misconceptions and a general lack of understanding about the importance of immediate climate change mitigation and adaptation are impeding support for national and local policy responses (Donatti et al., 2019). Furthermore, it has been reported that researchers use large amounts of data and complex mathematical models to explain climate change, which is difficult for the general public to understand. As a result, mitigating and adapting to climate change is difficult for people who are unfamiliar with quantitative data. For example, quantitative data contained in the Paris Agreement, which aims to keep global temperature rise below 2°C and to 1.5°C by 2100, is difficult for the general public to comprehend. They have no idea what needs to be done to meet the 2°C or 1.5°C targets. Furthermore, ordinary citizens lack the time to develop a thorough understanding of complex mitigation, adaptation, and EE reports. It is reported that the general members of the public in the Global North are unable to access critical information for climate change mitigation due to complex mathematical models.

d) Lack of commitment and consistency on the part of the government and individuals.

Some countries in the Global North, such as Canada and Australia, fall short of meeting their commitments to the 1997 Kyoto Protocol's emissions reduction targets (Cushing et al., 2018). Australia, for example, did not ratify its Kyoto commitments until 2008, and Canada withdrew its commitment in 2011.

Furthermore, it has been reported that the millennial generation in the United States has seen a measurable decrease in car usage and ownership compared to previous generations. Cultural norms and structural barriers, however, limit EE for climate change mitigation and adaptation in rural areas of the Global North. For example, some people in the United States of America continue to prefer car use and ownership, which exacerbates the negative effects of climate

change. As a result, EE efforts must be strengthened to promote climate change mitigation and adaptation. It is suggested that an individuals' willingness to own and use fewer vehicles, increases with the perceived effectiveness of this action, implying a need for increased awareness of the most effective options for long-term lifestyle changes. According to Cushing et al. (2018), cultural norms or structural barriers act as impediments to climate change mitigation and adaptation. Car ownership is associated with wealth, status, and luxury in western cultural norms. EE for climate change mitigation and adaptation in rural areas of the Global North faces challenges as a result of conflicting cultural values.

The above-mentioned challenges for climate change mitigation, adaptation, and EE highlight the importance of effective EE efforts to improve mitigation and adaptation. This will result in more innovative and comprehensive efforts to implement EE to reduce the vulnerability of communities to climate change.

2.3. Climate change interventions in selected countries of the Global South: efforts at mitigation, adaptation and EE

This section discusses climate change mitigation, adaptation, and EE in the Global South. According to the Paris Agreement, UN (2015, article 4), a developing country is a country that is in the process of developing. Parties to the Paris Agreement are encouraged to continue to strengthen their mitigation efforts, and to work toward economy-wide emission reduction or limitation targets over time, taking into account different national circumstances (UNFCCC, 2015). Three countries, Bangladesh, Brazil, and Mexico, all of which are parties to the Paris Agreement, were chosen as case studies to investigate climate change mitigation, adaptation, and EE efforts. Bangladesh was chosen as it is a global hotspot for tropical cyclones, drought, and other climate change-related disasters events (IPCC, 2014). Brazil was chosen because of the diversity of its natural resources, which plays an important role in the global climate change agenda. It is home to roughly 60% of the Amazon, the world's largest area of continuous tropical rainforest, and it contains 20% of the world's freshwater (Audefroy & Sanchez, 2017; Donatti et al., 2019). Mexico was also chosen because of its unique location between two oceans and complex topography, which increases the country's vulnerability to highly negative climate change effects such as heat waves, floods, frost, and tropical cyclones (Audefroy & Sanchez, 2017; Murphy et al., 2016). Gwanda rural district, the case study in the current research, is experiencing extreme weather conditions such as floods, heat waves, and droughts (Mbereketo et

al., 2018; Ndlovu et al., 2020). Bangladesh, Brazil and Mexico are appropriate parallels for this study because they are experiencing adverse effects of climate change, similar to Gwanda rural district in Zimbabwe. Climate change interventions, mitigation, adaptation strategies, and the landscape of EE are covered in the following subsections:

2.3.1 Climate change mitigation in selected countries of the Global South

In Bangladesh, Brazil, and Mexico, the government and non-governmental organizations use a variety of mitigation strategies to address the negative effects of climate change. Climate change mitigation strategies will be discussed under four headings: the establishment of climate change mitigation policies, the use of renewable energy sources, the use of energy-efficient appliances, and the enhancement of carbon sinks.

a) The establishment of climate change mitigation policies

Governments in the Global South have a plethora of national policies and strategies aimed at mitigating climate change. The government of Bangladesh, for example, established the National Adaptation Programme of Action (NAPA) in 2005 intending to address immediate and urgent adaptation activities. Bangladesh's NAPA includes 15 priority projects that will be implemented with the help of the Least Developed Countries Fund (LDCF) established under the United Nations Framework Convention on Climate Change (UNFCCC) (Ayers & Huq, 2009). The Department of Forests implemented the Community-Based Coastal Forestation Program, which is one of the main adaptation strategies under NAPA (Donatti et al., 2019). To reduce greenhouse gas emissions, the government of Bangladesh has also introduced green energy to the rural people of Bangladesh (Hossain, et al., 2016; Khan et al., 2013). The government has implemented national renewable energy policies to promote, among other things, solar systems, wind power, and biogas. Thus, climate change mitigation strategies in Bangladesh are well-known and are being implemented in a variety of sectors across the country.

Furthermore, Brazil has a plethora of national policies and strategies aimed at mitigating climate change. Brazil's government ratified the UN Framework Convention on Climate Change (UNFCCC) in 1992 and the Kyoto Protocol in 2002. These international conventions assist the country in developing numerous mitigating strategies to reduce greenhouse gas emissions. The use of ethanol and sugar cane bagasse, the development of the natural gas industrial market, and alternative energy sources for less polluting power generation are among the mitigating measures

that help reduce greenhouse gas emissions. The National Electricity Conservation Programme (PROCEL) was established by the government in 1985. This programme supports a wide range of energy efficiency projects centred on information, utility demand-side management programs, direct implementation of efficiency measures, and technical assistance. PROCEL supports mandatory efficiency standards for household appliances, lighting, and motors. In 2001, the appliance and lighting standards were enacted. Fire control programmes and tax exemptions for landowners who protect forest cover on their property contributed to lower emissions (Donatti et al., 2019; Vieira et al., 2008).

Furthermore, Mexico has a plethora of national policies and strategies aimed at mitigating climate change. According to Hossain, et al. (2016), the Mexican government has enacted several ambitious policies to combat climate change. The government passed the General Law on Climate Change in 2012, establishing the institutional and programmatic framework for national policy (Khan et al., 2013). The Mexican National Climate Change System is comprised of four entities: 1) the Inter-Ministerial Commission on Climate Change (ICCC), 2) the Climate Change Council, 3) the National Institute of Ecology and Climate Change (INECC), and 4) state governments, representatives of national associations of municipal authorities, and representatives of the federal legislature (Hossain, et al., 2016; Nawrotzki et al., 2015).

The role of each entity of the Climate Change System is described in the General Law and the current National Strategy on Climate Change (2013) as follows: the ICCC is a commission of federal government ministries that develops and implements national climate policy while also assisting Mexico in meeting international climate targets. The Climate Change Council is an advisory body to the ICCC made up of leaders from the private sector, academia, and society. The INECC is a federal agency that conducts climate change research, monitors greenhouse gas emissions, reports under the United Nations Framework Convention on Climate Change (UNFCCC), and assesses climate change policies and programmes (Hossain, et al., 2016). State governments, representatives of national associations of municipal authorities, and members of the federal legislature coordinate national programmes and assist in the regional implementation of national policies.

b) The use of renewable energy sources

Rural electrification is being implemented by governments in the Global South to reduce carbon emissions. Bangladesh, for example, has established the Rural Electrification and Renewable

Energy Development Programme to mitigate climate change in rural areas because the use of electricity reduces the consumption of wood, lowering greenhouse gas emissions. To meet the electricity needs of remote rural areas, the Rural Electrification Board (REB), Local Government Engineering Department (LGED), and Bangladesh Power Development Board (BPDB) established solar PV systems. PV solar energy has been implemented to provide electricity in rural areas for vaccination refrigeration, PV electrification, railway sailing, and battery charging stations (Khan et al., 2013).

Furthermore, households in Bangladesh are implementing a variety of climate change mitigation strategies. Biogas from animal waste and municipal waste are being used in households. These mitigation strategies have been in place for several years. According to Khan et al. (2013), approximately 10 000 small biogas plants were operational in rural areas of Bangladesh as early as 2004 because it saves on the exploitation of wood and the use of biogas reduces greenhouse gas emissions.

It is reported that rural areas in Mexico adopted measures that helped slow the growth of the country's energy-related greenhouse gas emissions as early as the 1990s. Mitigation measures include using natural gas instead of more carbon-intensive fuels, using energy-efficient appliances, and reducing deforestation, which are the main contributors to climate change mitigation.

The use of non-polluting energy sources also aids in the mitigation of climate change. The most common and beneficial interventions encourage the use of alternative fuels, protect forests, and reduce deforestation.

c) The use of energy-efficient appliances

Communities in the Global South are embarking on various strategies to address climate change. For instance, in Brazil, the primary strategy is a utility-based programme for power savings. Households have embraced the strategy of substituting compact fluorescent lamps for home lighting that began as early as the 1990s. In addition, households have embraced gas at the expense of coal because gas is less polluting; hence the strategy mitigates climate change.

Furthermore, energy-efficient cook stoves are being used to conserve wood. In Mexico, these cook stoves were supported by the Tsiri Network, which empowers indigenous women to make cook stoves (Hossain, et al., 2016; Jiri et al., 2015b). These cook stoves help rural communities

in Mexico mitigate the adverse effects of climate change by reducing wood use, which is highly polluting.

d) The enhancement of carbon sinks.

It is reported that communities in the Global South are growing trees around their homesteads to act as windbreaks, which is indirectly a mitigation strategy by reducing greenhouse emissions since trees absorb carbon dioxide. According to reports, there are programmes in the Global South, particularly in Brazil, aimed at restoring recently deforested and degraded vegetation through tree-planting initiatives, which can restore forests, increase resilience to climate change, and help to reduce carbon dioxide in the atmosphere. Furthermore, it is reported that there are afforestation and reforestation programmes in Mexico that help to mitigate climate change because trees increase vegetation cover and biodiversity, improve ecosystem carbon stocks, reduce soil erosion, and improve small-holder farmers' livelihoods over the medium to long term. Bangladesh is also committed to improving carbon sinks. According to an article in the Dhaka Tribune (2021 June 5), the government of Bangladesh “plans to plant 72.7 million saplings by December 2021 to enhance the greenery of the country and tackle climate change”. The Secretary of Environment, Forest, and Climate Change, Ziaul Hasan, was quoted by the Dhaka Tribune news as saying on the occasion of World Environment Day that “this year, we have set a target to plant 72.7 million saplings across the country through different projects. We will plant these trees in four categories: mangrove forestry in the coastal region, block gardening, strip gardening, and assisted natural regeneration or planting were already established greenery was affected.” As a result, these case studies show that improving carbon sinks is a priority in the countries discussed from the Global South.

2.3.2 Climate change adaptation in selected countries of the Global South

The government and non-governmental organisations employ many adaptation strategies in Bangladesh, Brazil and Mexico to address the negative impacts of climate change. Strategies for climate change adaptation will be discussed under four headings: establishment of national programs, embarking on irrigation, changing building designs for climate change and changing agricultural practices. The subsections are as follows:

a) Establishment of national programs

Many national policies and strategies are in place in the Global South to adapt to climate change. In 2004, the government of Bangladesh, for example, established a Climate Change Cell (CCC)

within the Department of Environment. CCC's responsibilities included developing a Comprehensive Disaster Management Program, analyzing and monitoring the effects of climate change, and facilitating climate change adaptation strategies and innovations. The Bangladesh government established the Bangladesh Climate Change Strategy and Action Plan in 2009 to ensure food security, health protection, and social security during natural disasters such as droughts and floods.

Furthermore, Brazil has a plethora of national policies and strategies in place to address climate change. In 2010, the Brazilian government launched the ABC Plan, an adaptation model in the agriculture sector plan (Low Carbon Agriculture). This model serves as a bridge to more sustainable agriculture. It is based on the systematic logic of efficient farming methods and produces high yields in the face of climate change's adverse effects. The Brazilian government launched the National Programme for the Strengthening of Family Agriculture (PRONAF) in 1996 (Castillo et al., 2002; Chang & Pascua, 2017). The programme is carried out by the Ministry of Agrarian Development (MDA), with the goal of encouraging productive income-generating activities of family production units through rural credit facilities tailored to their needs. Similarly, in Mexico, the government established the programme that provides low-interest loans to individual farmers as well as farmer cooperatives. As a result, the programme assists farmers in obtaining the funds required to deal with climate change.

b) Embarking on irrigation

It is reported that irrigation is becoming popular in the Global South as a result of unreliable rainfall and frequent drought cycles. Individual farming systems exist in Brazil to supplement low rainfall, particularly during the winter season. Irrigation is becoming more popular as a result of climate change and the associated drought cycles. According to Castillo (2002), farmers who use irrigation can produce, consume, and sell significantly more food than farmers who do not use irrigation. However, between 2010 and 2012, there was a severe drought, which caused water sources to dry up and farmers to be unable to practice irrigation.

Furthermore, rural areas in Bangladesh adapt to drought by establishing irrigation schemes that use wind energy to power engines. This was made possible through the establishment of the Wind Energy Study (WEST) Project in 1995. With the assistance of the UK's Overseas Development Administration (ODA), the Bangladesh Centre established the project for Advanced Studies (BCAS) (Khan et al., 2013). As a result, communities have adapted to climate change by

constructing flood-proof structures and practicing irrigation to combat drought. Thus, one of the common and effective strategies used by nations in the region is the establishment of irrigation schemes. Wind and solar energy are being used to power irrigation engines.

c) Changing building designs for climate change

Communities in the Global South are changing building designs to cope with the effects of climate change, according to reports. Bangladesh, for example, has adopted strategies to deal with climate change. The coastal areas of the country, such as Khulna, Shatkhira, Bagerhat, and Pirojpur, are the most vulnerable to natural disasters and weather events such as cyclones, droughts, and floods (IPCC, 2007). As a result, communities in these areas have adapted by raising their houses on plinths and modifying their agricultural systems (Khan et al., 2013). Households who build and use low-carbon housing through the ECOCASA programme help Mexico reduce greenhouse gas emissions. The ECOCASA programme provides funding to households to build sustainable houses, which help to reduce energy consumption and spending, thereby lowering greenhouse gas emissions. According to the United Nations Framework Convention on Climate Change (UNFCCC) website (2021), ECOCASA is part of a multi-pronged strategy that will assist Mexico in following a low-carbon growth path in the medium term. As a result, there is evidence of climate change mitigation at the household level in Mexico's rural areas.

d) Changing agricultural practices

Agricultural practices such as waiting for rain before sowing, harvesting before heavy rains are expected, and practicing irrigation on small gardens were among the adaptation strategies. Other coping strategies include storing food reserves in silos in the event of crop failure the following year and storing food stocks on elevated shelves in the event of flooding. Due to the prevalence of drought, farmers keep fewer animals and sell the majority of their livestock before the occurrence of drought, saving money and purchasing new animals once the drought is over. Furthermore, some people may take a second off-farm job, abandon farming entirely, and seek other sources of income trading.

Farmers respond to climate change in a variety of ways, including changing agricultural practices, shifting livelihood strategies, and abandoning agriculture entirely. According to Khan et al. (2013), households in Mexico are shifting crop planting dates and adopting sustainable farming practices that improve ecosystem resilience. According to Jiri et al. (2015b), farmers in Mexico's

southern region are adjusting their farming seasons. As climate change adaptation measures, they are increasing crop variety diversity to spread the risk of crop failure.

2.3.3 EE in the Global South

The government and non-governmental organisations employ many EE programmes in these countries of the Global South to address the negative impacts of climate change. EE will be discussed under four headings: EE policies, EE workshops, education curriculum, and non-formal education at home. The subsections are as follows;

a) EE policies

EE field in Brazil began in the 1970s, during the earliest environmental movements and the emergence of organizations dedicated to nature conservation. The Brazilian government established the National Secretary of Environment in 1972 to promote EE. This government initiative was established in response to the international debate sparked by the United Nations Conference on the Human Environment, also known as the Stockholm Conference (Chang & Pascua, 2017). According to Castillo et al. (2002), the process of institutionalizing EE through public policies began in the 1980s and was consolidated in the 1990s. There was already a well-structured legal framework in place to regulate EE in 2010, and public policies for EE had been improved. Furthermore, the Campo Limpo System's EE Programme in Brazil is a complementary education initiative aimed at fourth and fifth-year students in Brazil (Government of Brazil, 2014). Every year, the programme provides free educational kits to schools across the country to raise teachers' and students' awareness of shared responsibility in solid waste management.

b) EE workshops

The governments of these selected countries in the Global South are holding workshops to educate people about energy conservation. During such workshops, participants share their experiences, empowering communities with knowledge about mitigating and adapting to climate change (Castillo et al., 2002; Chang & Pascua, 2017). EE workshops are designed to raise public awareness of climate change issues and encourage individual action in rural areas of the Global South. Brazil, for example, has implemented participatory methods through workshops to engage traditionally marginalized societies, identify the diverse needs of communal farmers, expose people to as many adaptation options as possible, and instill a sense of ownership in climate change projects among communities.

Furthermore, there are community programmes in Mexico that focus on developing and promoting new drought and disease-tolerant seed varieties. Farmers are educated about various ways to adapt to climate change, and they have the opportunity to share ideas. Local governments, with the help of the governments in the Global South, are recognizing the importance of farmer empowerment through training and educational awareness in order to promote climate change adaptation.

c) Educational curriculum

It is reported that the governments in the Global South have implemented an ongoing EE curriculum ranging from primary school education to tertiary education. The government has designed an EE curriculum for schools in order to inspire students to care for the environment. To make every school more environmentally friendly, students are required to create gardens with traditional medicinal plants and a tree nursery. According to Castillo et al. (2002), ecological courses in schools raise public awareness of environmental protection through a green campaign. As a result, educational courses in Mexican schools teach children how to mitigate and adapt to climate change (Castillo et al., 2002).

Furthermore, the Mexican government is working tirelessly to close the gap in EE opportunities between rural and urban areas. According to Chang and Pascua (2017), since the end of the twentieth century, a transformation process has been taking place in the educational environment of rural schools in Mexico. Rural schools are leading development because the educational environment has since evolved to become more open and accessible to the rural population (Ghiurca et al., 2015).

d) Non-formal education at homes

EE is not only taught in schools in selected countries of the Global South, but it is also evident at home through household chores. According to Williams et al. (2017) in their study, which focused on a climate adaptation study of flood preparation and household resilience, children were primarily viewed as agents of EE. They reported that children use their school-based climate change education to influence the behaviour of family members. EE is evident at the household level in the rural areas of Bangladesh, where children practice what they learned in school and family members have learned in the process. As a result, households and schools are regarded as the primary contexts for climate action, and children are regarded as the primary agents of EE dissemination in their homes. Thus, there is evidence of non-formal EE in rural communities in

some countries of the Global South. In Bangladesh, it was discovered that children teach their parents how to save energy.

Furthermore, in order to adapt to climate change, households in the Global South are engaging in a variety of EE initiatives. For example, in Brazil, establishing small plots of land for households is the primary facility for EE through non-formal education at home. These small plots of land within the homes expose children to a variety of gardening skills as well as environmental knowledge in order to help them cope with climate change. At home, parents teach their children basic horticultural techniques such as soil preparation, organic composting, planting schedules, and crop spacing (Castillo et al., 2002; Ghiurca et al., 2015).

Household gardening activities teach children about the primary challenges of small and medium-sized farms, as well as the nuances of systematic plant cultivation. By experimenting with small-scale vegetables using scarce resources, the gardening activities help children understand the common environmental challenges in agricultural production. Thus, farm-related household activities help children gain EE, and children can share knowledge with their parents that they would have gained at school. Furthermore, children practice proper waste management in the home by using biological waste as manure in gardens.

World Bank (2011) also state that children at the household level in rural Mexico frequently begin to learn through their eagerness to be active participants in their communities. Children's gardening chores at home teach them about environmental stewardship because they practice water harvesting techniques and water conservation through mulching (World Bank, 2018). Children in traditional Mexican villages such as Yucatan participate in mature activities that enable them to participate in and contribute appropriately to environmental protection and conservation (Chang & Pascua, 2017). Thus, home gardens serve as classrooms for learners to engage in farming activities with their parents, serving as a non-formal form of EE. Furthermore, clean-up activities at home help children value the environment because the experiences of their households instill skills and positive attitudes toward environmental protection and conservation.

2.3.4 Challenges to climate change mitigation, adaptation and EE in selected countries in the Global South.

This section presents significant challenges to climate change mitigation, climate change adaptation and EE in the Global South. These challenges include natural disasters, deficits of resources, massive deforestation, lack of resources and lack of cooperation.

a) Natural disasters

In the selected countries of the Global South, the process of climate change adaptation faces a slew of obstacles. The majority of these challenges in Bangladesh are related to environmental and population characteristics. Due to extreme weather events and high population density, the country is vulnerable to natural disasters. Floods are the most common and cause the greatest economic and human losses in the country. Flooding is exacerbated by high discharge and sediment is transported by three major rivers that traverse the floodplain: the Ganges, Brahmaputra, and Meghna (Ayers, 2011). Heatwaves, droughts, pests, and diseases are other impediments to climate change mitigation. Because of these unfavourable conditions, which destroy trees grown to mitigate climate change, mitigation strategies are futile. During the wet season, global warming increases the risk of flooding, erosion, and mudslides (Clark et al., 2016; Ayers, 2011), limiting climate change mitigation.

It is reported that Bangladesh's rural areas face several environmental issues as a result of the country's high population density, poor socioeconomic development, and inefficient resource management and institutional framework. Climate change and frequent natural disasters have made life in Bangladesh, particularly in rural areas, unbearably difficult (Alam, 2005; Islam et al., 2016).

Also, environmental hazards in Mexico make adaptation to climate change difficult. The country is vulnerable to the effects of climate change, such as rising sea levels, rising sea surface temperatures in the Gulf of Mexico, the occurrence of hurricanes, and more frequent droughts (World Bank Website, 2021). These environmental hazards primarily have a negative impact on the adaptation strategies described in the preceding subsections. Persistent climate change hazards undermine adaptation gains, and people are unable to cope with the ever-increasing effects of climate change.

b) Deficit of resources

Climate change mitigation, adaptation, and EE face numerous challenges in the Global South, including a lack of resources. While governments are working on proactive climate change interventions, due to resource constraints, they are unable to assist all populations affected by the adverse effects of climate change. Furthermore, climate change mitigation is hampered because people prioritize survival skills over mitigation and adaptation measures.

According to Rahman and Alam (2003), formal education coverage beyond the primary school level in rural Bangladesh is relatively low (Islam & Nursey-Bray, 2017). Furthermore, most rural Bangladesh schools have inadequate facilities, unqualified teachers, and inept educational administrators, all of which jeopardize EE in the country, particularly in rural areas (Islam et al., 2014; Begum & Bhuyan, 2005). As a result, there is an inadequate level of EE in schools. As a result, learners are produced who lack basic knowledge of climate change mitigation and adaptation. The communities face significant challenges in mitigating the negative effects of climate change, owing primarily to ignorance.

EE is hampered by a lack of time, insufficient EE, teaching materials, a lack of funds, and insufficient transportation (Islam et al., 2014; Williams et al., 2017). Furthermore, there is a lack of competencies in EE, particularly among older parents who received their professional training before EE was incorporated into the tertiary curriculum (Castillo, 2018; Paredes Chi & Viga de Alva, 2017). As a result, it is possible to conclude that, aside from the government's commitment to educating citizens and students, constraints are impeding the effectiveness of EE programmes and efforts.

c) Massive deforestation

Massive deforestation is a significant challenge in the Global South, owing to the expansion of extensive cattle ranching. It is caused by extensive cattle ranching in Brazil, particularly in the humid tropics of the southeast, which leads to habitat destruction (Castillo, 2018; Williams et al., 2017). The conversion of forestlands to agriculture, unsustainable logging, and overgrazing all contribute to high rates of deforestation.

d) Lack of resources

Rural areas suffer from a lack of local capacity to manage climate risks, which is critical for dealing with the negative effects of climate change (Castillo, 2018). Furthermore, there is an insufficient alignment of policies and programmes across sectors, as well as a lack of community capacity to mitigate the effects of climate change (World Banks, 2011). As a result, there are obstacles to expanding many low-carbon interventions, ranging from information gaps to regulatory and policy constraints.

One of the major challenges is a lack of access to scientific information, particularly in rural areas (Matson et al., 2016). Thus, given the persistence of societal problems over the last few decades, questions have been raised about how scientific knowledge is constructed (Castillo, 2018; Gezie,

2019). In addition, the economic situation in the selected countries of the Global South makes it difficult to implement EE projects, particularly in rural areas plagued by pollution of air, water, soil and waste. According to Matson et al. (2016), the long-term viability of EE in rural communities in Mexico is jeopardized by the current economic crisis.

Countries are unable to adapt to the effects of a changing climate. The economic situation of the selected countries in the Global South impedes the implementation of climate change mitigation, adaptation, and EE. EE is primarily constrained because these selected countries in the Global South are experiencing an economic crisis and are primarily concerned with survival at the expense of environmental stewardship. The responsible use and protection of the natural environment through conservation and sustainable practices to improve ecosystem resilience and human well-being is referred to as environmental stewardship (Chapin et al., 2011). As a result, for the selected countries in the Global South, the low level of economic development is a hindrance to climate change mitigation and adaptation, as well as the implementation of EE.

e) Lack of cooperation

Climate change mitigation is hampered by a lack of cooperation among community members in the development of policies and programs. According to Gezie, (2019), North-eastern Brazil has long relied on a top-down policy-led approach to assisting communities in dealing with drought. As a result, the ineffectiveness of adaptation policies is attributed to a lack of engagement of all stakeholders during the programme design phase. It is also reported that the majority of climate change adaptation strategies implemented in Brazil are emergency interventions implemented without a clear discussion about what types of technologies should be purchased with government funds to implement long-term solutions (Gezie, 2019). As a result, public support for these strategies is lacking. According to reports, local authorities' interest in environmental protection is very low in Mexico's rural populations (Castillo, 2018; Matson et al., 2016). The local government's lack of interest in controlling and mitigating environmental issues has harmed the quality of environmental factors, resulting in pollution caused by inappropriate local behaviour (Clark et al., 2016).

To conclude, EE efforts for climate change mitigation and adaptation fall short of providing the critical support to rural areas required to create significant and measurable changes on specific issues improving adaptive capacity (Chang & Pascua, 2017). Thus, from this vantage point, EE,

particularly in rural communities in the selected Global South countries, has failed the more important cause and may have lost sight of its original purpose (Matson et al., 2016).

2.4. Climate change interventions in Sub-Saharan Africa: mitigation, adaptation and EE

This section discusses climate change mitigation, adaptation, and EE in Sub-Saharan Africa. According to UNDP (2021), Sub-Saharan Africa includes 46 African countries. Three countries, South Africa, Botswana, and Mozambique have been chosen as case studies for this study to investigate mitigation, adaptation, and EE efforts in the context of climate change. The Southern African Development Community's Climate Change Strategy and Action Plan (SADC 2015) emphasizes the importance of climate change adaptation responses in Sub-Saharan Africa in addressing the region's vulnerabilities caused by climate change. The reason for choosing these countries is that the study was conducted in Zimbabwe, and the other three countries share borders with Zimbabwe and experience the same climate. The following paragraph of this section explains why these case studies from Sub-Saharan Africa were chosen.

South Africa was chosen because of the country's climatic conditions as a result of climate change. It is experiencing higher temperatures as well as a decrease in rainfall. The primary source of concern is that South Africa's development is heavily reliant on climate-sensitive industries such as agriculture and forestry (SANBI, 2019). Botswana was also chosen because climate variability is still regarded as a significant threat to development. The greatest impact is being felt on the country's water sources and forestry. Climate change has had a significant impact on Mozambique, as evidenced by severe droughts, floods, and cyclones (Bambaige, 2007; Government of Mozambique, 2007; McSweeney et al., 2015). These circumstances influenced these countries' decision to investigate mitigation, adaptation, and EE efforts in the context of climate change in Sub-Saharan African countries. Climate change interventions: mitigation, adaptation, and EE were discussed under the following subsections.

2.4.1 Climate change mitigation in Sub-Saharan Africa

The government and non-governmental organisations employ many mitigation strategies in South Africa, Botswana, and Mozambique to address the negative impacts of climate change. Strategies for climate change mitigation are discussed under three headings: establishment of policies for

climate change mitigation, using renewable energy sources, improving biomass efficiency, and enhancing carbon sinks. The subsections are presented overleaf.

a) Establishment of policies for climate change mitigation

Sub-Saharan Africa has several national policies and strategies in place to combat climate change. For example, the introduction of GIS in South African universities helps to combat climate change. Students are taught to use Geographic Information Systems, remote sensing, and satellite data technology to map climate change and deforestation to appreciate global change (UN, 2012). In 2021, the University of KwaZulu-Natal began offering a GIS and Earth Observation degree. According to UKZN (2021, 21 May), “The programme, which offers a three-year study in Geo-Information Science and Earth Observation (Remote Sensing), aims to develop and build high level theoretical and practical skills in spatial data analysis and environmental monitoring using GIS and remote sensing technologies.” This strategy assists the government in identifying areas that require immediate attention to mitigate climate change. It also assists the government in making informed decisions by providing adequate information from graduates and scientists. In 2016, South Africa's Minister of Environmental Affairs signed the Paris Agreement on Climate Change in New York at the United Nations (DEA, 2019). South Africa, as a signatory to the Paris Agreement, is committed to undertaking efforts that will help to reduce global temperature rise by 1.5 degrees Celsius. Climate change mitigation is being implemented through significant investment in renewable energy sources and industrial energy efficiency (DEA, 2019; Winkler, 2017; UN, 2012). This shows that, even though South Africa is the highest carbon emitter in Africa, the government is committed to reducing the country's carbon footprint.

Furthermore, Botswana has a number of national policies and strategies in place to combat climate change. Botswana's government maintains a website called Botswana Climate Change Network (BCCN), which is a membership-based network of organizations and individuals that share climate change educational materials and guides. Citizens across the country can access information to help them mitigate climate change through the program.

Similarly, Mozambique has a number of national policies and strategies aimed at mitigating climate change. Mozambique has been a signatory to the UN Framework Convention on Climate Change since 1995 (Artur & Hilhorst, 2012). As a result, Mozambique's government is committed to developing measures to reduce greenhouse gas emissions and to promoting cooperation in

scientific, technological, technical, and socioeconomic research fields related to climate change mitigation. Mozambique's government also ratified the Hyogo Framework for Action (2005-2015), which guides the main actions leading to disaster risk reduction, primarily related to climate change hazards.

Furthermore, as part of the government's effort to mitigate the effects of climate change and meet the UNFCCC, funds for climate change mitigation have been allocated. There are government programmes that assist vulnerable groups in rural areas in adapting to climate change. Rural communities are being educated in order to develop a good public understanding of the causes of climate change and the importance of people of all ages learning about and contributing to environmental protection in general, as well as the reduction of greenhouse emissions.

a) Use of renewable energy sources

South Africans are implementing a variety of climate change mitigation strategies. Households in South Africa are using green fuels to boost efforts to conserve forests and increase carbon sinks (DEA, 2017). The majority of households use hydropower as a source of renewable energy. This helps to mitigate climate change because the use of electric stoves replaces wood fuel, and there is also the use of gas stoves, which are less polluting. According to DEA (2018), solar energy for geysers is also gaining traction in South African households. Thus, using renewable energy by households is an effective climate change mitigation strategy because it reduces greenhouse gas emissions and conserves forests. It is argued that South Africa's government should address regional inequalities in the country so that regions such as the Eastern Cape can improve their use of solar energy to combat climate change (DEA, 2019).

Botswana has national policies that promote renewable energy sources such as solar energy and gas for cooking (Silo & Mswela, 2015). However, it has been reported that there is a lack of project implementation in Sub-Saharan Africa. In Botswana, for example, despite developing renewable energy policies and legislation, there are few existing renewable energy projects (Silo, 2007).

Mozambique's government is encouraging the use of renewable forms of electricity. It is reported that it launched the Rural Electrification Project, which provides communities with access to electricity via renewable energy sources. Furthermore, the local government in Mozambique places a high value on the use of environmentally friendly energy sources (Asante, 2009).

b) Improving the efficiency of biomass

Households in Sub-Saharan Africa are improving the efficiency of biomass by using improved stoves as one of the mitigation measures to address climate change. People in Mozambique are switching from the traditional boat-like charcoal kiln to the Casamance kiln, increasing the efficiency of charcoal production from 18% to approximately 35% (Winkler, 2017). This contributes to a reduction in carbon dioxide emissions, thereby mitigating climate change.

c) Enhancing carbon sinks

In the 1970s, the Rural Afforestation Programme (RAP) established small-scale plantations. However, the project is not viable, and the land set aside for it is underutilized due to the high cost of wood production. Botswana has made progress in natural resource conservation, according to Mukute et al. (2012). It has banned the use of persistent organic pollutants and is pursuing rural electrification with renewable energy.

The government of Botswana, in collaboration with non-governmental organizations, assists households in forming committees for tree planting projects. Members of the community participate in afforestation and reforestation programmes by planting trees to increase vegetative ground cover and thus promoting carbon sinks. Indigenous knowledge and practices by households in Botswana, according to Silo (2013), contribute positively to climate change mitigation. The Khoikhoi culture, for example, forbids any household from cutting down a tree for any reason. Their culture also prohibits households from interfering with the taproots of trees or removing the entire bark of a tree for herbal extraction or any other purpose.

Furthermore, trees are being planted in Mozambique as a mitigation strategy. Cashew tree planting projects have been established in Mozambique's Nampula province and coastal region. Because trees act as carbon sinks, they help to mitigate climate change. Reforestation projects were also established near major cities such as Maputo, Beira, and Nampula in order to supply biomass to these cities. Furthermore, rural residents' practices such as avoiding uncontrolled bushfires, re-planting forests, and conservation farming demonstrate Mozambique's climate change mitigation strategies.

2.4.2 Climate change adaptation in Sub-Saharan Africa

The government and non-governmental organisations employ many adaptation strategies in South Africa, Botswana, and Mozambique to address the negative impacts of climate change. Strategies

for climate change adaptation are discussed under four headings: establishment of national programs, changing agricultural practices and diversification.

a) Establishment of national programs

South Africa has a number of national policies and strategies in place to address climate change. South Africa's government established the National Climate Change Adaptation Strategy (NCCAS), which provides a shared vision of climate change adaptation and resilience for the country and outlines priority areas for achieving this vision (Government of South Africa, 2019). According to the DEA (2012), the vision of NCCAS is derived from a number of policy documents, including South Africa's National Climate Change Response Policy (NCCRP), the National Development Plan (NDP) (NPC 2011), the National Strategy for Sustainable Development (NSSD) (DEA 2012), adaptation commitments included in its NDCs, sector adaptation plans, and provincial adaptation plans.

According to DEA (2018), South Africa strives to promote efforts to adapt to the short-, medium-, and long-term impacts of rising temperatures and decreased rainfall in many parts of the country. The NCCRP focuses on developing adaptation strategies that are informed by rigorous research and take into account the local context and local knowledge. It identifies a number of key adaptation-related sectors, such as human settlements, agriculture and ecosystems, and disaster risk reduction and management. It advocates for the inclusion of climate change adaptation plans in a variety of sectors (DEA, 2011). Significant progress has been made in developing adaptation policies, plans, and strategies in many government departments since the establishment of the NCCRP (DEA, 2018).

Municipal Committees on Climate Change have been established in municipalities, according to DEA (2018). These committees' primary function is to coordinate climate change adaptation responses in the relevant rural communities. The composition of these committees is determined by municipal departments, and it includes representatives from relevant municipal departments, political representation, and civil society. However, some municipalities have yet to establish these committees, and the South African government is working to establish these Municipal Committees on Climate Change (DEA, 2019).

Furthermore, Mozambique is a signatory to the UN Framework Convention on Climate Change, which requires the country to implement development policies in response to the negative effects of climate change. Mozambique's government provides education to raise public awareness and

equip citizens with the skills needed to deal with the effects of climate change. Mozambique's government announced the National Climate Change Adaptation and Mitigation Strategy (NCCAM), which will run from 2013 to 2025. One of these strategies seeks to identify key areas and actions that can be taken to mitigate the severity of climate change impacts through adaptation measures. NCCAM also promotes the inclusion of adaptation policies and strategies in the environmental sections of social and economic plans.

b) Changing agricultural practices

The typical climate change adaptation strategies in South Africa include planting different crops or crop varieties, replacing farm activities with non-farm activities and changing planting and harvesting dates (DEA, 2018). According to DEA (2012), farmers at the household level in rural areas have adopted various strategies to adapt to the impact of climate change on their farming, and the adaptation strategies include the following:

- reducing planting areas of certain crops, such as wheat which requires plenty of water
- planting crop varieties with a shorter growing period
- delaying the start of planting according to rainfall
- investing in additional machinery to shorten planting time
- collecting rainwater by creating furrows near planted areas, and
- increasing the use of irrigation

The above list was provided by the Department of Environmental Affairs in 2013. It demonstrates how farmers in South Africa are dealing with climate change issues such as a lack of rainfall and rising temperatures. Similarly, in Botswana, individual farmers implement adaptation strategies such as on-farm food storage, stockpiling of feeds to be used during the dry season, strategic use of fallow, and late planting due to the region's delay in the onset of the rain season (Ketlhoilwe, 2007; Silo, 2015).

c) Diversification

Among the coping strategies are allocating farm labour across the season in ways that follow unpredictable intra-season rainfall variations; utilizing biodiversity in cultivated crops and wild plants; increasing livestock integration into farming systems (at the expense of increased labour demands); and working land harder, in terms of labour input per hectare, without increasing external non-labour input.

Investing in non-farm income activities is the most common form of climate change mitigation in Mozambique's rural areas. Due to poor harvests caused by climate change, new avenues for income generation other than farming have emerged over the last decade. According to Brown et al. (2012), farmers in rural areas are diversifying in response to drought push factors and pull factors related to the growing economy. It is reported that farmers in many rural areas of Sub-Saharan Africa rarely focus on a single income-generating activity that is sustained through a variety of income generation strategies, and these coping strategies are due to the adverse effects of climate change, as evidenced by declining soil fertility, crop and livestock failures, increasing drying of water sources, and recurring droughts (Brown et al., 2012; Tshuma & Mathuthu, 2014). Households in developing countries such as Mozambique use diversification as an important adaptation strategy. Farming, on the other hand, remains vital, even if it is unable to provide a sufficient means of survival in rural areas due to climate change in the country (Klein & Smith, 2003, Klein et al., 2005).

2.4.3 EE in Sub-Saharan Africa

The government and non-governmental organisations employ many EE programmes in Sub-Saharan Africa to address the negative impacts of climate change. EE will be discussed under three headings: EE projects, EE sharing platforms, education curriculum, and non-formal education at homes. The subsections are as follows.

a) EE projects

South African EE dates back to the 1970s when the Wildlife Environment Society of Southern Africa (WESSA) launched the Umgeni Valley Project in Natal in 1973 (Mukute et al., 2012). The project's goal was to create teaching materials for EE in the country and to promote collaboration between the formal and non-formal education sectors. More organizations have started EE projects over the years. The National Environmental Awareness Council (NEAC), for example, includes teachers, children, and youth in its annual EE programmes. Furthermore, a decade later, in 1982, the South African government went a step further by hosting the first international congress at Mooi River (Palmer, 1998).

Furthermore, the South African government promotes EE through the implementation of the Eco-Schools programme (Ontong & Le Grange, 2015). The Eco-Schools Programme is a global Foundation for EE (FEE) programme that operates in 54 countries. It was launched in South Africa in 2003, with the Wildlife and Environment Society of South Africa (WESSA) chosen as

the primary implementer. South Africa is Sub-Saharan Africa's most industrialized country. It is an economic powerhouse in the SADC region, and it plays an important role in promoting EE in educational systems (Mukute et al., 2012).

Many projects in Mozambique have spearheaded EE. The major environmental priorities in Mozambique concern local and institutional aspects such as EE, legal compliance, and institutional capacity development. Community leaders collaborate in the sustainable use of the environment by working on a variety of EE tasks such as mobilizing communities on issues such as sanitation, forest fire-prevention, and local conflict resolution (Stringer et al., 2014). The government of Mozambique established national programmes for addressing environmental issues to reduce the adverse effects of climate change (Pelling, 2011).

b) EE sharing platforms

According to Mandikonza and Lotz-Sisitka (2016), in recent years, environmental awareness has been perceived as the core of sustainable development in rural South Africa. According to the DEA (2018), the South African government is promoting knowledge sharing platforms in rural areas and is committed to continuing to support community-based organizations, academia, NGOs, the business community, and civil society organizations that provide platforms for the exchange of ideas and knowledge in order to build climate resilience in rural areas. This encourages learning from the experiences of rural communities through local collaborations with NGOs, academia, the business community, and civil society organizations to aid in climate change adaptation. However, the level of participation continues to be a source of concern. The current issue is that, while there is more global environmental awareness, there is still a lack of participation at the local level. Most likely, there is a lack of evaluation, in which people do not fully comprehend the benefits of investing time and resources in EE (Fien, Scott & Tilbury, 2001). According to Mukute et al. (2012), the South African education system has not fully recovered from its discriminatory apartheid past. In comparison to urban schools, most rural schools are under-resourced.

In Botswana, the government's climate change education responses include social media platforms such as the Botswana Climate Change Network's Facebook page and the Twitter platform, twitter.com/BCC-Network. It is reported that the radio and television programmes discuss how communities can respond to immediate risks such as cyclones and droughts, which are common weather hazards caused by climate change.

c) Educational curriculum

Sub-Saharan African governments share a vision of creating an environmentally educated nation. Efforts have been made at all levels of education to incorporate EE into the entire curriculum. Teachers in Botswana have been trained to teach EE in their schools since 1996, and this training has been done through in-service workshops. Furthermore, the government of Botswana implemented a Revised National Policy on Education (RNPE) in 1994, which mandated the incorporation of EE into the entire curriculum, and teachers were required to teach the concept of EE across the curriculum (Ketlhoilwe, 2003). Environmental issues have been incorporated into Mozambique's national curricula, and the primary environmental priorities in Mozambique are with the rural population, whose livelihoods are solely dependent on the exploitation of natural resources. The EE curriculum contains the guidelines of natural resources exploitation. Environmental laws are taught to students in schools and colleges in order to combat environmental issues such as climate change and land degradation.

d) Non-formal education at homes

Furthermore, South African municipalities identify individuals and communities within their communal areas that are more vulnerable to climate change and deliver targeted climate change vulnerability reduction programmes to these individuals and communities (Smith, 2013; Roberts, 2008). These programmes aid in the development of knowledge and capacity for climate-resilient rural livelihoods. Communities in these areas also require EE empowerment to understand the consequences of continued wood use. By the time the solar system programme is implemented in the region, households will be able to transition smoothly away from the use of wood.

South African households are embarking on a variety of EE initiatives in order to adapt to climate change. Children at home share with their parents the information they learn in school about phasing out inefficient appliances and the importance of taking public transportation instead of driving a private vehicle (Ontong & le Grage, 2015). Farming, gardening, and cleaning responsibilities at home provide children with direct experiences with environments that foster positive feelings and attitudes toward the environment. Thus, sustainable practices performed by children at home, such as gardening, composting, mulching, and soil erosion mitigation, aid in the acquisition of EE. Children also do indoor practices in their homes that promote EE. For instance, children are engaged in energy efficiency practices, waste recycling, and waste reduction, which

help them learn about the important habits of environmental protection (Bryan et al., 2009; Maponya et al., 2013).

Furthermore, in Botswana, children at home share with their parents the knowledge they gain from school about the importance of replacing inefficient appliances with public transportation rather than private vehicles (Ketlhoilwe & Silo, 2016; Silo & Mswela, 2015). Children's farm, gardening, and cleaning responsibilities at home expose them to environments in a way that fosters positive feelings and attitudes toward the environment (Ketlhoilwe, 2007; Silo & Sinvula, 2018). For example, children are involved in energy efficiency practices, waste recycling, and waste reduction, which helps them learn about the important habits of environmental protection.

Furthermore, in order to adapt to climate change, households in Mozambique are undertaking a variety of EE initiatives. Informal climate change education is passed down from generation to generation as households engage in activities that reduce poverty, diversify food security, build resilience to climate and market fluctuations, and promote improved technologies (Maponya & Mpandeli, 2012). Children have access to EE at home, as well as farm activities that provide practical learning experiences for climate change mitigation and adaptation. Conservation agriculture is a component of Mozambique's agricultural and socio-economic development at the household level in rural areas that provides opportunities for EE (Nkala et al., 2011). As a result, involving children in household farming and gardening activities promotes the transmission of EE from parents to children.

2.4.4 Challenges to climate change mitigation, adaptation and EE in selected case studies for the SSA.

Common constraints on climate change mitigation, climate change adaptation, and EE implementation arise from the following: limited resources, weather hazards, heavy dependence on fossil fuels, lack of cooperation, massive exploitation of wood, and poor implementation of climate change national policies.

a) Limited resources

According to Mandryk et al. (2015), low human adaptive capacity combined with a heavy reliance on rain-fed agriculture pose challenges to Sub-Saharan Africa's climate change mitigation and adaptation, as well as EE strategies. Furthermore, as cited by the IPCC (2014), Sub-Saharan Africa's widespread poverty, lack of economic and technological resources, insufficient safety

nets, and educational progress further constrain climate change mitigation, adaptation, and EE strategies. According to Unganai (2009), one of the farmers' limitations to effective climate change mitigation is a lack of credit facilities, climate information, and insufficient access to inputs. Rural communities in Sub-Saharan Africa are especially vulnerable to the effects of climate change, owing to a lack of funds to launch EE programmes (Stringer et al., 2014; United Nations Development Programme, 2018). As a result, the government should increase its financial contributions to finding solutions to climate change issues, as there is a reported shortage of skilled personnel to embark on EE programs. More agricultural extension officers in Botswana should be trained and deployed to educate rural communities about climate action strategies (Hardee & Mutunga, 2010; Ketlhoilwe, 2007; Silo & Ketlhoilwe, 2020). This will aid in mitigating and adapting to the negative effects of climate change. According to Silo and Mswela (2015), effective EE efforts are required to promote climate change mitigation and adaptation. The personnel who will be trained must understand the significance of such training and retraining in order to recognize its importance and to be competent to teach farmers in rural areas.

According to Ketlhoilwe (2007), Botswana's school curricula have largely incorporated participation in EE. However, EE efforts in Botswana have been hampered by a lack of agricultural extension officers to equip communities with climate change mitigation and adaptation strategies (Silo, 2011; Silo & Sinvula, 2018; Ketlhoilwe, 2003). According to Ketlhoilwe (2007), one of the challenges faced by communities in Botswana in terms of climate change mitigation and adaptation is a lack of resources, particularly irrigation equipment. As a result, EE is confronted with a number of issues that necessitate immediate government intervention.

Furthermore, one of the major challenges to climate change interventions in Mozambique and Sub-Saharan Africa, in general, is a lack of appropriate assets and technologies to cope with adverse climate changes and associated weather extremes. Cyclones, for example, are a common occurrence in Mozambique. Cyclone Eloise made landfall in central Mozambique in 2021 near Beira, a major city in Sofala province, with high winds, heavy rains, and severe flooding. Cyclone Idai struck Mozambique in 2019, killing over 600 people and injuring hundreds more (Gwaka & Dubihlela, 2020). Government of Mozambique report, 2020). The occurrence of cyclones poses a threat to climate change mitigation because the country is constantly spending money to address cyclone damage at the expense of investing in climate change mitigation strategies. Furthermore,

Mozambique's climate change adaptation strategies are constrained by the country's vulnerability to drought and underdeveloped irrigation potential.

To conclude, one of the major challenges to climate change interventions in Sub-Saharan Africa is a lack of funding. EE policies necessitate the development and implementation of financial resources, which are generally lacking in most developing economies (Mandikonza & Lotz-Sisitka, 2016; Silo & Kethloilwe, 2020). Some countries are less likely to take environmental issues seriously in the face of a drained global donor community. Most people are preoccupied with survival issues, which causes them to disregard environmental protection (Shumba, 2017). Botswana and other Sub-Saharan African countries are facing socioeconomic development challenges (Kethloilwe, 2007; Msholapheko et al., 2012; Silo, 2009). It lacks the financial resources to provide enough classroom space for students, pay teachers a living wage, and provide adequate teaching and learning support resources, and many parents are unemployed.

b) Weather hazards

The physical environment also contributes to the challenges that communities face in South Africa in mitigating climate change. For example, coastal provinces are more vulnerable to cyclones, whereas the Western Cape is more vulnerable to drought. The observed rate of warming in the western and northeast has been 2°C per century or higher, which is more than double the global temperature increase (DEA, 2018).

Furthermore, the Eastern Cape, Kwa-Zulu Natal, and Limpopo are the most vulnerable provinces to climate change, owing to the provinces' high proportion of poor subsistence farmers who rely solely on agriculture for a living (Morton, 2007). Thus, in South Africa, poverty and extreme weather conditions have resulted in inappropriate land uses that degrade the environment and jeopardize climate change mitigation because people are more concerned with their survival than mitigating climate change.

According to Masipa (2017), drought severity has increased in Sub-Saharan Africa, particularly in South Africa. Many rural households rely primarily on subsistence farming for survival. As rainfall has decreased, these households have been forced to adapt to climate change in order to improve food security. According to DEA (2018), rapid geophysical changes caused by climate change make adaptation difficult. This is consistent with the findings of Wichmann (2017), who found that the understanding of impacts, adaptive capacity, and adaptation costs is weaker in social systems than in biological systems and that uncertainties are high. This is especially true

when considering cross-cutting impacts like droughts, floods, pest infestations, and plant diseases, as well as other non-climate-related stresses like human health, poor infrastructure, and poor governance (DEA, 2018; Easterling et al., 2007; Masipa, 2017).

Furthermore, due to its geographical location, Mozambique is vulnerable to climate effects, which is difficult for a developing country due to its lower adaptive capacity. The primary barrier to EE efforts is a lack of appropriate assets and technologies to launch EE programs. Rural areas in Mozambique are characterized by a number of under-developmental issues, including inadequate basic health care, poor road networks, portable drinking water, a high illiteracy rate, and the prevalence of extreme poverty (Shackleton et al., 2015; O' Brien et al., 2009). These developmental issues are thought to be obstacles to the process of educating Mozambican children in rural areas. EE in rural areas is lagging, owing to educational disparities between rural and urban children in Mozambique (Nkala et al., 2011; Nyasimi et al., 2014). As a result of the poor infrastructure in most rural areas, most teachers are unwilling to work in rural schools, and district education officers rarely supervise rural schools, putting communal education at risk. While Sub-Saharan Africa contributes relatively little to global anthropogenic greenhouse gas emissions, the region remains the most vulnerable to the adverse effects of climate change (Mandryk et al., 2015; Molnar, 2010; Nyasimi et al., 2014). As a result, the region's vulnerability to climate change impedes effective mitigation and adaptation, as well as the implementation of EE.

c) Heavy dependence on fossil fuels

The greatest challenge that the country is facing is a heavy dependency on fossil fuels such as coal. South Africa, for example, is one of the highest emitters of greenhouse gases in Africa, as well as one of the highest in the world. According to the Carbon Brief (2018), South Africa is the 14th largest emitter of greenhouse gases in the world due to its reliance on non-renewable energy sources. Thus, local communities' priorities in South Africa, particularly, in the Limpopo province, are livelihood activities and not climate change adaptation. Similarly, it is reported that one of the constraints of climate change interventions in Mozambique is the heavy dependence of citizens and industries on fossil fuels.

d) Lack of cooperation

Another challenge for EE in South Africa is that most rural communities, particularly in developing countries, do not participate in climate action programmes (Winkler, 2017). The reason for this could be a lack of information dissemination to these communities, causing them

to disregard the consequences of their environmental actions, a factor that makes sustainable living difficult to achieve. Furthermore, there is a lack of collaboration among schools when it comes to environmental issues. According to Silo and Mswela (2015), rural schools in Botswana lack the practice and structures necessary to ensure children's widespread and genuine participation in environmental issues that affect them. It is reported that countries in Sub-Saharan Africa require participatory approaches to teaching and learning that address societal issues involving competing interests among children, teachers, and other stakeholders within school communities (Silo & Ketlhoilwe, 2020; United Nations Development Programme, 2018). It is argued that poverty and ignorance dominate the social lives of the majority of the rural population in SSA (Muchuru & Nhamo, 2019; O'Brien et al., 2009). As a result, people's attitudes and levels of participation in their children's education are affected (Nkala et al., 2011; Nyasimi et al., 2014). In general, EE lessons are not practiced in Sub-Saharan Africa because people are more concerned with survival than with environmental protection.

e) Massive exploitation of wood

There is overexploitation of wood due to high demand for fuel wood, timber extraction for the manufacturing industry, land clearance for agriculture, overgrazing, and overstocking. The regeneration of wood from afforestation and reforestation programmes is far less than that of unsustainable tree exploitation. Thus, overexploitation of forests limits climate change mitigation in Botswana (Ketlhoilwe & Silo, 2016; Silo & Sinvula, 2018). The main challenge for climate change mitigation is the slower rate of deforestation in comparison to the rate of deforestation. According to Silo and Mswela (2015), reforestation is less effective in Botswana because it occurs at a slower rate than deforestation. This means that the number of trees cut each year exceeds the number of trees planted.

2.5 Climate change interventions in Zimbabwe: mitigation, adaptation and EE

This section consists of the case study of Zimbabwe concerning mitigation, adaptation, and EE towards climate change. Zimbabwe is the country where the study was conducted, and the country is susceptible to the adverse effects of climate change exacerbated by poor economic growth. Challenges to mitigation, adaptation and EE strategies are also presented under each sub-section.

2.5.1 Climate change mitigation in Zimbabwe

The government and non-governmental organisations employ many mitigation strategies in Zimbabwe to address the negative impacts of climate change. Climate change mitigation strategies will be discussed under three headings: national, regional, and household. The section also contains the challenges faced during climate change mitigation across different levels in the country. The subsections are as follows.

a) At national level

Zimbabwe has a number of national policies and strategies that are earmarked to mitigate climate change. According to GoZ (2015), Zimbabwe ratified the UNFCCC, multilateral environmental agreements such as the Convention on the Conservation of Biological Diversity and ratified the United Nations Convention to Combat Desertification (UNCCD) in Africa. At the regional level, the SADC has developed the Climate Change Adaptation Strategy for the Water Sector. Various sectoral policies, strategies, and action plans have been put in place. These policies include the National Policy and Programme on Drought Mitigation, the Draft Disaster Risk Management Policy and Strategy, the Second Science, Technology, and Innovation Policy 2012 (Dyszynski, 2011; GoZ, 2015; Shumba, 2017). The government of Zimbabwe is helping farmers to embark on climate change adaptation strategies throughout the country (Sango & Nhamo, 2015; Tshuma & Mathuthu, 2014).

b) At the regional level (rural context)

The rural areas in Zimbabwe have mitigation strategies that they employ to mitigate climate change. There is evidence of mitigation strategies in Zimbabwe's rural areas through operational agents such as the Environmental Management Authority (EMA), which focuses on the conservation of the natural environment, specifically targeting forests, soils, water, and wildlife protection (Phiri et al., 2019). EMA plays a vital role in mitigating climate change through its efforts to contain veld fires, deforestation, and illegal gold panning in the area.

Furthermore, in rural areas, some acts help to mitigate climate change. These acts include the Rural District Council Act and the Traditional Leaders Act. The Rural District Councils Act (Chapter 29:13) of 1988 provides for the following:

- declaration and establishment of Rural District Councils
- administration of areas under their jurisdiction
- establishment of environmental committees and subcommittees

- establishment of rural district and ward development committees
- empowerment of RDCs on matters of sewerage and drainage (Government of Zimbabwe, 1988)

The most important provision to this study is establishing the environmental committees and sub-committees that play an important role in mitigating climate change by regulating the exploitation of natural resources such as a forest.

Furthermore, the Traditional Leaders Act (TLA) emphasizes the role of traditional leaders, for example, Chiefs, Headman, and Villages Heads. They have been central to environmental management and resource exploitation for a very long time, even before the enactment of this Act. The establishment of TLA has formalized the role of traditional leaders in mitigating climate change as they now derive their mandate from the Traditional Leaders Act Chapter (29:17) of 2000 (EMA, 2012c). The Act provides for the following.

- appointment of Chiefs, Headman and Village Heads
- establishment of village and ward assembly and development committees
- the setting of village boundaries v allocation and disposal of rights of communal land
- resettling people on communal land
- ensuring sustainable management and utilization of natural resources to avoid over-cultivation, overgrazing, and degradation of natural resources (Government of Zimbabwe, 2000b)

The provisions of TLA reveal that climate change mitigation is evident in the rural areas of Zimbabwe, and traditional leaders have a central role in protecting forests that act as carbon sinks to absorb carbon dioxide that causes climate change.

c) At the household level (rural context)

Households in Zimbabwe are embarking on various strategies to mitigate climate change. In the agricultural sector, climate-smart agriculture serves as the primary strategy that embraces the twin goals of mitigation and adaptation at the household level (Chanza & Gundu-Jakarasi, 2020). According to FAO (2016), climate-smart agriculture refers to a sustainable climate-sensitive response in the agriculture sector that increases productivity and builds the resilience of agricultural-based livelihoods in communities while reducing the emissions of greenhouse gases. Climate-smart agriculture resulted in higher yields, raised farm income, and increased food availability, improving food security, alleviating poverty, and building more resilient livelihoods.

As a result, the benefits of climate-smart agriculture assist smallholder farmers in making a meaningful contribution to reducing greenhouse gas emissions, as increased vegetation cover enhances carbon sequestration (Mtambanengwe et al., 2012; Nyasimi et al., 2014).

d) Challenges to climate change mitigation

Afforestation and reforestation are the main mitigation strategies of climate change that face many challenges from the household level up to the national level. Various livelihood strategies in Zimbabwe and Southern Africa, in general, are dependent on the forest and other natural resources (Chagutah, 2010; Goulden, 2013). The rural population depends on locally made household implements such as the axe and hoe handles, pestles and mortars, cooking sticks, plates and bowls, ox yokes, oxcarts, drums, and hunting tools (Hulme, 2016; Moyo et al., 2012). Furthermore, most income-generating activities are also dependent on the forest, and they cause massive destruction of vegetation, which is a threat to climate change mitigation. The gains of afforestation and reforestation are threatened by income-generating activities such as carpentry, roof mending, thatching, selling wood fuel, and selling wild fruit (umnyiye) in poor communities of Zimbabwe and Southern Africa (Hulme, 2009). Thus, climate change mitigation faces the challenge of deforestation because the survival for most poor peasant households depends on woodland resources.

It is reported that agriculture is adversely affected by climate change in Zimbabwe and other SSA countries making communities more vulnerable to poverty (Mburu et al., 2015; Mubaya et al., 2012, Ndlovu et al., 2020). As such, woodland resources become over-exploited, causing more challenges to climate change mitigation. Furthermore, responsible authorities such as Environmental Management Agency (EMA), face challenges when taking actions that help to mitigate climate change. One of the main challenges is EMA's incapacitation to enforce environmental laws prohibiting deforestation. Also, community members refuse to comply with environmental laws because they are desperate to survive outside of traditional farming activities by resorting to unsustainable resource extraction activities (Dube et al., 2016; Manyani & Bob, 2017). For example, there is the widespread practice of gold panning on dry riverbeds, forested areas, and even crop fields, which have seen many parts of the communal areas being degraded as people thrive on earning a living. Thus, the lack of funds from government agencies to

implement migration programmes and poverty affecting peasant farmers contribute to a plethora of challenges to climate change mitigation (FAO, 2016; Moyo et al., 2012).

2.5.2 Climate change adaptation in Zimbabwe

The government and non-governmental organisations employ many adaptation strategies in Zimbabwe to address the negative impacts of climate change. Climate change adaptation strategies will be discussed under three headings: national, regional, and household levels. The section also contains the challenges faced during climate change adaptation across different levels in the country.

a) At national level

Zimbabwe has quite a number of national policies and strategies that are earmarked to address adaptation to climate change. The Zimbabwean national policies and strategies for climate change adaptation result from the UNFCCC Convention, Kyoto Protocol, and the Paris Agreement, which the government of Zimbabwe signed and ratified. The Zimbabwean government in 1992 ratified the UNFCCC Convention. The Convention is implemented by the Climate Change Management Department in the Ministry of Lands, Agriculture Water, Climate and Rural Resettlement. The UNFCCC help to prevent negative anthropogenic influences on the climate system by developing climate change mitigation and adaptation policies and strategies. Zimbabwe also ratified the Kyoto Protocol in 2009, an international agreement that commits its parties by setting internationally binding emission reduction targets. The government of Zimbabwe of late signed the Paris Agreement on 22 April 2016, ratified it on 7 August 2017, and it became effective on September 6, 2017. The Paris Agreement's main aim is to bring all nations to a common cause to undertake efforts to combat climate change and adapt to its effects through the establishment of national committees, government institutions, and national climate change adaptation strategies. Zimbabwe's commitments to the UNFCCC, Kyoto Protocol and Paris agreement are evidenced by establishing various national climate change policies and strategies. These include the National Climate Change Response Strategy in 2014; Intended Nationally Determined Contribution in 2015; National Climate Policy of 2017; the First, Second, and Third National Communication to the UNFCCC as well as the United Nations Programme on Reducing Emissions from Deforestation and Forest Degradation (UN REDD+) (Chanza & Gundu-Jakarasi, 2020).

b) At the regional level (rural context)

The rural areas in Zimbabwe have specific adaptation strategies that they employ to cope with climate change. The study conducted by Sango (2013) unveiled adaptation strategies for climate change in Makonde communal lands farmers, Zimbabwe. In his study, the most popular coping option for farmers in Makonde communal was engaging in 'food for work' projects run by either government or non-governmental organizations. The other options include buying, borrowing, and food handouts. The Figure 2.2 below illustrates the adaptation strategies in Makonde communal land.

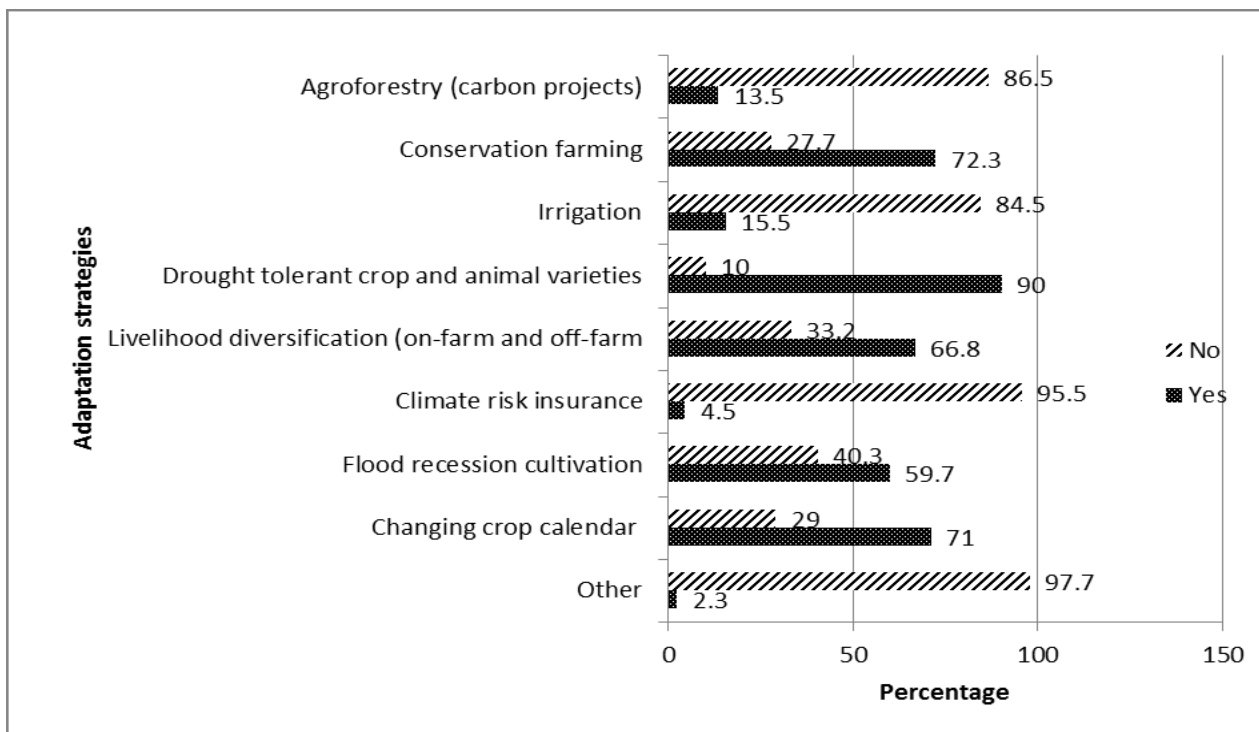


Figure 2.2: The adaptation strategies in rural areas (Chadereka Ward 1). Source: Manyani (2017, p. 182)

Figure 2.2 above shows that the Chadereka Ward 1 farmers are adapting to the adverse impact of climate change, which causes crop failure. The households have several adaptation strategies to cope with the situation. The most prevalent adaptation strategy in the ward was growing crops and keeping drought-tolerant livestock. According to Manyani (2017), conservation farming and changing of the crop were amongst the most frequently practiced adaptation strategies in the district. Moderately employed adaptation strategies included livelihood diversification (on-farm and off-farm activities) and flood recession cultivation. The least common adaptation strategies

were irrigation, agroforestry (carbon projects), climate insurance cover, mulching, and food rationing. Thus, there is increasing evidence that rural areas in Zimbabwe adapt in the best way they can to the adverse effects of climate change. These adaptation measures are being employed with varying frequencies.

c) At the household level (rural context)

Households in Zimbabwe are embarking on various strategies to adapt to climate change. One of the adaptation strategies to climate change is the practice of mixed farming that allows farmers to sell their livestock to buy grains when there are poor harvests. Sango (2013), in his study, states that the sale of livestock is usually a last resort in the face of a looming food and income crisis. Thus, keeping livestock is an adaptation strategy to cope with the food crisis, especially in drier regions of Zimbabwe where arable farming has poor returns.

According to the Government of Zimbabwe (2018), subsistence farmers have adopted climate-smart practices such as crop residue management, mulching, composting, and rotations to cope with the adverse impacts of climate change. The application of crop residue is common to farmers who grow vegetables. The other popular adaptation strategy pertains to short-season varieties and small-grained crops such as sorghum and millet that survive under harsh conditions. Adaptation strategies are also evident in pastoral farming practices, including diversification of livestock breeds and supplementary feeding. Furthermore, farmers also keep livestock that is tolerant to arid conditions. According to the Government of Zimbabwe (2018), keeping small livestock such as goats is increasingly gaining popularity in subsistence farming due to a shortage of water and poor pastures. Some of these climate change adaptation strategies include crop rotation, intercropping, and agroforestry. These strategies are discussed in detail below.

i) Crop rotation

Crop rotation is the practice of growing various crops in succession on a plot of land to ensure the addition of humus, improved soil fertility, erosion control, and pest and disease control (FAO, 2008; Makate, et al., 2019). Examples include maize following beans, leaf vegetables following fruit, and root crops following root crops. This is done to conserve the nutrients from one season to the next hence interrupting the life cycles of pests, diseases, and weeds. As a result, crop rotation can help households mitigate the negative effects of climate change (Dube & Phiri, 2013; FAO, 2018).

ii) Intercropping

Intercropping is the practice of growing multiple crops in alternating rows of the same field at the same time (FAO, 2016). Fast-growing legumes, such as beans and cowpeas, can provide soil cover earlier in the season than other crops. Farmers are encouraged to plant these fast-growing legumes to improve water retention, and these crops act as a canopy to protect the soil from raindrops. The benefit of intercropping is a more efficient use of available resources and increased productivity when compared to each sole crop of the mixture. It is reported that intercropping of legumes and cereals are common in Zimbabwe's subsistence farming (Brown et al., 2012; Dube et al., 2018). The presence of multiple rooting systems in the soil reduces water loss, increases water uptake, and increases transpiration. Intercropped plants use a higher percentage of available water from the field than mono-cropped plants, making this concept critical during times of water stress. Cereals in a field with a shorter crop reduce wind speed above the shorter crop, reducing desiccation (FAO, 2016). Cereal grain legume intercropping can help smallholder farmers address soil nutrient depletion (Sanginga & Woome, 2009). Legumes are nitrogen fixers and an important source of nutrients for humans and livestock alike (Nandwa et al., 2011). Farmers intercrop in order to benefit from the high protein content of beans and cowpeas as well as improved soil fertility.

iii) Agroforestry

Agroforestry is the planting of appropriate trees or shrubs or the preservation of those already present in fields and pastures (FAO, 2018; Waldron et al., 2017). This system is used to provide shade to the soil, lowering soil temperature and evaporation. The trees planted provide numerous benefits to both the farmer and the soil. Leguminous trees such as *Acacia* species, *Faidherbia albida*, *Moringa mellifera*, and many others can be included. The trees are fodder plants that also serve as windbreaks, reducing wind erosion. They supply leaf litter for mulching and recycle nutrients from the soil's depths. Leguminous trees fix nitrogen, which feeds food crops.

Trees are productive because they provide fruits, fuel wood, and timber while also mitigating the effects of climate change. On farms, these become long-term capital assets. A mix of annuals and perennials can help to contribute to the idea of never-ending food (FAO, 2010). This is an alternative to the mainstream focus on a single large harvest followed by a long period of no harvest. Families frequently struggle to feed themselves properly. As a result, evidence exists of various climate change adaptation strategies used by households to adapt to climate change.

iv) Challenges to climate change adaptation

From the household to the national level, the process of climate change adaptation faces numerous challenges. The major challenge for climate change adaptation is a lack of funding, as adaptation strategies necessitate funding. Simultaneously, as an economically unstable country, Zimbabwe is hampered from effectively implementing climate change adaptation. According to Chanza and Gundu-Jakarasi (2020), the majority of Zimbabwe's climate change resilience strategies have been driven by the donor community. The government's direct assistance is insufficient to cover the wide range of adaptation strategies. Individuals from low-income families are unable to implement climate change adaptation strategies without external assistance. In Zimbabwe, for example, there is a lack of funds to build the irrigation infrastructure needed to mitigate the effects of climate change (Mberekho, 2018; Ndlovu et al., 2020; Nyasimi et al., 2013). Irrigation projects are primarily supported by NGOs such as World Vision. However, there are significant shortcomings in the establishment of irrigation schemes mainly due to lack of funding. As such, there is need for government intervention in allocating adequate funding for the establishment of irrigation schemes (Moyo et al., 2016; Musiyiwa et al., 2014; Mutambara et al., 2014). Furthermore, Chanza and Gundu-Jakarasi (2020), reported that Zimbabwe's current irrigation practice is both slow and unsustainable.

2.5.3 EE in Zimbabwe

The government and non-governmental organizations employ many EE programmes in Zimbabwe to address the negative impacts of climate change. EE will be discussed under three headings: national, regional (rural context), and household level. The section also contains the challenges faced by EE across different levels in the country.

a) At national level

EE in Zimbabwe dates back to 1954, during the colonial era, when farmers, schools, and colleges were given conservation education (Government of Zimbabwe, 2016). The Natural Resources Board (NRB), a branch of the Ministry of Lands and Agriculture, was founded in 1941. It was critical in both EE research and dissemination (Makate et al., 2016; Ncube, 2010). During the colonial era, Zimbabwe did not have a written EE policy document until the end of the millennium. Prior to 2002, various government departments and organizations provided EE on their own. This fragmented approach, however, proved ineffective, and the government was forced to enact the Environmental Management Act (Chapter 20:27) in 2002. The creation of an

environmental management agency (EMA) unified EE at the local and national levels (Government of Zimbabwe, 2016).

Furthermore, Chagutah (2010) and Ndhlovu and Mpofu (2016) identified the use of the media for disseminating climate information as important initiatives for addressing the negative effects of climate change in Zimbabwe. The media's ability to reach the community level provides an opportunity to disseminate accurate and important climate information, such as weather forecasts, early warning, and medium to long-term trends.

EE and Sustainable Development have been identified as a priority intervention tool for environmental issues by SADC (SADC Report, 2006). Zimbabwe, as a member of SADC, signed the SADC protocol on the United Nations Decade of Education for Sustainable Development (UNDEAD), which ran from 2005 to 2014 (Lotz-Sisitka, 2010). The SADC Regional EE Programme (REEP) was established in 1993, and the initiative was formalized in 1997 after securing implementation partners. The main goal of establishing REEP was to enable EE practitioners in the SADC region to strengthen EE processes in order to make equitable and sustainable environmental management decisions (Lotz-Sisitka & Urquhart, 2014). REEP has supported policy development processes, the production of ESD literature, networking, workforce training, and research and evaluation since its inception.

Furthermore, civil society organizations have been actively involved in networking around climate change issues, such as by forming climate change working groups (Chanza & Gundu-Jakarasi, 2020; Government of Zimbabwe, 2012). These groups have facilitated the exchange of information about activities and techniques for assisting with adaptation and development. Zimbabwe UNESCO, through the “Sustainability Starts with Teachers program”, will also support the process in 2020 (UNESCO, 2020).

b) At the regional level (rural context)

It is reported that between 2000 and 2004, the Zimbabwean government implemented the National Environmental Policy through a multi-stakeholder consultative process (Government of Zimbabwe, 2016; Van Ongevalle et al., 2011). EE in Zimbabwe dates back to the colonial era, but due to a lack of publicity, little is known about it in the rural areas (Government of Zimbabwe, 2015; Makoni, 2013). Despite its scattered efforts, the country lacked an official EE policy during the colonial era and the first two decades after independence.

The establishment of national policy has promoted EE in Zimbabwe's rural communities. EE was included at various levels in all learning institutions as part of the implementation processes (Chagutah, 2010; Chanza & Gundu-Jakarasi, 2020; Government of Zimbabwe, 2013). Rural areas, on the other hand, are lagging in terms of embracing EE in the context of adapting to and mitigating climate change.

Some national programmes in Zimbabwe have negative consequences for EE. For example, the 2002 land reform programme resulted in massive deforestation due to small-scale farmers settling in wooded areas (Sango & Nhamo, 2015; Shumba, 2017; Thebe, 2012). As a result, the effects of climate change and land degradation have become significant challenges in these areas. There is a scarcity of land in Zimbabwe's communal areas, which leads to land degradation (Chitongo, 2019; Government of Zimbabwe, 2007). As a result, the rural population prioritizes survival skills over environmental conservation (Dunford et al., 2015, Ndlovu, 2011). Thus, land degradation in communal areas is caused in part by rising population and overstocking pressures, which exacerbate environmental management efforts.

Overpopulation and poor environmental management practices are significant causes of climate change mitigation and adaptation in Zimbabwe's rural areas (Chagumbura et al., 2016; Mubaya et al., 2012; Ndlovu, 2016). According to Mukute et al. (2012), poor governance, financial constraints, and corruption are limiting Zimbabwe's climate change mitigation and adaptation efforts. As a result, EE strategies fail to achieve their goals in rural areas and nationally; as a result, fundamental changes must be made to strengthen the legal framework within which they operate and address poverty issues.

c) At the household level (rural context)

Zimbabwean households are embarking on a variety of EE initiatives in order to adapt to climate change (Government of Zimbabwe, 2016; Makoni, 2013; UNDP, 2013). Climate change education is provided to children at home in order to foster the long-term behavioural changes required to adapt to and mitigate climate change. This is accomplished through gardening and farming activities in which they participate while assisting their parents.

d) Challenges to EE efforts

EE efforts face a slew of obstacles, from the household to the national level. According to Chagutah (2010), there is a lack of specialist skills and knowledge in climate change across key

critical sectors such as health, water, and natural resource management, particularly in rural areas. Furthermore, the media's lack of coverage of climate change is to blame for communities' lack of awareness and knowledge about climate change mitigation and adaptation, particularly in rural areas (Muchuru & Nhamo, 2019; Mtambanengwe et al., 2012).

According to Mukute et al. (2012), Zimbabwe has a comprehensive EE policy document; however, this does not address the challenges associated with EE efforts. This is due to a number of issues, including inadequate EMA funding, understaffing, corruption among some of the organization's officials, poverty, a scarcity of EE literature, and a lack of alternative energy sources, particularly in rural areas (Chagumbura et al., 2016). As a result, rather than simply acquiring scientific knowledge about the environment, there is a need to focus on behaviour change in the formal education sector.

Furthermore, due to financial constraints, government institutions such as rural district councils and AGRITEX departments in rural areas are unable to engage in effective policy implementation related to EE. Skilled migration, combined with limited financial resources in government departments and research organizations, further limits climate change research and development (Chagutah, 2010). As a result, capacity development continues to be a significant institutional challenge for EE programmes.

2.6 Theoretical framework and models

The Sustainable Rural Livelihoods (SRL) Framework (Carney, 1998; Scoones, 2015) and the Nested model of Sustainability (Department of Environmental Affairs (DEA), 2012) guided the study.

2.6.1 Sustainable Rural Livelihoods Framework (SRLF)

This section will present SRLF as theorised by Carney's SRLF (1998) and developed by Scoones' SRLF (2015). This study used a holistic and people-centred approach called Sustainable Rural Livelihoods (SRL). According to the British governments' Department for International Development (DFID) (1999), SRL is an analytical tool used to improve livelihoods, particularly the livelihoods of needy individuals and communities. This study will be used as an analytic tool to understand the adaptation and mitigation strategies of the rural poor communities of Gwanda District. According to Carney (1998), the SRL approach is about working together to build on people's strengths in addressing environmental issues. In the current study, the environmental issue is climate change. As such, SRLF is an ideal analytic tool for the current study. In addition,

Carney (1998) states that the SRL framework was developed by the Sustainable Rural Livelihoods Advisory Committee on request from DFID to promote sustainable livelihoods. This view also qualifies SRLF as a relevant analytical tool to the current study as it explores how EE can promote climate change mitigation and adaptation.

The SRL framework was chosen in this study because it provides a guide on how to understand and promote sustainable livelihoods while at the same time promoting adequate management of the natural and physical environment (Carney, 1998; Ncube et al., 2016). In essence, the SRL approach starts with people and does not compromise the environment (Carney, 1998; Scoones, 2009). Doing so allows the research to emphasize people and their livelihoods greatly and not on resources as such. (Carney, 1998; Scoones, 2004). Furthermore, the SRL framework is chosen as an analytical tool because it mainstreams the environment within a holistic framework. It is inherently responsive to people's interpretations of and priorities for their livelihoods in their communities. Figure 2.3 shows the SRL framework developed by Carney (1998).

a) Sustainable Rural livelihoods Framework (Carney, 1998).

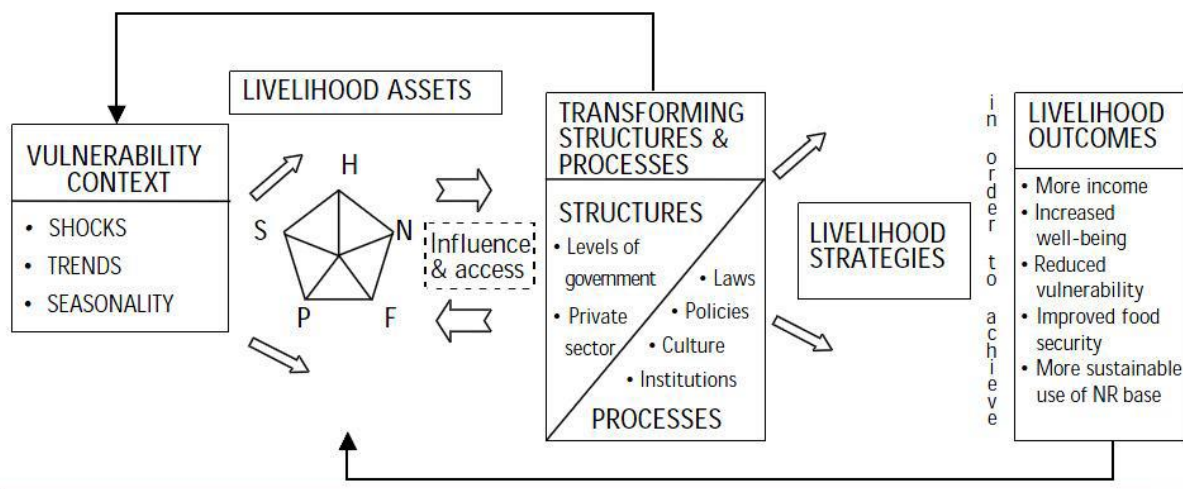


Figure 2.3: Sustainable Rural Livelihoods (Carney, 1998).

Figure 2.3 above illustrates the framework provided by Carney which comprises three main components: the vulnerability context, the livelihood assets, and transforming structures and processes. These three main components influence livelihood strategies that eventually lead to livelihood outcomes. Thus, the framework serves as the best analytical tool for the current study, which aims to explore climate change mitigation and adaptation mainly under the influence of EE. Many theoretical frameworks for sustainable rural livelihoods have developed after Carney's

SRLF of 1998 (Ncube et al., 2016). The latest version of SRLR by Scoones (2015) guided this study since it is geared towards capacity building among rural and vulnerable communities (Sharma et al., 2016). Figure 2.4 presents SRLF by Scoones (2015).

b) Sustainable Rural Livelihoods (Scoones, 2015)

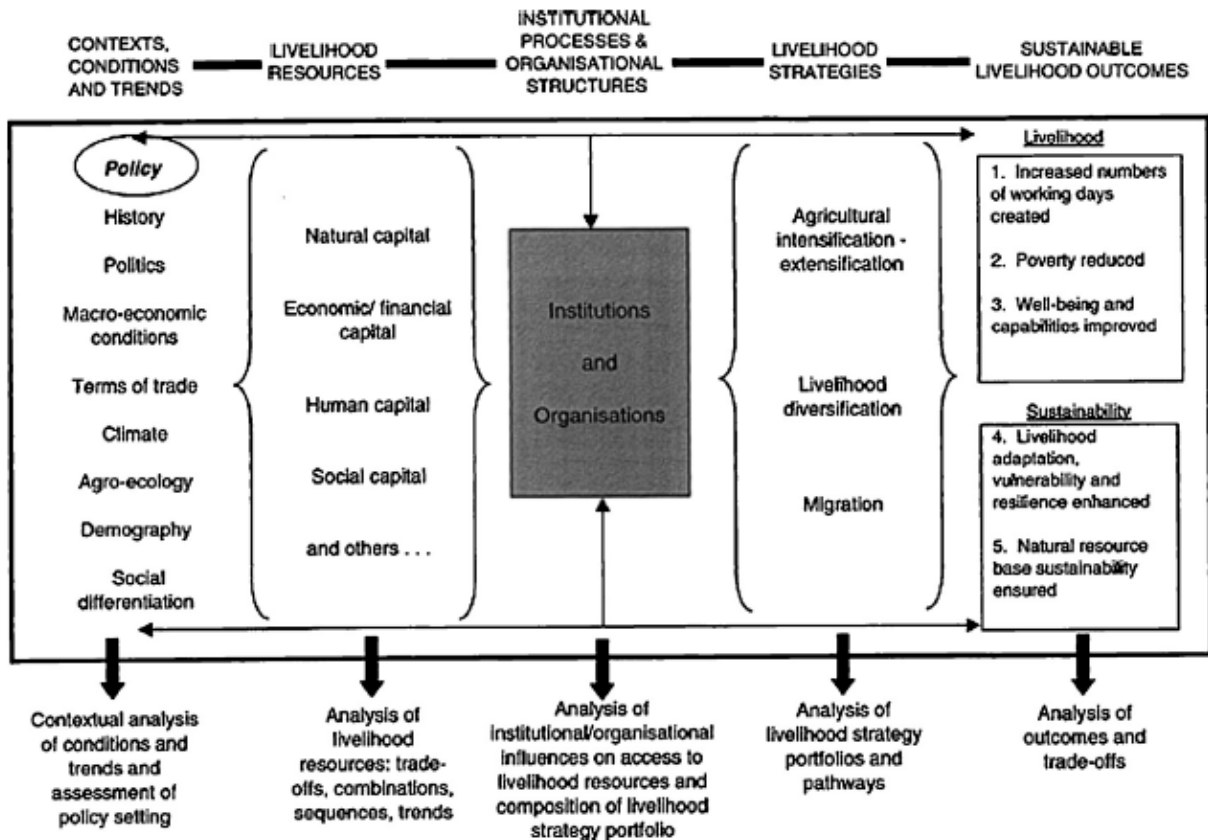


Figure 2.4: The Sustainable Livelihoods Framework (Scoones 2015, p. 36)

The study followed these themes in Gwanda rural district. The main theme of the study is EE, and the themes of the SRL framework were evaluated by taking EE as a starting point. Thus, the SRL framework is one of the most suitable frameworks used to analyze mitigation and adaptation strategies pursued by individuals and communities to respond to external shocks and stresses such as drought, civil strife, failed policies, and anti-poor regulatory frameworks. In this study, the external shock is Climate Change.

2.6.2 The aspects of SRLF and their relevance to the current study

This section presents aspects of SRLF and an explanation of how each aspect relates to the current study is also provided.

a) Vulnerability context

The vulnerability context refers to the external environmental factors that have an impact on people's asset accumulation or livelihoods. It includes various trends (demographic, resource, and governance), biophysical and socioeconomic shocks, and seasonality, all of which reflect variations in prices, outputs, or employment opportunities (Scoones, 2009; Wang et al., 2016). The circumstances may either provide excellent opportunities or limit climate change mitigation and adaptation. As a result, the current study explored the vulnerability context in Gwanda District in terms of climate change mitigation and adaptation.

b) Livelihood Resources

The context of livelihoods' assets is about people and their socio-economic well-being or assets (capital) at their disposal (Scoones, 2015; Sharma et al., 2016). The livelihood assets determine the livelihood outcome status and, they can either improve or reduce the resilience of the rural communities within a particular place (Huai, 2016). According to Sharma et al. (2016), asset analysis is an important tool for empirical research. Thus, the livelihood assets analysis suited the current study which explored the role of EE in climate change mitigation and adaptation. The livelihoods resources include natural capital, economic capital, human capital, social capital, and so on (Scoones, 2015). These forms of livelihoods resources are presented in the following sub-sections.

i) Natural Capital

Natural capital refers to natural resources or assets that include water, forests, land, air quality, biodiversity, and climate (Huq et al., 2015; Masud et al., 2017). They determine rural livelihoods development (Huq et al., 2016). Natural capital is closely related to the vulnerability context. Extreme climatic events such as heatwaves, floods, and drought negatively affect livelihoods development (Scoones, 2015). Favourable natural resources such as plenty of water supply dense forests and species richness (biodiversity) capacitate the rural poor to diversify their economic activities. Thus, the natural capital is crucial in climate change mitigation and adaptation. It was explored to understand the successes and challenges to climate change mitigation and adaptation in Gwanda rural district.

ii) Economic Capital

Economic capital refers to financial resources required to embark on effective livelihoods strategies (Huai, 2016; Scoones, 2015). The economic capital is necessary to finance livelihood strategies. The availability of capital enables livelihood strategies while its shortage constrains the implementation of livelihood strategies. The significant role played by economic capital on livelihood strategies qualifies it as an important aspect to be considered during the current study for climate change mitigation and adaptation in Gwanda District.

iii) Human Capital

Human capital is an important asset that enables people to venture into diverse livelihood strategies and achieve their livelihood objectives or goals (Scoones, 1998). According to Sharma et al. (2014), it includes skills, knowledge, ability to work, and good health. Human capital is determined by the educational or skills level, leadership and decision-making potential, and health status (Huai, 2016). Thus, EE can be used to improve human capital. For the current study, the impact of EE on climate change mitigation and adaptation will be explored. According to Sharma et al. (2014), changes in the status of human capital strongly affect all other assets. Thus, the current study explored how human capital affects the resilience of Gwanda District communities under the threat of climate change.

iv) Social Capital

Social capital refers to networks and connectedness, relationships among people, and mutual understanding. Rural communities in traditional societies mainly rely on social capital as safety nets and work on communal lands (Ncube et al., 2016). The aspect of social capital closely relates to the current study, which is based on the communal lands of Gwanda rural district where communities rather than individuals are owning land; hence, more interaction is emphasized in the social capital context. According to Huq et al. (2016), social capital affects livelihoods development both positively and negatively. Thus, there was a need to explore how social capital affects rural communities in Gwanda rural district during the critical times of extreme effects of climate change. EE as one of the attributes for social capital on informal networks was explored to establish how EE affects mitigation and adaptation for climate change in wards 12 and 16 of Gwanda rural district.

v) Organizational Structures and Institutional Processes

This context has an influential role in the livelihoods strategies and outcomes since it can either enable or disenable Sustainability (Scoones, 2015). Organizational structures constitute different stakeholders who influence access to resources needed to adopt and implement livelihood strategies. These stakeholders have an influential role in decision-making and craft policies. According to Sharma et al. (2014), institutions enable critical processes as they directly promote or hinder livelihood the adoption and implementation of livelihoods strategies. Thus, the role of government and non-governmental institutions affects livelihoods strategies. The current study used SRLF to explore how the institutional structures and processes affect climate change mitigation and adaptation in Gwanda rural district.

vi) Livelihood Strategies

Livelihood strategies include a wide range of practices undertaken by individuals or communities to meet the expected livelihood goals (Scoones, 2015; Wang et al., 2016). The livelihood strategies are mainly dependent on asset status found within the livelihood framework of a particular place (Scoones 2009, 2015). The components of SRLF strategies determine the livelihood strategies (Ncube, 2015). The current study is mainly based on the livelihood strategies context; how rural communities in Gwanda rural district are mitigating and adapting to climate change. Part of the livelihood strategy is an EE and how it affects other livelihood strategies. Thus, SRLF best suits the current and its context of livelihood strategy forms a relevant analytic tool for this research.

vii) Livelihood Outcomes

The livelihood outcomes refer to the outputs of the livelihood strategies, which include more money, improved well-being, improved resilience to vulnerabilities of climate change, improved food security, and increased sustainability in natural resource usage as well as reduced greenhouse gases emissions (Scoones, 2015). Livelihood outcomes depend on how the aspects of SRLF are combined within a given household or community (Huai, 2016). SRLF explored the livelihood outcomes of rural people in Gwanda District so that the necessary strategies to improve these outcomes could be established. Thus, the livelihood outcomes aspect of the SRLF provided an analytic tool for the current study. The positive livelihood outcomes in the district were explored so that policymakers can use them to motivate stakeholder participation in different livelihood strategies towards mitigating and adapting to climate change. The undesirable livelihood

outcomes were explored so that corrective measures, mainly through EE, could be recommended to improve farmers' resilience to climate change and to reduce greenhouse gas emissions. Also, the livelihood outcomes context is utilized to provide opportunities for further exploration into new livelihood strategies in the study area.

2.6.3 Nested Model of Sustainability

The concept of Sustainability can be illustrated graphically using the three spheres: social, economic, and environmental. The nested model shows that sustainable development must be cognisant of the absolute dependence of both the economic and social dimensions on functioning ecosystems that can supply ecosystem services such as water, air, natural resources, disaster risk mitigation, and so forth. The social dimension includes the role of a government that can provide leadership and strategic guidance for sustainable development. The government's role is significant in ensuring fair allocations of responsibility and obligation to the environmental and developmental spheres. The Nested Model of Sustainability illustrated below is contained within the South African National Strategy for Sustainable Development (NSSD) (DEA, 2012).

Nested model of Sustainability

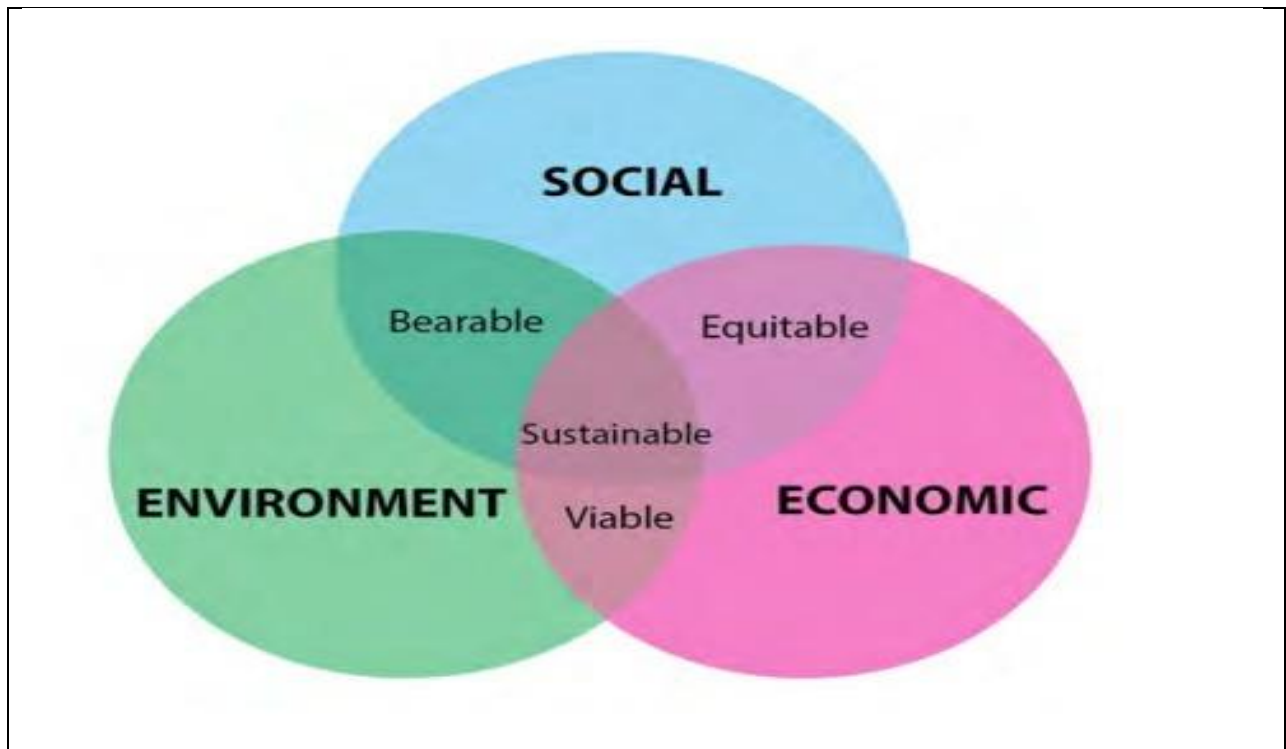


Figure 2.5: The nested model of Sustainability (DEA, 2012)

Figure 2.5 above illustrates the nested model of Sustainability provided by the Department of Environmental Affairs (DEA) (2012). The framework depicts the social, environmental, and economic aspects that are linked with each other to influence sustainability. Sustainable livelihoods solely depend on the interdependence of these three aspects of Sustainability. This framework is relevant to EE in climate change mitigation and adaptation because DEA (2012) illustrates that conducive aspects of Sustainability are needed to adapt and deal with the significant changes and stresses currently facing rural areas. Thus, the nested model of sustainability was developed to elucidate the need for a holistic approach when exploring sustainability in the community. The social aspect, particularly knowledge (EE), forms the basis for the analysis regarding climate change mitigation and adaptation, which occupies the centre stage in this study.

2.6.4 The Combined SRLF and the Nested Model of Sustainability

Environment ↔ **Economic** ↔ **Social** → **Mitigation and Adaptation**

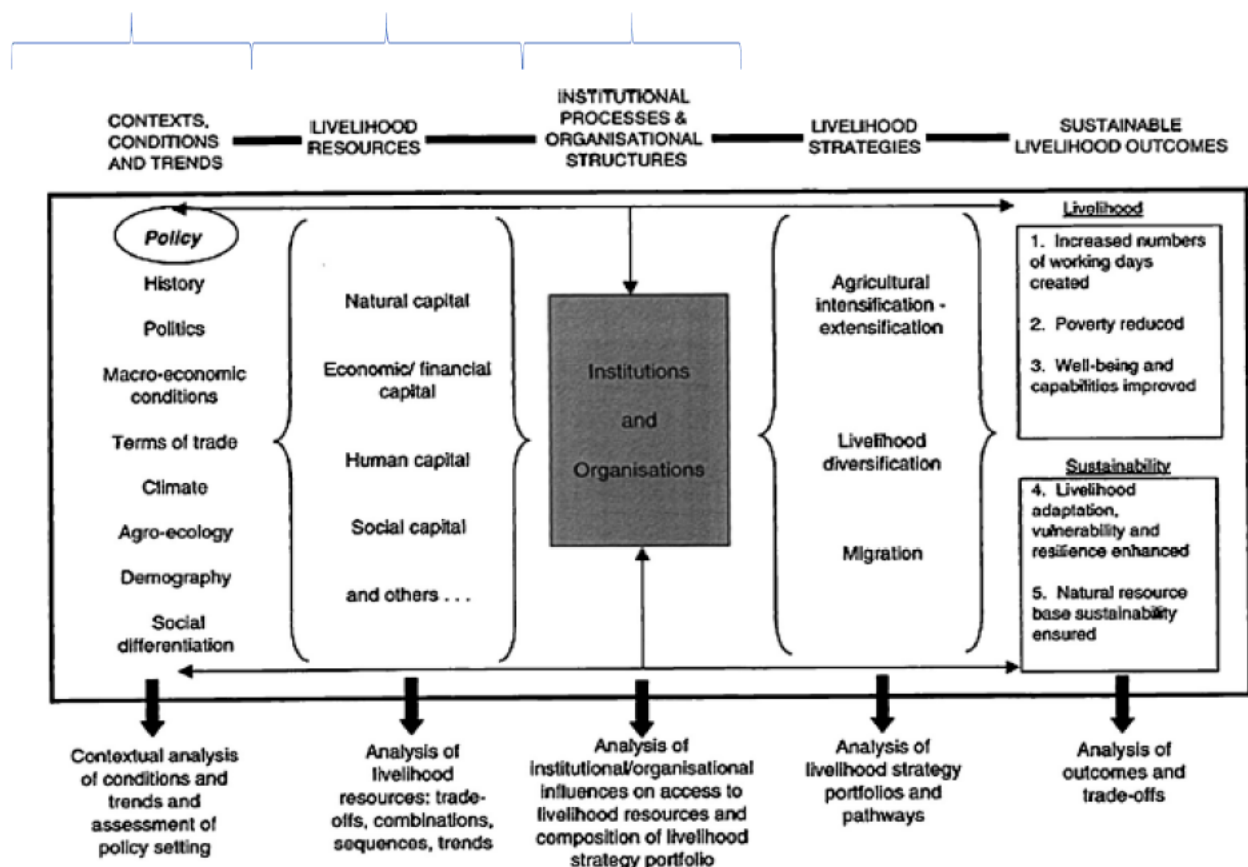


Figure 2.6: The Combined SRLF and the Nested Model of Sustainability in exploring climate change migration and adaptation and EE in wards 12 and 16, Gwanda District.

The combined model demonstrates that the SRLF's vulnerability context is closely related to the environment sphere of the Sustainability nested model. As a result of the district's geographical location in a drought-prone region, the communities in Gwanda rural district are vulnerable to the effects of climate change. The context of livelihood assets correlates with the economic sphere, which determines farmers' ability to respond to the negative effects of climate change. Climate change mitigation and adaptation are aided by the availability of funds, whereas a lack of funds makes communities more vulnerable to the effects of climate change. The SRLF's organizational structures and institutional processes are inextricably linked to the social sphere of the Sustainability nested model. This aspect of the combined framework plays a critical role in determining resource access. For example, the role of government influences farmers' ability to mitigate and adapt to climate change. Livelihood strategies and outcomes have been combined with mitigation and adaptation, demonstrating the potential of sustainability.

2.7 Conclusion

The second chapter of this thesis focused on the global, regional, and national experiences of EE. The chapter also sketched some literature on the study's critical concepts. Climate change, climate change mitigation, climate change adaptation, adaptive capacity, EE, EE approaches, challenges to EE implementation, and the effectiveness of EE efforts were among the critical concepts examined. The theoretical framework on the Sustainable Rural Livelihoods (SRL) Framework and the Nested Model of Sustainability are also examined in this chapter. It was revealed in this chapter that SRL is important in understanding climate change mitigation and adaptation because it mainstreams the environment within a holistic approach, and it is inherently responsive to people's interpretations and priorities for their livelihoods. The Nested Model of Sustainability revealed that the pillars of sustainability, namely social, economic, and environment, are interdependent and can enable or disable sustainability.

The ensuing chapter described the research methodology and employed to study, which explores the role of EE in climate change mitigation and adaptation. It describes in detail the research methodology and design employed in the study.

CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

The previous chapter explored the pertinent literature, conceptual and theoretical frameworks to establish a basis to understand the successes and challenges of EE in climate change mitigation and adaptation in Gwanda rural district, Zimbabwe.

This chapter delineates the context of the study, methodology, the research paradigm, research tools, their justification, the ethical issues, validity and reliability, and limitations to the study. The methodology entailed qualitative research methods as the study is positioned in the interpretive paradigm since the study is on EE in climate change mitigation and adaptation. The research instruments included semi-structured interviews and focus group discussions with key informants: EMA officers, AGRITEX officers, and community members. Document analysis was also used apart from interviews and focus groups. Purposive and convenience sampling were used to access the key participants.

3.2 Research Paradigm

There are numerous definitions of the concept of ‘paradigm’ in methodology texts. Cohen et al. (2018, p. 1) advises “fitness of purpose” entailing “different research paradigms for different research purposes”. As such, interpretive paradigm was employed to explore the successes and challenges of EE efforts in climate change mitigation and adaptation among the communities of Gwanda rural district in Zimbabwe. Furthermore, Creswell (2007, p. 5) avers that “paradigms are sets of assumptions, values or beliefs about fundamental aspects of reality which give rise to a particular world view and serve as the lenses or organising principles through which researchers perceive and interpret reality, hence they represent what we think about the world.” According to Patton (1990, p. 479), a paradigm is, “a world view, a general perspective, and a way of breaking down the complexity of the real world.” While, Guba and Lincoln (1994) and Johnson and Onwuegbuzie (2004, p. 25) state that “a research paradigm is a set of beliefs, values and assumptions that a community of researchers has in common regarding the nature and conduct of research.” In addition, Denzin and Lincoln (2003) define a research paradigm as “an interpretive framework” while they also derive from Guba (1990, p. 17), that it is “a basic set of beliefs that

guides action.” Thus, a research paradigm can be defined as a general worldview guiding a researcher’s interpretation of reality (Dannels, 2018; Umer & Razi, 2018).

The research paradigm employed in this research is the interpretive paradigm because I want to deal with the emotions, experiences, and views of farmers, AGRITEX, and EMA officers in Gwanda rural district by understanding the role of EE in climate change mitigation and adaptation in the district apart from the successes and challenges in Gwanda rural district. Cohen et al. (2018, p.1) advise "fitness of purpose" entailing "different research paradigms for different research purposes." According to Creswell (2009, p. 8), an "interpretive methodology is directed at understanding the phenomenon from an individual's perspective, investigating interaction among individuals as well as the historical and cultural contexts which people inhabit." In the same view, Scotland (2012, p. 12) further explained that "interpretive methods yield insight and understandings of behaviour, explain actions from the participant's perspective, and do not dominate the participants. Examples include open-ended interviews, focus groups, open-ended questionnaires, open-ended observations, think-aloud protocol, and role-playing. These methods usually generate qualitative data". Thus, the interpretive paradigm entailed a "study (of) things in their natural settings, attempting to make sense of or to interpret phenomena in terms of the meanings people bring to them" (Denzin & Lincoln, 2008, p. 3).

This research situates itself firmly in the interpretive paradigm. Cohen et al. (2018, p. 19) state that “...the central endeavour in the context of the interpretive paradigm is to understand the subjective world of human experience,” which this study aimed to do in the Gwanda district. In the same point of view, Cohen et al. (2007, p. 19) argue that “within the interpretivist paradigm, the role of the researcher (scientist) is to understand, explain, and demystify social reality through the eyes of different participants.” Thus, the researcher in this study sought to understand and explain the phenomenon under study as postulated in the interpretive paradigm. In this study, a scrutiny of the successes and challenges of EE efforts in climate change mitigation and adaptation among the communities of Gwanda rural district is largely proffered through the lens of the communal farmers, AGRITEX, and EMA officers. Furthermore, in pursuance of the interpretivist paradigm, the researcher generated data from the participants (Creswell, 2010; Creswell & Poth, 2018). The interpretive paradigm ensured that the researcher did not yield an alien and outsider interpretation

of EE efforts in climate change mitigation and adaptation. The next section of the chapter discusses the case study research approach that was adopted in this study.

3.3 Research Approach

Creswell (2014) argues that there are three research approaches: quantitative, qualitative, and mixed approaches. A qualitative research approach was used in this study to derive an in-depth examination of the phenomenon of interest through tapping numerous research participants and reports (McGuirk & O'Neill, 2016). According to Denzin and Lincoln (2011, p. 3) cited in Creswell and Poth (2018, p. 7), "Qualitative research is a situated activity that locates the observer in the world. Qualitative research consists of a set of interpretive, material practices that make the world visible...This means that qualitative researchers study things in their natural settings, attempting to make sense of, interpret phenomena in terms of the meanings people to them". The qualitative research approach was used to explore the successes and challenges of EE efforts on climate change mitigation and adaptation among the communities of Gwanda District in Zimbabwe. Thus, qualitative approaches to data collection, analysis, interpretation, and report writing were used in this research. The study involved qualitative procedures such as purposeful and convenience sampling, open-ended data collection, analysis of text, representation of information in figures and tables, and personal interpretation of the findings. According to Creswell and Poth (2017), qualitative research is a means for exploring and understanding the meaning individuals or groups ascribe to a social or human problem. The process of qualitative research allows the "researcher to see and understand the context within which decisions and actions take place" (Myers, 2009, p. 5). Thus, qualitative research enables the researcher to identify economic, social, political and environmental aspects that shape the behaviour of the participants towards climate change mitigation and adaptation.

According to Mohajan (2018), qualitative research produces holistic understandings of rich, contextual, and generally unstructured, non-numeric data. The researcher engages in conversations with the research participants in a natural setting (Creswell, 2009; Singh, 2017). Denzin and Lincoln (2011, p. 3), cited in Creswell and Poth (2018, p. 7), aver that "Qualitative research is a situated activity that locates the observer in the world. Qualitative research consists of a set of interpretive, material practices that make the world visible. This means that qualitative researchers study things in their natural settings, attempting to make sense of, interpret phenomena in terms of the meanings people have ...". A researcher who engages in this form of inquiry supports a way of

looking at research that honours an inductive style, focusing on personal meaning and the importance of rendering the complexity of a situation (Creswell & Poth, 2017; Johnson & Christensen, 2007; Mohajan, 2018). Thus, this study was qualitative employing semi-structured in-depth interviews and focus group discussions as the fundamental data generation techniques. Qualitative methodology enabled the generation of rich descriptive data that facilitated an understanding of the successes and challenges of EE efforts in climate change mitigation and adaptation among the communities of Gwanda rural district.

3.4 Research Style

The research used a case study approach. Yin (2017) elucidates that a case study is an experimental method that investigates a case in-depth and in a real-world context. According to Saunders et al. (2009), case studies help provide a holistic view of a situation since they are convenient and flexible when carrying out research. According to Creswell and Poth (2018, p. 97), “Case study research begins with the identification of a specific case that will be described and analyzed. Examples of a case for study are an individual, a community, a decision process, or an event”. Thus, based on these schools of thought, case studies are a strategy of inquiry. In this current study, I explored EE programmes in Gwanda rural communities in terms of climate change mitigation and adaptation. Cases are bounded by time and activity, and the timeframe for this study was three years based in Gwanda rural district. The researcher generated detailed information using a variety of data collection procedures over a sustained period.

The case study method supports theory building (Yin, 2009, 2014) and theory testing (Eisenhardt, 1989). The case study method's support for theory building is mainly significant in areas where existing theoretical and conceptual frameworks are inadequate. In this study, “theoretical and conceptual frameworks” concerning EE for climate change mitigation and adaptation are considered inadequate. However, general ideas or expectations can guide empirical research (Alasuutari et al., 2009; Creswell & Poth, 2018; Yin, 2013). The insights arising from case-based theory-building research can be used as hypotheses or propositions in further research. According to Creswell and Poth (2018, p. 10), "Case study researchers provide an in-depth understanding of a case (or cases). Therefore, case study research plays a vital role in advancing a field's body of knowledge.

The case study was the preferred strategy as the researcher wanted to know about the successful strategies for mitigation and adaptation to climate change in Gwanda rural district; the challenges for climate change mitigation and adaptation in Gwanda rural district; and the role of climate information dissemination in the mitigation and adaptation of climate change in Gwanda rural district. According to Cohen et al. (2018, p. 376), "A case study provides a unique example of real people in real situations, enabling readers to understand ideas more clearly than simply by presenting them with abstract theories or principles." This implies that a thorough study of the nature of EE efforts in Gwanda rural district was done to gain an in-depth knowledge of climate change mitigation and adaptation through EE.

Types of Case Studies

Elper (2019) states that there are different types of case studies: illustrative, descriptive, explanatory, prospective, cumulative, and embedded. I used a descriptive case study to explore the successes and challenges of EE efforts on climate change mitigation and adaptation amongst the communities of Gwanda rural district in Zimbabwe. This type of case study is used to explore those situations in which the intervention being evaluated has no clear, single set of outcomes (Yin, 2003). Elper (2019) adds that an explanatory case study involves specific research on a particular topic to the extent that deep understanding occurs. Thus, I also used the explanatory case study to access detailed insights about the EE efforts in climate change mitigation and adaptation in Gwanda rural district. This also links with interpretivism, the chosen research paradigm.

3.5 Sampling

According to Siririka (2007, p. 34), sampling refers to "the procedure a researcher uses to select people, places, or things to study." Thus, sampling is a process whereby a certain group or sample is chosen to represent a larger group (Creswell & Poth, 2018). Bless and Higson-Smith (2010, p. 85) view "a sample as a subset of the whole population which is investigated by a researcher, and whose characteristics are generalised to the entire population." Cardwell (1999, p. 202) explains the need for a sample population and argues that "as an entire population tends to be too large to work with, a smaller group of participants must act as a representative sample." During sampling, the researcher has to consider the following: "...whom to select as participants (or sites) for the study, the specific type of sampling strategy, and the size of the sample to be studied" (Creswell & Poth, 2018, p. 157). Thus, sampling allows the researcher to select a few individuals to represent

the entire population during data generation (Cohen et al, 2018; Denzin & Lincoln, 2005; Sarstedt et al., 2017). In the same line of thought, O'Leary (2004, p. 102) added, "Our inability to access every element of a population does little to suppress our desire to understand and speak for it." Thus, sampling is essential in any research, and according to Creswell and Poth (2018, p. 157), the researcher has to consider the following: "...whom to select as participants (or sites) for the study, the specific type of sampling strategy, and size of the sample to be studied." There are various sampling techniques usually classified into two: probability sampling (random sampling) and non-probability sampling (non-random sampling).

Sample and sampling procedure

Probability sampling is also known as random sampling. According to Leedy and Ormond (2010, p. 205), in probability sampling, "the researcher can specify in advance that each segment of the population will be represented in the sample." This means that the generated data is generalised to reflect an entire population based on information supplied by the sample. Random sampling gives each member of the population a fair chance to be chosen, which helps achieve a representative sample (Creswell & Poth 2018; O'Leary, 2012; Umer & Razi, 2018). This trait of probability sampling is contrary to non-probability sampling, where research participants do not have equal chances to be selected. There is no bias in probability sampling because the selection of research participants does not rely on the human verdict. Random sampling can be used to further select research participants within samples selected using non-probability sampling techniques (Sarstedt et al., 2017). For instance, participants for focus group discussions from a non-probability sample may be determined using random sampling. However, it is generally reported that the most appropriate sampling technique in conducting qualitative research is non-probability sampling which will be discussed in detail in the following section. In this current study, I used non-probability sampling and the reasons for using it are explained in detail in the following section.

Convenience sampling was used to choose communal farmers from wards 12 and 16 in Gwanda rural district. Communal farmers situated along the main roads in selected communities were selected for easy accessibility. Magwa and Magwa (2015) asserted that convenience sampling involves choosing individuals who are easily accessible to the researcher to serve as respondents until the required sample size has been obtained. Etikan (2016, p. 2), describe convenience sampling as "accidental samples" because research participants are selected based on their

simultaneous presence within the geographical context where the researcher is conducting the data generation. Thus, the critical objective of convenience sampling is to generate data from research participants who are “easily accessible to the researcher” (Etikan., 2016, p. 2). Furthermore, it is reported that even though convenience sampling may conclude generalisations, the information retrieved could nonetheless be of value. Similarly, Cohen et al. (2018) state convenience sampling is employed where access to some parts of the study area may be a challenging endeavour and the research select research participants who are easily accessible.

The study employed purposive sampling to select research participants as well as wards 12 and 16. Leedy and Ormond (2010) aver that a purposive sampling technique ensures that participants with desired information about the topic are selected. Similarly, Silverman (2010, p. 148) states that "Purposive sampling allows us to choose a case because it illustrates some features or processes in which we are interested." Within Gwanda rural district, I further purposively selected two wards, 12 and 16. These wards were chosen because they are located in the southern part of Gwanda rural district, experiencing severe drought conditions and effective climate change mitigation and adaptation are eminent in these wards. In addition, the two wards were suitable for the phenomenon under study because they are under the spotlight of NGOs such as World Vision and Care in addressing adverse impacts of climate. Therefore, as revealed in Simuchimba and Luangala (2007, p. 11), "purposive sampling rich information rather than the number of participants is important." Therefore, the AGRITEX and EMA officers can be argued to be well-informed participants in terms of the successes and challenges of EE efforts on climate change mitigation and adaptation amongst the communities in Gwanda rural district.

I deliberately selected specific individuals in the district to provide information that is crucial for the research. Purposive sampling was used to sample the EMA and AGRITEX officers. They were considered to have much information about the successes and challenges of EE efforts on climate change mitigation and adaptation amongst the communities in Gwanda rural district. The use of purposive sampling resonates with the point raised by Johnson and Christensen (2004, p. 175) that "purposive sampling constitutes the selection of information-rich cases." Furthermore, according to Kurebwa (2013, p. 177), purposive sampling “...is intended to facilitate a process whereby research generates and tests theory from the analysis of data rather than using data to test out or to falsify a pre-existing theory.” Fraenkel et al. (2012, p. 100) argue that “qualitative researchers

prefer purposive sampling since it allows them to use their judgments to select participants that they believe will provide the data they need.” AGRITEX officers and EMA officers were deemed to be information-rich participants because they are in charge of implementing EE programmes in Gwanda rural district.

Furthermore, Patton (1990, p. 478) adds, “purposive sampling seeks information-rich cases which can be studied in-depth.” In-depth information was gained through the use of multiple research tools (interviews, focus group discussion, and document analysis) with the purposively selected participants (farmers, AGRITEX officers, and EMA officers). Thus, purposive sampling entails identifying and utilising information-rich cases a researcher can study thoroughly, which resonated with this present study (Cohen et al., 2018; Osuagwu, 2020). Purposive sampling is defined by Bernard (2012) and Bless and Higson-Smith (2010) as a process when a researcher selects precise people within the population to use for a specific study. Hence, it entailed the researcher concentrating on people with particular characteristics who could assist with the relevant information.

There is generally a lack of consensus in the literature on the ideal number of participants for research purposes. However, various recommendations have been forwarded on the number of participants sufficient to reach saturation. Among these are suggested two to ten participants in qualitative research whereas Creswell (2008) endorses ten people in a research study. Thus, it can be extrapolated that a sample should be large enough to allow data saturation. In addition, a sample has to be manageable for the researcher to analyse the research findings thoroughly. Considering this background, a sample of ten communal farmers, three AGRITEX officers, three EMA officers, and two focus groups of six members composed of community leaders and retired professionals were considered sufficient to reach data saturation for this study. The sample used in this study was diverse and less representative due to the limited funds and time (Creswell & Poth, 2018). However, this selection criterion did not compromise the validity of the results because a qualitative sample should reflect diversity rather than only being representative (Cohen et al., 2018). Thus, it is always a good idea to elicit multiple perspectives on a given research topic. I approached Matabeleland South regional EMA office. Three officers responsible for the Gwanda district volunteered to participate in the study before random sampling was done to select members for interviews. The two focus group discussions were chosen from the lists provided by the

councillors of each respective ward. The selected members were invited through telephone calls to participate in a focus group discussion. A convenient day for the focus group discussion was chosen after the consultation of all concerned members.

3.6 Research tools and data generation

According to Creswell (2014), qualitative techniques for eliciting data from sources include observation, interviewing, collecting, or gaining access to documents, artifacts, or environments rather than relying on a single data source. In this study, the qualitative research tools used for data collection included semi-structured interviews, focus group discussions, and document analysis. Each of these tools is discussed below.

3.6.1 Semi-structured interviews

The interview constitutes a social situation between two people; the psychological process involved requiring both individuals to mutually respond though the social research purpose of the interview call for a varied response from the two parties concerned (Creswell, 2009; Mohajan, 2018). An interview is a two-way method that permits an exchange of ideas and information. According to Creswell and Poth (2018, p. 163) “An interview is considered to be a social interaction based on a conversation”. While Brinkmann and Kvale (2015, p. 4) state that an interview is where “knowledge is constructed in the interaction between the interviewer and the interviewee”. The qualitative research interview is further described as “attempts to understand the world from the subjects’ point of view, to unfold the meaning of the experience, to uncover their lived world” (Brinkmann & Kvale, 2015, p. 3). In this study, the interview was used to promote the exchange of information between the researcher and research participants on the successes and challenges of EE efforts in climate change mitigation and adaptation among the communities in Gwanda rural district. I was also keen to understand why certain strategies were successful and equally so why certain were not successful.

Semi-structured interviews (appendix one is a semi-structured interview guide) were used to gather data from the successes and challenges of EE efforts on climate change mitigation and adaptation amongst the communities in Gwanda rural district from communal farmers, AGRITEX, and EMA officers. I made notes to document the interviews. In semi-structured interviews, there is no strict adherence to preformulated questions since the order of the questions can be changed depending on the direction of the interview, and new questions can emerge during the conversation (Myers,

2009). I interviewed three AGRITEX, three EMA officers, and ten farmers on their successes of EE strategies for mitigation and adaptation to climate change in Gwanda rural district. The interview was also meant to gather data from all three categories of participants about climate change mitigation and adaptation challenges in Gwanda rural district. The research participants could not be met simultaneously or day; hence appointments were made well in advance.

3.6.2 Focus group discussions

Focus group discussion is a research tool that collects data through group interaction on a topic determined by the researcher (Creswell & Poth, 2018; Osuagwu, 2020). According to Denscombe (2007, p.115), a "focus group consists of a small group of people, usually between six and nine in number, who are brought together by a trained moderator (researcher) to explore attitudes and perceptions, feelings and ideas about a topic." Thus, a focus group discussion provides a setting for the relatively identical group to reflect on the questions asked by the interviewer.

A focus group discussion was used to gather information supplementing information gathered using interviews drawing from the most important points raised about the successes of particular strategies. This allowed the researcher to generate more data to know the strategies that work in this rural context. It can be drawn upon another rural area with similar contextual realities, such as the Gwanda rural district. I held a focus group because it enabled data gathering relatively quickly from many participants and provided a relatively natural everyday conversation while debating key issues. Two focus groups were conducted, and each had 6 participants; such small and manageable groups gave each participant enough time to discuss the EE efforts. I requested permission from the participants to record them and write notes during focus group discussions, and I was granted permission. Table 3.1 overleaf presents a summary of the characteristics of two focus group discussions for this study.

Table 3.1: The characteristics of two focus group discussions used in the study

Research participants	Site	Number of the participants	Group composition
Focus Group Discussions 1	Ward 12	6	Community leaders and retired professionals.
Focus Group Discussions 2	Ward 16	6	Community leaders and retired professionals.

Source: own

3.6.3 Document analysis

Document analysis was an additional data collection tool to corroborate information gathered from interviews and focus group discussions. Myers (2009, p. 154) states that a document is "any symbolic representation that can be recorded or retrieved for analysis." The document contents for qualitative research are in the form of words, sentences, and phrases that can be classified and compared (Creswell & Poth, 2018; Alasuutari et al., 2009; Osuagwu, 2020). According to Alasuutari et al. (2009), document analysis involves selecting both textual and visual documents and analyzing the contents. This implies that document analysis is a form of qualitative research in which the researcher interprets documents to deduce meaning around an assessment topic (Owen, 2014).

According to Myers (2009), documents are classified into three main categories: personal documents, private documents, and public documents. The confidential documents include individuals' letters, diaries, notes, drafts, files and books. Private institutions produce personal documents for internal use, such as minutes of meetings, personnel records, budgets, and memos. Public documents are produced for public consumption, such as annual reports, media statements, or articles in newspapers. According to Owen (2014, p. 15), documents may "corroborate interview data, or they may refuse them, in which case the researcher is 'armed' with evidence that can be used to clarify, or perhaps, to challenge what is being told." Thus, these documents allowed a researcher to build a clear picture of a given phenomenon that corroborates or refutes interview data (Myers, 2009).

In this study, two categories of documents were analyzed, namely personal and public documents. I analyzed the confidential documents of AGRITEX officers and public documents for EMA. Personal documents that were analyzed include files and notes for AGRITEX officers from wards 12 and 16. As for the public documents, the researcher analyzed the latest three published annual reports of EMA- 2014, 2015, and 2016 annual reports. The procedure of analysis entailed "finding, selecting, appraising (making sense of), and synthesizing data contained in documents" (Bowen, 2009, p. 23). Files and notes analysed depicted that AGRITEX programmes and activities are mainly based on climate change adaptation. At the same time, annual reports for EMA expressed that the organisation is primarily concerned with climate change mitigation. According to Bowen (2009), document analysis helps the researcher deduce meaning, develop understanding and discover insights relevant to the research problem. Thus, the documents that were analysed helped the researcher to identify climate change mitigation and adaptation strategies. Relevant insights to EE in climate change mitigation were also discovered. Thus, as a means of triangulation in this study, document analysis was used together with data analysis from semi-structured interviews and focus group discussions.

Table 3.2 overleaf illustrates how each of the research questions was addressed using a grid with each column showing the critical question, reasons for data collection, research strategy used in addressing the question, data source, number of participants, and site of data collection.

Table 3.2: Research imperatives and strategies used in the study

CRITICAL QUESTIONS	REASON FOR DATA BEING COLLECTED	RESEARCH STRATEGY (Instrument)	DATA SOURCE	NUMBER OF SOURCES	SITE OF DATA SOURCE
1. What are the successful strategies for mitigation and adaptation to climate change in Gwanda rural district and why are they successful so they can be utilized in EE programmes?	-To identify the successful strategies for mitigation and adaptation to climate change in Gwanda rural district and why they are successful so they can be utilized in EE programmes.	-Semi-structured interview	-AGRITEX officers -EMA officers -Communal farmers	-Three AGRITEX officers and EMA officers -Ten communal farmers	-Ward 12 and 16 -EMA and AGRITEX offices
		-Focus group discussion	-Community leaders and retired professionals	-6 from ward 12 -6 from ward 16	-Ward 12 and 16
		-Document analysis	-Annual EMA reports (2014, 2015 & 2015) - AGRITEX documents	- 3 EMA's annual reports - 1 file and one notebook	-EMA and AGRITEX offices
2. What are the climate change mitigation and adaptation challenges in the study area, and how can EE programmes overcome these challenges?	-To explore the challenges to climate change mitigation and adaptation in study area and to explore how EE programmes can overcome these challenges.	-Semi-structured interview	-AGRITEX officers -EMA officers -Communal farmers	-Three AGRITEX officers and EMA officers -Ten communal farmers	-Ward 12 and 16 -EMA offices -AGRITEX offices
		-Focus group discussion	-Community leaders and retired professionals	-6 from ward 12 -6 from ward 16	-Ward 12 and 16
		-Document analysis	-Annual EMA reports (2014, 2015 & 2015) - AGRITEX documents	- 3 EMA's annual reports - 1 file and one notebook	-EMA and AGRITEX offices
3. What is the role of EE dissemination in mitigation and adaptation to climate change in the study area?	-To examine the role of EE dissemination in mitigation and adaptation to climate change in study area.	-Semi-structured interview	-AGRITEX officers -EMA officers -Communal farmers -EMA and AGRITEX	-Three AGRITEX officers -Three EMA officers -Ten communal	-Ward 12 and 16 -EMA offices -AGRITEX offices
		-Focus group discussion	-Community leaders and retired professionals	-6 from ward 12 -6 from ward 16	-Ward 12 and 16
		-Document analysis	-Annual EMA reports (2014, 2015 & 2015) - AGRITEX documents	- 3 EMA's annual reports - 1 file and one notebook	-EMA and AGRITEX offices

Table 3.2: Research imperatives and strategies used in the study (Adapted from Manik, 2005, p. 64)

3.7 Validity

In this study, internal and external validity were used. The study was informed by Anney (2015, p. 276), who quoted the assertion made by Guba and Lincoln (1994) that “internal validity should be replaced by that of credibility, external validity by transferability...”. Thus, the research process employed in this study ensured that both credibility and transferability were achieved. Anney (2015, p. 276) quoted the suggestion made by Guba and Lincoln (1982) that "internal validity should be replaced by that of credibility, external validity by transferability, reliability by dependability and objectivity by confirmability." According to Anney (2015, p. 276), internal validity can be achieved by implementing the following credibility criteria: "prolonged and varied field experience, time sampling, reflexivity (field journal), triangulation, member checking, peer examination, interview technique, establishing authority of researcher and structural coherence." As a result, I used the suggested credibility criteria to ensure internal validity and triangulation was the primary credibility criterion in this current study. On the other hand, external validity (transferability) is achieved when the data is generated. The conclusion of research findings can also be relevant in other research studies (Hussein, 2009; Onwegbuzie et al., 2009). The conclusion of my research findings is relevant to other research studies, indicating that external validity was achieved in this study. According to Anney (2015, p. 278), two strategies can be employed to achieve transferability, which include providing “thick” descriptions and doing "theoretical of purposive sampling." I provided ‘thick description’ of the successes and challenges of EE efforts in climate change mitigation and adaptation among the communities of Gwanda rural district in Zimbabwe.

According to Struwig and Stead (2001, p. 136), “validity is the extent to which a research design is scientifically sound or appropriately conducted.” McCaig (2010) affirms that validity is also “concerned with the integrity of the conclusions that are generated from a piece of research” As such, it was important for this study to have validity measures so that conclusions drawn from the research findings can be of high integrity. Reinharz (1992, p. 240) avers that "validity is the consistency of a measure with some outside criterion or standard by which to judge the test." Therefore, validity also entails establishing whether an investigation accurately measures what it purports to study to a more significant extent. According to Creswell and Miller cited by Creswell (2014, p. 201), "validity is one of the strengths of qualitative research and is based on determining whether the findings are accurate from the standpoint of the researcher, the participant or the

readers of an account." The term that refers to validity in qualitative research is trustworthiness. One way to check the validity/trustworthiness of research findings is to employ triangulation, using two different methods to get at the same research question and looking for convergence in research findings (Creswell & Clarke, 2011).

The credibility of the research study was ensured by being fully immersed in the study over three years. As such, I gained better insight into the context of the study while building a sense of trust with research participants. Triangulation was used as a recursive check for the validity of the researcher's interpretations since qualitative research relies primarily on the informants' formulations and constructions of reality (Creswell, 2013). I used triangulation on different data sources of qualitative data, namely interviews, focus group discussion, and documents used to generate data for EE efforts in climate change mitigation and adaptation in Gwanda rural district. This helped to examine evidence from the sources and I also used it to build a coherent justification for themes. According to Creswell (2018), if themes are established based on converging several sources of data or perspectives from participants, this process will add to the study's validity. The qualitative data from the interviews, focus group discussions, and document analysis was used to ensure validity, and the data were analysed using inductive content analysis techniques. Thus, triangulation reduces the threats to validity.

To ensure that transferability was achieved in this study, I clarified the research processes employed from data generation, analysis and presentation. Extensive insight into the research processes will help other researchers understand how the conclusion of findings is valid and replicate the results in similar settings. Thus, I ensured that this research is extensively done to provide rich information and achieve 'thick' descriptions. Thus, transferability was achieved because the research methodology was explained in detail, research findings were discussed in detail and conclusions were derived from the research findings.

3.8 Reliability

The study was informed by Anney (2015, p. 276), who quoted the assertion made by Guba and Lincoln (1994) that reliability should be replaced by "dependability and objectivity by confirmability." Similarly, reliability is also defined by Joppe (2000, p. 1) as "the extent to which results are consistent over time, and an accurate representation of the total population under study is referred to as reliability and if the results of a study can be reproduced under a similar method, then the research instrument is considered to be reliable." This dependability of the research is

achieved through a “multiple set of mental and social, context-specific constructions.” (Wiersma 2000, p.198). Furthermore, Palys (1997, p. 4) upholds that reliability implies that, “repeated observations of the same phenomena should yield similar results, and different observers following the same [research methodology] or procedures should arrive at the same conclusions.” Kurebwa (2013, p. 188) concurs that reliability is, “the extent to which independent administrations of the same instrument yield the same results under comparable conditions and it is synonymous with dependability, stability, consistency, predictability, and generalisability.”

According to Yin (2003), qualitative researchers need to document their case studies' procedures and techniques employed during the research. I have produced a detailed report of the study about the role of climate change mitigation and adaptation in Gwanda rural district. He also recommends setting up a detailed case study protocol and database. I used reliability procedures, which included checking the transcripts to make sure that they do not contain apparent mistakes made during transcription and making sure that there is no drift in the definition of codes or a shift in the meaning of the codes during the process of coding. The latter procedure was accomplished by constantly comparing data with the codes and writing memos and their definitions. Grosseohme (2014) stated that reliability in qualitative research is achieved through consistency. Thus, I was consistent in the use of content analysis when analyzing data. To achieve reliability, the researcher referenced all the quantitative data. According to Creswell and Poth (2018), the research study's scope and analysis should be comprehensive, and the quantitative aspects should be referenced where possible. Using various data sources, appropriate sources of data, referencing qualitative data, and consistency in using content analysis helped the researcher ensure both validity and reliability of the research findings.

3.9 Ethical considerations

To comply with the principles of conducting research, ethical considerations were implemented in this study. Silverman (2010, p. 434) defines ethics as the "guidelines or principles relating to good professional practice." Ethical considerations address individual rights to dignity, privacy, confidentiality, and harm avoidance. In addition, Creswell and Poth (2018, p. 53) argue that researchers should have a plan to address any foreseeable ethical challenges because, in most cases, there is a "common misconception [that] these issues only surface during data collection." Thus, ethics in research is all about the respect of human rights. This means that the rights and culture of research participants were respected. I ought to give a great deal of attention to measures of ethical

considerations. Steps were taken to ensure respect, dignity, and freedom of each participant. The practical ethical concerns included permission to study, voluntary participation, informed consent, confidentiality, and anonymity.

3.9.1 Permission to study

An important ethical consideration for this study was permission to undertake research which was granted by the university and the responsible authorities where the study was conducted. Kombo and Tromp (2006, p. 98) contend that “a researcher requires a research permit before embarking on a study.” The researcher ensured that the “aims of the research and what is expected of the potential participants were communicated to them” (Marshall & Rossman, 2011, p. 47-48). Creswell and Poth (2018, p.54) state that “Prior to conducting a study, it is necessary to gather college or university approval from the institutional review board for the study.” Thus, the researcher had Ethics Clearance (HSSREC/00000790/2019) from the University of KwaZulu-Natal in South Africa to carry out the study.

The researcher sought permission to carry out the study from the responsible authorities before engaging the participants. I was granted permission from Gwanda rural district, AGRITEX, and EMA offices before generating data in the district. The researcher was also permitted to take pictures as long as they did not lead to the identification of the research participants. After obtaining permission to study, the researcher ensured that the informed consent letters were printed and issued to the research participants. The informed consent is discussed in detail in the following section.

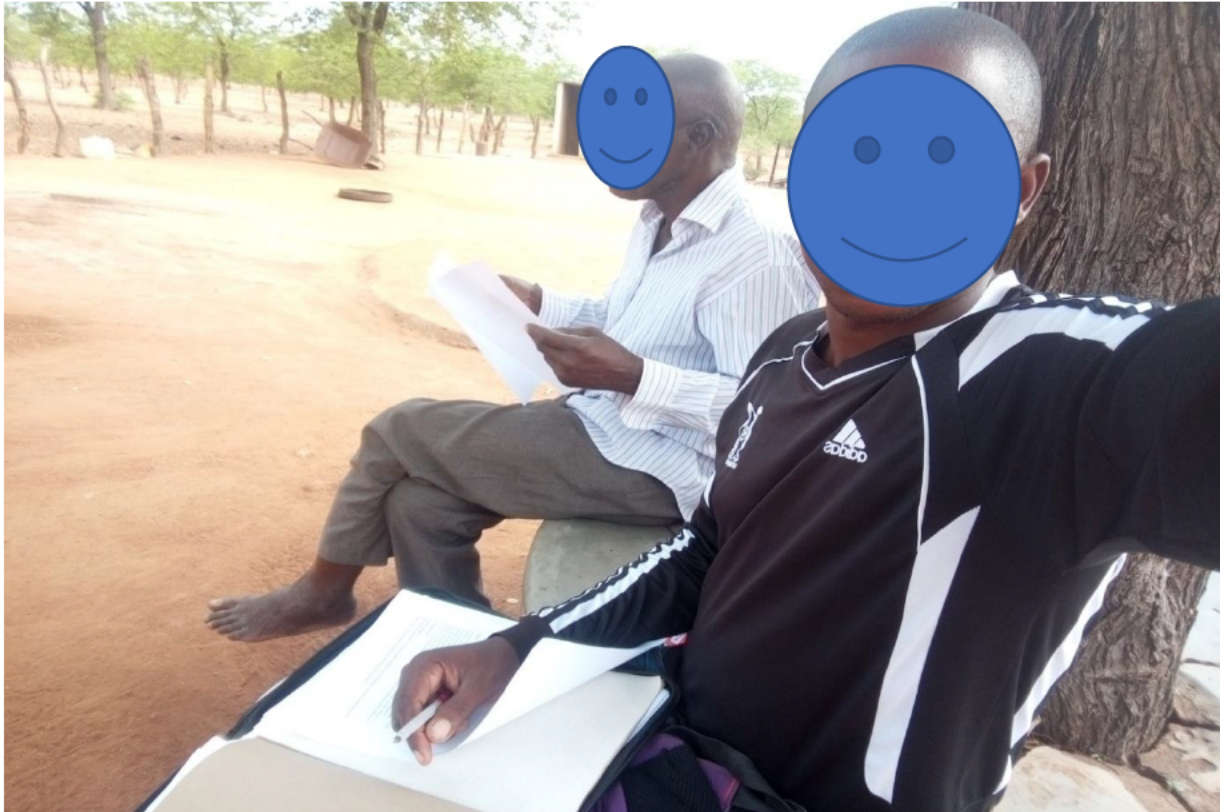
3.9.2 Informed consent

During the data generation process, informed consent was obtained to ensure that research ethics were followed. Informed consent help people to understand what it means to participate in a particular research study so they can decide whether they want to participate or not. Similarly, Hussein (2009) says that research should be based as much as possible on freely given information on what potential participants need to understand before they consent to take part. The researcher gave necessary and relevant information to all participants about the research process for them to be able to make informed consent. The researcher ensured that participants in the focus group discussions and semi-structured interviews were aware of the implications of their participation in the study on the role of EE in climate change mitigation and adaptation.

According to Sarantakos (2005), the consent form has the following elements: identification of the researcher, identification of the sponsoring institution, an indication of how the participants were selected, identification of the purpose of the research, identification of the benefits for participating, identification of the level and type of participant involvement. It also involves establishing the notation of risks to the participant, a guarantee of confidentiality, assurance that the participant can withdraw at any time and provision of names of persons to contact if questions arise. I used consent forms containing the researcher's description of the study, the reasons for carrying out the study, and what will be done with the findings. The subject's signature on the form will be taken as evidence of informed consent (Creswell & Poth, 2017).

O'Leary (2014, p. 53) argues, "participants can only give informed consent if they have a full understanding of their requested involvement in a research project, including the time commitment, type of activity, topics that will be covered, and all physical and emotional risks potentially involved." The researcher gave research participants a detailed informed consent form that elaborated on the purpose of the study. It was written in Sesotho, the mother language for the farmers. According to Helsinki (2009), consent needs to be written because behaviour or oral consent could be misinterpreted as consent when it is not. Thus, all participants invited to participate were informed extensively about the study. Those who consented completed and signed the informed consent forms after the researcher clarified the research process. The image overleaf illustrates the researcher with the farmer completing the informed consent letter. The informed consent form is attached at the end of the thesis as appendix three.

Image 3.1: The researcher with the farmer completing the informed consent letter before the interview



3.9.3 Voluntary participation

It has been asserted by Borg and Gall (1989, p. 411), "participation in all research should be voluntary and there should be no compulsion or dishonesty." Thus, people must be free to decide whether to participate in a study and ethics scholars aver that they should be told that they have the right to withdraw from participating at any stage or time of the research (Borg & Gall, 2009; Creswell & Poth, 2017, Cohen & Manion, 2000). It was clearly stated on the informed consent letters that participation in the study was voluntary, and all participants were told that they could freely withdraw at any time.

The researcher also ensured that all participants freely participated in this study without coercion or deception. According to Strydom in De Vos et al. (2011, p. 66-67), deception involves "withholding information or offering incorrect information to ensure participation of subjects who otherwise might have refused." The researcher clearly stated on the consent forms that the study aimed to explore the successes and challenges of EE efforts in climate change mitigation and

adaptation among the communities of Gwanda District, Zimbabwe. Thus, the researcher elucidated the aim of the study to all the participants, and the data generation was done ethically by not withholding any information. Furthermore, the researcher ensured confidentiality, which is elaborated in the following section.

3.9.4 Confidentiality

According to Fleming and Zegwaard (2018, p. 211), “Participant confidentiality means the participant’s identity are known to the researcher, but the data was de-identified and the identity is kept confidential”. Similarly, O’Leary (2004, p. 54) states that “confidentiality involves protecting the identity of those providing data.” The researcher used pseudonyms to protect the identities of the research participants. Thus, anonymity was employed to achieve confidentiality so as not to embarrass or harm participants. The consent form also guaranteed the confidentiality of the research participants in the study. O’Leary (2004, p. 54) elaborates, “protection of confidentiality may involve secure storage of data; restricting access to raw data; obtaining permission for subsequent use of data; publication of research findings in a manner that does not allow for ready identification of subjects; and eventual destruction of raw data.” Thus, confidentiality involves ensuring security to the information provided by the research participants. The consent forms stipulated that all data for the research would be stored securely at the University of KwaZulu-Natal in the Social Sciences archives of the School of Education for five years, and after that destroyed by shredding of papers and deleting electronic data.

3.10 Method of Data analysis

Data analysis is the sorting of responses given and ordering or categorizing the collected data considering the design and techniques employed in the research (Creswell, 2014; Cohen et al., 2011). Kothari (2005, p.122) states that data analysis entails "editing, coding, classification, and tabulation of collected data so that they are amenable to analysis and interpretation." Kumar (2011, p. 202) concur that "data analysis involves analyzing the contents of interviews or observational field notes in order to identify the main themes that emerge from the responses given by the participants, or the observation notes made by the researcher.” The qualitative data from the interviews, focus group discussions, and document analysis was analysed using the inductive content analysis technique (Cohen et al., 2005; Yin, 2009). Inductive content analysis is a qualitative method of content analysis used by researchers to develop theory and identify themes by studying documents, recordings and other printed and verbal material (Silverman, 2010).

Themes were derived during data analysis. According to Bradley et al. (2007, p. 1766), "Themes are general propositions that emerge from diverse and detail-rich experiences of participants and provide recurrent and unifying ideas regarding the subject of inquiry." The inductive content analysis relies on inductive reasoning, in which themes emerge from the raw data through repeated examination and comparison. Using inductive analysis, I analysed qualitative data from interviews, document analysis, and focus group discussions through coding for conceptual themes, topics, and subtopics (Berg, 2011).

The qualitative data from key informant interviews and focus group discussions were analyzed through coding (putting data into thematic areas), and this started during the data collection phase, as expressed by Sarantakos (2013). The semi-structured interviews and group discussions with communal farmers (from wards 12 and 16) were conducted in the Sesotho language. It was their preferred home language. Semi-structured interviews with the EMA officers and AGRITEX officers used the English language. Thus, the researcher invested considerable time in translating the focus group discussions and semi-structured interviews into English. The coding and categorisation of data in this study were also informed by the specific way I intended to use the data. The sub-research questions guided the process of inferring meaning from the data. Thus, the initial stage of analysis was inferential. As I read the data and specific themes emerged. All inferential codes were marked in black and blue in all transcripts. Instances of these codes were grouped on separate sheets of paper.

Creswell (2008) advises that when similar codes are aggregated, they form a central idea in the database. The transcripts were kept safe to continue referring to them for context. Creswell and Poth (2017) argue that every instance of verbatim speech in an interview has a context in which it is said, and it must be recorded so that it is not to be lost. In this study, the researcher utilized the transcript-based analysis for data generated during focus group discussions. This approach entails a researcher listening to the recording of the focus group discussion and creating a shortened transcript (Creswell, 2008). Thus, I recorded the two focus group discussions held in this study, and the recording was played several times for thematic analysis.

In this study, the researcher also searched for recurring patterns from data informed by the legitimization process. Creswell and Poth (2018) state that if the bank of qualitative data is not analysed through well-formulated methods, few guidelines will protect the researcher against self-delusion and the presentation of unreliable, invalid results and conclusions. Patterns of recurrence

emerged as data was re-read. I used numbers to mark recurring patterns, and instances of the same issues being mentioned were collated and grouped. It was in those groups that the minor themes emerged.

The final stage of data analysis involved the abstraction of minor themes to major or conceptual themes. According to Braun and Clarke (2006), abstraction amounts to deducing what the specific minor themes mean concerning the phenomena that are being studied. Creswell (2008) contends that it is a categorisation process in which minor themes are subsumed into more abstract concepts. The researcher used thematic analysis, which entails a 'widely-used qualitative analytic method' (Braun & Clarke, 2006, p. 4). According to Braun and Clarke (2006, p. 6), thematic analysis is a method of 'identifying, analysing and reporting patterns (themes) within data.' In addition, the researcher was guided by six critical stages for thematic analysis as suggested by Neuman (2000, p. 123): which are to 'read and annotate transcripts, identify themes, developing a coding scheme and coding the data.' The themes derived from this study relate to the successes and challenges of EE efforts in climate change mitigation and adaptation among the communities in wards 12 and 16 of Gwanda district. The theoretical framework presented in chapter two was used during data analysis to construct concepts for theory building which are presented in chapter four, section 4.9.

3.11 Presentation of Results

The findings for each of the critical questions were presented in response to each research question, stated at the beginning of chapter 3. The main themes that emerged are reported in explaining the key findings, and appropriate verbatim quotes have been used as evidence to support the conclusions. Table 3.3 overleaf illustrates the main headings of findings for each critical question.

Table 3.3: Critical Questions and Themes

CRITICAL QUESTIONS	THEMES
<p>1. WHAT SUCCESSFUL STRATEGIES FOR MITIGATION AND ADAPTATION TO CLIMATE CHANGE IN GWANDA RURAL DISTRICT CAN BE UTILIZED IN EE PROGRAMMES?</p>	<p>Strategies for climate change adaptation</p> <ul style="list-style-type: none"> • dry planting of crops • establishment of nutritional gardens • Growing indigenous crops (small grain crops) • keeping indigenous breeds of livestock • supplementary feeding schemes of livestock • Transhumance • diversification of economic activities • harvesting of wild fruits
<p>2. WHAT CHALLENGES ARE CLIMATE CHANGE MITIGATION AND ADAPTATION CHALLENGES IN STUDY AREA AND HOW CAN EE PROGRAMMES OVERCOME THESE CHALLENGES?</p>	<p>Mitigation strategies to climate change</p> <ul style="list-style-type: none"> • woodland management Project • Indigenous Knowledge System • Renewable energy sources (electricity and solar energy) • Growing fodder plants • Energy-saving cook stoves.
<p>3. WHAT IS THE ROLE OF EE IN MITIGATION AND ADAPTATION TO CLIMATE CHANGE IN THE STUDY AREA?</p>	<p>People’s perceptions of EE in mitigation and adaptation to climate change</p> <ul style="list-style-type: none"> • Creating awareness at the community level enables individuals and communities to respond appropriately to climate change's observable impacts. • Providing knowledge of the causes and effects of climate change. • Equipping people with the knowledge of mitigation and adaptation practices that contributes to community resilience and sustainable practices. • Promoting the understanding of factors that influence various responses to climate change and EE can enable individuals <p>EE programmes and efforts in the community</p> <ul style="list-style-type: none"> • field days • Information and skills sharing amongst neighbours • AGRITEX’S periodic reports on successful drought mitigation strategies • skills sharing on community gardens

3.12 Limitations of the study

I encountered challenges organizing the research participants, especially for the focus group discussions and visiting other areas in Gwanda rural district, Zimbabwe. This challenge was addressed by interviewing the research participants to avoid disturbing their usual farming activities during their spare time.

Limited financial resources also constrained this study at the researcher's disposal since all the costs of travel, accommodation and the researcher's financial resources met generating data costs. Thus, due to limited funds, the sample size chosen was small but manageable. However, I overcame this limitation by mining deep in gathering data from a small sample as supported by O'Leary (2014, p. 186), who states, "the core principle of qualitative research is not representativeness but rich understanding that may come from the few rather than the many. Such studies are reliant on the ability of the researcher to argue the 'relativeness' of any sample (even a single case) to a broader context." In addition, the study results are particular to Gwanda and cannot be extrapolated to another district because it is a small-scale qualitative study. Thus, the results are not representative of all rural communities in Zimbabwe.

3.13 Conclusion

This chapter began with the explanation and justification of using a qualitative research approach regarding the critical questions. The aim and objectives of the research were stated, together with the critical research questions that guided the study. It was highlighted that community members were sampled using convenience sampling. It has also been noted that the participating AGRITEX and EMA officers were identified using purposive sampling to get people who are knowledgeable about or experienced with the phenomenon of interest for the study, namely EE amongst communal farmers. Research methods and research tools used in the data generation exercise were explained. Lastly, issues of ethics, validity, reliability, and limitations of the study were discussed. Chapter Four, which follows next, presents the study's findings and a discussion of the main findings linking it to relevant literature.

CHAPTER FOUR

FINDINGS AND DISCUSSION

4.1 Introduction

The previous chapter explained the research design and methodology, the blueprint used by the study to generate, present and analyse the data to answer the research questions. This chapter presents research data generated from the case study of Ward 12 and 16 of Gwanda rural district council of Matabeleland South, a province of Zimbabwe. The chapter also presents a discussion of the main findings linking them to relevant literature. The chapter also explains key concepts constructed from the research findings for theory building. Twenty-eight participants, composed of three AGRITEX officers, three EMA officers, and twenty-two communal farmers from the two case study wards, were the primary data sources. They were subjected to in-depth semi-structured interviews and focus group discussions answering the study's main research question and sub-questions. The participants were given pseudonyms to protect their identities and promote confidentiality of generated data as an ethical consideration procedure. Secondary and complementary data was also collected from an analysis of official documents, the EMA and AGRITEX report.

The focus of the study was to explore the role of EE in climate change mitigation and adaptation in the Gwanda rural district of Matabeleland South, province of Zimbabwe. Data presentation and analysis were done thematically, and assertions were corroborated by verbatim transcriptions gleaned from semi-structured interviews and focus group discussions. Research data were classified into major recurring themes that constituted the findings of the study. Identified themes were:

- Sources of EE in Gwanda and EE programmes
- Profiles of research participants
- Climate change adaptation strategies
- Climate change mitigation strategies
- People's perceptions of EE in mitigation and adaptation to climate change
- EE programmes and efforts in the community
- Challenges encountered in the implementation of programmes that seek to mitigate and adapt to climate change

- Recommendations for best practices in mitigation and adaptation to climate change in Gwanda rural district

The research data generated was earmarked to answer the critical questions outlined in Chapter 1. The data analysis process was preceded by the transcription of recorded interviews followed by coding common phrases that emerged from each respondent's responses. The outcome of data coding led to data organization whereby recurring and emerging themes were identified and used as discussion frames (as identified above) to present participants' voices, perceptions, and experiences in various mitigation and adaptation programmes towards climate change. The chapter begins with a presentation of the characteristics of residents in wards 12 and 16. It also presents the profiles of research participants, which are structured to show their biographical details, professional qualifications, work experiences, and encounters with climate change mitigation and adaptation strategies. Most importantly, the chapter presents the experiences and perceptions of participants concerning EE as a mitigation strategy for alleviating the impact of climatic change.

4.2 Sources of EE in Gwanda and EE programs

The key sources of EE identified in the district are AGRITEX officers, NGOs, and farmers' traditions and cultures. The research findings revealed that farmers in the district have access to EE from different sources. It was also revealed that these different sources sometimes contradict each other. For example, indigenous beliefs contradict the EE which comes from agricultural extension officers. The conflicting ideas between scientific knowledge and indigenous knowledge systems at times inhibits climate change mitigation and adaptation, as explained in the following sections. Effective climate change mitigation and adaptation requires extensive EE programmes to enhance the resilience of communities against the adverse impacts of climate change. It was also revealed that agricultural extension officers in the district are incapacitated, limiting the implementation of environmental programmes for climate change mitigation and adaptation. These factors are elaborated upon below.

4.3 Demographic characteristics

The research findings from document analysis of the Zimbabwe National Statistics Agency (ZIMSTAT) inter demographic census, August 2017, are presented in table 4.1 below.

Table 4.1: The households characteristics of wards 12 and 16, Gwanda district.

WARDS	12	16
Males	2308	2461
Females	2788	3010
Total	5096	5471
% ratio	45.3 & 54.7	45 & 55
Sex ratio	82.8	81.8
The average size of hh	4.4	4.6
Total households	1152	1192

The data from the ZIMSTAT inter demographic census (2017) shows that the population is dominated by females. The situation is further exacerbated by internal and international migration, where men leave women to manage the farms with the burden of mitigating and adapting to climate change whilst they seek employment to supplement the household income. The household size (size of hh) refers to the number of people per household. The sex ratios presented above show a shortage of labour as men are few in the district, and women are overwhelmed with the double burden of child care responsibilities and farming activities.

Profiles of Research Participants

This section presents the demographical profiles of each of the research participants from the semi-structured interviews. It focuses on group discussions in Ward 12 and 16 of Gwanda rural district council in providing primary data to answer the study research questions. The demographical profiles of the interviewed research participants are presented in Table 4.2, below.

Table 4.2 Profiles of Research Participants

Research participants	Codes	Sex	Professional qualifications	Work experience in climate change programmes
EMA officer	E1	F	Degree	15 years
EMA officer	E2	F	Degree	20 years
EMA officer	E3	M	Masters	9 years
AGRITEX officer	A1	M	Certificate	10 years
AGRITEX officer	A2	M	Diploma	22 years
AGRITEX officer	A3	M	Diploma	26 years
Farmer	F1	F	O level	13 years
Farmer	F2	M	Diploma	15 years
Farmer	F3	F	Primary education	25 years
Farmer	F4	F	Degree	5 years
Farmer	F5	M	Secondary education	19 years
Farmer	F6	F	Secondary education	23 years
Farmer	F7	F	Primary education	24 years
Farmer	F8	M	Diploma	16 years
Farmer	F9	F	Primary education	26 years
Farmer	F10	F	Zimbabwe Junior Certificate (ZJC)	23 years

The above table reflects that more females compared to males were sampled for the study. Qualifications, experience as AGRITEX and EMA officers, and working experience in climate change mitigation and adaptation varied. Participants' qualifications for EMA and AGRITEX officers mirror competency, experience in dealing with climate change and mitigating programmes. In terms of qualifications for AGRITEX and EMA officers, there was a range from National Certificate in Agriculture/Geography to Master's Degree. The qualifications for farmers ranged from basic Primary education to a Bachelor's Degree. This shows that some of the farmers had a background in EE. The lowest qualification for farmers was a primary education, which is enough to equip an individual with three fundamental skills: reading, writing, and arithmetic. Literacy is significant in mitigating and adapting to climate change as it enables farmers to access EE (Brown et al., 2019). Experience in farming ranged from 3-26 years, implying that participants

were familiar with climate change mitigation and adaptation programmes and not new to farming. Regarding the age variable, it showed that research participants' age ranged from 28 years to 52 years of age, which constituted a mix of novice and highly experienced participants.

From the presented data, another variable that emerges pertains to the dominance of females over males. Thus, females constituted a more significant proportion of the participants as males migrated from rural to urban areas to secure employment. Men also migrate to neighbouring countries such as South Africa and Botswana in search of employment. Ndlovu et al. (2020) and Dube et al. (2018) confirmed this trend in other studies. The issue of a striking gender imbalance in wards 12 and 16 mirrors the inactive participation of men in climate change mitigation and adaptation programmes in rural communities of Gwanda rural district. This means that women had more exposure to mitigation and adaptation than men, given that women dominated the rural landscape in Gwanda farming areas. The results were comparatively similar to the research undertaken by Ndlovu et al. (2020) and Phiri et al. (2019), who found that the majority of men from the Gwanda district live in the diaspora, which makes it difficult for nuclear families to embark on collective /shared climate action due to the limited workforce and time of women who are split between child-bearing and farming duties.

4.4 Strategies for climate change adaptation

The first theme sought to solicit participants' experiences and praxis in organising and implementing adaptation strategies towards climatic change. A summary of the adaptation strategies is given below:

- Dry planting of crops
- Establishment of nutritional gardens
- Growing indigenous crops (small grain crops)
- Keeping indigenous breeds of livestock
- Supplementary feeding schemes of livestock
- Transhumance
- Diversification of economic activities

- Harvesting of wild fruits

4.4.1 Dry planting of crops

This section presents verbatim quotes of the successes and challenges in dry planting. It also presents a discussion and analysis of the research findings on the successes and challenges of dry planting.

The research participants revealed that dry planting is an effective and common strategy in the district. Dry planting refers to sowing seeds when the soil has insufficient moisture to trigger germination. The following verbatim quotes reveal the arguments for dry planting:

Kgomu E1: 'oh Yes, my Department runs several climate change adaptation programmes in the ward, and communities are taught many strategies such as practising dry planting.'

Tulo E2: "dry planting allows seeds to germinate during the first rains of summer and the chances for germination are very high. However, few farmers practice it, and those few stand a better chance of achieving better yields."

Mare A3: "the growing season is now shorter due to climate change, and farmers are strongly encouraged to sow the crop before the onset of summer so that when the rains start, seeds are already in the soil to begin the process of germination."

Nare F7: "One of the advantages of dry planting is that the chances of seeds germinating are higher compared to planting after the onset of the wet season."

Research findings from EMA officer's file (Mare A3's file): "farmers who practice dry planting generally achieve better yields than those who do sowing after the onset of the rain season."

It is evident from the articulations of research participants and documents analysis that dry planting is considered one of the most critical climate change adaptation strategies in the district. It was also revealed that dry planting has the highest percentage of seed germination. The research study identified dry planting as one of the successful strategies, as it allows seeds to germinate during the first rains of summer. However, only 10% of the study's participants said they practice dry planting. According to the statistics, dry planting is less commonly used in the district, despite the fact that the few participants who used it said it was a successful climate change adaptation strategy. The research findings on the presence of farmers who have resorted to dry planting as an

adaptation strategy in drought-prone regions were comparatively similar to the research undertaken by Ncube et al. (2016) and Ndlovu et al. (2020).

Despite the benefits of dry planting as presented above, there are challenges associated with the implementation of dry planting. The research findings revealed that traditional beliefs constrain dry planting. Some farmers revealed that they do not do dry planting because it contradicts their traditional norms, which uphold that the first rains (*insewula*) are to be respected. Farmers are thus prohibited from cultivating the land due to their traditional customs. The following verbatim quotes reveal this:

Nare F7: 'We hear government officials are advising us to do dry planting, but as elders of the community, we are against that because it contradicts our customs. We are very much worried about people who are seen weeding immediately after the first rains.'

Mare A3: 'dry planting has proved to be fruitful to those farmers who practice it. However, there is a conflict between its implementation and traditional leaders who believe there should be no farming activities during the first rains.'

Moyo from FGD 1: 'dry planting before the onset of summer causes more labour on weeding. In most cases, farmers with the shortage of labour suffer from this practice as they fail to clear weeds well in time, consequently reducing crop productivity.'

Vundla F9: 'I don't practice dry planting because it promotes weeds, and sometimes when light showers are received, they can cause the rotting of seeds, and that will be a great loss since I hardly afford to buy treated seeds.'

It is evident from the articulations of the research participants that customary beliefs and particular views influence the choices which farmers make about when to plant. The verbatim quotes presented above confirm the challenges associated with dry planting in the Gwanda rural district. The research findings revealed that EE programmes are lagging in addressing all obstacles, limiting the extensive use of dry planting, preventing more farmers from achieving better results in wards 12 and 16 of Gwanda rural district. It was also revealed that some farmers do not prefer dry planting. They prefer to do land tillage after weeds have germinated in order to bury them. This saves labour because by the time seeds germinate, the weeds would have been destroyed, saving on weeding. Another challenge associated with dry planting is the limited amount of rainfall

received after the sowing of seeds. It can cause the seeds to rot, and most farmers in rural areas face challenges acquiring seeds; hence, they wait for the ideal rains to be received before sowing seeds. Similar observations have been made by Mbereko et al. (2018) from the studies carried out in other communities of Zimbabwe. They reported that some farmers are hesitant to do dry planting due to the rotting of seeds if little rain is received after sowing.

4.4.2 Establishment of nutritional gardens

The research findings revealed that villagers in wards 12 and 16 had established nutritional gardens and ventured into irrigation to ensure food security. The region is experiencing poor farming from rain-fed agriculture due to the adverse impact of climate change. In these gardens, people grow various crops and plants such as vegetables, beans, fodder, and eggplants. The gardens generally fall under two categories, namely individual owned and communal owned nutritional gardens. Image 4.1 overleaf illustrates an individually owned nutritional garden.

Image 4.1: Individually owned nutritional garden



An individually owned nutritional garden along Tuli River in ward 16.

The above image shows the researcher with the farmer who is the owner of the garden. The individually owned nutritional gardens are also common in homesteads, and the farmers use submersible pumps to irrigate their crops.

Image 4.2: The submersible pumps and storage tank



There are also community-owned nutritional gardens in the district. However, one of the community gardens in ward 16 is currently not functional because the solar panels were stolen. World Vision sponsors the community gardens, which help farmers grow vegetables and fruit to supplement poor harvests in the fields. In these gardens, people grow various crops and plants such as vegetables, beans, fodder, and eggplants. On average, the gardens have 30 members. Thus, the district has a shortfall of gardens because the majority of community members do not own individual gardens and are not members of World Vision's community gardens. An analysis of the AGRITEX reports revealed that there are generally three nutritional gardens per ward, translating to 90 community members per ward, while each ward has an average of 5000 people. For instance, according to ZIMSTAT inter demographic census, August 2017, the population of ward 12 was 5096 while ward 16 was 5471. This means that World Vision's nutritional gardens benefitted 1.7 percent of the total population in wards 12 and 16. As a result, the number of community members who benefit from World Vision-sponsored nutritional gardens is small.

Puo F4: “We are appealing to the government and donors to avail more nutritional gardens.”

Vundla F9: “We are very much grateful of the World Vision gardens, and now we can grow different types of crops: vegetables, beans, fodder, and eggplants in these gardens throughout the year.”

Dube from FGD 2: “The nutritional gardens are very significant in curbing hunger and starvation, which are common during drought periods.”

Ndlovu from FGD1: “Most people buy fertilizers and seeds from Gwanda and Bulawayo towns and we have a great challenge of accessing these key farming inputs due to frequent national lockdowns which are being implemented to curb the spread of COVID-19. Also, some people are failing to buy farming inputs because they have lost their jobs. The loss of jobs is caused by retrenchment associated with the decline of sales during national lockdowns that have been established by the government to curb the spread of COVID-19.”

The majority of farmers believe that nutritional gardens are one of the most effective adaptation strategies for climate change. The study revealed that nutritional gardens are essential for food security, nutritional supplementation, and income-earning. Villagers in wards 12 and 16 have established nutritional gardens and ventured into irrigation to ensure food security since the region is experiencing poor farming from rain-fed agriculture due to the adverse impacts of climate change. The research findings revealed that COVID-19 has led to the establishment of national lockdowns which negatively affect farmers because they fail to access farming inputs from local towns. Also, some community members have lost employment due national lockdown since the decline of sales has led to retrenchment of workers by some organisations. However, lack of access to farming inputs such as fertilisers is a blessing in disguise because current research has shown that chemical fertilisers that being promoted by Bill Gates are causing more harm than good (Phillips, 2021). Thus, despite the negative impacts of COVID -19, it is teaching Gwanda rural communities to depend on indigenous farming inputs such as manure since mobility has been restricted by the outbreak of COVID-19. Farmers are forced to use indigenous manure to improve soil fertility which is important since the findings of current study have revealed that African problems require African solutions.

4.4.3 Growing indigenous crops (small grain crops)

This section presents the findings of small grain crops as an adaptation strategy for climate change. The study established that some farmers have since shifted from growing maize to indigenous crops such as sorghum and millet, which are drought tolerant. The section also presents the role of EE in promoting the use of small grain crops. Some of the verbatim quotes about the use of the indigenous crops are presented below;

The majority of research participants from FGD 2 were in agreement with one of the group members, Dube who stated that “the growing small grain crops are less popular in the district despite being drought tolerant. Children, in general, prefer maize meals more than small grain meals. Some children say sorghum and millet are meant for hens, and they refuse to eat small grain meals.”

The AGRITEX officer report stated that “few farmers are growing small grain crops such as sorghum, and millet which is doing well in Gwanda district and other drought-prone regions.”

Document analysis reveals (EMA officer’s report): “the growing of maize in the district is just as good as gambling because the harvests are most likely to be bad while growing of small grains has guaranteed good yields.”

Kgomu from FGD 1: stated that “small grain crops are less dominant because most farmers prefer to grow maize since it is the nation’s staple crop.”

Moyo from FGD 2: ‘The growing of maize in our region is now a risk because of frequent droughts. Small grains such as millet and sorghum are doing well even during the worst years of low rainfall, and farmers who rear drought-tolerant animals such goats are also achieving a high output.’

The research findings revealed that few farmers had adopted the strategy of growing small grain crops. Matsa and Dzawanda (2019), have made similar observations from the study carried out in the western parts of Zimbabwe. They stated that few farmers are growing small grains crops even though the strategy has proved successful for those who practice it. Furthermore, in consensus with the research findings that some people in the Gwanda rural district prefer to grow maize to small grains, Mbereko et al. (2018, p. 8), from a study carried out in ward 11, Gwanda rural district had

similar findings. They reported that ‘some people still grow the long-season variety crops even though they have observed that in the past 10 years, the rainy season has been shorter with intra-season dry spells.’

However, research findings of small grains being less popular within Zimbabwean communities contradict Mawere and Mubaya (2015). They stated that growing small grain crops are dominant in drought-prone areas since the crops tolerate arid conditions. The current research findings revealed that external forces at the macro-level influence farmers to grow maize instead of small grains. For instance, some farmers are more biased toward growing maize simply because it is regarded as a staple food crop. However, maize has an increased vulnerability to climate change while small grain crops are resilient to harsh conditions. In addition, the research findings revealed that parents are forced to continue growing maize because children refuse to eat small grains meals claiming that they do not taste good. Matsa and Dzawanda (2019) made similar observations that small grain crops are less preferred over maize. Their study was carried in the Beitbridge district of Matabeleland South, a province in Zimbabwe. They stated that people prefer to eat maize meals to sorghum and millet meals despite health practitioners’ recommendation of small grain meals due to their nutritional value in comparison to maize.

4.4.4 Keeping indigenous breeds of livestock

This section presents the research findings regarding keeping indigenous breeds as an adaptation strategy to climate change. According to the research findings, the most common indigenous breeds in Gwanda district are Matabele goats, Tuli cattle breeds, and Nkoni cattle breeds. The study revealed that using indigenous breeds of livestock improves farmers' productivity in the district. Indigenous livestock breeds refer to domestic animals that traditionally belong to a particular region. The study revealed that indigenous breeds adapt to harsh conditions such as drought and extremely high temperatures. The research findings also revealed the importance of keeping indigenous livestock breeds.

Thabo from FGD 1: ‘farmers are adapting to frequent droughts by keeping indigenous breeds such as the Matabele goat to boost farming outputs.’

Tsibo from FGD 1: ‘Nguni breed is the common breed kept by farmers in the region due to its tolerance to arid conditions.’

Tlou A1: 'indigenous breeds can travel long distances to access water hence they are well suited to Gwanda District since some cattle in the district travel 7km to access water from Tuli river.'

Ndlovu F6: 'Its high time we specialize on keeping goats more than cattle, especially our indigenous breeds such as Matabele and veldt goats which are less vulnerable to climate change than the exotic goats'

Three research participants from FGD 1 were in agreement with the one of the group members, Ndlovu, who stated that “communities have noted some challenges concerning keeping exotic breeds. The Brahman, for example, if it is not properly fed or exposed to unfavourable conditions; it can take up to three years without giving a calf. Yet, the AGRITEX officers are equipping us with the knowledge to ensure our cattle give us a calf yearly.”

Data from document analysis (Tlou A1's file): “the use of indigenous breeds of animals helps farmers boost farming yields, and frequent droughts have forced people to keep the Nguni breed.”

These verbatim quotes and a quotation from the Chronicle about indigenous breeds show that the government agencies use the media to communicate EE programmes. Farmers are encouraged to adapt to climate change by keeping livestock breeds tolerant to drought conditions and traveling a long distance to access water. As such, the research findings reveal the need for communities to focus on small stocks such as goats as they are more tolerant to drought conditions than cattle. Most importantly, the small stock should be indigenous breeds such as the Matabele goat. The following image shows the Nguni breed photographed in Gwanda District during data generation. The breed thrives in harsh conditions, reducing farmers' vulnerability to the adverse impacts of drought. The breed can walk long distances to search for water along the Tuli River during the dry season. As such, subsistence farmers in the district and the province are strongly advised to keep indigenous breeds to adapt to the El Nino-induced drought, which has depleted grazing lands in Gwanda District.

Similarly, the Chronicle, a Zimbabwean newspaper, had an article on 13 June 2019, which encouraged people from Matabeleland to keep the indigenous breeds; the article's title reads; *Mat'land farmers advised to keep indigenous livestock breeds*. The Matabeleland South provincial livestock production and development officer, Mrs. Simangaliphi Ngwabi, reveals that indigenous breeds such as Tuli and Nkoni are “able to adapt and withstand the prevailing drought situation.”

Thus, the research findings were comparatively similar to the data reported by the media. In addition, the negative impact of the El Nino-induced drought on pastures in Gwanda District has been confirmed by the local newspaper, Chronicle (13 June 2019). The image overleaf illustrates the Nguni cattle, one of the indigenous breeds in the district and capable of surviving under harsh conditions.

Image 4.3: The Nguni cattle



The Nguni cattle are exceptionally well adapted to hot and dry areas, and they are also capable of surviving on poor-quality pastures.

Furthermore, another image extracted from the Chronicle Newspaper, 13 June 2013, illustrated an indigenous breed, the Tuli breed, ideal for the harsh climatic conditions of Matabeleland south province. The image is illustrated overleaf.

Image 4.4: Tuli breed



Source: Chronicle: 13 JUN, 2019

The research findings presented and discussed earlier in this section revealed that using indigenous livestock breeds improves farmers' productivity in the district. However, the majority of farmers in the district had lost interest in indigenous breeds of animals. Some of the verbatim responses from research findings, which reveal participants' arguments against the keeping of indigenous breeds, were as follows:

Tlou A1: "the main challenge associated with the use of indigenous breeds is that they have low beef production compared to the exotic breeds. As such, most farmers prefer to keep the Brahman due to its high beef production, but the unfortunate thing is that this breed is not performing well in arid conditions."

Sebata A2: “indigenous breeds bring less income to farmers because they weigh less than exotic breeds. However, we have conducted many workshops encouraging people to keep indigenous breeds since exotic breeds are very sensitive to harsh climatic conditions. Farmers require high capital to buy stock during drought periods.”

The research findings revealed that indigenous breeds are being underutilised in the Gwanda District mainly due to their slow growth rates and low carcass yields, among other reasons. This finding is in agreement with previous studies carried out by Mapiye et al. (2019) and Chingala et al. (2017), which stated that some farmers do not still recognize the value of indigenous breeds, and they rely on exotic breeds, which are perceived to be superior. Yet, they are adversely being affected by climate change. This study revealed that exotic breeds are more vulnerable to the adverse effects of climate change. Furthermore, the study revealed that indigenous veldt goats are tolerant to diseases and harsh climatic conditions. The adaptation strategies have also been confirmed in various ways by Madobi (2014) and Manatsa and Gadzirai (2010). Thus, EE programmes are inadequate in presenting new strategies to pastoral farmers that promote indigenous breeds to boost the output of communal farmers.

4.4.5 Supplementary feeding schemes of livestock

Besides the pastoral adaptation strategy presented in the preceding section, farmers in wards 12 and 16 in Gwanda district have also resorted to feeding livestock due to poor pastures. The study revealed that farmers in the district embark on supplementary feeding as an adaptation strategy since climate change has adversely affected pastures. The research findings established that for the past two decades, it has become the norm to feed livestock from the late periods of the winter season to the early periods of the summer season. Thus, in general, the supplementary feeding phase covers the period from July/August to December. Farmers pile stock feeds on top of the trees to feed livestock during the winter season.

Some of the verbatim responses from participants were:

Noko F3: 'For the past ten years, supplementary feeding has been necessary, and most farmers who practice it find it very beneficial. The drier season is now longer than it was in the past; hence pastures can no longer sustain livestock throughout the year.'

Ndlovu F6: "if you want to witness your livestock dying, be lazy to stock crop residue for supplementary feeding because the pastures get depleted by July or August, and it will be like the ground has been swept."

Vundla F9: "We are no longer cultivating our entire fields. Some sections of our fields left so that the grass that grows there can be used for feeding livestock in winter."

Sebata A2: "many farmers in the district are practicing supplementary feeding, but we still have to educate them on how best to do it. For instance, some farmers start feeding their livestock when they start to collapse due to hunger, and it will be difficult for the livestock to recover."

Four participants from FGD 2 concurred to the view raised by one of the group members, Dube, who said: "I think we need to be taught how to preserve stock feed that we collect from crop residue and grass because in most cases they rot while on piles and pests such as termites are also a challenge."

It is evidenced that farmers know the importance of stocking crop residue and grass. Stocking crop residue involves the process of collecting waste materials from farms, mainly after harvesting. The grass is collected from new fields and stored to feed livestock in winter when pastures are depleted. The research findings revealed that the adaptation strategy for stocking crop residue and the grass is significant because it does not require capital compared to buying stock feeds from the shops. However, the process is done haphazardly. The study revealed a lack of EE programmes about gathering and collecting crop residue and grass. The image 4.5 overleaf shows farmers piling grass and crop residue on top of the tree.

Image 4.5: Piling of grass and crop residue on top of trees



According to the responses of most research participants, supplementary feeding for livestock is one of the best practices in climate change mitigation and adaptation due to a lack of pastures during the long drier season. The research findings also revealed that grass and crop residue is kept at home and on top of the toilets and fowl runs, as illustrated by the image overleaf.

Image 4.6: Crop residue stored on top of toilets and fowl run



The majority of farmers in the district are incapacitated to buy stock feeds due to a shortage of funds. Hence, they resort to the exploitation of grass and the gathering of crop residue. Some farmers complained of pests such as termites that destroy their stock feeds. There are few homesteads in the district without visible piles of grass and crop residue.

The study revealed that pastoral farming in the district which relies on supplementary feeding as crop pastures are adversely affected by climate change. The research findings established that for the past two decades, it had become the norm to feed livestock from the late periods of the winter season to the early periods of the summer season; thus, in general, the supplementary feeding phase covers the period from July/August to December. The cost of stock feeds is expensive, and it is beyond the affordability of many farmers in the district. In addition, the stock feeds are not readily available because farmers have to travel to Gwanda town to access them. To address these challenges, farmers in the district have resorted to using alternatives such as the leaves of local trees and crop residue. This resonates with the study conducted by Dube et al. (2018) in Matobo District in Zimbabwe; they reported that farmers collected and stored crop residues for livestock. Even though supplementary feeding schemes are one of the successful strategies in the district, EE

programmes were not evident to improve the effectiveness of this strategy. The major challenge with supplementary feeding is that most farmers delay feeding their livestock. They start it when the livestock begin to die, which makes it difficult for livestock to recover. There is no EE evidence on educating farmers to overcome nutritional shortcomings; farmers do not know that they need to buy molasses to be mixed with leaves to overcome the nutritional limitation of dry leaves that have high fibre.

4.4.6 Transhumance

The long dry season in arid areas forces pastoral farmers to practice transhumance, a process where farmers will be seasonally migrating to areas that have better pastures (Mogotsi et al., 2011). The research findings revealed that the majority of farmers in wards 12 and 16 practice transhumance. These farmers migrate with their livestock to areas with water and pastures in winter. Some of the verbatim responses from the participants provide evidence of transhumance in the district:

Vundla F9: 'Transhumance is significantly becoming popular in the district, and we mainly migrate with cattle, other livestock remains home.'

The AGRITEX report stated that transhumance is increasingly becoming popular. Initially, farmers migrated to the Shashi River, but of late, they are migrating to the local river, Tuli.

The majority of research participants in FGD 2: were in consensus with Dube, who stated that "transhumance is doing well for those farmers who practice it; however, some people have since stopped practising due to cattle rustlers."

Tlou A1: "Semi-nomadism has since gained popularity in the district. However, some farmers are not practicing it because of challenges such as livestock being vulnerable to attacks by wild animals such as hyenas and a shortage of human resources to herd livestock."

These verbatim quotes illustrate that transhumance remains important for herders in dryland regions, and when employed, it can buffer against animal loss of weight or death (Chitongo, 2019). This finding is similar to what Dube and Phiri (2013) observed in Matobo District, Zimbabwe, where farmers travelled long distances with their cattle to access pastures. However, some challenges are associated with transhumance, and such challenges hinder the adoption of the strategy by some farmers.

4.4.7 Diversification of economic activities

The study established that farmers in wards 12 and 16 cope with the adverse effects of climate change through diversification of economic activities such as moulding bricks, pastoralism, cultivation, hunting, gathering wild fruits, cross border trading, remittances from relatives in the diaspora, mainly in Botswana and South Africa and the gathering of Mopani worm (mafoza). Some of the verbatim quotes from research participants about diversification of economic activities were as follows:

Puo F4: 'Crop production on its own is no longer enough to sustain livelihoods due to recurrent drought cycles.'

Dube from FGD 2: 'Our livelihoods are now dependent on several economic activities, and farming is slowly becoming unpopular because sometimes the capital we invest in farming, buying seeds, and hiring labour are never recovered due to unreliable rainfall.'

The study established that farmers in wards 12 and 16 cope with the adverse effects of climate change through various activities such as pastoralism, cultivation, hunting, gathering wild fruits, cross border trading, remittances from relatives in the diaspora, mainly in Botswana and South Africa, and gathering of Mopani worm (mafoza). Thus, livelihood diversification helps communal farmers survive despite the adverse effects of climate change being experienced in the region. The Mopani worms are the primary source of income in the wards. The income is used to purchase farming inputs such as stock feeds, treated seeds, and farming equipment. Similarly, Mbereko et al. (2018), from a study carried out in Ntalale village, found that farmers adapt to climate change by being engaged in economic activities. Furthermore, Dube et al. (2018), in their study carried out in Matobo District, Zimbabwe, reported that farmers had adopted several economic activities to reduce the adverse impacts of climate change in agriculture. The economic activities which they reported are generally the same as those revealed by the current study.

4.4.8 Harvesting of wild food

Harvesting of wild food is becoming a popular livelihood strategy in the district. Communal farmers are coping with the adverse effects of climate change by supplementing low agricultural output by collecting and drying wild fruits for use in the future.

Sibanda F5: 'We thank God for blessings us with wild fruits. Otherwise, we could have died long ago without these wild fruits.'

Sebata A2: "The collection of wild food help farmers to supplement food, especially during drought periods."

Moyo from FGD 2 stated that: "Wild fruits play an important role in our community because we sell them in our nearby towns. For instance, umnyiye, umkhomo, and uxakuxaku have a large market in our local towns, Gwanda and Bulawayo. Some of our customers travel from these towns to buy the wild fruits, which save us time to travel and look for customers in towns."

The research findings revealed the significant role of wild food in reducing the vulnerability of communities against drought. As quoted above, wild fruits such as *Berchemia discolor* (umnyiye), *Adansonia digitata* (umkhomo), and *Azanza garckeana* (uxakuxaku) are used as a source of income due to their high demand in Gwanda and Bulawayo towns. In addition, the research findings revealed that communal farmers are coping with the adverse effects of climate change by supplementing low agricultural output through collecting and drying wild fruits for use in the future. Erskine et al. (2015) and Hazzah et al. (2013) have observed similar research findings in studies that were carried in Kenya. They noted that the exploitation of wildlife resources is significant for sustainable livelihoods and overall resilience to climate change. The farming output has significantly dropped to such an extent that it threatens food security, as witnessed by the reliance on donations from NGOs such as World Vision. Crops such as groundnuts, round nuts (include), beans, and pumpkin (amathanga) used to be part of household meals, but they have since become less common as meals due to lack of rainfall short rain season. In response to food shortages, wild fruits such as *Berchemia discolor* (umnyiye), baobab (umkhomo), and *Azanza garckeana* (uxakuxaku) are being collected and dried for future use to be part of household meals.

The research finding established that the harvesting of wild food in wards 12 and 16 include insects, fruits and roots. Wild food is a viable climate change adaptation strategy in the district since it provides an important safety net during droughts. This finding aligns with the research undertaken by Chidumayo et al. (2011), who found that the collection of wild resources provides considerable subsistence support to local livelihoods. The research findings established that wild food had been adversely affected by climate change, which has reduced the quality and quantity of products. This

finding was previously highlighted by Waldron et al. (2017), who stated that climate change has reduced farming outputs and wild food.

4.5 Mitigation strategies to climate change

The research findings revealed that initiatives are in place in wards 12 and 16 to mitigate the effects of climate change. During data generation, 100% of participants stated that they are aware of the numerous climate change mitigation strategies implemented in the two wards. A summary of mitigation strategies is given below:

- Woodland management and conservation project
- Indigenous Knowledge Systems
- Renewable energy sources (electricity and solar energy)
- Growing fodder plants
- Energy-saving cook stoves.

4.5.1 Woodland management and conservation project

The research findings revealed a woodland management project in the district even though the project is still at the early stages of implementation. The Pelele woodland project in ward 12 was established to protect the woodland and develop opportunities such as beekeeping and improving carbon sinks. Woodland management is the management of tree-covered areas that arose naturally that have passed the establishment stage (Campbell et al., 2017). It includes all measures aimed at preserving woodland, maintaining litter and conserving other natural resources within the woodland ecosystem. These measures are enrichment planting, improvement cutting (e.g., pollarding), thinning, pruning, slash disposal, and protection from fire and unregulated browsing. These measures are intended to enhance the productivity and utility of woodlands in providing products and environmental/ecological services.

The majority of research participants from the two FGDs stated that woodland management has several benefits to their livelihoods. When asked to identify the significance for protecting and conserving woodlands, they identified the following:

- enhanced bee forage for honey production
- fodder for livestock
- wild fruits, insects and mushrooms for food and nutrition security
- conservation and protection of the soil from land degradation
- medicinal benefits from herbs

- fuel wood for various activities which require heat energy

The data from the focus group discussions revealed that farmers are aware of the importance of woodland management. They are also aware that climate change is reducing the carrying capacity of woodlands. However, environmental programmes to support farmers to establish tree conservation projects at the micro-level are lacking even though farmers are aware of the importance of conserving trees. Dube et al. (2016) also reported on the importance of conserving woodlands. Their study reported that the woodlands support livestock and wildlife systems in Zimbabwe, and they are being protected to reduce deforestation, particularly by livestock. The research findings of this current study revealed that climate change mitigation and adaptation strategies to protect rangelands include shifting to small livestock like goats, reducing livestock heads, and providing supplementary feeds and mixed farming (livestock and crop production) in the rangeland.

Similarly, in their studies, scholars such as Dube and Phiri (2013) reported that farmers in Zimbabwe are transforming their farming activities to protect and preserve rangelands. However, some farmers do not cooperate with growing trees mainly because of the influence of traditional beliefs about the causes of climate change. Some verbatim quotes are presented below:

Tlou A1: "Some people resistant the woodland conservation and protection strategies such as reducing the number of livestock because they believe it is against their culture which values the rearing of large herds of cattle."

Dube from FGD 2: "It is difficult to shift from keeping cattle to goats because we need cattle to pay lobola. Besides, our wealth is measured by the number of cattle we own. By only having goats, that is associated with poverty in our community."

Sebata A2: "There is some form of lack of cooperation in engaging on strategies for climate change mitigation such as woodland management because some people believe climate change is a punishment by ancestors for abandoning some of the cultural practices such as visiting the Njelele mountain for rainmaking ceremonies."

The research findings revealed that some farmers are resistant to reducing livestock heads because it contradicts their cultural values of having more cattle as a sign of virility. The measure of wealth in the community is mainly based on the number of cattle owned by a farmer. From the traditional perspective, a person with many cattle is very much respected in the community. Furthermore, some farmers are resisting shifting from large livestock (cattle) to small livestock (goats) because cattle have a cultural value, particularly in paying for the bride (lobola). Some people believe that drought can be mitigated by reviving traditional rainmaking ceremonies. The research findings were comparatively similar to what was noted by Mbereko et al. (2018, p. 5), who reported that some people in Ntalale Gwanda rural district believe that the occurrence of dry spells "is a problem of people abandoning Njelele shrines (the rain making shrines south of Bulawayo)." Sadly, there are no EE programmes in the district to address cultural beliefs and environmental misconceptions, making farmers more vulnerable to climate change.

4.5.2 Indigenous Knowledge Systems

According to Mapara (2009), indigenous knowledge systems refer to traditional societies' intellectual behaviour and beliefs or local information about the relationship of living beings with one another and their environment. The research findings revealed that customs and traditional practices by the local community are part of the indigenous knowledge system mitigating against climate change. Mitigation plays an essential role in suppressing the impact of climate change by enhancing carbon dioxide sinks and reducing greenhouse gases emissions (IPCC, 2007, 2014). Indigenous knowledge systems promote sustainable tree conservation practices, thereby enhancing carbon sequestration. As such, customs and traditional practices do enhance environmental management, which promotes climate change mitigation. The following verbatim quotes present utterances by research participants about the role of the indigenous knowledge systems in climate change mitigation and adaptation.

Tlou A1: 'There are opportunities enhancing greenhouse gas sinks under the customs and traditional practices in the community.'

Tsibo from FGD 1: 'Trees like Combretum imberbe (umtswiri) and (Lonchocarpuscarpasa) ichithamuzi are prohibited from being cut. Some trees are used to bury the deceased such as Ziziphus mucronata (imphafa).'

Ndlovu F6: 'The establishment of communal farms is regulated by traditional leaders and of late before someone is allocated a new farm, the traditional leaders look for abandoned farms, and they are given to aspiring farmers.'

The research findings revealed that the stands of sacred trees in the district play a significant role in climate change mitigation. The traditional leaders enforce the view that these sacred trees should neither be burnt nor cut down because they are only meant to be used for important events such as the burial of the deceased. Cutting down trees such as *ichithamuzi* is believed to inflict misfortunes on society as the local name of the tree '*ichithamuzi*' means the cause of divorce. Thus, the naming of trees also plays an essential role because it retards their exploitation because no one is prepared to burn the wood that will bring divorce within the family.

In addition, the research findings also revealed that it is taboo to burn *umtswiri* wood because it invites bad luck in livestock; it is believed that the domestic animals will only bear male offspring. Farmers are discouraged from exploiting such trees because of the perceived bad luck associated with the cultural prohibition of the exploitation and use of trees. Thus, the indigenous knowledge systems enhance climate change mitigation by creating a bond between people and their environment. Similarly, Manyani et al. (2017) found that traditional norms help people be attached to the environment, thus mitigating against climate change. In addition, Hazzah et al. (2013), share a similar view that cultural beliefs are associated with the sacredness of forests and trees, which reduce their exploitation and enhance carbon sinks. Chanza (2016) also found that customary practice helps to establish an intrinsic bond between people and their environment, which achieves sustainability.

The research findings also revealed that indigenous knowledge systems in customary leadership arrangements conserve trees whereby abandoned farmlands are redistributed to new farmers instead of establishing new farms. The local leadership has established local regulations concerning land use because land allocations for cultivation, settlement and livestock grazing are done with guidance from the chiefs and headmen, the custodians of local customs. Similarly, in his study, Chanza (2016) found that communities in the eastern part of Zimbabwe are prohibited from burning forests or exploiting trees from sacred places without the traditional leaders' permission. It is believed that the burning of the forests disturbs the spirit mediums who reside in them. Thus, indigenous knowledge is essential in mitigating climate change, as revealed by the research findings and other studies conducted in other parts of the country. However, indigenous knowledge is not

fully embraced in the community because some people associate it with traditional religion (*amadlozi*) and most people in Gwanda are Christians.

4.5.3 Renewable energy sources (electricity and solar energy)

The research findings revealed that both wards 12 and 16 in Gwanda rural district benefited from the rural electrification programme in 2006. This availed more opportunities for livelihoods diversification given the impacts of climate change. It was said to have reduced rural to urban migration, which is responsible for some men in rural communities like Gwanda leaving for the urban areas. The following verbatim quotes pertain to the research participants' views about the use of electricity and solar energy in wards 12 and 16.

Thabo from FGD 1: 'The Rural Electrification Programme only benefited the communities for a short period immediately after the implementation exercise, few years down the electric poles had already fallen.'

Tlou A1: 'The use of solar systems in pumping water for gardens has substituted diesel, which is expensive and causes pollution.'

Vundla F9: "We are generally using solar energy for irrigation and lighting purposes. Due to lack of funds, most of us have not yet installed the solar system in our homes for cooking and heating, but we are aware of such initiatives in some wards such as ward 19, Mashaba, where people are using the solar system; for cooking."

AGRITEX report: 'All the nutritional gardens in wards 12 and 16 are using solar energy.'

The research findings revealed that the use of renewable energy sources in the district plays a significant role because it replaced petrol and diesel, thereby reducing greenhouse gas emissions. When the rural electrification programme was implemented in 2006, most shops shifted away from diesel and petrol. People using electricity mainly for welding, carpentry, and other livelihoods needed the power to support their livelihoods. In addition, the verbatim quotes above revealed that solar energy is being used for pumping water from deep wells and boreholes, which enhances the resilience and sustainable livelihoods of communities in the district. The research findings revealed that solar energy plays a crucial role in reducing the over-reliance on non-renewable energy sources such as diesel and petrol for pumping water into the nutritional gardens.

Similarly, Kaya (2016) found that the use of renewable energy sources such as solar power is significant in reducing overdependence on sources of energy that contribute to the greenhouse

effect. However, the use of the solar system in the district is still limited to pumping water in nutritional gardens. In addition, some solar panels installed by World Vision were stolen, as earlier stated in the previous section. Furthermore, EE and financial funding are lagging in promoting the extensive use of solar energy. Regarding cooking and heating, the communities rely mainly on firewood due to a lack of funds to install solar systems in their homes. The research findings revealed that households in wards 12 and 16 solely rely on firewood for cooking, promoting deforestation and reducing carbon sinks. Thus, as much as solar systems are evident in the district, it has not yet replaced firewood.

4.5.4 Energy-saving cook stoves.

The research findings revealed that households in wards 12 and 16, Gwanda district, use fuel-efficient wood-burning stoves made out of mud or bricks. They can be either fixed or portable. The fixed stoves are mounted on walls in kitchens, and they have ovens. On the other hand, portable stoves are one-plate stoves that can be carried from one point to another. These stoves use twigs instead of big logs for cooking. Wood-saving stoves are an effective cooker for less energy in terms of firewood. The following verbatim quotes present the views of research participants about the use of the fuel-efficient wood-burning stove.

Vundla F9: 'We are now using energy-saving cook stoves to save firewood, which is now scarce in the village.'

Sibanda F5: 'Firewood is now a crisis, and we are travelling more than 3km to get dry wood, and some people have resorted to cutting trees and keeping them at home to become dry because firewood is now a crisis.'

Tlou A1: 'We appreciate the establishment of energy-saving cook stoves in various parts of the district because they are a relief on massive destruction of trees for firewood.' *FGD2: 'There are few people in the ward who use energy-saving cook stoves, but the initiative saves wood and saves farmers from spending more time collecting firewood.'*

The verbatim quotes show that the research participants perceive the value of using energy-saving cook stoves. The research findings revealed that wood is becoming scarce in the district, which shows the vulnerability of trees to the impact of climate change. The use of energy-saving cook stoves helps to reduce the overburden of travelling long distances in search of firewood. More importantly, it helps to conserve trees since it was stated that people are now cutting trees instead of using dry fallen

trees. Thus, the conservation of trees helps to mitigate climate change by enhancing carbon sinks. The image overleaf illustrates one of the types of energy-saving cook stoves.

Image 4.7: An example of an energy-saving cook stove in the district.



The design of the energy-saving cooks' stoves, as illustrated in image 4.7, helps retain heat, thereby saving firewood. Thus, the stoves are fuel wood savers and conservation of wood helps to mitigate climate change because trees are also conserved, thereby enhancing carbon sinks. Similarly, the United Nations Framework Convention on Climate Change (2021, online report) states that 'the use of energy-saving cook stoves leads to less fuel wood usage, fewer trees cut down, and lower greenhouse gas emissions. This is helping to mitigate climate change and reduce deforestation.' The report is based on an energy-saving cook stoves project in Kenya. Therefore, the role of energy-saving cook stoves in mitigating climate change is clear. In Gwanda district, the energy-saving stoves lack EE support to significantly mitigate climate change because few people currently implement the initiative.

4.5.5 Growing fodder plants

Fodder plants are crops cultivated primarily for animal feed, and they may be categorised as either temporary or permanent crops. In Gwanda rural district, there is evidence of temporary fodder plants, and they are cultivated and harvested like any other grain crop. Permanent fodder crops were not evident from the research findings. These types of fodder grass relate to the land used for herbaceous forage crops, either cultivated or growing wild (i.e. wild prairie or grazing land), and may include some parts of forest land which is used for grazing. The fodder is grown permanently or for an extended period, such as five years or more. The following are verbatim quotes regarding the growing of fodder plants in wards 12 and 16:

Four participants from FGD 1 were in agreement with Thabo who stated that: *“Fodder plants are grown from cuttings per year and they mainly include grasses and cereals that are harvested green.”*

Tlou A1: *“There are positive initiatives in the district where people are now growing fodder grass to feed their livestock.”*

Dube from FGD 2: *“The growing of fodder grass helps reduce overgrazing and deforestation because farmers feed livestock at home hence reducing pressure on grazing lands.”*

The research findings revealed that fodder plants are used to feed livestock. The fodder plants are fed to livestock as green feed, hay (crops harvested dry or dried after harvesting), or hay/ensilage products. The silage, or ensilage, refers to green fodder preserved without drying by fermentation that retards spoiling (FAO, 2016). Some fodder crops are components of compound feeds. There are many advantages of growing fodder grass to feed animals. Fodder grass is nutritious to livestock since they contain crude fibres, crude protein and many other minerals. The legumes are very rich in proteins and minerals. In addition, the root crops are easy to digest because they contain more starch and sugar and less fibre. The fibre content found in fodder crops consists of cellulose and is a good energy source for livestock. The use of temporary fodder plants helps mitigate climate change by reducing the destruction of trees through deforestation and increasing carbon sinks. The research findings revealed that EE lags in establishing permanent fodder plants in wards 12 and 16. In addition, the growing of fodder plants is scanty, and it was noted in gardens along the Tuli River. According to the data generated from focus group discussions, people primarily grow food crops to alleviate hunger, and food crop waste is then used to feed livestock.

4.6 People's perceptions of EE in mitigation and adaptation to climate change

It is reported that climate change is a global challenge as it negatively influences the environment and people's lives, and EE in the communities has not had much impact on transforming perceptions and altering the activities at the grassroots communities' level (IPCC, 2018). Hence, knowing peoples' perceptions of EE in mitigation and adapting to CC is essential. The research findings presented below reveal that the research participants were positive that EE plays a crucial role in mitigating and adapting to climate change. The research findings revealed that EE has the following roles in mitigating climate change:

- Creating awareness at the community level enables individuals and communities to respond appropriately to climate change's visual impacts.
- Providing knowledge of the causes and effects of climate change.
- Equipping people with the knowledge of mitigation and adaptation practices that contributes to community resilience and sustainable practices.
- Promoting the understanding of factors that influence various responses to climate change and EE can enable individuals to evaluate the validity of these factors concerning sustainable practices critically.

Some of the responses from the AGRITEX officers were as follows:

Sebata A2: 'EE is a pillar for the community in responding against climate change. It helps communities get informed about the effects of human and animal activities on the climate and further suggest how individuals and communities should address the challenges and apply preventative measures.'

Tlou A1: 'EE is a multi-disciplinary approach and process that teaches people about the environment to make intelligent and informed decisions. However, in wards 12 and 16 of Gwanda, there is a lot to be done in terms of investment on supportive programmes so that perceived benefits of EE can be realised.'

Tsibo from FGD 1: "EE programmes such as workshops help us to be aware of the possible sustainable practices to respond to climate change."

A synopsis of the above utterances suggests that EE has to be ongoing- it is both a short- and long-term response to climate change mitigation and adaptation. Through EE programmes such as workshops, communities at grassroots levels are empowered positively to get to know what human and animal activities have done or can do to the environment and climate. The research participants indicated that EE for climate change should be promoted to equip farmers with relevant information for climate change migration and adaptation. According to Morton (2007), EE is essential in cultivating problem-solving and critical skills through farming messages to emphasise an individual's capacity to achieve positive outcomes. Thus, EE has to be promoted to help farmers in making informed decisions.

4.7 EE programmes and efforts in the community

This theme sought to generate data about the EE programmes and efforts in the community. In addition, it sought to identify micro innovations with growth potential in the district. The findings indicate a myriad of EE efforts by the government and NGOs that require local innovations in their implementation. These EE efforts include workshops, meetings, roadshows, TV shows, climate radio shows, drought web articles, press statements, debates, and print media. The responses revealed that people in the community are aware of national programmes meant to disseminate EE regarding climate change mitigation and adaptation. The study revealed that EE efforts must focus on the local factors jointly determined by agricultural extension officers (AGRITEX, EMA) and local people. Refinements and adjustments are required on all national EE efforts and policies before their implementation at a local scale. The negative impact of drought can be reduced if locally designed EE policies are put in place. Hence, the third theme identified the following as micro innovations for EE efforts with growth potential:

- field days
- Information and skills sharing amongst neighbours
- AGRITEX'S periodic reports on successful drought mitigation strategies
- skills sharing on community gardens

These EE efforts were identified as micro innovations with growth potential.

Some of the verbatim responses from the research participants concerning the EE programmes and efforts in wards 12 and 16 were as follows:

Tlou A1: 'In our district, we have realised some effective EE efforts that work best for us, and we are strongly encouraging all people to embrace these EE efforts. One of the most effective efforts is field days, and we strongly encourage people to partake in these programmes so that they can have an opportunity to learn and share experiences.'

Vundla F9: 'yes, I am aware of national EE programmes, but some of them are a waste of time and irrelevant to us, for example, the issue of media and internet websites don't benefit us rural people, we don't have gadgets to access the information which is disseminated through the media.'

Verbatim responses from the research participants availed various channels for disseminating EE to the general members of the community, for example, through field days. Field days refer to selected days where agricultural extension officers select a farm to be visited by community members to learn some successful farming strategies. It further emerges from the data that people in the district have identified micro innovations, which they believe can achieve climate change mitigation and adaptation through EE programmes. World Vision is embarking on EE programmes to equip villagers with ways of managing nutritional gardens. The research findings from the AGRITEX officer revealed that there are farmer field schools where farmers will be sharing their experience of working in their gardens. This process of sharing information includes practical lessons through demonstrations, and it is under the guidance of the AGRITEX officers. The study established that field days are evident in the district; however, there is a need to conduct more practical lessons, and they should be done regularly. The research findings revealed that the agricultural extension officers are incapacitated to visit all the farms in their wards due to a shortage of transport. As such, the selection of farms for field trips is compromised due to transport constraints.

In addition, the research findings revealed that communities do not have media for communicating information such as radios and televisions to access information from national programmes. There is also a lack of signal to access national radio stations. Thus, communities in wards 12 and 16 are constrained in their access to information for climate change from radio and television programmes. As such, poverty is a hindrance to climate change mitigation and adaptation. Similarly, Dube et al. (2018) reported that rural poverty significantly limits climate action in rural communities. Thus, farmers cannot utilize and access national EE programmes on radio or television due to poverty.

4.8 Challenges encountered in the implementation of EE programmes that seeks to mitigate and adapt to climate change

Challenges refer to factors or conditions that make it difficult to execute any activity as expected (Klein et al., 2014). Contextually, they refer to all the barriers, obstacles, or constraints to climate change mitigation and adaptation initiatives. Challenges can be classified as those that reduce mitigation and adaptation options, those that increase the cost of mitigation and adaptation, and those that reduce the efficacy of selected options to achieve sustainable livelihoods (Klein et al., 2014). The fourth theme sought to collect data on the challenges AGRITEX and EMA officers and farmers encountered in implementing programmes that seek to mitigate and adapt to climate change. A 100 percent of participants were unanimous that the mitigation programmes in wards 12 and 16 of Gwanda rural district council face financial, logistical, and perceptual challenges that negatively influence its success. Research participants expressed sadness about the reality in Zimbabwe, where government and donor funding for climate change mitigation is meagre and shrinking each year. The research participants cited that massive climate change and mitigation programmes would have influenced rural communities' rollout programmes of climate change and mitigation and this would have influenced rural communities had it not been for the country's economic challenges. Similarly, Moyo et al., (2013) found that Zimbabwe is constrained in mitigating and adapting to climate change due to the economic crisis experienced in the country.

According to the research findings for this study, 80% of participants identified numerous challenges to climate change mitigation and adaptation. There is inadequate funding of climate change mitigation programmes due to the economic crisis in Zimbabwe and most organizations involved in climate change. Furthermore, there is a lack of cooperation from farmers to shift from the usual maize crop farming to small grains farming. In addition, farmers lack irrigation equipment to provide an alternative source of farming water in the rain-starved Gwanda rural district council. The research findings revealed that wards 12 and 16 lack effective climate change mitigation and adaptation education programs.

Equally interesting was the long-held traditional view, held by one of the oldest participants aged 55 that the lack of rain and drought is due to the anger of the rain gods at Njelele, one of the national rain shrines in Zimbabwe. Thus, challenges from a cultural perspective towards climate change mitigation depict that EE programmes are yet to address cultural beliefs that limit climate

change action in mitigation and adaptation. Some of the verbatim responses from the research participants were as follows:

Ndlovu F 10: 'The information on climate change mitigation and adaptation is being disseminated through field days, but these field days are less effective because the selected fields are not the best sites where climate change mitigation and adaptation is being practised. The selectors are incapacitated to move around all fields to identify the best sites for field days.'

Vundla F9: 'These frequent droughts are not natural, somehow and somewhere the ancestors are not happy. As Bolamba community, we have to go back to the old practices and perform rituals at Njelele to end this crisis of little rainfall and persistent drought cycles.'

Dube from FGD 2: 'If the government is serious with climate change mitigation and adaptation, it has to avail more funds for EE programmes, deploy more AGRITEX officers and evaluate each EE programme.'

Mare A3: 'As farmers, we know many strategies for mitigation and adaptation to climate change mitigation, but the main challenge is that almost all these strategies require financial support and due to poverty and economic crisis in the community and Zimbabwe in general, farmers are facing challenges during the implementation phase.'

Nare F7: 'The dominant mitigation and adaptation strategies spearheaded by the local authorities in the district are biased on arable farming at the expense of pastoral farming, which stands a better chance in terms of high output due to aridity in the region.'

The verbatim quotes above revealed that there are many challenges concerning mitigation and adaptation to climate change. These challenges include the lack of adequate funding for climate change programmes and perceptive cultural challenges that prevent shifts from traditional to modern ways of farming, among others. Lack of funds due to the economic crisis to support climate change mitigation and adaptation initiatives is one of the most significant challenges. Similarly, in their studies, Ndlovu et al. (2020) and Dube et al., (2018) found that Zimbabwe's economy is dwindling. The past decade experienced an economic crisis that has caused a sharp increase in inflation reached 231%. Thus, farming extension officers in Gwanda rural district are incapacitated to embark on EE programmes for mitigation and adaptation. The people of Gwanda rural district are aware of climate change, but they have some views about its leading causes. Some believe that

low rainfall during the rainy season is due to the anger of the rain gods at Njelele, who are feeling abandoned, as people are no longer performing rituals at Njelele. This was also observed by Mbereko et al. (2018), who stated that some people in ward 11, Gwanda rural district, believe that droughts result from the abandonment of the Njelele rain-making shrine. Thus, cultural beliefs hinder effective climate change mitigation and adaptation. It was also noted that scientific farming ways such as crop rotation faces resistance in the community since most farmers prefer to do things the way it was done by their ancestors, such as mono-cropping, despite the negative impacts of this practice on their crop yields.

The other challenge faced by farmers is a shortage of water for irrigation due to heavy rains that destroyed dams in the district. The diagram overleaf illustrates the Gungwe dam in ward 12, which collapsed in 2016.

Image 4.8: Gungwe dam wall that collapsed in 2016 due to floods.



The collapse of dam walls poses a significant challenge to the community because there is a severe water shortage available for irrigation. The green pastures that were usually found around the dams were destroyed. Nutritional gardens that used to flourish around the dams have also been abandoned due to a water shortage.

4.9 Key concepts constructed from the research findings for theory building

This section aims to lay the foundation of theory building that is presented in the following chapter. The concepts emerged from the analysis of challenges and opportunities for EE in mitigating and adapting to climate change. This study revealed that successful climate change mitigation and adaptation strategies require more EE support to reduce vulnerability while enhancing resilience and sustainable livelihoods. Three concepts were constructed for theory building which includes; "cultural impediments, "unsustainable personal preferences and tastes," and "climate action is an issue of affordability and feasibility in a rural context."

4.9.1 Cultural impediments

The research findings revealed a lack of compliance by some farmers to practice some successful climate change mitigation and adaptation strategies such as dry planting. In this thesis, cultural norms and practices contrary to EE are "cultural impediments." These "cultural impediments" make some community members vulnerable to climate change despite the evidence of successful strategies in the community. There are opportunities for EE to promote climate mitigation and adaptation by specifically addressing "cultural impediments." Mitigation and adaptation strategies for climate change require extensive EE programmes that address "cultural impediments" and reduce farmers' vulnerability while enhancing resilience and sustainable livelihoods. Thus, agricultural extension officers should consider the "cultural impediments" which make communities vulnerable to climate change. For instance, there are EE opportunities to address "cultural impediments" concerning climate change mitigation and adaptation strategies since the research findings revealed that dry planting is limited in reducing farmers' vulnerability due to "cultural impediments." Thus, addressing "cultural impediments" will enhance both resilience and the sustainable livelihoods of communities since dry planting ensures that crops can grow and mature within the short rain season.

4.9.2 "Unsustainable personal preferences and tastes"

The research findings revealed that both indigenous crops and animals are doing well in the district, which is drought-prone. However, some people continue to grow maize due to personal preferences. In this research, these personal preferences against climate change mitigation and adaptation are "unsustainable personal preferences and tastes." Their research findings revealed some gaps in climate change mitigation and adaptation, which must be addressed by EE to reduce farmers' vulnerability to climate change, associated with "unsustainable personal preferences and tastes." Indigenous animals and crops are tolerant to harsh conditions posed by climate change. EE programmes that focus on promoting indigenous breeds are very significant in enhancing resilience and sustainable livelihoods in drought-prone areas.

4.9.3 Climate action is an issue of affordability and feasibility in the rural context

The research findings revealed climate change mitigation and adaptation is not only about being educated on what to do but is influenced by "can I afford or can I manage to do it." It was revealed that many strategies in the district have proved to be successful but are not common simply because

the majority of farmers cannot afford them. For instance, nutritional gardens are one of the most successful strategies in mitigating and adapting to climate change. However, there are few gardens in the district due to the issue of affordability. Establishing irrigation facilities and purchasing farming inputs (water pumps and pipes) are extremely expensive and out of reach for the vast majority of people. Furthermore, people are aware that conservation farming is very effective. Still, most farmers are not practicing it because it is not feasible considering the shortage of labor caused by the international migration of the active economic group in the district. In addition, most farmers are not practicing transhumance because they cannot afford the cost of vaccinating the livestock due to associated causes of diseases. They cannot manage to handle the issue of rustlers and attacks by wildlife. Thus, EE efforts for climate change mitigation and adaptation should consider affordability and feasibility to ensure resilience and sustainable livelihoods.

In conclusion, extensive education programmes by AGRITEX and EMA officers are significant in promoting climate change mitigation and adaptation strategies that are reported to be yielding better results in the district. Most importantly, other issues that affect the adoption of feasible mitigation and adaptation strategies should be considered to ensure sustainable livelihoods. Similarly, Dilling and Moser (2007) reported that EE practitioners must consider how social factors such as group identity, the threats to values posed by solutions, and a lack of political will make it challenging to explore climate change mitigation and adaptation. Thus, the research findings revealed that communities are vulnerable to climate change mainly due to a lack of funding, and cultural obstacles which lead to misconceptions, and resistance to change.

4.10 Conclusion

The chapter presented, discussed, and analysed the study's findings on the role of EE in mitigating and adapting to climate change in wards 12 and 16 of Gwanda rural district council in Matabeleland South province of Zimbabwe. The data was collected using a qualitative research approach with data triangulated from interviews, focus group discussions, and AGRITEX reports from 2019-2020, which were analysed. The bulk of the data generated was qualitative. It was categorized into recurring themes and sub-themes used to analyze the study's findings. The study found that climate change has negative impacts. Through the Ministry of Agriculture and Environment, the government has programmes that seek to mitigate and adapt to the impacts of climate change. The best approach to mitigating climate change involves putting EE at the centre of grassroots programmes and activities on the environment and sourcing funding for such

programmes. The next chapter presents the summary of key findings and their theoretical insights. Literature gaps for future research are also unpacked and critical recommendations for EE in Gwanda district.

CHAPTER FIVE

THEORISATION

5.1 Introduction

This chapter aims to present valuable theoretical aspects of the study as they emerged from the data generated and its interpretation to understand the role of EE in climate change mitigation and adaptation. The chapter comprises sections with the following subheadings: theoretical aspects on research findings, models developed from the research findings and conclusions.

5.2 Theoretical aspects from research findings

The Livelihoods (SRL) Framework and Nested model of sustainability informed the current study. Using these two frameworks as data analytical tools resulted in four valuable concepts related to the role of EE in climate change mitigation and adaptation in Gwanda rural district. These concepts include *situated vulnerability, generative resilience, cultural resistance and sustainable rural African livelihoods*. The locus of the study was to explore the role of EE in climate change mitigation and adaptation amongst the rural communities of Gwanda rural district. The summary of the research outcomes is presented considering the valuable theoretical ideas in line with the critical questions. The findings were based on the salient issues that emerged from the combination of the Sustainable Rural Livelihoods (SRL) Framework and Nested model of sustainability which were considered relevant and essential in this research. The study's results exposed the critical linkage between EE and climate change mitigation and adaptation in fostering generative resilience and sustainable rural African livelihoods in this era of climate change amongst the communities of Gwanda rural district. However, it also unearthed resistance that was evident due to cultural norms. These concepts will be discussed in depth in the following sections.

The human asset formed the basis for the analysis and the discussion regarding the sustainability of rural livelihoods, which occupied the centre stage in this research, which focused on climate change mitigation and adaptation. While communal farmers are involved in climate change mitigation and adaptation strategies, their vulnerability to climate change would remain if EE programmes were lacking and ineffective for their situation. This implies the need to develop more effective EE programmes to promote knowledge acquisition and transfer on best practices for climate change mitigation and adaptation to address their *situated vulnerability*. The following sections include those critical concepts, which contribute to the sealing of the knowledge gap identified by this research. The four main environmental concepts that emerged during data analysis

are *situated vulnerability, generative resilience, cultural resistance* and *sustainable rural African livelihoods*. In addition, some terms were constructed for theory building which include: “cultural impediments”, “unsustainable personal preferences and tastes,” and “climate action as an issue of affordability and feasibility in a rural context.” These concepts and ideas which emerged during the discussion of research findings constitute aspects upon which the theorization of the research findings is based on, guided by the SRL Framework and Nested model of sustainability.

The following sections explain the four main environmental concepts that emerged during data analysis are situated vulnerability, generative resilience, cultural resistance and sustainable rural African livelihoods. The concepts that led to the development of the EERSL model.

a) Cultural Resistance

Despite the global and national campaigns about climate action, some individuals are unwilling to take personal actions to mitigate and adapt to climate change. The research findings revealed that cultural beliefs hinder some adaptation strategies for climate change, such as early planting. Some people believe that it is culturally unacceptable to cultivate the land during the first rainfall in summer. In addition, cultural myths about the causes of droughts compromise farmers' commitment to adopting climate-smart agricultural practices and conserving trees. EE programmes that directly address these myths and unsustainable cultural practices are lacking in the district.

Furthermore, some farmers resist conservation farming efforts because they believe that it is labour-intensive. Thus, individual preferences are also hindering climate change adaptation. Some community members resist growing small grains because of taste issues and not due to nutritional value. The research findings revealed that most people prefer maize because it is palatable compared to small grains. Resistance due to cultural beliefs, ideologies, preferences and tastes compromise generative resilience of communities to climate change.

Furthermore, cultural beliefs constitute one of the hurdles to climate change mitigation and adaptation and are considered a social barrier. Resistance due to cultural beliefs constitutes cognitive barriers where psychological and thought processes influence people's reactions to the adverse impacts of climate change (Alvera, 2013; Swim et al., 2011). From the research findings, cultural resistance is associated with misunderstanding and a misconception of issues related to the causes and effects of climate change issues (Gifford et al., 2011; Pandey et al., 2018). This finding is comparatively similar to the study carried by Le Dang et al. (2014). They stated that cultural

beliefs negatively influence climate change and cause cognitive or psychological barriers that have been generally overlooked in developing countries. There are various culturally oriented cognitive tactics being used by farmers to avoid implementing some strategies to mitigate and adapt to climate change.

According to Stafford et al. (2011, p. 201), their research found that people use cultural beliefs to avoid "accepting the likelihood of disagreeable futures and the need to act now". Thus, cultural beliefs are an important barrier to climate change mitigation and adaptation. It causes the psychological distance to climate change since people reject climate change information that conflicts with their spiritual beliefs (Grothmann & Reusswig, 2006). Farmers are not taking mitigation to climate change as a serious issue because they believe that the abandonment of the Njelele shrine causes climate change. The finding is comparatively similar to what Artur and Hilhorst (2012) reported in their study in Mozambique, where they found that people related the occurrence of drought cycles to religious issues. They believe that climate change is happening due to "God's will," the ancestors and witchcraft. This perception contradicts scientific facts, which state that climate change is a result of greenhouse gas emissions (amongst other influential factors). Hence, people resist embarking on climate change mitigation and adaptation strategies. In the study conducted in Nigeria by Apata et al. (2009), they found that people relate food shortages to spiritual intervention rather than to the science of climate change. The impact of this is immense for climate change adaptation and mitigation efforts.

In addition, cultural norms and values cause normative barriers to climate change mitigation and adaptation. Scientifically approved climate change mitigation and adaptation strategies are resisted because of normative barriers that influence people's responses to climate change. Due to cultural norms, some people deny climate change; they blame their ancestors and resist adopting the proposed initiatives to address climate change. In this regard, a key impediment to addressing the adverse effects of climate change is a lack of EE to tip the scales toward a scientific understanding of climate change and address beliefs and cultural norms that conflict with climate change mitigation and adaptation. Similarly, in their study, Jones and Boyd (2011) found that shared cultural norms and beliefs constrain climate change mitigation and adaptation strategies in Nepal. Climate change mitigation and adaptation strategies are resisted if cultural beliefs negatively influence climate risk perceptions, the significance of mitigation and adaptation (Shackleton et al.,

2015, Jones et al., 2003). Thus, resistance to climate change mitigation and adaptation is closely linked to cultural beliefs because they influence the way farmers interpret information.

Cultural resistance to adapting and mitigating climate change arises when personal and cultural values are considered more significant than climate change mitigation and adaptation strategies (Le Dang et al., 2014). Resistance to climate change mitigation and adaptation is also a result of appealing to fear and guilt by the law enforcers against people who are involved in unsustainable livelihoods practices. However, appealing to fear does not motivate adapting and mitigating climate change as research has indicated instead it causes resistance, thereby inducing unsustainable behaviour (IPCC, 2007). The EERSL model developed below depicts how resistance to climate change can be approached using the tool of EE so that people can be motivated to adopt mitigation and adaptation strategies to climate change. Appealing to fear is reported as above, to exacerbate resistance to climate change and promote behaviour that constitutes malpractices which increase the *situated vulnerability* of communities to climate change.

b) Situated vulnerability is a key component of the EERSL model

As highlighted in the EERSL model, the vulnerability of communities inhibits climate change mitigation and adaptation. From the research findings presented and discussed in the previous chapter, in general, wards 12 and 16 in Gwanda rural district experience deficiencies in all the five livelihood assets stated in the Sustainable Rural Livelihoods (SLR) framework (Carney, 2002; Scoones, 2015), which includes: natural capital, physical capital, financial capital, social capital, and human capital. From the research findings of this study, land, pasture and water are identified as critical assets for climate change mitigation and adaptation. However, most farmers in the district are vulnerable to climate change due to a shortage of these critical assets. A serious shortage of land was articulated by research participants who highlighted that they were victims of land dispossession during the colonial period and have not yet benefited from the land reform programme. The subsections below explain the conditions that cause situated vulnerability and cultural resistance amongst farmers. It explains how EE and financial support can transform vulnerability and resistance into resilience and build sustainable livelihoods.

i) Conditions that make communities vulnerable in wards 12 and 16 of Gwanda rural district

The research findings depicted severe water shortages as the place receives low rainfall in most cases and dams dry up during the long dry season. There are poor pastures in Gwanda rural district, which calls for EE programmes to empower people to identify indigenous animal breeds that are both browsers and grazers to survive on grass and Mopane leaves. The land's carrying capacity impacts the communal lands: overstrained by a high population, which leads to a shortage of land for grazing. Low rainfall is also a challenge that reduces the effectiveness of dam construction and the establishment of consolidated gardens. EE programmes that allow people to share their experiences and skills of coping with low rainfall are minimal in the district. The research findings show that some farmers with quality livestock despite the adverse effects of climate change due to the availability of funds. Research findings revealed that some successful farmers survive by practising transhumance during the dry season; they leave their permanent homes and occupy the Tuli and Shashe rivers areas to gain access to water and pastures. However, few farmers practice semi-nomadism even though it has proved useful to those who practice it. As such, EE programmes lack to market transhumance as an adaptation strategy for the entire community.

The state of physical assets found in Gwanda rural district inhibits climate change mitigation and adaptation. The research findings revealed that most farmers rely on dams for consolidated gardens and pastoral farming; however, these common mitigation strategies are ineffective due to floods that destroyed dams. The research findings revealed that heavy rains destroyed the Gungwe dam in 2016. The dam was not yet repaired during data generation, which marked four years of suffering from ward 12 since the dam was the primary source of water for consolidated gardens and livestock. Thus, the research participants have considered physical assets as areas that need attention and support to enhance climate change mitigation and adaptation. This aligns with the research carried out by Chang et al. (2014), which postulates that poor infrastructural development in rural areas inhibits climate change mitigation and adaptation.

Furthermore, roads connecting the wards with other places lacked maintenance and were poorly developed with broken bridges. This finding aligns with the research carried out by Magana-Lemus et al. (2016), which states that many small-scale rural farmers are located where there are poor quality roads, making it difficult for them to access the services from extension programmes such

as field days and workshops. Thus, essential services are untapped due to poor infrastructure. The research findings revealed that heavy rains destroyed the Cause Way Bridge on Tuli River, the shortest route from wards 12 and 16 to Gwanda and Bulawayo in 2017. This makes it expensive for farmers to access supplementary feeds and treated seeds.

Furthermore, research participants confirmed that climate change mitigation and adaptation are constrained by a lack of household physical assets such as ploughs and hand tools, hindering farmers from adapting to the short growing season. The agricultural activities are prolonged due to inadequate farming equipment to hasten the process of farming since some farmers rely on borrowing farming equipment and they can only be lent the equipment after owners are done with land tillage. The findings of this research also revealed that climate change is widening the farmers' gap between the haves and have-nots, worsening disparities between rich and poor farmers. As a result, it is business as usual for the rich farmers, who are investing in irrigation and other mitigation and adaptation strategies, resulting in good yields while the poor farmers produce poor harvests. The current study revealed that despite the government input scheme, which donates ploughs to farmers in the district, the household physical assets remained inadequate and critical in fostering climate change mitigation and adaptation. Research participants also confirmed the lack of social networking to support the dissemination of climate change mitigation and adaptation strategies in the area. There were no weather stations for farmers and AGRITEX officers to use in the wards. Ward 12 has only one weather station at Gungwe High School, and this weather station was not of much help to the farmers since it was a school facility mainly used by learners at school for educational purposes.

In addition, wards 12 and 16 also lacked communication devices such as radios and TVs to warn people of pending or looming climate change-related disasters such as droughts and floods. The research findings also depicted that those few farmers with access to radios are still constrained in accessing information disseminated by the government of Zimbabwe through Zimbabwe Broadcasting Corporation (ZBC) because it is easier to tune to Botswana and South African radio stations than Zimbabwe for someone in wards 12 and 16. Thus, the poor coverage of the local Zimbabwe Broadcasting Corporation hinders effective planning for climate change mitigation and adaptation in Gwanda rural district. The results were comparatively similar to the research undertaken by Chang (2014), which stated that without reliable information on the approaching

rainy season, planning becomes a challenge since climate change results in more erratic and irregular rainfall regimes, shorter growing seasons, prolonged intra-seasonal and inter-seasonal dry spells.

Furthermore, the research findings showed that the financial assets in wards 12 and 16 were supported by the sale of Mopani worms (locally known as mafoza), grains and livestock. The harvest of Mopani worms or mafoza was infrequently done because, in most seasons, they die due to a lack of rainfall. The sale of livestock and grains was less effective for securing funds needed to support mitigation and adaptation strategies for climate change mainly because farming yields were declining, perpetuating a lack of surplus for sale. In addition, financial capital was in short supply to support EE programmes in the district. It was reported that AGRITEX officers were incapacitated to carry out their duties mainly due to a lack of fuel. The study revealed that most AGRITEX officers own motorbikes, but Zimbabwe's fuel crisis adversely affects their operational capability. Thus, the lack of financial assets is a great threat to climate change mitigation and adaptation.

The human capital in wards 12 and 16 were underutilized mainly due to the deficiencies in skills and knowledge for climate change mitigation and adaptation. Though there were reportedly high literacy rates in wards 12 and 16, most farmers were not skilled and had some misconceptions about the causes of climate change, which hindered mitigation and adaptation. The number of AGRITEX officers was in short supply considering the restriction on mobility mainly due to the lack of fuel. Each ward only has two officers, thus making it difficult to move around the entire ward, which has an average radius of 5km, conducting EE programmes. These conditions compromised programmes that were meant to be implemented in climate change mitigation and adaptation.

Furthermore, part of the vulnerability of farmers to climate change is caused by their cultural beliefs and practices. As presented in the previous chapter, some farmers do not practice early planting because their traditional beliefs do not allow them to till the land during the first rains. This traditional belief exposes farmers to the impacts of climate change since the rain season is now shorter hence the need to practice early planting (Chitongo, 2019; Dube, 2015; Ndlovu et al., 2020).

This study established that communities in wards 12 and 16 are vulnerable to climate change due to a shortage of land, skills, capital and poor infrastructure, and traditional beliefs and practices that conflict with scientific strategies for climate change mitigation and adaptation.

The next section explains the role of funding and extensive EE programmes to capacitate the livelihood assets of communal farmers in wards 12 and 16 of Gwanda rural district, which is essential for strategies in climate change mitigation and adaptation.

ii) The role of EE and funding to transform *situated vulnerability and cultural resistance* to generative resilience building sustainable rural livelihoods

The research findings highlighted that EE and funding support is necessary for climate change mitigation and adaptation. Financial support is required for the establishment of consolidated gardens, revitalization of irrigation schemes, and paddocking. EE is required to train farmers on how to implement mitigation and adaptation strategies effectively. The shortage of land and pastures calls for urgent intervention by the government to transform traditional extensive farming into intensive farming to achieve high output per unit area. Extensive EE programmes are necessary to address traditional beliefs and practices that conflict with climate change; there was not any that sought to alter traditional beliefs. Additionally, the pandemic (COVID-19) demands that programmes of the future offer greater support and build generative resilience amongst the farmers for sustainable rural livelihoods.

c) Generative resilience is a critical component of the EERSL model

The resilience of farmers to climate change in wards 12 and 16 of Gwanda District is mainly influenced by EE and funding. The following sub-sections explain how EE and funding influence farmers' resilience to climate change mitigation and adaptation. Generative resilience involves particular ways of thinking that leads to robust decision making and planning for the future which may not have been anticipated at the outset (Grandori, 2020) and EE can be a tool to develop this type of resilience.

i) EE as a pathway to building farmers' generative resilience to climate change mitigation and adaptation

This study established EE programmes in wards 12 and 16, but they still need some improvements to maximize benefitting the communities they serve. It was reported that EE programmes are evident in the district, and community members are usually selected to attend workshops about climate change mitigation and adaptation. In most cases, it was reported that the local leadership had access to EE programmes that usually are conducted in Gwanda town in the form of workshops and conferences. The trickle-down effect occurs when local leaders and

representatives roll out the EE programmes in their communities after being taught in Gwanda town which is approximately 100km away. This helps the communities to acquire knowledge about mitigating and adapting to climate change, hence enhancing their resilience. NGOs such as World Vision plays a crucial role in financing these workshops. The research findings revealed that those farmers who had access to EE programmes have gardens that are doing well. However, most farmers are still lagging, and it was established that the main cause is a lack of funding and inadequate personnel to embark on outreach programmes for EE. Since the current study revealed that there are only two AGRITEX officers per ward, more AGRITEX officers must be deployed to assist farmers in mitigating and adapting to climate change. Furthermore, the government should provide fuel to agricultural extension officers in order to address the issue of mobility in order to effectively implement EE programmes.

Furthermore, it was established that some farmers fail to adapt to climate change due to traditional beliefs, which contradict mitigation and adaptation to climate change. There is a need for integrating indigenous knowledge and scientific knowledge to reduce vulnerability, enhance resilience and increase sustainable rural livelihoods (Jiri et al., 2016). The study concludes that effective mitigation and adaptation to climate change are evident in wards 12 and 16. If there is adequate funding to implement mitigation and adaptation strategies, farmers who have access to EE programmes such as workshops effectively embark on climate change action. The evidence of resilience in the district was comparatively similar to the research undertaken by Dube et al. (2016), who reported that the availability of capital to finance farming activities enhances the implementation of climate change action. Thus, there is a ray of light concerning EE programmes for building resilience to climate change in the district.

In addition, there is evidence of EE programmes such as field days and meetings in wards 12 and 16, Gwanda rural district. During field trips, farmers mainly share information on climate change's adverse impacts and strategies for mitigation and adaptation. The research findings revealed that productive farmers are used as resource persons to share their strategies to cope with climate change. This also serves as evidence that EE is shared through field trips to enhance resilience and reduce vulnerability to climate change in the communities. However, the research findings revealed that the frequency of these field trips was a cause of concern. More financial support is required to enhance these field trips so that each AGRITEX officer can have transport

money or motorbike fuel to conduct field trips across the entire ward. That some farmers still prefer growing maize that requires high rainfall compared to small grain crops shows that there is limited EE at the household level on the impact of drought on crops and the benefits of small grain crops, which are drought-tolerant. The research findings revealed that farmers are resistant to growing small grains because of taste issues; small grain meals are unpalatable, while maize meals are palatable. However, maize usually fails in drought years, leaving most rural households vulnerable to hunger and poverty. EE programmes that address the need to prioritize sustainable practices to overcome food insecurity over taste were lacking in the district.

ii) Finance, a factor promoting resilience to climate change mitigation and adaptation

The research findings revealed that at a macro scale, NGOs such as World Vision and Care International in Gwanda rural district play an important role in disseminating information on climate change, which promotes resilience amongst the community members. This aligns with the research carried out by Madobi (2014), which reported that NGOs provide an enabling environment for farmers to transition towards more climate-resilient livelihood strategies. However, it was established that some of the climate change mitigation and adaptation strategies taught by NGOs are less effective in wards 12 and 16. It was noted that mitigation and adaptation to climate change vary from place to place, and each community requires its unique strategies. The findings reflected that foreign-oriented mitigation and adaptation strategies for climate change had proved to be less successful. For example, research findings revealed that conservation tillage is less effective while it has been reported by FAO (2008) as an effective livelihood resilience strategy in drought-prone regions. The reason why conservation farming is ineffective in wards 12 and 16 is that the practice is labour-intensive. At the same time, most farmers are elderly folk since the active population is flooding the neighbouring countries for greener pastures, out-migrating from the rural areas. Thus, the NGOs and Government are inconsiderate of the social status of communities when establishing climate change action, which renders some mitigation and adaptation strategies ineffective.

Furthermore, it was reported that the government institutions such as schools could enhance resilience, as illustrated by the SLM. These institutions embark on EE programmes using printed media such as flyers and posters. One of the exciting posters which were seen in Gungwe High School reads; *“Do not just grow old, grow trees”* this serves as evidence of EE efforts in the 12

Ward where Gungwe High School is located; there are EE efforts in the form of posters to mitigate climate change. However, the fact that the poster was written in the English language in a predominantly Sesotho language area, makes the EE less effective because members of the community who only know the Sesotho language miss essential information on EE due to the medium of communication. Climate change information should be printed in the vernacular to be accessed and understood by all community members since most rural areas do not understand English. Thus, EE programmes in printed media should be designed so that each community member can get the message. The best way to achieve this is to use the local language. Most importantly, there is a need to present the content of climate change information to make it easy for the general public to understand climate change mitigation and adaptation for their lives.

d) Sustainable livelihoods as a critical component of the EERSL model

As presented in the previous aspects of the EERSL model, EE and funding are the main determinants of sustainable livelihoods in a drought-prone region. Personal funds and financial aid from NGOs help farmers to achieve sustainable livelihoods. Availability of funds enhances sustainable livelihoods since they can embark on intensive farming through nutritional gardens, improving nutrition and reducing poverty. Furthermore, when resilience is promoted and vulnerability reduced, farmers achieve sustainable livelihoods by being involved in diversified economic activities to reduce strain on natural resources and spread the risk of losses in extreme weather events. As such, diversification in economic activities helps farmers to mitigate and adapt to climate change. Mitigation is achieved in the sense that there will be reduced stress on natural resources. In comparison, adaptation is achieved because farmers will cope with adverse drought conditions when they are engaged in farming and other non-farm activities. Sustainable livelihoods mainly achieved through nutritional gardens and diversified economic activities lead to the conservation of woodlands that promote the continuous supply of wild fruits (Bharucha & Pretty, 2010), honey, Mopani worms, etc. as well as improving carbon sinks.

The theorization process led to the development of two models that provide guidance on how EE can be enhanced to promote climate change mitigation and adaptation amongst communities in drought prone Gwanda rural district. More importantly, the models illustrate that African problems require African solutions and foreign solutions are generally temporal and detrimental to the environment in the long run. A good example is the issue of Bill Gates' promoted fertilizers which

have been recently reported to be causing more harm than good to the environment (Phillips, 2021). Thus, African communities should use indigenous farming inputs to achieve sustainable rural African livelihoods. Also, these models are needed to inform EE strategies in other contexts. The models will be discussed in the following sections.

5.3 Models developed from the research findings

Two models were developed in this study introducing different levels: the micro, meso, and macro levels while extrapolating from the concepts of SRLF(Carney, 2002; Scoones, 2015) and the Nested model of sustainability (DEA, 2012), which are related to the research findings. The models developed are EE for Rural Sustainable Livelihoods (EERSL) and the Box Model for Rural Sustainable Livelihoods (BMRSL). The EERSL model illustrates that EE and finance plays a significant role to reduce situated vulnerability, diminish cultural resistance and enhance generative resilience towards sustainable rural African livelihoods. BMRSL model illustrates that the political sphere is an enveloping sphere that determine rural communities' generative resilience, situated vulnerability, and sustainability. Thus, the models illustrate how EE and funding can enhance generative resilience, reduce situated vulnerability and foster sustainable rural African livelihoods.

5.3.1 EE for Rural Sustainable Livelihoods (EERSL).

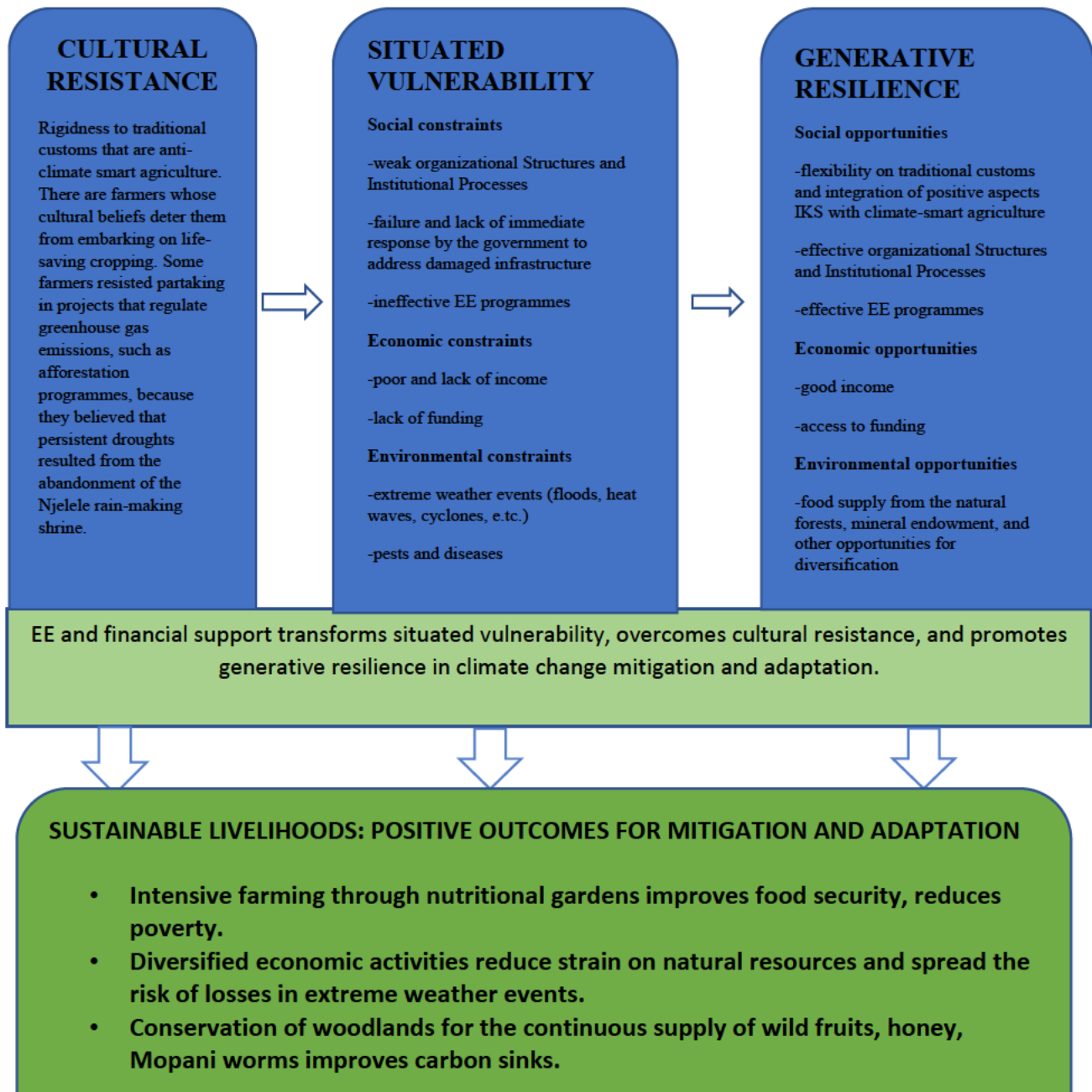


Figure 5.3.1: EE for Rural Sustainable Livelihoods (EERSL).

The EE for Rural Sustainable Livelihoods (EERSL) model presented in figure 5.3.1 illustrates important theoretical ideas from the research findings. The EERSL model illustrates the role of EE and financial support to reduce situated vulnerability, diminish cultural resistance and enhance resilience towards sustainable rural African livelihoods, necessary for climate change mitigation

and adaptation in drought-prone rural communities. As explained in the preceding chapter during the discussion of research findings, COVID-19 has deepened the vulnerability of Gwanda rural communities hence the need for generative resilience. Thus, these two concepts; EE and financial support are married to each other because adequate finance is needed to implement EE. The model illustrates that cultural resistance to climate change mitigation and adaptation strategies mainly leads to farmers' vulnerability to climate change. In addition, EE can reduce the vulnerability of individuals and communities, thereby increasing their resilience to climate change. Furthermore, the model illustrates that climate change mitigation and adaptation strategies are impossible without finances in a poor rural community because finances are required to ensure EE programmes unfold. Finance can provide for the inclusion of staff (such as agricultural extension officers) in EE programmes. Agricultural extension officers need to be trained to go to farms, meet with people, organize workshops and move around the farms monitoring the implementation of mitigation and adaptation strategies. The EERSL model also illustrates that EE and financial support transform vulnerability, overcome resistance, and promote resilience, resulting in sustainable livelihoods and outcomes.

The following section presents the second model developed from the research findings of this study.

5.3.2 Box Model for Rural Sustainable Livelihoods (BMRSLS).

Resilience and sustainable livelihoods in rural contexts are dependent on the availability of funds, cultural norms and technical support from agricultural extension officers. EE and funding, mainly provided by NGOs and government, play a significant role in ensuring sustainable rural African livelihoods. These factors guided the development of the BMRSLS model, which consists of four sustainability spheres; social, environmental, and economic boxed by the political sphere which has an overarching influence on the four spheres. The model presents the political sphere as the enveloping sphere determining rural communities' generative resilience, situated vulnerability, and sustainability as shown across each sphere's micro, meso, and macro levels. The model is illustrated overleaf.

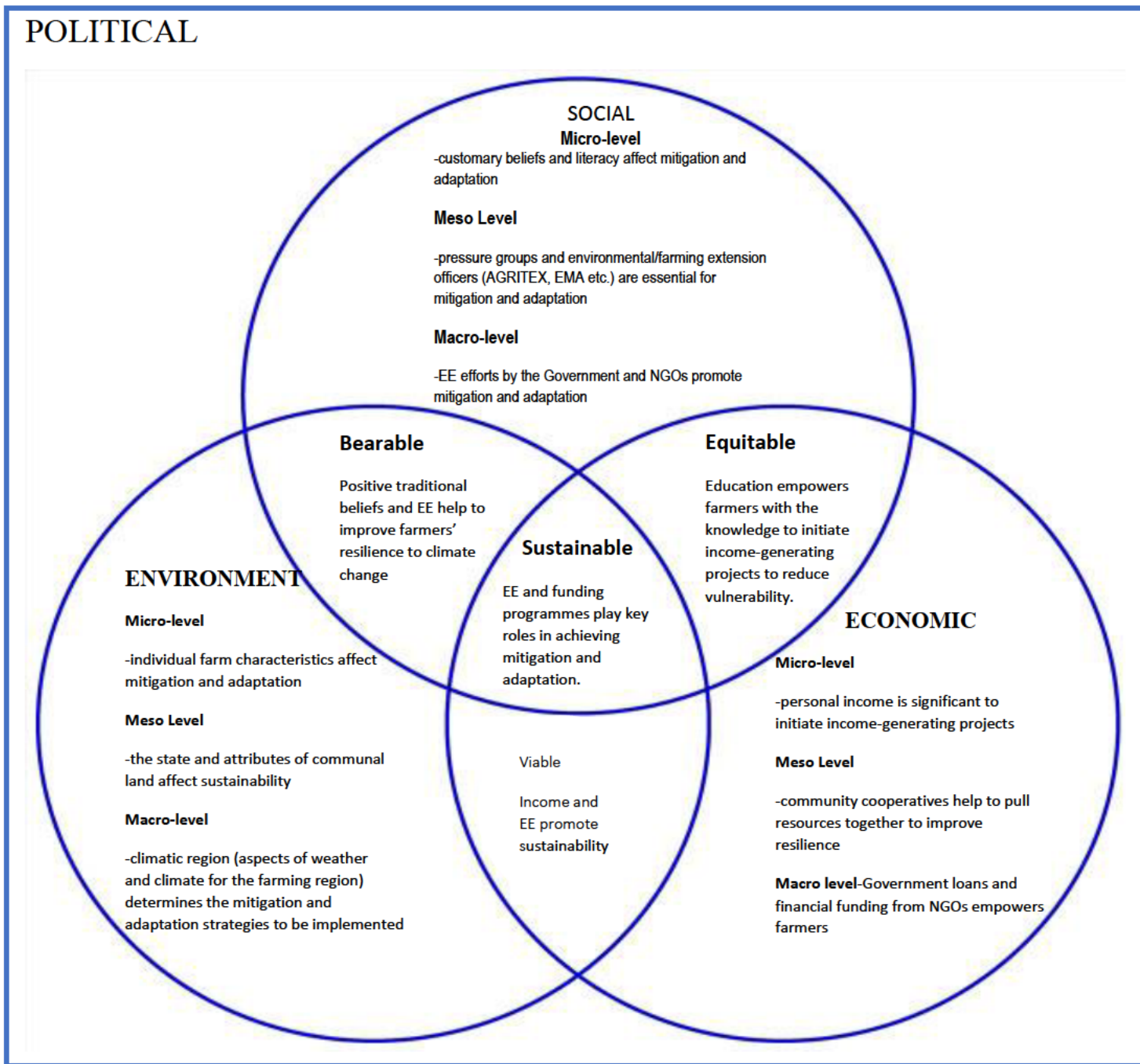


Figure 5.3.2: Box Model for Rural Sustainable Livelihoods (BMRS�).

The BMRS� model presented in Figure 5.3.2 illustrates how the political sphere envelopes/boxes in different spheres of sustainability, with all spheres affected by the following factors: resistance, resilience and vulnerability. This model is called the box model because the political sphere envelopes and overarchingly affects all the other three spheres, namely social, environmental,

and economic in Gwanda, Zimbabwe. These other three spheres intersect at the centre. Individuals and communities find themselves 'boxed in' because their resilience is mainly determined by the country's political landscape, which is generally unfavourable due to inflation. The intersecting region represents an ideal environment whereby all spheres allow farmers to mitigate and adapt to climate change, where rural sustainable livelihoods can be achieved. The following sections explain how the four spheres of sustainability affect climate change mitigation and adaptation.

a) Political sphere

As illustrated in the BMRS model, the political sphere plays a crucial role in climate change mitigation and adaptation. It also affects other spheres of sustainability, and there is a reference to the role of the government at a macro level of each sphere. For instance, the government's position on the nation's staple crop inhibits climate change mitigation and adaptation at a macro level. The research findings revealed that some farmers prefer growing maize to small grain crops because maize is the nation's staple food crop even though maize increases vulnerability to climate change while small grain crops enhance resilience. The government of Zimbabwe's open-door policy to NGOs positively influences economic, social and environmental spheres of sustainability as it enhances resilience to climate change by providing EE programmes, funding and technology to farmers. NGOs train farmers about mitigation and adaptation strategies that capacitate the human asset. Zimbabwe and China's bilateral agreements help the farmers access farm equipment even though the programme has not benefited the entire communities. However, those who received the farm equipment can practice intensive farming, which improves resilience to climate change.

On the other hand, the reported abuse of human rights in Zimbabwe and the controversial land reform policy attracted sanctions from western countries, negatively affecting climate change mitigation and adaptation because the country has limited access to external funding due to the sanctions. The research findings revealed evidence of positive initiatives for climate change in wards 12 and 16. The main drawback is the lack of funding for climate change mitigation and adaptation projects and inadequate EE projects. Thus, the political sphere in Zimbabwe, as illustrated in the BMRS model, determines and affects the extent of climate change mitigation and adaptation across all levels, micro, meso and macro.

b) Social sphere

This section discusses the social sphere for sustainability at the micro, meso, and macro levels.

i) Micro-level

Customary beliefs and literacy affect mitigation and adaptation. As reported in the previous chapter, some farmers believe that low rainfall results from the anger of the rain gods at Njelele, who feel abandoned since people no longer perform rituals at Njelele. Similarly, Mbereko et al. (2018) found that some people in Gwanda rural district believe that droughts result from the abandonment of the Njelele rain-making shrine. Cultural beliefs hinder effective climate change mitigation and adaptation since the community is not taking mitigation to climate change seriously by not taking part in the annual National tree-planting day while people continue to cut down trees that cause global warming and climate change. Lack of understanding by some of the community members that climate change results from deforestation and carbon emissions is a cause of concern, as it is likely to compromise the commitment towards conserving trees and engaging in climate-smart production systems. The research findings revealed that in wards 12 and 16 of Gwanda rural district, there is a lack of EE and skills to manage their gardens properly. It was revealed that farmers get less support from agricultural experts who seem to be based on community-owned nutritional gardens. Thus, EE programmes should be designed in such a way that they will cater to both community and individual-owned nutritional gardens. These programmes should train people to deal with parasites, properly manage their crops and market their produce.

ii) Meso Level

Pressure groups and farming extension officers (AGRITEX, EMA, etc.) are essential for mitigation and adaptation. Failure to understand the social factors regarding the communities causes disharmony between the social values and EE efforts. The availability of more and active farming extension officers in the communities helps to achieve resilience and reduce vulnerability to climate change. Lack of effective farming extension services in the communities hinders implementing climate change mitigation and adaptation strategies due to limited information and lack of knowledge (Pandey et al., 2018). The incapacitation of agricultural extension has an impact on mitigation and adaptation since it is evidenced by a lack of information about climate change, insufficient knowledge about coping strategies and lack of appropriate information on climate-related risks (Islam & Nursey-Bray, 2017; Shackleton et al., 2015; Van et al., 2015). As illustrated

by the BMRS model, a lack of information by communities can prevent them from attaining sustainable livelihoods.

Pressure groups and agricultural extension officers play an important role in mitigation and adaptation by enhancing communities' knowledge, awareness, and capacity to respond to climate change. They embark on EE programmes that improve the interest of communities in climate change mitigation and adaptation. Access to climate change education at the community level has been identified as a significant issue in climate change action. The access to climate change education is enhanced by the availability of agricultural extension officers and Non-Governmental Organizations (NGOs), which conduct workshops, allow community members to share farming experiences about successful climate change responses as well as introducing new climate change mitigation and adaptation strategies (Howden et al., 2007).

iii) Macro-level

EE efforts by the government, churches, and NGOs promote mitigation and adaptation. These are the key actors in wards 12 and 16 of Gwanda rural district thriving to achieve resilience to climate change-related perturbations, which achieve sustainable livelihoods. Churches such as Lutheran mainly assist with relief aid through food hand-outs droughts. Government departments and parastatals like GMB, EMA, and Social Welfare help communities to adapt and mitigate climate change. However, research findings revealed that in wards 12 and 16 of Gwanda rural district. These public organizations were considered less helpful than NGOs when helping farmers adapt and mitigate climate change. The economic instability in the country is responsible for the passive role of the government to help farmers mitigate climate change. The research findings revealed that the government organizations such as EMA cannot embark on extensive EE programmes to help farmers sustainably manage natural resources in the district. There is a very severe challenge of deforestation. From research findings, the government and NGOs are more responsive to the adverse effect of climate change. They respond to weather hazards such as cyclones and droughts by providing relief aid and development programmes to enhance local resilience, reducing vulnerability.

c) Environmental sphere

This section discusses the environmental sphere for sustainability at the micro, meso, and macro-level.

i) Micro-level

Individual farm characteristics affect mitigation and adaptation. The research findings revealed that individually owned nutritional gardens are experiencing challenges such as parasites and a shortage of pastures. The extension officers recommend growing small grains in wards 12 and 16 of Gwanda South District. However, some farmers continue to grow maize because the small grain crops are more vulnerable to consumption by pests such as quelea birds. The research findings established that small grains such as sorghum and millet face a significant challenge of being attacked by pests during drought periods. Thus, the prevalence of pests in the farms is one of the reasons why farmers are reluctant to grow small grain crops even though they are drought-tolerant.

ii) Meso Level

The nature and attributes of communal land affect sustainability. The research findings established a lack of secure land tenure arrangements in wards 12 and 16 of Gwanda rural district, which is necessary to enhance communities' capacity to adapt and mitigate the adverse impacts of climate change. The pastures are overwhelmed with livestock mainly because there are no clear policies about the maximum number of livestock that each household should keep. As such, where such policies are not available, the communal pastures suffer from overgrazing, and the land, in general, is exposed to overexploitation of resources such as wood. As revealed from the research findings, pilot projects are evident in Gwanda rural district. For instance, the Pelele woodland project in ward 12 is meant to protect woodland and develop beekeeping opportunities and improve carbon sinks.

iii) Macro-level

The climatic region (aspects of weather and climate for the agricultural region) determines the implementation of mitigation and adaptation strategies. Gwanda rural district is drought prone, and the community members are more vulnerable to environmental hazards such as floods. For instance, the community nutritional gardens established near dams such as Matulungundu and Gungwe are currently not functional mainly due to a shortage of water since these dams burst in 2016. Thus, climate conditions lead to vulnerability to rural communities in areas with a lack of immediate government intervention on addressing disasters caused by climate change.

d) Economic sphere

This section discusses the social sphere for sustainability at the micro, meso and macro level.

i) Micro-level

Personal income is significant to initiate income-generating projects. For instance, the findings revealed that the bursting of dams led to some innovations, especially on farmers who have access to funds. Farmers have established individual nutritional gardens, and most of these gardens relied on boreholes in their homesteads, and some were found along the Tuli River. The emerging nutritional gardens have brought a sigh of relief to the community as people can supplement low yields achieved on rain-fed agriculture. The research findings revealed that wealthier households could hire labour and afford draught power, which helps adapt and mitigate climate change. In addition, wealthier households could sell some of their livestock, as they have many, and use the proceeds to sustain themselves and buy stock feed during drought. Thus, poverty in the district increases vulnerability to climate change while wealth enhances resilience and sustainable livelihoods.

Furthermore, poverty hinders farmers from accessing suitable technology to adapt and mitigate climate change. Agricultural technology is essential for agricultural development and enhances farmers' resilience to climate change (Kuhl, 2019; Smit & Skinner, 2002; Smit & Pilifosova, 2003). Wealthier farmers can acquire agricultural technology while low-income families lack access to appropriate agricultural technology. As revealed from the research findings, most farmers in poverty-stricken communities are restricted from implementing the range of climate change mitigation and adaptation strategies available to farmers. Thus, the lack of agricultural technology is an important limit to climate change mitigation and adaptation strategies (Hayati et al., 2010; Kragt et al., 2013; Yazdanpanah et al., 2013b). Farmers' access to agricultural technology, particularly irrigation techniques, is a vital part of climate change mitigation and adaptation in communal farming.

ii) Meso Level

Community cooperatives help to pull resources together to improve resilience. The community experiences adverse effects of climate change and makes short- to long-term livelihoods adjustments. Farmers who belonged to community cooperatives coped better than poorer households who did not belong to any cooperative when germination was flawed because of dry

spells. Furthermore, cooperatives help poorer households to afford the seeds for early maturing and drought-tolerant crops.

iii) Macro-level

Government loans and financial funding from NGOs empower farmers. For instance, Agribank is offering loans to farmers, which help them to buy farming inputs. However, there is a lack of government intervention to address the negative impacts of climate change. The research findings revealed that dams destroyed by floods some years ago are still not yet repaired. As such, institutional processes for enabling mitigation and adaptation are lacking in the district. It is most likely that the lack of government intervention to reverse the damage to infrastructure is due to a lack of financial capital. The government of Zimbabwe is offering subsidized inputs in the form of mainly maize seeds and fertilizer to resettled farmers and communal farmers. However, these farming inputs are less beneficial to the farmers in Gwanda rural district, a semi-region that rarely needs fertilizer. The region is generally associated with poor maize harvests. As such, some government schemes are contrary to EE initiatives that promote the growth of small grains. Thus, lack of consistency in government policies, as evidenced by the provision of farming inputs (fertilizers and maize seeds) which do not tally with the agro-ecological location of the farmer, compromises the effectiveness of EE.

The research findings revealed that the lack of government support for small grains farming is an obstacle to the growth of small grains farming, thus reducing resilience to climate change in the district. Thus, Zimbabwe, as an economical unstable country, faces economic constraints to capacitate communities in climate change mitigation and adaptation. Financial constraints to mitigation and adaptation exacerbate vulnerability to climate change, especially in developing countries (Yazdanpanah et al., 2013a). The agricultural sector in developing countries is vulnerable to the adverse impacts of climate due to financial constraints. The research findings revealed that farmers lack government support mainly due to government budgetary insufficiencies. Thus, climate change mitigation and adaptation are constrained by a lack of financial and credit facilities. Bryan et al. (2009) and Hayati et al. (2010) argue that lack of funds and credit facilities is slowing the implementation of climate change action by farmers in most parts of the world, especially in the Global South. As revealed by the research findings, the other drawback to climate change mitigation and adaptation is implementing programmes that do not suit households' agro-ecological conditions, as alluded to earlier in this paragraph.

5.4 Conclusion

This chapter offered valuable theoretical caveats on EE drawing from the findings of this study. Two models were developed to better understand the role of EE in climate change adaptation and mitigation among farmers in the drought prone Gwanda district. Furthermore, these models can inform EE in other contexts. The next chapter summarizes literature gaps for future research, conclusions, and recommendations relative to the research findings.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

This concluding chapter of the dissertation outlines a summary of the study as espoused in the ensuing five chapters where the focus was on exploring the role of EE in climate change mitigation and adaptation in the Gwanda district of Matabeleland South province of Zimbabwe. The study was critical from a climate change lens with the intention to empower farming communities on best environmental practices. This qualitative study employed the following tools: a semi-structured interview, focus group discussion, and document analysis. The study catapulted my academic and research prowess to heights that will shape my future research interests and practice. To be a successful EE researcher, one needs to possess unlimited patience, vision, and insight into society's climatic and environmental aspects.

6.2 Key theoretical caveats on EE drawing from the findings of this study

This section presents the key conclusions that were made by this present study.

6.2.1. Ray of light on climate change mitigation and adaptation

Climate change is threatening humanity and Gwanda district, a drought-prone region found in Sub-Saharan Africa is more vulnerable. However, the study concludes that Gwanda rural communities are developing *generative resilience* as climate change threatens human survival. There are successful strategies for climate change mitigation and adaptation in Gwanda rural district. Successful climate change mitigation strategies include dry planting of crops, the establishment of nutritional gardens, growing indigenous crops (small grain crops), keeping indigenous breeds of livestock, supplementary feeding schemes of livestock, transhumance, diversification of economic activities and harvesting of wild fruits. While successful climate change mitigation strategies include woodland/rangeland management projects, Indigenous Knowledge System, renewable energy sources (electricity and solar energy), growing fodder plants, and fuel-efficient stoves. The research findings were comparatively similar to the findings of many studies conducted in Zimbabwe (Ndlovu et al., 2020; Phiri et al., 2019). They found that many strategies are being implemented to reduce the adverse impacts of climate change and some of the common strategies for climate change mitigation and adaptation implemented in the

country include crop and livestock management, conservation farming, water management, diversification of livelihoods and agroforestry (Gukurume, 2013; Jiri et al., 2015a; UNDP, 2013).

6.2.2 Impediments to climate change mitigation and adaptation

Despite evidence of successful district strategies, financial constraints and cultural norms impede climate change mitigation and adaptation. According to the IPCC report (2021), the majority of people are still unaware of the critical importance of mitigating and adapting to the climate change crisis. The study's findings revealed that successful strategies in the Gwanda district are not widely implemented, and the majority of community members are living in poverty as a result of climate change. In general, the minority ("haves") in the district who are financially stable have individually owned gardens that sustain their livelihoods, a scenario that I refer to in this current study as "its business as usual to the haves despite the climate change crisis." Thus, the research findings revealed that climate change mitigation and adaptation strategies experience many challenges that increase the vulnerability of communities to the effects of climate change.

The research participants unanimously expressed that they face challenges related to mitigation and adaptation to climate change, including lack of adequate funding of climate change programmes and cultural challenges. These challenges prevent shifts from traditional to modern ways of farming, among others. Therefore, based on the research findings, one can conclude that the question was answered. Similarly, based on studies conducted in Zimbabwe, many challenges to climate change mitigation and adaptation in Zimbabwe exist. Some of the challenges include shortage of resources, natural hazards like diseases and pests, inadequate access to credit facilities, over-reliance on natural resources, lack of knowledge and extension services (Chagutah, 2010; IPCC, 2001; Gukurume, 2013; Masud et al., 2017; Jiri et al., 2015a; UNDP, 2013). This aligns with the IPCC report (2014), which reports that communities in Africa are constrained from effectively mitigating and adapting to climate change due to poverty, lack of economic and technological resources, insufficient safety nets. Thus, EE and adequate funding are required to address the situated vulnerability and cultural resistance in Gwanda rural district.

6.2.3 Climate action efficacy as a function of EE, financial capital, and human capital

According to the research findings, the key determinants of climate change mitigation and adaptation are EE, financial support, and human capital. These determinants are summarized in the current study's key variables. Climate Action Efficacy = EE, plus Financial Capital, plus Human Capital. As a result, this study concludes that climate change mitigation and adaptation are insufficient in the absence of EE, human capital, and financial capital.

a) EE

The research findings revealed that despite the presence of successful strategies for climate change mitigation and adaptation, some gaps had to be addressed by EE. Also, the study concludes that EE for climate change should be promoted to equip farmers with relevant climate change migration and adaptation information. This aligns with other studies which reported that EE plays a significant role in climate change mitigation and adaptation (Bustreo, 2019; Palmer, 2019; Morton, 2007; Ricke, 2017). The study concludes that EE helps communities to reduce vulnerability and achieve resilience to climate change. The lack of effective EE programmes in the communities hinders climate change mitigation and adaptation strategies (Pandey et al., 2018). The study concludes that EE should be promoted to address challenges such as lack of knowledge about coping and mitigating the adverse effects of climate change (Islam & Nursey-Bray, 2017; Van et al., 2015; Shackleton et al., 2015).

EE programmes play a significant role in climate change mitigation and adaptation by enhancing communities' knowledge, awareness, and capacity to respond to climate change. Thus, the study concludes that extensive EE programmes are crucial in addressing farmers' resistance to adopting climate change mitigation and adaptation initiatives. Access to climate change education at the community level is a significant factor in climate change action. Through workshops and field trips, EE initiatives allow people to share farming experiences about successful climate change responses, improving resilience to climate change while reducing resistance and vulnerability. Thus, one can safely conclude that the critical question was well answered.

b) Financial capital

Climate change mitigation and adaptation require financial capital. Capital availability aids in the implementation of EE programs. The significant role of financial assets in climate change

mitigation and adaptation in Gwanda District qualifies it as a key determinant. Furthermore, financial capital is strongly linked to EE. According to the research findings, funding is required to implement EE. Furthermore, community members require capital to begin climate change mitigation and adaptation efforts. According to the current study, EE and financial capital reduce situated vulnerability and promote generative resilience to climate change.

c) Human capital

Human capital is a key factor in effective climate change mitigation and adaptation. Skilled personnel are capable of implementing various climate change mitigation and adaptation strategies. The research findings revealed that community members' skills, knowledge, ability to work, and good health are needed to deal with the climate change crisis. Human capital is inextricably linked to EE financial capital. EE is critical in developing the skills needed for climate action. As a result, EE is essential for improving human capital. Furthermore, financial resources are required to train people and fund their education. Thus, the current study's findings revealed that human capital influences the resilience of Gwanda District communities. This means that capital availability improves the efficacy of climate action.

6.3 Literature gaps for future research

The findings of this study show that various research gaps can be explored for future research as stated below:

- Similar studies should be conducted in different areas of Zimbabwe to attain a more comprehensive understanding of the role of EE in climate change mitigation and adaptation in the country.
- A similar study with a larger sample size should be conducted to attain quantitative evidence to determine the role of EE in climate change mitigation and adaptation for policy.
- Research can be undertaken to determine evidence of successful EE efforts in climate change mitigation and adaptation in communal areas of Sub-Saharan Africa which can serve to inform practices and strategies in other similar contexts.
- Furthermore, research can also explore the relationship between successful adaptation strategies and their links to EE programmes by local and overseas NGOs.

6.4 Conclusion

The purpose that drove this study was to explore the role of EE in climate change mitigation and adaptation in Gwanda rural district, Zimbabwe. A substantial amount of pertinent information was retrieved through research tools such as semi-structured interviews, focus group discussions, and document analysis. The study revealed that climate change mitigation and adaptation lag when the strategies are treated in isolation from EE. This study aimed to better understand the reasons for the successes and challenges for climate change mitigation and adaptation. There is a need for multi-sectoral collaboration in supporting EE programmes and addressing misconceptions and myths. If EE programmes are not supported, the communal farmers will continue to experience the adverse effects of climate change. This study hopes to appeal to the government to prioritise EE in all endeavours for climate change mitigation and adaptation.

Recommendations in the following section have been posed to the government to fund EE programmes to strengthen successful climate change mitigation and adaptation and address climate change mitigation and adaptation challenges. Recommendations for future research on this topic were also provided.

6.5 Recommendations made to the government departments, NGOs and other agents of climate action.

This study has brought to light the successes and challenges of EE efforts in climate change mitigation and adaptation among the communities of Gwanda rural district in Zimbabwe. The following recommendations have been made concerning designing and implementing EE programmes for mitigating and adapting to climate change in a drought-prone rural district. Thus, based on the research findings, the following recommendations can be made:

- There should be extensive EE programmes for climate change mitigation and adaptation in the district. The challenges identified in implementing climate change mitigation and adaptation strategies borders on a failure by some farmers in the community to perceive the adverse effects of climate change due to beliefs and notions about climate change. For example, there is a widespread belief that climate change is caused by communities' failure to adhere to cultural practices. Some people believe that climate change is a punishment from God or their ancestors. Thus, several EE programmes should be arranged to capacitate farmers in climate change mitigation and adaptation.

- Furthermore, EE programmes are required to market community gardens so that individuals can pool resources together and form cooperatives to establish their gardens. The percentage of farmers who are the direct beneficiaries of nutritional gardens sponsored by the World Vision is 1.7, which is very small. In addition, the current study revealed that individual-owned nutritional gardens along Tuli River are run at a small scale with a low surplus for sale. Thus, effective EE programmes should help farmers improve their productivity and commercialise their products which can generate more wealth for them as they are currently struggling financially.
- EE programmes should be designed to formalise the collection and drying of traditional wild food as the process is haphazardly done. Farmers should be trained on the correct drying of wild fruits such as *Umnyiye* using indigenous knowledge since scientific methods are at times detrimental to the environment. The study established that wards 12 and 16 have never experienced any training on the correct ways of drying wild fruits. Furthermore, farmers should be trained in the sustainable management of wild food resources.
- It is also revealed that the district is benefiting from adaptation strategies for climate change, but they are lagging in strategies for pastoral farming. Thus, there is a need for EE on mitigation and adaptation strategies for climate change concerning pastoral farming.
- Thus, the research findings revealed the need for the government to address the issue of stable food and EE needed to facilitate the shift from growing the nation's staple crop to small grain crops such as millet and sorghum. Thus, this study recommends that, if possible, the nation's staple crop should be marketed as one of the small grain crops. This recommendation is based on farmers' growing maize simply because it is the nation's staple crop and it thus occupies a high status. This change can help households cope with drought because small grains are drought tolerant and favourable to long-term storage that can cushion communities during successive drought cycles. Small grains are more relevant in the semi-arid regions owing to their levels of drought tolerance. They have a substantial adaptive advantage and lower risk of failure in semi-arid districts of the country. During drought periods, small grains have better chances of success when compared to maize thus it isn't rational to advocate for the continuation of maize as Zimbabwe's staple food
- Government should invest in the repair and renovation of infrastructure such as bridges and roads to enhance the resilience of farmers to climate change. According to the research

participants, government is neglecting the development of roads in rural areas. Some research participants believe that the money allocated for the development of roads in rural areas is insufficient and that the government should attempt public/private partnerships or attract funders to assist in the development of the roads.

- To promote sustainable livelihoods and reduce vulnerability to climate change, the government needs to establish an optimal agricultural policy that would offer small grain seeds to farmers in semi-arid regions such as Gwanda and keep maize for those regions in the eastern parts of Zimbabwe that generally experience favourable rainfall.
- Thus, to achieve resilience, measures should be put in place to protect and conserve livelihood resources, and people need to be educated to get better results from their activities.
- Furthermore, EE programmes are required to promote the growth of both temporary fodder plants and establish permanent fodder grass to enhance carbon sequestration and reduce the destruction of trees associated with overgrazing.
- There is a need for EE programmes to share experiences on how best to keep the stock feeds because some farmers were complaining of pests such as termites that destroy their stock feeds. In addition, farmers should be educated about the significance of starting early to feed their livestock whilst they are still strong. Furthermore, EE programmes should be designed and implemented to teach and advise all farmers to buy molasses to be mixed with leaves to overcome the nutritional limitation of dry leaves with high fibre, which has health repercussions in terms of digestion.
- The AGRITEX and EMA officers should embark on intensified EE efforts. They should consider how social factors such as group identity can make it difficult for communities to mitigate and adapt to climate change. Thus, climate change mitigation and adaptation gaps should be addressed by EE. The research findings revealed a potential to protect and restore rangelands and pastures, mainly if the negative traits of culture can be addressed.
- The environmental/farming extension workers need to be capacitated through vehicles and fuel to promote resilience amongst farmers. This increase in physical resources will help them address taste issues regarding the palatability of small grains that inhibit farmers from growing small grains that can build resilience to droughts and prevent food insecurity.

- The research findings also revealed that the local communal farmers benefit from these micro innovations for climate change such as installing nutritional gardens, and growing fodder crops, and transhumance. There are also micro-innovations for EE such as (1) field days, (2) information and skills sharing amongst neighbours, (3) AGRITEX'S periodic reports on successful drought mitigation strategies and (4) skills sharing on community gardens. However, a few farmers only practised these micro innovations for EE and climate change action. There is a need for marketing these locally based EE initiatives and climate change mitigation and adaptation innovations to benefit the entire district. The NGOs and government departments should embark on research in climate change mitigation and adaptation strategies that suit the local communities. Most importantly, the local communities must be consulted when designing EE programmes to establish mutual co-beneficial relationships that can reduce the possibility of resistance to climate change mitigation and adaptation strategies.
- The research findings revealed a need for continuous community engagement through EE programmes to address contradictions between modern farming techniques and traditional customary beliefs. Thus, EE should be promoted to encourage people to practise dry planting.
- EE programmes are required to educate people on sustainable ways of improving soil fertility. For instance, farmers should be educated about the importance of using manure to improve soil fertility as supported by indigenous knowledge systems on natural fertilizers. This will help to avoid the poisoning of the soil that is associated with the use chemical fertilisers since current research has reported that Bill Gates promoted fertilisers for Africa are detrimental to the environment (Phillips, 2021).
- EE programmes should be designed for marketing climate action strategies such as dry planting, which face some form of resistance by community members due to cultural beliefs. The research findings depicted that not all farmers practice dry planting even though it has proved to be a successful strategy amongst the farmers who practice it. Like any other strategy, the challenges associated with dry planting should be identified, and farmers should provide mitigation measures.
- EE programmes should be promoted to encourage the use of energy savers which reduce the carbon footprint of households. For instance, households should be encouraged to use

electrical gadgets that have a label indicating environmental safety. This is a similar idea to the ENERGY STAR label commonly used in the Global North and it should be promoted in rural African communities such as Gwanda rural district to encourage awareness.

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Appendix One: Semi-Structured Interview Guide

SEMI STRUCTURED INTERVIEW GUIDE

Environmental education on climate change mitigation and adaptation: The case of Gwanda rural district, Zimbabwe.

INTRODUCTION:

My name is Mr Aroriso Sibanda; I am a PhD student at the University of KwaZulu-Natal, Edgewood campus, South Africa. The title of my research is Environmental education on climate change mitigation and adaptation: The case of Gwanda rural district, Zimbabwe. I am interested in exploring the successes and challenges of environmental education efforts in climate change mitigation and adaptation among the communities of Gwanda rural district in Zimbabwe. You are assured that the information you provide will be kept confidential and will only be utilized for research purposes. You must be honest in giving your views and feel to ask questions if you do not understand any question.

TOPICS:

1. Can you tell me about climate change mitigation and adaptation strategies implemented in your community?

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2. a) Which mitigation and adaptation strategies for climate change are successful and can be used in environmental education programmes?

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- b) What do you think makes these strategies successful?

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3. What challenges are faced in mitigation and adaptation for climate change in Gwanda rural district

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b) How do you think these challenges can be addressed by environmental education programmes?

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4. a) Identify environmental education programmes in the district:

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b) What do you think has to be done to support environmental education programmes in the district?

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Appendix two: Focus Group Discussion Guide

FOCUS GROUP DISCUSSION GUIDE

Environmental education on climate change mitigation and adaptation: The case of Gwanda rural district, Zimbabwe.

INTRODUCTION:

My name is Mr Arorisoe Sibanda; I am a PhD student at the University of KwaZulu-Natal, Edgewood campus, South Africa. The tittle of my research is; Environmental education on climate change mitigation and adaptation: The case of Gwanda rural district, Zimbabwe. I am interested in exploring the successes and challenges of environmental education efforts in climate change mitigation and adaptation among the communities of Gwanda rural district in Zimbabwe. You are assured that the information you provide will be kept confidential and will only be utilized for research purposes. You must be honest in giving your views and feel to ask questions if you do not understand any question.

TOPICS:

- 1. What are the climate change mitigation and adaptation strategies currently adopted in Gwanda?

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- 2. What do you think can be done to promote mitigation and adaptation strategies for climate change in the district?

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- 3. Is environmental education currently contributing to successful strategies for climate change mitigation and adaptation? Explain

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- 4. What do you think are the limits for environmental education programmes and can they be improved? Explain how if you believe so.

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- 5. Do you have any suggestions on ways of improving environmental education programmes in the district?

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Appendix Three: Informed Consent Form for Community members

Gwanda High School
P O Box 40
Gwanda

Dear Participant / community member

INFORMED CONSENT LETTER

My name is Mr. Arorisoe Sibanda; I am a PhD student at the University of KwaZulu-Natal, Edgewood campus, South Africa. My supervisor is Associate professor Sadhana Manik (manik@ukzn.ac.za). The title of my research is; Environmental education on climate change mitigation and adaptation: The case of Gwanda rural district, Zimbabwe. I am particularly interested in exploring the successes and challenges of environmental education efforts in climate change mitigation and adaptation among the communities of Gwanda rural district in Zimbabwe.

As a community member, you are one of my targeted population. To gather the information, I am interested in asking you some questions.

The instruments I will be using to collect data are:

- Interviews
- Focus group discussions

Please note that:

- Your confidentiality is guaranteed as your inputs will not be attributed to you in person, but reported only as a participant's opinion.
- The interview may last for about 30 minutes.
- Any information given by you will be used for purposes of this research only.

- All documents will be stored securely at the University of KwaZulu-Natal in the Social Sciences archives of the School of Education for a period of 3 years and thereafter destroyed by shredding.
- You have a choice to participate, not to participate or to stop participating in the research. You will not be penalized for taking such an action.
- The research aims on exploring the successes and challenges of environmental education efforts in climate change mitigation and adaptation among the communities of Gwanda District in Zimbabwe.
- Your involvement is purely for academic purposes only, and there are no financial benefits involved.

Please indicate your willingness to participate in each of the following:

Instrument	Willing	Not willing
interview		
Focus group discussion		

If you are willing to be interviewed, please indicate (by ticking as applicable) whether or not you are willing to allow the interview to be recorded by the following equipment:

Equipment used	Willing	Not willing
Audio equipment		

Thank you for your contribution to this research.

My email address is: aromatzibandah@gmail.com

My cell phone number is: XXXXXXXXXX

DECLARATION

I..... (Full names of participant) hereby confirm that I understand the contents of this document and the nature of the research project, and I consent to participating in the research project.

I understand that I am at liberty to withdraw from the project at any time, should I so desire.

.....
SIGNATURE OF PARTICIPANT

.....
DATE

Appendix Four- Informed Consent Form-EMA Officer

Gwanda High School
P O Box 40
Gwanda

Dear Participant/EMA officer

INFORMED CONSENT LETTER

My name is Mr. Arorisoe Sibanda;I am a PhD student at the University of KwaZulu-Natal, Edgewood campus, South Africa. My supervisor is Associate Professor Sadhana Manik (manik@ukzn.ac.za).The title of my research is; Environmental education on climate change mitigation and adaptation: The case of Gwanda rural district, Zimbabwe. I am particularly interested in exploring the successes and challenges of environmental education efforts in climate change mitigation and adaptation among the communities of Gwanda rural district in Zimbabwe.

As an EMA officer, you are one of my targeted participants. To gather the information, I am interested in asking you some questions.

The instruments I will be using to collect data are:

- Interviews
- Focus group discussions

Please note that:

- Your confidentiality is guaranteed as your inputs will not be attributed to you in person, but reported only as a participant’s opinion.
- The interview may last for about 30 minutes.
- Any information given by you will be used for purposes of this research only.
- All documents will be stored securely at the University Of KwaZulu-Natal in the Social Sciences archives of the School of Education for a period of 3 years and thereafter destroyed by shredding.
- You have a choice to participate, not to participate or to stop participating in the research.
- The research aims on exploring the successes and challenges of environmental education efforts in climate change mitigation and adaptation among the communities of Gwanda rural district in Zimbabwe.
- Your involvement is purely for academic purposes only, and there are no financial benefits involved.

Please indicate your willingness to participate in each of the following:

Instrument	Willing	Not willing
interview		

Focus group discussion		
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If you are willing to be interviewed, please indicate (by ticking as applicable) whether or not you are willing to allow the interview to be recorded by the following equipment:

Equipment used	Willing	Not willing
Audio equipment		

Thank you for your contribution to this research.

My email address is: aromatzipandah@gmail.com



DECLARATION

I..... (Full names of participant) hereby confirm that I understand the contents of this document and the nature of the research project, and I consent to participating in the research project.

I understand that I am at liberty to withdraw from the project at any time, should I so desire.

.....
SIGNATURE OF PARTICIPANT

.....
DATE

Appendix Five Proposed Informed Consent Form-AGRITEX Officer

Gwanda High School
P O Box 40
Gwanda

Dear Participant/AGRITEX officer

INFORMED CONSENT LETTER

My name is Mr. Aroriso Sibanda; I am a PhD student at the University of KwaZulu-Natal, Edgewood campus, South Africa. My supervisor is Associate Professor Sadhana Manik (manik@ukzn.ac.za). The title of my research is; Environmental education on climate change mitigation and adaptation: The case of Gwanda rural district, Zimbabwe. I am particularly interested in exploring the successes and challenges of environmental education efforts in climate change mitigation and adaptation among the communities of Gwanda district in Zimbabwe.

As an AGRITEX officer, you are one of my targeted participants. To gather the information, I am interested in asking you some questions.

The instruments I will be using to collect data are:

- Interviews
- Focus group discussions

Please note that:

- Your confidentiality is guaranteed as your inputs will not be attributed to you in person, but reported only as a participant's opinion.
- The interview may last for about 30 minutes.
- Any information given by you will be used for purposes of this research only.
- All documents will be stored securely at the University Of KwaZulu-Natal in the Social Sciences archives of the School of Education for a period of 3 years and thereafter destroyed by shredding.
- You have a choice to participate, not to participate or to stop participating in the research.
- The research aims on exploring the successes and challenges of environmental education efforts in climate change mitigation and adaptation among the communities of Gwanda District in Zimbabwe.
- Your involvement is purely for academic purposes only, and there are no financial benefits involved.

Please indicate your willingness to participate in each of the following:

Instrument	Willing	Not willing
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interview		
Focus group discussion		

If you are willing to be interviewed, please indicate (by ticking as applicable) whether or not you are willing to allow the interview to be recorded by the following equipment:

Equipment used	Willing	Not willing
Audio equipment		

Thank you for your contribution to this research.

My email address is: aromatzibandah@gmail.com



DECLARATION

I..... (Full names of participant) hereby confirm that I understand the contents of this document and the nature of the research project, and I consent to participating in the research project.

I understand that I am at liberty to withdraw from the project at any time, should I so desire.

.....
SIGNATURE OF PARTICIPANT

.....
DATE

APPENDIX SIX: ETHICAL CLEARANCE APPROVAL



05 December 2019

Mr Aroriso Sibanda (219093949)
School Of Education
Edgewood Campus

Dear Mr Sibanda,

Protocol reference number: HSSREC/00000790/2019

Project title: The role of Environmental Education in climate change mitigation and adaptation: The case of Gwanda Rural District, Zimbabwe.

Approval Notification – Expedited Application


This letter serves to notify you that your application received on 05 November 2019 in connection with the above, was reviewed by the Humanities and Social Sciences Research Ethics Committee (HSSREC) and the protocol has been granted **FULL APPROVAL**.

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment/modification prior to its implementation. In case you have further queries, please quote the above reference number. **PLEASE NOTE:** Research data should be securely stored in the discipline/department for a period of 5 years.

This approval is valid for one year from 05 December 2019.

To ensure uninterrupted approval of this study beyond the approval expiry date, a progress report must be submitted to the Research Office on the appropriate form 2 - 3 months before the expiry date. A close-out report to be submitted when study is finished.

Yours sincerely,


Professor Urmilla Bob
University Dean of Research

/dd

Humanities & Social Sciences Research Ethics Committee
Dr Rosemary Sibanda (Chair)
UKZN Research Ethics Office Westville Campus, Govan Mbeki Building
Postal Address: Private Bag X54001, Durban 4000
Website: <http://research.ukzn.ac.za/Research-Ethics/>

Founding Campuses:  Edgewood  Howard College  Medical School  Pietermaritzburg  Westville

INSPIRING GREATNESS

APPENDIX SEVEN: APPROVAL TO CONDUCT RESEARCH BY GWANDA RURAL DISTRICT COUNCIL



GWANDA RURAL

Fax2 No. + 263 284 23102

Telephone: +263 284 22312 / 22369
E-mail: grdc@wyafrica.co.zw
All Correspondence to be addressed to
The Chief Executive Officer
REF: XC/135/36

DISTRICT COUNCIL

**P O BOX 59
GWANDA
ZIMBABWE**

18 June 2019

TO WHOM IT MAY CONCERN

RE: APPROVAL TO CONDUCT EDUCATIONAL RESEARCH AND LETTER OF INTRODUCTION: ARORISOE SIBANDA ST NO 219093949

The above subject matter is relevant.

May you be notified that Gwanda Rural District Council, a local authority established under the auspices and provisions of the Rural District Council Act Chapter 29:13 has duly allowed the above mentioned individual to carry out his educational endeavours. It is buttressed and emphasized that the attained information or data will solely be used for his educational purposes while his opinions are as per individual perception, Council will not be responsible for any circumstantial misdeeds. While he conducts his research proper educational ethics should be adhered to and we believe by granting such Council is contributing relevantly to the country's manpower development. His findings or feedback will be most welcome to our data bases and decision making input. Aroriso Sibanda (219093949) is a PHD student at University of Kwazulu- Natal and his topical research subject is "*Environmental education on climate change mitigation and adaptation. The case of Gwanda Rural District*".

We look forward to your profound assistance while wishing him all the best success in her studies and future endeavours.

Kind regards

.....
K. Sithole
Executive Officer Administration
For: CHIEF EXECUTIVE OFFICER



APPENDIX EIGHT: APPROVAL TO CONDUCT RESEARCH BY AGRITEX



May 25, 2019

Arorisoe Sibanda 219093949

Gwanda High School

P Bag 40

Gwanda

RE: Environmental education on climate change, mitigation and adaptation in Gwanda district

The department has no objection to the intended research to be conducted in Gwanda district.

The department values the confidentiality of the information: I therefore encourage you to use the information for the intended use that is for the research. The department also will be interested in getting the summary of the finding to improve decision making process.

Yours



Hove G

A/DCLPO

GWANDA



APPENDIX NINE: APPROVAL TO CONDUCT RESEARCH BY EMA



ENVIRONMENTAL MANAGEMENT AGENCY

All communications should be addressed to "The Director General"
685/686 Lorraine Drive/Faber Road, Bluffhill,
P O Box CY 385, Causeway, Harare
Harare
Telephone 08677006244; (04) 305550 /310084; 305543
E-mail: ema@ema.co.zw

03 July 2019

Gwanda High School
P.O Box 40
Gwanda

Att: Mr A Sibanda

RE: Approval to carryout PhD Research in Gwanda

The above matter refers. The Agency has approved your request to carry out environmental research in Gwanda. You are requested to fully identify yourself as a student in the field and to abide with all national regulations that regulate research in the country.

If you gather data from EMA please share your findings with the Agency upon completion.

All the best in your studies.



Ntandokamlimu Nondo

Principal Research Officer

TOGETHER - PROTECTING THE ENVIRONMENT

Mrs F.Z. Chideya (Chairperson); Mr C Chitindi (Vice Chairperson); Mr N Mushangwe (Member); Mrs S Sidambe (Member); Mrs J Chiketa (Member) Mr L Muwoni (Member); Ms M Mayahle (Member); Mr I D Kunene (Member); Mr A Matiza (Member); Mr.A Chigona (Member)

Appendix Ten: Turnitin Report



Aroriso Sibanda PhD Thesis by Aroriso Sibanda

From PhD thesis (Geog Phd)

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Word Count: 62479

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