

**SIMON DIEDONG DOMBO UNIVERSITY OF BUSINESS AND
INTEGRATED DEVELOPMENT STUDIES**

**CLIMATE CHANGE ADAPTATION PRACTICES IN GHANA:
HARNESSING LOCAL KNOWLEDGE SYSTEMS IN TIME OF DISASTER
IN THE BONGO DISTRICT OF THE UPPER EAST REGION**

ERNEST DABIL NABWOMYA

2024

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**THESIS SUBMITTED TO THE DEPARTMENT OF COMMUNITY
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DEVELOPMENT STUDIES IN PARTIAL FULFILLMENT OF THE
REQUIREMENTS FOR THE AWARD OF MASTER OF PHILOSOPHY IN
PROJECT MANAGEMENT AND COMMUNITY DEVELOPMENT**

JULY, 2024

DECLARATION

Candidate's Declaration

I hereby declare that this thesis is the outcome of original research conducted by me and that no part of it has been presented for another degree in this university or elsewhere, except citations that have been acknowledged as references.

Candidate's Signature.....


Date: 27th August, 2024

Name: Ernest Dabil Nabwomya

Supervisor's Declaration

I hereby declare that the preparation and presentation of this thesis were supervised under the guidelines on supervision of the thesis laid down by the SD Dombo University of Business and Integrated Development Studies (SDD- UBIDS)

Name: Prof. Samuel Ziem Bonye

Supervisor's Signature.....

Date:

ABSTRACT

Globally, climate change adaptation efforts sometimes disregard the unique contribution of indigenous knowledge systems. This study sought to assess climate change adaptation techniques that include local knowledge systems into disaster management in the Bongo District of the Upper East Region. The mixed method was employed in the study, with 351 respondents sampled. The simple random and purposive sampling procedures were used. Primary and secondary data sources were also used. Data collecting methods included questionnaires, focus group talks, and key informant interviews. The findings revealed a diverse local knowledge system within the Bongo District, such as multi-cropping, cultivation of drought-resistant and water-resistant crops, tree planting around dwellings, and the use of sandcrate blocks for construction, which were integrated into modern disaster management frameworks. The study also highlighted the use of these local knowledge systems in managing climate-related disasters such as floods, droughts, windstorms, and pest infestations. Notable approaches included cultivating early developing crop varieties, using sand for block molding, strategic tree planting, rooftop reinforcing, applying organic fertilizers, soil conservation techniques, and using traditional crop protection methods. These approaches, when integrated into disaster management plans, provide robust responses to climate-induced adversity. Based on these findings, recommendations are provided to relevant agencies such as the National Disaster Management Organization, the Environmental Protection Agency, and the Ghana Meteorological Agency to strengthen community capacity-building initiatives for disaster preparedness and mitigation. Communities can increase their resilience to the effects of climate change by combining indigenous knowledge systems with modern techniques.

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DEDICATION

I dedicate this work to my lovely family; most especially my wife (Madam Vida Agana-Nabwomya) my mother (Mma Janet Ziyaaba), my son (Conrad Yinmoya Nabwomya) and my daughter (Empress Chi-ka Yinsongmani Nabwomya) for their inspiration and moral support throughout the academic journey

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LIST OF ABBREVIATIONS

BDA	Bongo District Assembly
CG	Central Government
CSIR	Center for Scientific and Industrial Research
CSOs	Civil Society Organizations
DA	District Assembly
DAs	District Assemblies
DoP	Department of Planning
EHSU	Environmental Health and Sanitation Unit
EPA	Environmental Protection Agency
EPA	Environmental Protection Agency
FAO	Food and Agriculture Organization
FGD	Focus Group Discussion
FSD	Forest Service Division
GFC	Ghana Forestry Commission
GFWP	Ghana's Forest and Wildlife Policy
GIS	Geographic Information System
GSS	Ghana Statistical Service
GWCL	Ghana Water Company Limited
IDRC	International Development Research Centre
IEG	Institute of Environment and Governance
KII	Key Informant Interview
MEST	Ministry of Environment, Science, and Technology
MLNR	Ministry of Lands and Natural Resources
MMDAs	Metropolitan Municipal & District Assemblies

MoFA	Ministry of Food and Agriculture
MTS	Modified Taungya System
MWRWH	Ministry of Water Resources Works and Housing
NADMO	National Disaster Management Organization
NGOs	Non- Governmental Organization
OECD	Organization of Economic Cooperation and Development
SES	Social-Ecological Systems
SPSS	Statistical Package for Social Sciences
UN	United Nation
UNCCD	Convention to Combat Desertification
UNDP	United Nations Development Programme
UNEP	United Nations Environmental Programme
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
UNFCCC	UN Framework Convention on Climate Change
URT	United Republic of Tanzania
WB	World Bank
WLD	Wildlife Division

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Globally, climate change has been acknowledged as a principal humanitarian and environmental crisis (Malhi et al, 2020). Climate change has become a monster and is currently a major development challenge in many countries in the world (Borowski, 2020). It is acknowledged that the occurrences of climate change in dry land and semi-arid regions linked to changes in rainfall are severe worldwide (IPCC, 2014). However, locations near the tropics, notably those in the northern and southern latitudes, are anticipated to be negatively impacted by a reduction in rainfall intensity (IPCC, 2019). This is in contrast to other temperate regions, which will benefit from enhanced rainfall intensity (IPCC, 2019). Their vulnerability to climate change is increased by the addition of a new set of threats (IPCC, 2019). Extreme weather occurrences like droughts, floods, and heat waves are predicted to increase in frequency in the future in many regions of the world (Abram et al. 2021). Anticipated developments include rising temperature extremes and an increased occurrence of hot days throughout West African countries, as noted by the United States Environmental Protection Agency in 2016 and further corroborated by Weber et al. (2018). Increases in temperature extremes and the frequency of hot days are predicted to occur across West African nations, and the Sahel region in particular (IPCC, 2018; WMO, 2021).

The increasing effects of climate change in developing countries including Sub-Saharan Africa have become more pronounced (Nightingale et al, 2020). The vulnerability of third-world countries to climate change is largely because of their dependence on agriculture as the mainstay of their economies (Nightingale et al, 2020). These effects are undoubtedly already present in many regions of the world, with potentially

disastrous repercussions for the rural poor (Adger et al. 2009). The rural poor must adopt tactics that have evolved and are not dependent on the climate since they face climatic challenges (Fan and Rue, 2020). Water supply, pests and illnesses, food production, and food insecurity are all predicted to get worse in the next years as a result of climate change (Wijana, 2015). The contribution of adaptation to lessening the negative effects of climate change is beyond dispute (IPCC, 2014; Williams, Crespoa, & Mumuni, 2019). The capacity of nations to adapt to climate change has recently been constrained by issues like access to capital, knowledge, education, and technology (UNEP, 2014). These obstacles have made it more difficult for nations and communities to develop strategies for adapting to climate change (UNEP, 2014).

The success of climate change adaptation in Ghana depends on the local knowledge systems that enable local groups to react to climatic shocks (Agrawal, 2001). However, most climate-affected regions, including Ghana, frequently overlook the contributions that local knowledge systems arrangements can make to rural residents' ability to respond to climate change impacts and develop a sustainable strategy to disaster management.

Sadly, according to statistics from Ghana Statistical Service (GSS) (2014), the Upper East Region of Ghana has been one of the poorest regions in the country. The region was placed eighth in terms of the incidence of poverty. Additionally, a report by the World Food Program, WFP (2012) claims that the region is vulnerable to additional factors such as climate change and variability due to a larger percentage of food-insecure households and a 56% poverty rate. The transition from traditional subsistence farming to agribusiness in the Bongo district is fraught with formidable difficulties. Food insecurity and risks to improved lives are influenced by a variety of variables,

including limited access to land, improved agricultural inputs and inventions, poor soils, a lack of storage facilities, and markets (Bongo District Assembly, 2014). Furthermore, given the vulnerability of the community's environment and its reliance on rain-fed agriculture, climate change is aggravating already-existing problems by encouraging changes in farming seasons, introducing new pests and diseases, and increasing temperatures.

1.2 Statement of the Problem

The effects of climate change are felt locally in communities around the world; it is a global phenomenon (Barros 2014). By 2050, the global cost of adaptation is predicted by the IPCC (2014) to be between \$70 billion and \$100 billion (IPCC, 2014). However, according to projections from the World Bank, the total amount will be between \$10 billion and \$40 billion at the same time (UNEP, 2014). There are variations between nations in this. Regardless of the number, adaptation to climate variability is financially challenging, especially in developing nations that are already struggling to satisfy their own adaptation demands. Adaptive capacity is constrained by the high prevalence of poverty and insufficient financial resources (UNEP, 2014). The Food and Agriculture Organization (FAO) predicts that agricultural production will need to expand by 70% by 2050 in order to meet the anticipated demand for food and feed if current income and consumption patterns continue (FAO, 2013a; 2013b). Farmers must both adapt to climate change and reduce their contribution to it in order to limit the rate at which this global issue advances, which adds to these difficulties (FAO, 2014).

Temperature extremes and the number of hot days is anticipated to rise across West African countries, particularly in the Sahel region. The ongoing warming of the earth's climate is causing changes in precipitation around the world (Gathii, 2020). Rainfall patterns in Southern Africa, for example, have grown more variable and unpredictable

(Kariuki, 2020). A trend of declining mean rainfall is expected across West Africa under greater global warming scenarios (Kariuki, 2020).

Furthermore, it is projected that there would be more unpredictable rainfall patterns and extreme occurrences such as droughts, floods, and heatwaves in the future (Kummu et al., 2021). SSA is one of the most vulnerable regions to climate change due to its high exposure to climate risks (Bardsley et al., 2021), as well as the fragility of its production and livelihood systems. Despite the fact that the Sub-Saharan Africa (SSA) countries contribute comparatively little to global warming in comparison to the industrialized world, the region is anticipated to incur disproportionately high climate change risks due to its relative exposure and sensitivity.

In Ghana, climate change threats are a result of a variety of reasons, including poverty, difficulties with agro-infrastructure, traditional land tenure systems, institutional limitations, and a lack of social safety nets become a barrier to building resilience to adaptation (Nyantakyi-Frimpong, 2020). Furthermore, as a result of limited resources that constrain their ability to adapt, climate change is heightening the susceptibility of agricultural systems in Ghana (Abdul-Razak and Kruse, 2017 and Owusu et al., 2021). Presently, a key factor exacerbating food scarcity and malnutrition in the northern region of Ghana is the agricultural sector's vulnerability to the impacts of climate change, (Wood et al., 2019).

Antwi-Agyei and Nyantakyi-Frimpong (2021) argue that in Ghana there are a variety of local storage techniques, such as erecting barns and platforms, to protect harvests, particularly grains, from post-harvest losses in the area. Though residents, particularly those in rural regions, are benefiting from these traditional methods in terms of food security, there is still a lack of understanding regarding how these methods could

flourish or be maintained (Alhassan et al, 2018). By implementing cultural restrictions on rainwater collection and the conservation of forests, farming households and communities utilize indigenous knowledge to conserve water for agricultural purposes, as demonstrated in studies by Bofo et al. (2016) and Opare (2018). In this region, farmers have harnessed traditional ecological wisdom to develop tactics for combatting insect pests that affect food crops, as evidenced in research by Shaiba et al., (2019). Additionally, to broaden the scope of their agricultural activities, numerous smallholder farmers in northern Ghana are cultivating various drought-resistant indigenous crops (Asante et al., 2021; Fagariba et al., 2018). Farming and mixed cropping are two other significant traditional methods that are frequently used by many Indigenous farmers to manage their lands and crops to reduce the hazards associated with climate change (Alhassan et al., 2018).

Unfortunately, climate change adaptation strategies in Ghana place less emphasis on local knowledge systems (Atanga, 2020; DeGraft-Johnson et al., 2014; Sova et al., 2014). Emphasis has been placed on a strategy that does not integrate local knowledge systems. For instance, to improve agriculture across the country, the government of Ghana has put in place initiatives like the Agricultural Mechanization Service Centers, National Fertilizer Subsidy Initiative, and Planting for Food and Jobs that involve the importation and distribution of tractors, fertilizers, pesticides, and improved seeds to farmers (Kasanga et al., 2018; Ministry of Food and Agriculture, 2017). It is extremely worrying to see how traditional knowledge and related technologies are slowly vanishing. This is partly because of the focus on scientific knowledge and methods, but it is also because there hasn't been enough effort put into figuring out how local knowledge could support modern agricultural development in Ghana, especially in the north.

The impact of neem on fall armyworm damage to maize crops: a field-based study in Nabdam District, EUR, Ghana, and a study on the function of local knowledge systems in integrating local and scientific knowledge in the management of community-based disaster are just two examples of the numerous studies on climate change and adaptation practices that have been conducted. Mugambiwa's (2018) research delves into strategies for adapting to climate change through the integration of local practices and indigenous knowledge systems within Zimbabwe's Mutoko rural district. Makondo and Thomas' (2018) study focuses on climate change adaptation and the effective incorporation of local knowledge systems alongside Western science. Klenk et al. (2017) explore the role of local knowledge in climate adaptation research, advocating for a shift from extracting knowledge to co-producing it. Additionally, Mapfumo, Mtambanengwe, and Chikowo's (2016) work centres on the utilization of local knowledge systems to bolster the resilience of smallholder farmers, facilitating their adaptation to climate change and variability in southern Africa.

Again, disadvantaged communities are drawing on Indigenous wisdom to supplement modern techniques to addressing social and environmental hazards (Ebhuoma and Simatele, 2019). Integrating Indigenous knowledge with scientific knowledge in the context of climate change adaptation at various local spatial scales is especially important because it allows farmers to reduce their vulnerability to climatic risks and future climate uncertainties while maintaining their livelihoods (Hamilton and Lubell, 2019).

Furthermore, effective integration of Indigenous knowledge with other knowledge systems will provide up chances for sustainable livelihood and environmental management for many household groups, particularly in rural areas (Auer et al., 2020). Although studies have highlighted the contributions of local knowledge systems to

climate adaptation, the value of Indigenous knowledge is being overlooked in Ghana, despite the fact that many studies and policies around the world demonstrate the importance of understanding and applying that knowledge for effective adaptation. This study sought to investigate climate change adaptation practices that harness local knowledge systems in times of disaster in the Bongo District of the upper east region of Ghana where the threats of climate change could be imminent.

1.3 Research Questions

1.3.1 Main Research Question

What are the local knowledge systems and to what extent can they harness climate change adaptation in times of disaster in the Bongo District?

1.3.2 Specific Research Questions

1. How does the local knowledge system enhance climate change adaptation in time of disaster in Bongo District?
2. What are the local climate change adaptation strategies that are used in time of disaster in the Bongo District?
3. What local adaptation practices are integrated into disaster management plans in the Bongo District?

1.4 Research Objectives

1.4.1 Main Research Objective

To assess the extent to which local communities experience and adapt to climate change impacts using the local knowledge system in a time of Disaster in the Bongo District

1.4.2 Specific Research Objectives

1. To explore for local knowledge systems contributions to climate change adaptation in times of disaster in the Bongo District.

2. To examine the local climate change adaptation strategies used by local communities in times of disaster in the Bongo District
3. To explore local adaptation practices that are integrated into disaster management plans in the Bongo District

1.5 Significance of the Study

The study is expected to contribute to NADMO's work in designing climate adaptation strategies in a time of disaster as findings from the study could be a game-changer given the issues of climate change, adaptation, disaster, and local knowledge systems emanating from the research.

This work not only adds up to existing knowledge and theories but also contributes positively to harnessing the local knowledge system in a time of disaster in the Bongo District. This is because the study proffers possible strategies that can be adopted by local communities and actors, including the Bongo District Assembly and NGOs to harness local knowledge during a disaster. Also, the research serves as a source of knowledge or information that can help local and external stakeholders to re-examine their approaches to climate change adaptation while making conscious efforts at maximizing the benefits of local knowledge systems to adaptation in times of disaster.

1.6 Scope of the Study

Geographically, the study was conducted in the Upper East Region's Bongo District, which is bounded by Burkina Faso to the north, Kasena-Nankana district to the west, Bolgatanga Municipality to the south, and Nabdam district to the east. Contextually, the study focuses on climate change adaptation practices that harness local knowledge systems in times of disaster; it also focuses on adaptation strategies, the effectiveness of adaptation strategies, and local knowledge integrations in disaster plans. Regarding the timeline, the study began with the development of research proposal in June, 2021

and continued to the development of literature, methodology, data collection, and analysis and submission of final report in March, 2023, signifying the end of the study.

1.7 Organization of the Thesis

There are five chapters in the thesis. The context of the study, issue statement, research aims, and research questions are presented in the first chapter. It also captures the significance of the study, the Scope of the study, and the Organization of the study. Chapter two examines the definition of key concepts, empirical review, and theoretical perspectives on climate change adaptation practices and local knowledge systems. The study's methodology is presented in Chapter three. The chapter entails the research methods, study design, and profile of the study area. It also draws attention to the procedures used for gathering, analyzing, and presentation of research data.

The results and a discussion of the research's conclusions are presented in chapter four. The last chapter (chapter 5) summarizes the findings and draws conclusions while bringing together the topics covered in the earlier chapters, reflecting on the goals, and addressing the research questions. It also discusses the study's theoretical ramifications and makes suggestions for further investigation and policy direction.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter examines the literature on climate change adaptation harnessing local knowledge systems in times of disaster. It also explores the concepts and theories on the subject matter. These are theories of climate, climate change, adaptation, local knowledge systems, and disaster.

2.2 Theoretical Underpinning

From a theoretical perspective, the study adopts Roger's Diffusion of Innovation Theory. Details of the theoretical perspective are presented in this section.

2.2.1 Roger's Diffusion of Innovation Theory (RDIT)

The study adopted Roger's Diffusion of Innovation Theory (Rogers, 1995), which primarily explains the knowledge and ideals of a group of people. To Rogers (1995), people create new ideas and practices which become the fibre of the community (Rogers, 1995). Roger argues further that new ideas and inventions could be integrated into the community's adaptive capacity to respond to shocks and stress. Roger (1995), defined diffusion of Innovation as the spread of abstract ideas and concepts, technical information, and practices within localities and or communities. These norms and practices are adopted into external strategies to influence outcomes. The beliefs, norms, and practices could be spread through communication or learning experiences (Roger, 1995; Wejnert, 2002). Roger (1995) conceptualized diffusion as the mechanism through which an innovation is conveyed over a period to individuals within a societal framework through specific channels.

In his theory of "diffusion of innovation," Roger (1995) identified four main factors that are essential in influencing the diffusion of innovation: the Innovation itself, means

of communication, the nature of social structure and time. Roger (1995) argues further that to achieve innovation, the process of adoption goes through numerous phases such as understanding, persuasion, decision, implementation, and confirmation (Roger, 1995). This process relies profoundly on the social structure including beliefs and practices.

Considering the significance of the theory, the decision to build adaptive capacity is essential in empowering communities to respond to a disaster. According to Roger (1995), local knowledge could be termed as ideas and practices that could be exploited in building adaptation mechanisms. It could also be appreciated that the process of transferring new ideas to influence outcomes further highlights the effectiveness of knowledge transfer.

The theory focused on highlighting innovation, and practices for adaptation mechanisms without relating to a possible shortcoming, such as the challenge of harnessing local knowledge systems. It however provides a wider explanation relating to integrating local knowledge systems with modern strategies for building adaptive capacity. It thus makes it suitable to guide the study.

The theory will largely provide the bases for the conduct of the study as it can be suggested that local knowledge systems could be innovative in designing adaptation strategies. The theory indicates the relevance of local knowledge systems to disaster management or to the mitigation of its impact. While the theory identifies technologies that might mitigate the effects of natural disasters brought on by climate change, coping and methods for adaptation are also identified (as shown in Figure 2.1), which will help integrate local knowledge systems first, and secondly, promote effectiveness and

identify local adaptations as suggested in the framework. This will help build resilience to minimize vulnerability to disaster.

2.3 Climate Change

Climatic change is the phrase used to describe changes in historical climatic patterns at the regional or global levels that result in intermittent but escalatingly frequent extreme consequences. (IPCC, 2012). Climate change has become a contentious issue due to the way it is impacting people's lives and the future of the world (IPCC, 2012). In particular, it adversely and seriously impacts food supply, incomes, and social protection (IPCC, 2012)." The IPCC (2014b) defines a shift in the climate as "a change in the state of the climate that may be characterized by changes in the mean or the variability of its attributes that persist for a sustained period, generally decades or longer."

Megumi (2021) views climate change as a prolonged, continuous change that can be an increase or a decrease in the spectrum of weather events, such as more frequent and more severe storms, or the average weather conditions (for example, average temperature). Megumi (2021) argues that long-term changes in both the average conditions and the frequency or severity of occurrences, or both changes, can potentially occur simultaneously. Nakashim et al. (2012) noted that the measure of climate change is mostly three decades or more and is considered to be long-term. IPCC, (2017) also argues that, unlike year-to-year variability, which is rapid and abrupt, climate change is slow and gradual, making it challenging to detect without the aid of scientific records.

Beo (2010) opinioned that climate change, in general, refers to modifications in the statistical distribution of meteorological variables over time ranging from decades to

millions of years. Okoruwa (2010) defined climate change as observable climatic variability that has adversely affected human life.

According to Bawakyillenuo et al. (2014), climate variability and change have caused many people in Ghana to be exposed to a different level of vulnerability. As a result of the complex nature of climate effects and their related variability, various factors may influence adaptation techniques (Bawakyillenuo et al., 2014). Teye et al., (2015) held the view that the climate of the Northern Savannah zone is relatively dry. Teye et al., (2015) added that many of the farmers reported noticing a decline in rainfall amounts, due to this farmers have noticed that over the past three decades, the average temperature in their communities has climbed while the amount of rainfall has dropped, and that perceptions of temperature vary slightly between study sites. (Teye et al., 2015). Determination of climate change among some farmers in Ghana is a problem,; for instance, they insisted that the pattern of rainfall had altered, and several farmers were unsure of what climate change meant (Teye et al., 2015).

MESTI's (2013) temperatures in the northern savanna regions will rise from 1.7°C to 2.04°C by 2030, with average temperatures reaching 41°C. According to the GSS (2014), the Bongo district has a tropical continental climate. The hottest season is from February to April, while the only wet season is from April to October (GSS, 2014). Climate change has led to a change in weather patterns (GSS, 2014).

2.4 Disasters and Disaster Management

Growing recognition of the value of traditional knowledge as a priceless and underutilized information repository provides developing nations, particularly those in Africa, with a potent tool for disaster management (Kemp, 2007). In particular, local communities in Africa have played a significant role in natural disaster management

for millennia. For their own advantage as well as the welfare of future generations, these communities use traditional knowledge to regulate the climate, keep an eye on other natural systems, and develop early warning indications (Lerner-Lam, 2007). In the context of traditional knowledge in Africa, environmental resources (land, water, animals, and plants) play a role in the sanctity of nature in addition to being significant production components with economic value (Millar, 2006).

Planning for and responding to disasters as well as hazard analysis, vulnerability reduction (readiness), prevention, mitigation, response, recovery, and rehabilitation are all included in disaster management (Criss and Shock, 2001). It is a crucial part of every framework for software development. The Millennium Development Goals (MDGs) regard effective disaster management as a crucial prerequisite (Criss and Shocks, 2001). To achieve and maintain safety, social well-being, social justice, and equity in the context of sustained community-based disaster risk reduction and management, the state, the business sector, civil society, and local government must engage in responsive governance (Criss and Shock, 2001).

Effective national disaster prevention and management in the past faced harsh criticism, mostly because of intrinsic structural and legislative flaws in the procedure (Criss and Shock, 2001). As a result, a deliberate effort was made to evaluate the structures and regulations to bring disaster management in line with contemporary methods. The 1996 statute (Act 517) that created the National Disaster Management Organization has to be reviewed in light of the paradigm shift (NADMO). Through information sharing, communication, and education, as well as job development and poverty reduction, the emphasis has switched to coordination, prevention, and awareness creation.

Additionally, initiatives have been made to organize and educate the youth and unemployed to give them the technical skills they need to take part in disaster management, to strengthen local disaster reduction and poverty reduction efforts through the development of grassroots Disaster Volunteers Groups (DVGs), and to provide adequate funding to organizations working on the country's disaster risk reduction program.

According to IPCC (2014), disasters are typically connected with unplanned events, whether they are caused by people or by natural disasters, and they can mean different things to different people. Theodory (2016), notes that local people's experiences have taught us important knowledge and lessons about local knowledge and disaster. These interactions affect farming system knowledge as well as agricultural practices for managing soil and preserving water. According to Mofongoya and Ajayi (2017), using indigenous knowledge practically helps to co-create farm-led knowledge about coping with climate change.

According to Gaillard (2010), policymakers have focused their attention primarily on the results and recommendations of the hazard paradigm. In many parts of the world, policies continue to be based on top-down, command-and-control frameworks that prioritize scientific knowledge (Gaillard, 2010). The existing disaster management policy in Zimbabwe likewise adheres to this paradigm, hence it is necessary to influence the incorporation of indigenous knowledge. Only on a global scale have policymakers considered the vulnerability paradigm's concepts (GNDR, 2011; IFRC, 2011).

In response to these prevailing technocratic approaches, civil society, disaster management professionals, and NGOs have pushed for greater participation of individuals affected by disasters in policy and actions to manage catastrophes (Delica

Willison & Gaillard, 2012). Recognition of residents and communities has been demanded (see definitions of communities in the context of disaster management) (Delica Willison & Gaillard, 2012).

A paradigm for incorporating local knowledge, activities, and stakeholders for managing the disaster was developed by Gaillard and Mercer (2012). They contend that disaster management is an integrated process that requires a roadmap since it must be inclusive and not exclusive. Gaillard and Mercer (2012) acknowledge the existence of many types of knowledge that are beneficial in mitigating disaster risk. According to Tibby et al. (2008), to lower the risk of disaster and assure prudent disaster management, activities at various scales, both from the top down and from the bottom up, are required. Collaboration across a wide range of stakeholders working at various scales is necessary for this. The horizontal process received increased attention in the road map (Gaillard & Mercer, 2012). Since scientists and geographers consider local knowledge to be subpar to scientific knowledge, they also support the merging of local knowledge with scientific knowledge (Mercer, 2012). Once more, Mercer (2012) advises that local knowledge should be thoroughly evaluated to make sure that it can be applied to help reduce the risk of catastrophe. This has been said in light of a growing emphasis on the application of local expertise in disaster management (Shaw et al., 2008, 2009).

This indicates a shift away from top-down technical solutions in favor of more contextually relevant "local" solutions (Shaw et al., 2008, 2009). Local knowledge has proven its ability to save lives, despite the widespread belief that "science" does so. The tsunami in the Indian Ocean in 2004 is one of the prominent examples (Arunotai, 2008).

Local communities in disaster-prone areas frequently start their unique methods of risk management (Tibby et al., 2008). Local expertise, however, is a priceless resource that can help disaster management be more affordable, participatory, and sustainable (Arunotai, 2008). According to Tibby et al. (2008), dealing with disasters seems to be a top-of-the-line duty. Because local communities are not powerless and always exhibit capacities; it is not just the responsibility of those in positions of authority (Tibby et al., 2008). Disasters are regional occurrences that mostly impact regional communities. No one is more interested in lowering the danger of a disaster than individuals whose survival and well-being are at risk, according to Willison and Willison (2004). Additionally, as locals are the ones who are most directly impacted by disasters, they are also the ones that respond to them first (Tibby et al., 2008). When a calamity strikes, outside help typically shows up within hours, if not days.

Hewitt (2007) proposed that because of their capacity for local knowledge, individuals and communities may manage a variety of duties in disaster response. People and local communities should work together in that situation since local institutions are more familiar with their needs and resources. Hewitt (2007) contends that people's sensitivity to disaster risk has increased as a result of changes in their social, economic, cultural, political, and environmental environments. Due to the loss of local knowledge in rural populations, indigenous groups are much less able to handle disaster risks (Cameron 2006). According to Campbel (2006), rural communities have historically been able to adapt and cope, but because of their remoteness, they are currently more vulnerable. Any sort of knowledge is dynamic, changes continuously, and adapts as societies react to societal and environmental changes, according to Larsen (2006) and Mercer et al. (2008). Local knowledge and science have been utilized to address disaster risk for a long time (Mercer et al., 2008). According to Louis (2007), there has been a shift in

worldwide disaster management from a top-down to a bottom-up strategy. Because of the employment of community-engagement-promoting participatory tactics, the bottom-up strategy has been successful. (Louis 2007) confirms that the bottom-up approach to international disaster management has been gaining ground in the top-down drive toward community engagement in disaster management. The adoption of participatory tactics that enable community participation and result in rural people being involved in the decision has made the bottom-up strategy successful.

2.5 Climate Change Adaptation

The discussion of climate change in the 1990s and early 2000s was mostly concerned with its mitigation. A growing focus has been given to adaptation in recent years (Adger et al., 2009; Dodman and Mitlin 2011). Moser and Ekstrom (2010), posit that adaptation encompasses the enduring actions and choices made by individuals and collectives to enhance their ability to withstand socio-ecological shifts. Nzeadibe et al. (2011) note that adaptation is a proactive process that averts prospective climate changes in the future. One's readiness to manage the effects of climate change on the production of food crops is correlated with their capacity for adaptation (Nzeadibe et al., 2011).

In both theory and real-world application, adaptation involves responding to environmental signals, (IPCC 2017). It is defined as "the modification of natural or human systems aimed at reducing the consequences of climate change" (IPCC, 2012). The IPCC report distinguishes between the adaptability of natural systems and human systems. In the case of natural systems, adaptation pertains to "the natural adjustment process to counter the adverse effects of climate change with the addition of strategic human interventions aimed at minimizing climate change's impact."(IPCC, 2012:). IPCC (2014), adaptation is a set of changes that, while seeking opportunities, lessen the hazards associated with the climate now and in the future.

Adaptation responses can take a variety of forms, such as planning for the possibility of disasters brought on by extreme weather occurrences or altering the production of resources at the ecosystem and landscape levels. With the use of local knowledge of natural and managed ecosystems, communities can alter their practices in agriculture, forestry, animal husbandry, land usage, water use, and other natural resource systems. In the face of climate change and other stressors, what are currently referred to as community coping capacity and autonomous adaptation techniques are small adjustments to established behaviors (Anik, 2012). Over time, people have adjusted to changing social, economic, and ecological conditions using their knowledge and beliefs.

Communities continue to implement these changes to lessen the dangers and challenges brought on by climate change, and these efforts have developed into native adaptation strategies (Anik, 2012). These methods help communities reduce their vulnerability to disasters and develop affordable, inclusive adaptation plans that improve their capacity to respond to and cope with disasters (Nakashima et al., 2012). This argument holds that native adaptation strategies result in innate resilience (Prakash, 2013). Seasons, past storm patterns, the color of clouds that will likely bring rain, wind patterns, and direction are a few examples of distinctive, local knowledge and information that societies could use to alter their cropping practices and outdoor activities (wind from the west dries crops, while wind from the east is cool and likely to bring rain).

Due to local knowledge, societies can effectively map their farming activities and create management techniques including irrigation schedules, windbreak construction, and homestead fencing (Mukhopadhyay, 2010). By analyzing the hue of the clouds, the sound of the thunder, the length of the drought, and other factors, local communities

can predict rain and hailstorms that may harm crops and property (Gearheard et al., 2010).

Local knowledge is the fundamental information that the rural population uses to prepare their community through informed decision-making and peer learning (Mukhopadhyay, 2009; GIZ, 2013; Gautam et al., 2013). There is global recognition of the role and significance of local knowledge in climate change adaptation (Mukhopadhyay, 2009; GIZ, 2013; Gautam et al., 2013), and the main justification for doing so is the urgent need to tailor solutions to local needs.

Because the knowledge system is embedded in local culture and norms, it helps people to create effective responses to climate change. For instance, to combat recurrent drought, landslides, and high rates of soil erosion, farmers in Nepal's hills have created various agro-forestry methods. Similar to how farmers in the Tarai have reacted to frequent flooding by building quick and inexpensive bamboo cottages. These instances show that this community's resilience is rooted in its ability to use local knowledge to foresee calamities before they happen (ICLMOD, 2007b).

By minimizing possible harm or embracing new opportunities, adaptation involves transforming processes or practices in social and ecological systems to increase resilience and reduce vulnerability (Adger et al., 2007). Rarely does climate change adaptation concentrate solely on climate change-related issues. Any methods or projects that boost community resistance to dangers that could exacerbate climate change are considered adaptation (Smith and Lenhont, 1996; Fankhauser, 1996).

Thus, in poor nations adaptation to climate change is crucial and of concern, especially in Africa where vulnerability is high due to a lack of capacity for adaptation (Hassan and Nkemechena, 2008). The procedures known as "adaptation methods" help an

individual or a group deal with or adapt to the effects of the local climate. These strategies will involve implementing effective environmental resource management methods that ensure the objective of successfully adjusting to the changing climate with the least amount of environmental impact (Gautam et al., 2013). These adaptations include changing planting dates and cultivars to accommodate particular meteorological occurrences, such as delays at the beginning of the impending rainfall season (Gautam et al., 2016).

Mberego and Sanga-Ngoie (2014) assert that when rainfall patterns appear unfavorable, it becomes crucial to shift from planting maize to more drought-resistant crops such as sorghum and millet. Nevertheless, when making such choices, one must also account for factors like market availability and reasonable prices, in addition to considering the weather projection (Mberego and Sanga-Ngoie, 2014). This indicates that our decision-making process relies less on seasonal forecasts and more on an internal system that takes multiple variables into account, regardless of their connection to forecasts. Nonetheless, adjusting planting schedules and crop varieties remains a significant factor in decision-making based on these projections (Mano and Nhemachena, 2007).

2.6 Climate Change Adaptation Strategies

Alessandro et al. (2010), observe that adaptation represents a deliberate compilation of measures, tactics, procedures, and regulations designed to address actual or expected climate alterations with the goal of reducing their impacts on individuals, communities, and the economy. According to Henry and Clement (2012), adaptation strategies aim to lessen the risks and effects of climate change, control its detrimental effects, and take advantage of its positive aspects. Therefore, if the right adaptation strategies are used, the disastrous effects of climate change can be mitigated. Farmers age, older farmers

are more experienced, and older farmers are expected to adapt to climate change better than farmers whose ages are lower, according to Hassan and Nhemachena's (2008) analysis of farmers' strategies for doing so. However, they also believed that younger farmers would adopt long-term strategies and have a wider planning horizon, which would affect their decision to boost production levels. According to Deressa et al. (2010), farmers' decisions to sell cattle as a method for adapting during extreme climatic occurrences are positively influenced by age. The association between farmers' income and adoption is favorable and significant at the 1% level (Iheke and Oliver-Abali, 2011). This implies that, for every unit of increase in the farmers' income, there would be a 0.24 increase in adaptation to strategies.

Hassan and Nhemachena's (2008) examination of farmers' strategies for climate adaptation, farmers' age, older farmers are more experienced, and older farmers are predicted to adjust to climate change better than farmers whose ages are lower. In addition, they thought that young farmers would adopt long-term plans and have a larger planning horizon, which would influence their choice to increase production levels. Deressa et al. (2010) found that age had a favorable impact on farmers' decisions to sell cattle as a means of adaptation during extreme climatic events. At the 1% level, the relationship between farmers' income and adoption is positive and significant (Iheke and Oliver-Abali, 2011). Every unit that the farmers has, grows, so the inference goes. It has been noticed that farmers' capacity to accept and assume risk is constrained by a shortage of funding (Iheke and Oliver-Abali, 2011). Using a Tobit model, socioeconomic factors that affect the adoption of cocoa technologies in Ghana have been discovered. These factors include farming experience, farmer training, household head age, gender, household size, farm age, and social capital (2013). The adoption of solutions to mitigate climate change was positively correlated with farmers' experience

in farming. This suggests that as the farming experience grows, adoption would become more likely. Skilled and experienced farmers are likely to be more knowledgeable about crop and animal management techniques, as well as changes in climatic conditions (Iheke and Oliver-Abali, 2011).

Using logistic regression, Ahmed et al. (2013) determined that factors influencing the adoption of rainwater harvesting techniques included the household head's education, experience with water storage, farm size, farmers' awareness of water harvesting techniques, farming as the primary source of income, and age. The adoption index and farm size have a negative relationship that is significant at 5%. This suggests that, due to economic considerations, the level of strategy adaptation would decrease as the size of the region to be farmed increases. This is because when a farmer has a lot of land, adopting techniques costs more money (Iheke and Oliver-Abali, 2011). Fadare et al. (2013) also pointed out that the size of the farmer's farm, the usage of fertilizer, the availability of extension visits, and the farmer's geographic location were all factors in their analysis of the factors influencing the adoption of enhanced maize varieties. They believed that having more knowledge and agricultural experience would boost people's awareness of possible advantages and willingness to engage in neighborhood natural management activities to maximize production (Fadare et al., 2013).

They, therefore, anticipated that increased farming expertise and knowledge would have a positive impact on farmers' decisions about production levels. When it comes to farm size, a farmer with a large farm might simply make a decision that would enhance production levels, while a farmer with a small farm is required to diversify their alternatives (Hassan and Nhemachena, 2008).

A study by Ghimire et al. (2015), on the adoption intensity of smallholder maize farmers, found that the farmers' adoption decisions were influenced by their age, education, farm size, livestock assets, social group membership, access to extension services, access to seeds, yield potential, and location (Ghimire et al., 2015). The adoption of solutions to combat climate change was adversely correlated with the farmer's age, which was significant at 1%. This suggests that the likelihood of a farmer adopting farm management and crop diversification measures decreases with age. Farmers would be more aware of the potential climate change adaptation techniques as their level of education rose (Iheke and Oliver-Abali, 2011).

Kpadonou et al. (2012) emphasize that while the benefits of adaptation and mitigation initiatives influence local communities and rural livelihoods, climate discussions have taken on a global dimension and are more expansive in scope. Farmers have developed their local reaction strategy in a variety of methods as a result of noting the diversity of climate change impacts (Callo Concha, 2018). The primary indigenous approaches or strategies proposed come under the categories of adaptation or mitigation (Saitabau, 2014; Marrakesh, 2016; Mofongoya & Ajayi, 2017). The majority of research has also highlighted how resource management and subsistence farming techniques have exhibited adaptation strategies (Saitabau, 2014; Antwi-Agyei, et al., 2018; ALP, 2013; Saah, 2015; Nyantakyi-Frimpong, 2013). According to studies, intercropping is the primary indigenous approach to producing food crops (Garutsa et al. 2018).

Mugambiwa (2018), found that farmers in Mutoko (Zimbabwe) switched from growing maize to millet and sorghum, which enhanced farm output and decreased their level of susceptibility to climate change. According to Theodory (2016), applications like planting crops in wetlands make it easier to grow food crops in areas prone to drought

and help farmers adjust to short-term rainfall patterns. Some of the recognized adaptive methods in Nigeria include constant weeding of cropped farmlands, early planting of crops like maize and cassava, and preservation and selection of seeds for the upcoming planting season (Nzeadibe et al., 2011). According to Gyampoh et al. (2009), Ghanaian farmers cultivate food crops that do well in the current environment.

According to Deressa et al. (2008), crop diversification, irrigation, shifting planting dates, utilizing draught-tolerant varieties, employing early-maturing types, soil conservation, and planting trees are all examples of collective adaptation strategies for crop production in developing nations.

Additionally, it was discovered that farmers in Northern Ghana preferred to grow traditional crop varieties over hybrid or synthetic ones because of their perceived fit for the regional climate (Nyantakyi-Frimpong, 2013). In line with these findings, Saitabau (2014) notes that farmers in the Loita Maasai have kept the native strain of livestock because they thought it could endure protracted drought circumstances. This suggests that unique indigenous practices have been adopted as adaptation strategies in various ecological zones. Additionally, some farmers have embraced regional methods like mulching and kraal manure as defenses against climate extremes like drought and decreasing rainfall patterns (Mugambiwa, 2018; Nzeadibe et al., 2011; Dakyaga et al., 2020).

Agroforestry is also crucial in developing food crops' adaptation to climate change as both a mitigation and adaptation approach (Appiah et al., 2018; Mngumi, 2021). Most farmers understand how important it is to have trees on their properties to protect crops from harsh sunlight (Dakyaga et al., 2020; Adolph et al., 2020). Growing cover crops like melon to preserve soil moisture and using zero tillage to reduce exposure to

pesticides are two strategies that have been widely adopted in the Nigerian region of the Niger Delta (Nzeadibe et al., 2011). Local knowledge use stone bonds and temporary riverside walls as methods of water management to address the issue of water scarcity (Mugambiwa, 2018; Dakyaga et. al., 2020). A decrease in soil fertility, irregular rainfall patterns, and droughts have led to the development of water-saving strategies (MFCS, 2014).

2.7 Coping Strategies for Climate Change

African local communities' well-developed traditional local knowledge systems for environmental management and coping mechanisms make them more resilient to environmental change (Fujieda, 2013). This information was widely accepted by the majority of the populations where it was kept, and it still is. These communities can readily relate to this information, which makes it easier for them to comprehend some contemporary scientific principles for catastrophe prevention, preparation, response, and mitigation (Fujieda, 2013).

The livelihoods of the population's most marginalized groups typically depend on resources that are extremely vulnerable to climate change. To deal with frequent extreme events and calamities, they are left with no alternative but to adjust their methods (UNESCO/UNU, 2013). Along with this, individuals alter their living spaces, change the way they cultivate their crops, and diversify their sources of income to cope with the current challenges. All of these initiatives work to increase resiliency to disasters that occur frequently. Local expertise and traditional institutions are the cornerstones of these adaptive processes (Fujieda, 2013).

Small-scale farmers in the ASAL regions are likely to act quickly and logically to achieve the best adaptation to climate variability, presuming they have complete

knowledge of climatic variability, trustworthy early warning systems, and socioeconomic constraints (Waldman et al., 2020). When analyzing empirical adaptation responses among small-scale farmers, assumptions about perfect adaptability capacity do not hold. Some of the elements that regularly influence farmer adaptation choices and introduce bias into otherwise rational decision-making are risks associated with the climate, as well as perceptions of natural capital, financial capital, human capital, social capital, and institutional capital (Schlüter et al., 2017).

As communities work to increase their resilience to probable future effects of climate change, this knowledge and related actions become more valuable (Fujieda, 2013). By its very nature, local knowledge is adaptive, pertinent to the local environment, and helps create family and community capacity to adapt to changing circumstances, such as climate variability and disasters. Local Native knowledge helps to create social capital, which is valuable for securing and improving economic possibilities (Alexander et al., 2011). The methods and procedures that lead to the evaluation of local expertise in the context of adaptation to climate change are deliberate actions that the populace designs and puts into practice while coping with the repercussions of change that they have historically faced.

In response to climate change, Dazé (2007) lists the following coping mechanisms: mixed farming, drought-tolerant crops or varieties, soil erosion prevention, planting and conserving trees, planting early- or late-maturing varieties, using chemical fertilizers, intensifying land use, agricultural diversification, expanding farming into marginal lands, cropping in moist valley bottoms, incorporating trees into crops, and raising livestock. Early planting has been highlighted as a key adaptive approach, according to

Paul et al. (2008); however, some farmers, particularly households headed by women, are unable to meet this challenge due to additional demands on their labour.

The difficulty in defining effective adaptation stems from the fact that success criteria are frequently debated and context-specific (Dessai et al., 2009). According to Adger et al. (2005), Mairura et al., (2022); Mugi-Ngenga et al., (2021); and Musafiri et al., (2022), the effectiveness of a coping mechanism is one of the crucial ingredients that can boost farmers' ability to deal with climate variability. Small farmers households are cautious of taking chances and will only adopt technology if the advantages exceed the disadvantages. However, selecting a particular coping method for climate variability is a challenging process that is influenced by the farm and farmer, institutions, and the environment (Mairura et al., 2022; Oyetunde-Usman et al., 2021).

Gender is a crucial aspect of farmer and farm characteristics that may encourage or discourage the adoption of measures for coping with climatic variability. The impact of gender on the adoption of technology has been studied in the past with varying degrees of success (Mairura et al., 2022; Musafiri et al., 2022b; Mwaura et al., 2021; Oyetunde-Usman et al., 2021). Male farmers' higher resource control and decision-making abilities than female farmers are thought to be the cause of gender inequalities in technology adoption (Ndeke et al., 2021; Ndiritu et al., 2014). The adoption of strategies for coping with climate variability is significantly influenced by age. Older farmers are less likely to take risks and are more likely to employ traditional methods than younger ones (Macharia et al., 2014; Musafiri et al., 2020). Farm size indicates the amount of space available for testing out new technologies as well as a proxy for both natural and financial capital. Larger farms owned by smallholder farmers are more likely to adopt new agricultural techniques. Martey and Kuwornu (2021), however,

discovered that farm size had a beneficial impact on the adoption of mineral fertilizer and a negative impact on the use of mulch and manure.

2.8 Local Knowledge Systems

Many scholars have developed their viewpoints on local knowledge systems. Odero (2011), notes local knowledge systems are a group's culture or indigenous customs that have been passed down from one generation to the next. Local knowledge systems are frequently articulated through practice, according to Ngenwi (2011), and they are connected to the cultures, values, norms, and beliefs of farmers. Local knowledge systems were characterized by Nahashima et al. (2012) as the knowledge and wisdom passed down through countless generations, which serve as a guide for human societies in how they interact with the natural world.

According to the Food and Agriculture Organization (FAO), local knowledge is acquired over time and passed down orally from generation to generation. The foundation of the local knowledge system is the narrative. These stories can offer intergenerational perspectives on various environmental resource issues (Alexander et al., 2011). Local knowledge frequently contributes to the understanding of the meaning of climate change beyond what is implied by statistically significant changes in livelihoods, attitudes, and ways of life (Alexander et al., 2011). For instance, we used to be able to forecast the start of each season. Using indicators like bird cries, one might anticipate the amount of rain for the day. The birds are still there, but they are no longer making noise (Shaffer, 2014).

Local expertise has been crucial in resolving issues for decades, particularly those relating to climate change (FAO, 2009). Ghana's rural poor, whose primary employment is farming, have developed several strategies to adapt to climate change

by relying on local traditional knowledge and beliefs (FAO, 2009). Local traditional ideas may provide insight into the development of effective and reliable tactics (FAO, 2009). The first and most significant local adaptation tactic is thought to be Feed Related Strategies (FRS) (FAO, 2009). To meet the rising demand for meat, milk, and eggs in emerging countries, it is crucial to take climate change into account and look at other options (Hegarty, 2012).

Climate change affects pasture production, whereas livestock productivity is influenced by pasture availability, livestock migration, and alternative sources of income (Ayantunde et al., 2011). Since crop fields are being converted to grazing grounds due to the growing human population, pastoralists must travel great distances to get food and water for their livestock (Bassett and Turner, 2007). For West African Farmers, crop residue now serves as their primary source of feed ingredients (Ayantunde et al., 2011). For dry season feeding, some farmers use leguminous crop remnants including cowpea and groundnut haulms and cereal straws like millet, maize, rice, and sorghum (FAO, 2014).

Cereal grains are also manufactured and provided to chickens as feed. Fresh grasses and cotton seed cake are some more types of poultry feed (Amadou et al., 2012). According to Khan et al. (2013), Health Related Strategies are the second-most significant indigenous strategy (HeRS). Farm animals' health is impacted by climate change as a result of stress and infections brought on by the heat. According to Khan et al. (2013), *calotropis procera* plant latex, shoots, and leaves can be used to treat wounds and lessen pain in farm animals. The plant's grasshopper can also be used to improve farm animals' sexual behavior (Khan et al., 2013). The authors further indicate that raw

fruits obtained from capris decidua's are used to treat anthelmintic ailments and to increase the appetite for grazing among livestock (Khan et al., 2013).

Singh et al. (2012) made the case that one major adaptation tactic employed by some farmers is the planting of fodder trees near livestock barns and pens to lessen the effects of cold or heat waves. Other housing-related tactics include putting pets outside at night in the summer, releasing them when the weather is bad so they may look for food and a safe location, and building platforms or perches within homes. According to (Meena et al., 2008), one of the other adaption tactics used by farmers is to provide fire in livestock sheds and pens during really cold weather.

Additionally, because farm birds are typically housed in cramped cages, infections like parasitic gastroenteritis can spread easily among them (Nghonyuji et al., 2014). Breed Related Strategies are the fourth indigenous adaptation approach taken into account in this study (BRS). When the weather is bad, most farmers maintain tiny animals instead of their large ones. Small animals are supposed to do better under similar circumstances since they need less food and water. While some farmers purchase exotic kinds, others believe that native breeds are more resilient to disease and can thrive in unfavorable climatic circumstances, and don't need a lot of water (Singh et al., 2012).

2.9 Local Knowledge Systems and Climate Change

Research has demonstrated how crucial it is to discuss climate change and its implications from a local perspective. There are various logical and scientific arguments for taking into more account local viewpoints in climate research and policy contexts, according to Orlove et al. (2010), Alexander et al. (2011), Klein et al. (2014) Hulme (2010); Klein et al., (2014); and Offen, (2014). According to ethical experts, non-expert voices and opinions should be crucial in attempts to measure and address

these issues because people experience the effects of climate change locally (Brace and Geoghegan, 2011).

The local knowledge system, which can estimate climate constraints at incredibly small scales and fills in key gaps in experimental data, is a vital source of information about variations in different communities (Turnbull, 2002; Wilbanks, 2002; Roth, 2004; Laidler, 2006). Once more, if there are no data, or where model results are disputed, local knowledge can greatly aid in understanding and discussion of science (Klein et al., 2014). In order to develop effective and locally suitable adaptation and mitigation measures, it is practically vital to comprehend how people are experiencing, perceiving, and responding to climate variability and change (Becken et al., 2013).

Yaro asserts that local communities affected by climate change need to create indigenous-based adaptation plans (Yaro, 2013). This occurs when locals observe variations in the weather, such as shifts in temperature, precipitation, wind, or cloud cover. The previous debate made it evident that local communities are aware of how climatic occurrences change and fluctuate throughout time. Zimbabweans have created a toolkit of response strategies to tackle the dangers posed by climate change and safeguard lives and means of subsistence.

To mitigate climate risks in sensitive locations, local knowledge becomes crucial (Son et al., 2019). Utilizing indigenous knowledge systems to enhance the efficiency of agro-ecological resource management for reducing vulnerability represents a long-standing approach employed by African indigenous communities as a means to exhibit socio-ecological resilience, as highlighted by Theodory (2021). To illustrate, numerous disadvantaged small-scale farmers in arid regions face both difficulties and opportunities for adapting to their circumstances. This is due to the valuable cultural

wisdom and expertise that have been transmitted through generations, enabling them to manage their physical surroundings, irrespective of socio-political or geographical hindrances, as documented by (Makondo and Thomas, 2018). Consequently, the primary and substantial resource for evaluating risks and developing response strategies within resource-constrained households is the local communities' wealth of knowledge and perspectives (Funatsu et al., 2019).

According to IPCC's (2014a) report, the majority of Zimbabwe's rural communities are inspired to develop climate change-responsive actions by their awareness that recent changes to their local environment, such as uncertainties and anomalies, have driven rural communities to embrace appropriate methods for coping with and adapting to their circumstances.

Chanza (2014) notes that there are two types of local reactions to environmental stimuli: preventative and spontaneous. This viewpoint is that of the indigenous people. Chanza (2015) also makes distinctions between various local knowledge approaches in light of climatic events. There are methods for dealing with drought, floods, intense thunderstorms and lightning, and high heat, as was just discussed.

It is also feasible to manage the risks of food scarcity that might arise due to these weather conditions. The previous section already addressed regional knowledge and food security in this context. Consequently, the present discourse predominantly focuses on the cultivation of drought-resistant crops, followed by livestock husbandry and related practices, harnessing ecosystem services (the benefits of ecosystems), trade, sustainable farming practices, and rain-fed agriculture, (IPCC's 2014b).

In contrast to spontaneous adaptation, which lacks conscious awareness, preventative adaptation is proactive because people take action before being exposed to the stimuli.

Empirical research, for instance, demonstrates that Zimbabwe's indigenous knowledge-based adaptability is moving from proactive to reactive actions (IPCC, 2014b). Chanza (2015) assembles a range of immediate coping strategies (reactive adaptation), intermediate-term adaptive methods, and somewhat more extended proactive techniques. As outlined by Mubaya (2010), Zimbabwean local farmers have a diverse set of coping mechanisms at their disposal to address hunger or drought. In addition, Mubaya (2010) says that one of the coping mechanisms used by farmers entails choosing traditional crop varieties in response to drought conditions, such as sorghum, millet, beans, cowpeas, Bambara groundnuts, and numerous other crops. These species are known to withstand droughts (Mubaya, 2010). Because there aren't many modern agricultural seeds available, many local farmers prefer to grow crops that are native to their region (Mubaya, 2010). According to research by Klein et al. (2014), reducing the size of cattle herds to a manageable size makes it easier to maintain them in light of the drought-related shortage of pasture and drinking water.

Klein et al. (2014) claim that rather than just lowering the number of cattle at random, the villagers employ their expertise to eliminate the frail, sick, undernourished, or less productive livestock, a process known in the industry as "culling." Knowledge of wild fruits and their utilization becomes a vital survival skill during times of famine or drought. According to Chanza (2014), local residents utilize various tree species, including maungu (from *Landolphia buchananii*), shumha (from *Diospyros mespiliformis*), masau (from *Ziziphus* spp.), and many (from *Adansonia digitata*) to predict the onset of the agricultural or rainy season.

Chanza (2014) emphasizes that understanding how to prepare these fruits for consumption holds greater significance than simply possessing knowledge about the

fruits themselves, allowing individuals to realize more food value. According to studies, households and local communities in Africa and the Sahel have amassed advanced knowledge in reducing the vulnerability of the agricultural sector to climate change risks for long-term rural development (Makondo and Thomas, 2018). Makondo and Thomas (2018) also noted that a number of local farmers in Africa manage damaged farmlands using their indigenous knowledge while managing unproductive farmland using traditional agroforestry. As a result, the farmers' ability to produce more food and earn a living is improved.

Ajayi and Mafongoya (2017) observe that indigenous farming techniques like mixed cropping, minimal tillage, and intercropping are being used by farmers in Sub-Saharan Africa's dryland farming systems to increase yields and protect the environment. According to a study by Gumo (2017), the Abanyore, Akamba, Maasai, Meru, and Kikuyu communities in Kenya are coping with the extremes of climate change by praying and worshipping for rain during prolonged dry spells. Theodory (2021) reports that farmers in Tanzania's Ngono River Basin engage in similar activities.

Bapfakurera et al. (2020) report that farmers in north-western Rwanda's Musanze and Nyabihu districts employ various techniques like crop rotation, ridge planting, stone bunds, composting, traditional dam construction, and the use of water retention ditches or ponds for irrigation. In Burkina Faso, farmers in the Soudanian, Soudano-Sahelian, and Sahelian agroclimatic zones are addressing climate risks by improving their agricultural practices through the incorporation of organic matter and the use of furrows, (Alvar-Beltrán et al., 2020).

In northwest Ghana, as reported by Nyantakyi-Frimpong (2021), the "Zai" technique is being used by indigenous, to promote rainfall gathering, increase soil infiltration, and

enhance crop output. In a study conducted in 2021 by Antwi-Agyei and Nyantakyi-Frimpong, it was found that local farmers in northern Ghana have been applying their traditional wisdom to adjust their planting calendars, aiming to mitigate the impacts of erratic rainfall on their agricultural practices.

Local farmers in Northern Ghana have been growing a variety of drought and flood-resistant crops, according to Derbile et al. (2016), to minimize their sensitivity to drought conditions. The farmers asserted that their forefathers had been cultivating drought-tolerant indigenous crops like naara and zea seeds based on their findings.

Moreover, a study carried out in northern Ghana by Kuwornu et al. (2013) underscores the importance of the cultural practice of cultivating crops on elevated mounds and ridges as a vital adaptation strategy for safeguarding crops against windstorms. To withstand the shocks arising from unpredictable shifts in rainfall patterns, many female farmers in Ghana's northern region employ a form of mixed cropping that has been passed down orally through generations, as documented by Alhassan et al. (2019). This research illustrates how indigenous farmers in Ghana have progressively enhanced their utilization of native knowledge and technologies.

Social capital serves as a tactic employed by socio-ecological systems, particularly indigenous farmers and communities, to cope with the hardships and suffering caused by crop failures. An excellent example of this is how rural inhabitants in the Savanna regions rely on social networks to enhance their resilience to climate change, as noted by Dapilah et al. (2020). All of these applications of local knowledge contribute to increasing agricultural productivity and ensuring food security across the continent. In response to the challenges posed by climate change, local farmers in the Savanna region are employing various indigenous concepts, as highlighted by Dapilah et al. (2020).

2.10 Integration of Local Adaptation Practices into Disaster Management Plans

Contrary to assertions made by proponents of local knowledge systems, such as scholars of disaster risk reduction (Hiwasaki, Luna, and Syamsidik 2014; McAdoo et al. 2006), local knowledge of local communities can significantly help save human lives and property from the devastating effects of natural or climate related disasters.. Research shows that countries that have successfully managed and mitigated the impact of disaster made use of their local knowledge systems that were available (Rahman, Sakurai & Munadi 2016; Sethi et al. 2011, Iloka 2016).

Local knowledge is significant since it has helped local communities in Africa's Sahel region survive in the aftermath of climate change and fluctuation, as noted by Nyong, Adesina, and Elasha (2007). However, because local communities are unaware of the potential of local knowledge systems; nothing is known about the rate at which local knowledge has been employed or implemented in disaster management in Zimbabwe. Zimbabwe has been dazed by the frequency of occurrence of different types of disasters and their magnitude for almost two decades (Madamombe 2004). Bulilima and Mangwe districts have been affected by veld fires, while Tsholotsho and Muzarabani districts have been troubled by floods and droughts (Dube 2015; Mudavanhu 2014).

Communities living in flood-prone areas have been threatened by disasters like floods, which pose a hazard to human life and property. Experts are urged to adopt perspectives that will help them understand the value of using locally created, knowledge of local communities in coping with disasters, whether they are natural climate induced or not. This is in addition to applying current knowledge and technology to manage disasters.

Smallholder farmers in Zimbabwe have reportedly relied on their local expertise for survival over the years in order to deal with droughts and other hazards, Mutasa (2015). However, the full use of local knowledge has been in jeopardy since professionals

frequently ignore it in favor of cutting-edge disaster risk reduction expertise. Data available shows a greater use of the local knowledge that local people have historically employed for centuries in managing disasters in their communities (Gaillard & Mercer 2012; United Nations International Strategy for Disaster Reduction [UNISDR] 2005).

Since ancient times, local knowledge systems have been a part of daily life. This is significant because it has influenced how people interact with their surroundings. According to Dekens (2007), local knowledge is a practice that can help in disaster management. As a result, in the 1990s, this understanding became well known in the fields of disaster management and concerns relating to climate variability (Hiwasaki, Luna, and Syamsidik 2014). Local knowledge hasn't played a significant part in disaster policy or science, despite the fact that it is recognized as being crucial for disaster risk reduction and climate change adaptation (Adger et al. 2011). Local knowledge is still viewed by some disaster risk reduction practitioners as being narrow, provincial, unintelligent, primitive, and emotional, and they continue to question its relevance and usefulness (Herbert 2000; Mitchel 1995).

The applicability of local knowledge has been hampered by the lack of definition of what it is. The definition of local knowledge is subject to debate among academics (Fabiya & Oloukoi 2013). Local knowledge is recognized as traditional knowledge that is derived from local communities, according to Kelman et al. (2012). According to Agrawal (1995), local knowledge is information that has been transmitted down the years through dreams, visions, and intuition.

Local knowledge systems provide policymakers, academics, specialists, and local communities with a range of options for how to respond to various types of disasters. According to Mwaura (2008), local expertise can enable community members to

assume leadership positions in initiatives aimed at lowering the risk of disaster. For instance, mixed cropping is a type of local knowledge that can be used to increase the yield of different crops, providing a backup supply of food in the event that other crops fail (Mwaura, 2008). A town with extensive local mechanisms for disaster management and mitigation can handle any kind of calamity with little to no outside help. Prior to the introduction of professionals in disaster risk reduction, locals are able to handle various dangers and calamities by using their local expertise.

Local expertise is crucial for planning for community development, claims Mutasa (2015). This suggests that local communities might utilize their knowledge of the area as a planning tool to anticipate the onset of catastrophes and their effects in order to implement the appropriate responses. A community with strong local knowledge systems for disaster mitigation and management can handle any kind of calamity with little to no outside help. Communities handled numerous risks and disasters by using their local expertise before the arrival of specialists in disaster risk reduction. Mutasa, 2015 asserts that local knowledge is essential for designing for community development. This suggests that local communities might utilize their knowledge of the area as a planning tool to anticipate the occurrence of disasters and their effects so that the appropriate actions can be taken.

Furthermore, Nyong et al. (2007) stress that local knowledge must be incorporated into development methods for them to be effective. Communities that do not frequently employ local knowledge are more likely to experience severe effects from climate change. The indigenous populace is well knowledgeable and aware of their surroundings. As a result, they have integrated data that can be used to assist their communities to better prepare for managing disasters to lower the risk and impact. Their

involvement in disaster management initiatives that have an impact on their daily life is crucial. According to Sphere Project (2011), those who have been touched by a disaster are not helpless and actually possess crucial knowledge and skills that specialists may require to manage the disaster.

Local knowledge provides information and viewpoints that help scholarly studies and environmental observations. It can also provide a thorough understanding of how people interact with their surroundings, natural resources, and cultures (Galloway-McLean 2010; Nakashima et al. 2012; Tauli-Corpuz et al. 2009; Tebtebba Foundation 2009). As a result, it is likely that excluding communities from the design stage of programs that affect their lives will have negative project results and impacts. The value of local knowledge systems held by local communities is outlined by Shaw et al. (2008), along with explanations for why such knowledge must be included when developing strategies for disaster risk reduction. Local knowledge is important, according to Nakashima et al. (2012), because it can be applied to other communities in similar situations and modified accordingly; it encourages community involvement and empowers communities to lower disaster risk; it can provide crucial information about the local environment; and its informal means of dissemination can serve as a benchmark for education about disaster mitigation and management.

The Sendai Framework for Disaster Risk Reduction 2015–2030, which encourages the use of local peoples' knowledge and traditions to advance scientific understanding in disaster risk assessment, was approved by the Third United Nations World Conference, according to the UNISDR (2015). The framework recognizes that local people may make a significant contribution to the development and use of plans and systems for disaster management, including early warning indicators (UNISDR 2015). Local

expertise is therefore an essential part of disaster management. After acknowledging the impact of climate change on the country's growth, the government of Ghana has implemented a number of initiatives to promote planning for adaptation to the changing climate. There are already many institutional structures, regulations, and strategies relevant to climate change.

To formally launch its National Adaptation Plan (NAP) process, the government is currently rallying support. The NAP processes usually aim to support strategic investments in climate-resilient development and facilitate the coordination of national-level climate change adaptation initiatives (inside and between ministries as well as between the government and its development partners). The National Climate Change Policy (2013), National Climate Change Adaptation Strategy (2012), and Nationally Determined Contributions (NDCs) (2015) were all incorporated into Ghana's NAP process as the supporting framework for planning and implementing adaptation actions. All three documents were created within the context of sustainable development. In order to reduce poverty (SDG1), expand opportunities for livelihoods (SDG1), and advance gender equality (SDG5), the NAP approach will help local communities' capacity to adapt to climate change (SDG13).

The framework attempts to guide the country in planning, organizing, and implementing its NAP process. The goal of the document is to ensure that the NAP does not unnecessarily expand the number of planning procedures and accompanying documentation, while also outlining the advantages of the NAP process for Ghana. As a result, deciding the medium- and long-term objectives for climate change adaptation initiatives will be the emphasis of the NAP process itself rather than this framework.

The emphasis on adaptation during the 16th Conference of the Parties (CoP) to the United Nations Framework Convention on Climate Change (UNFCCC) in Cancun in 2010 had an impact on the development of the NAP process (UNFCCC, 2010).

"National priorities and sustainable development objectives through a continuous, progressive, and country-driven approach" is the stated goal of the NAP process (Least Developed Countries Expert Group [LEG], 2012). The basic document for Ghana's NAP is the 2013 National Climate Change Policy (NCCP). The NCCP was created to coordinate and direct the national response to climate change, particularly climate adaptation. Effective adaptation, equitable social development, and mitigation are the three goals of the NCCP. Climate resilience, climate-compatible development, and low-carbon efforts must be incorporated into all ministries, departments, and agencies as part of the NCCP (MDAs).

Additionally, the Ghanaian government's 2012 National Climate Change Adaptation Strategy (NCCAS), which was created between 2010 and 2020, has as its main objective "improving Ghana's current and future development to climate change impacts by strengthening its adaptive capacity and building resilience of society and ecosystems" (Gov. of Ghana, 2012). In Ghana's NDC, climate change adaptation measures are also given significant attention. The NCCP, NCCAS, and NDC work together to provide the framework for Ghana's NAP process.

Ministries, agencies, and organizations are urged to include adaptation in their policies, programs, and plans under Ghana's current planning approach for addressing climate change. The government's long-term objective is to include adaptation in each district's medium-term development plans. The National Climate Change Committee (NCCC) and Climate Change Unit have been established by the Environmental Protection

Agency (EPA) and the Ministry of Environment, Science, Technology, and Innovation (MESTI), respectively. Energy, forestry, and agricultural organizations, as well as other key ministries, departments, and organizations, have also established climate change divisions (Government of Ghana, 2012).

Ghana now employs a mixed strategy to incorporate climate adaptation issues into policy and planning. Planning for adaptation is being done concurrently at several levels, including the national level, sector-specific planning, and local development plans. Future adaptation planning and mainstreaming initiatives, according to the government, should be more sector- and district-focused (GoG, 2017a). In Ghana, responding to the adverse consequences of climate change has occasionally taken the form of an ad hoc strategy that gives priority to current vulnerability without enough consideration for potential future and related vulnerabilities.

Short-term adaptation techniques have consequently occasionally resulted in a severe loss of infrastructure and ecosystems. Because communities may be less able to adapt, their vulnerability may rise (Antwi-Agyei, Dougill, and Stringer, 2018; Juhola, Glass, Linner, and Neset, 2016). This can have negative effects on community resilience. Instead, as recommended by the NCCP (2013), the NAP would concentrate on incorporating climate change adaptation into Ghana's medium- and long-term development priorities and strategies.

With adaptation objectives established in important industries like agriculture, forestry, water, energy, gender, and health, the Environmental Protection Agency (EPA) will supervise the creation of a comprehensive national adaptation strategy. District-level adaptation planning and mainstreaming will be supervised by the National Development Planning Commission (NDPC). Priorities for local adaptation will be

established by creating separate adaptation plans for each district, while sectoral priorities will be established by performing climate change sensitivity assessments for major sectors. District-level adaptation plans will be piloted based on geographic characteristics and climate change sensitivity. The creation of a few independent sectoral adaptation strategies will address sector-specific adaptation issues and incorporate climate change and other important factors. Similar to the NAP approach, district-level medium-term development plans will include climate change adaptation. The creation of sector- and district-level standalone adaptation plans is the long-term objective (Dazé et al., 2016).

Vertical integration and community-based adaptation (CBA) techniques are closely related. This technique seeks to empower locals and puts local communities at the center of adaptation planning by strengthening local people's resilience and adaptive capabilities within their livelihood systems. Community-based adaptation is required because it occurs in regions where people must learn how to adjust to climate change and where its negative consequences are most acutely felt (Ayers & Forsyth, 2009). Locals have the chance to take part in adaptation planning in a participatory and collaborative way through the fusion of scientific and local knowledge thanks to community-based adaptation, which recognizes the current value systems to increase livelihood assets and security and address disparities (Ayers & Forsyth, 2009). The CBA ought to aid in climate change adaptation by relying on Ghana's conventional political system. By encouraging local people to take part in the planning and implementation process, CBA is consistent with the Forest and Wildlife Policy (2012), which likewise places a strong emphasis on community involvement in the conservation of forestry resources.

2.11 Conceptual Framework

It is important to recognize that climate change has an impact on individuals, livelihoods, and social structures. In light of the problems faced by climate change, communities adopt techniques, including local knowledge, to enable stronger resilience to respond to disasters. The development of strategies during the decision-making and action phases leads to adaptation. This has a direct impact on how outcomes relate to livelihood. The majority of adaptation strategies are well-planned solutions with long-term answers to deal with climate change. Even if some coping strategies are largely reactive, they nonetheless contribute to lowering the effect of climate change, which lowers the likelihood of disasters.

Local knowledge systems can be used to reduce disaster risk by adjusting to the effects of climate change (indigenous technologies, traditional institutions and practices, belief systems, and norms). For instance, traditional institutions are powerful and influential because chiefs and Tindanas inspire their subjects to take action. According to Bonye (2007), Chiefs and Tindanas in Northern Ghana are crucial in encouraging their people to take part in civic activities. In some villages, traditional authorities are the local administrative power (Bonye, 2007). Once more, according to Bonye's 2007 research, community development may be at odds with the social norms, values, and practices that traditional leaders reflect. As a byproduct of local knowledge systems, this points to the increased role of traditional leadership, norms, and practices in influencing adaptation to increase resilience to disasters. The theory argues that to increase the effectiveness in lowering vulnerability to catastrophes, coping mechanisms could be incorporated into adaptation tactics.

The framework shows how local knowledge systems, contribute effectively to the development of adaptive ability. The framework also described early warning indicators, community disaster risk reduction plans, and response mechanisms that could help lessen the effects of disasters or increase disaster resilience. The framework allows for the creation of communities' adaptation plans using local knowledge systems, thereby reducing vulnerability to disasters. However, the effectiveness of the coping mechanisms in lessening vulnerability to disaster is limited and short-lived. Broken lines in the framework serve as a visual cue for this.

The theory suggests that adaptation takes place in the context of local communities. Therefore, one of the most important mechanisms for communities vulnerable to climate change impacts to increase their resistance to catastrophes is climate change adaptation. Depending on the type and extent of the threat, the spatial shape, and the purpose of the impacted communities, many solutions may be used to adapt to the effects of climate change. To respond to disasters, these techniques are implemented inside the boundaries of communities and integrated with their local knowledge systems as shown in Figure 1 below:

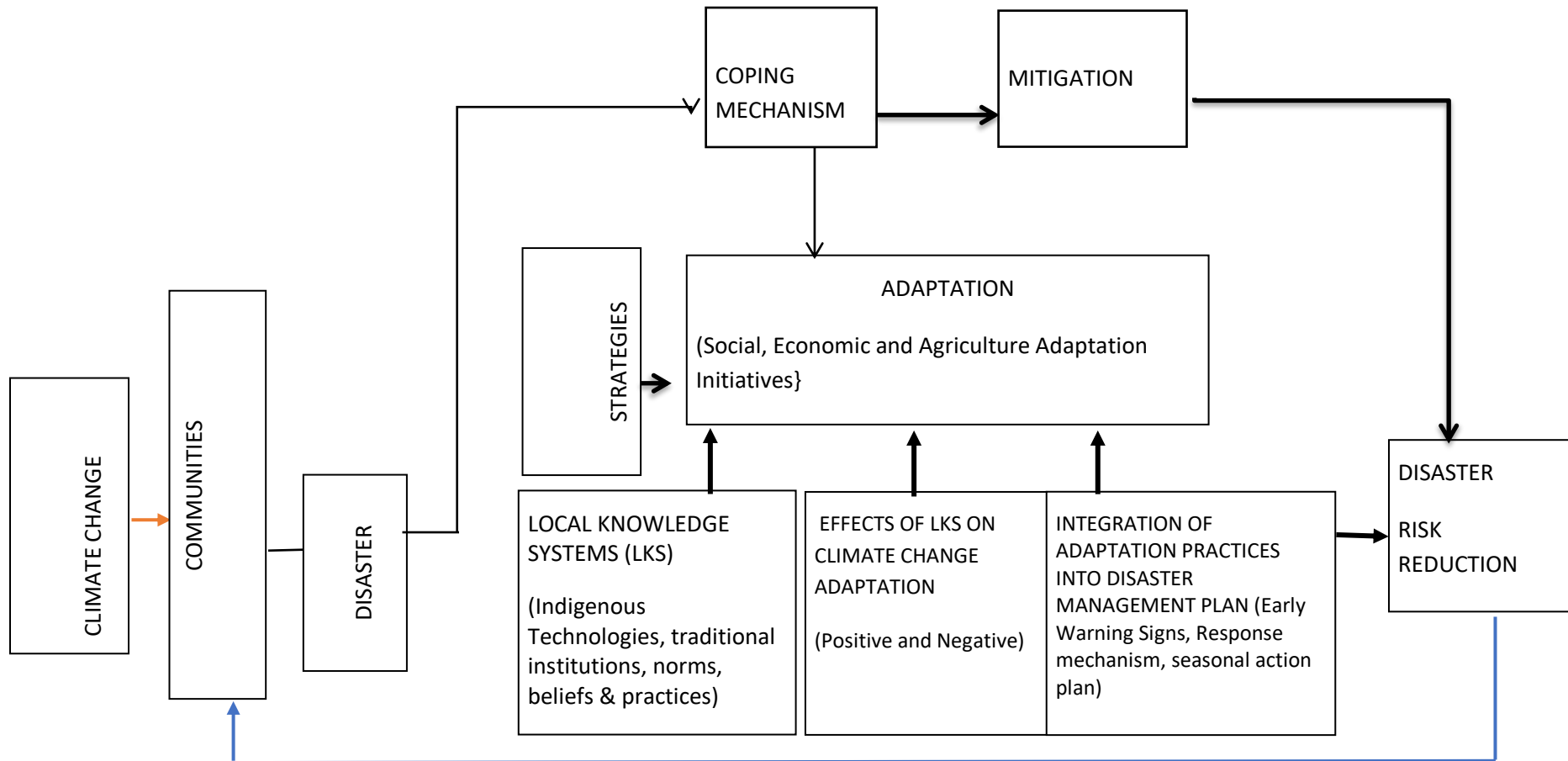


Figure 2.1: Conceptual Framework

Source: Authors Construct, 2022

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter explains the methodological choice, and goes into great detail on the study's research design process. The methodological selection is guided by the study's philosophical perspective. It explains why the mixed methods research methodology is seen to be suited for the subject. The procedures for acquiring, analyzing, and reporting data are also established in this chapter. Both the quantitative and qualitative techniques were applied in the study, although in distinct ways. The approaches that were taken to enhance the study's validity and reliability are also described. The chapter ends by outlining research methodologies and highlighting ethical implications.

3.2 Study Area

The Kassena-Nankana West and East Districts, Bolgatanga Municipal, and Burkina Faso all share borders with the Bongo district in the west and east, respectively. Bolgatanga, the Upper-East region's capital, is precisely 15 kilometers away (Bongo District Assembly; 2012). The district has a total size of 459.5 square kilometers and is located between longitudes 10.50° N and 11.09° W. It is located in an area free of onchocerciasis. There are seven Area Councils and around 36 settlements in the district (Bongo District Assembly, 2012). It is estimated that the total population of the district is 120,254 which is about 9.2% of the regional population. The male population of the district is 56,920 (47.3%) and females 6,334 (52.7%). There are 22,242 households in total, 118,262 people live in those houses, and there are 5.3 people per household on average (GSS, 2021).

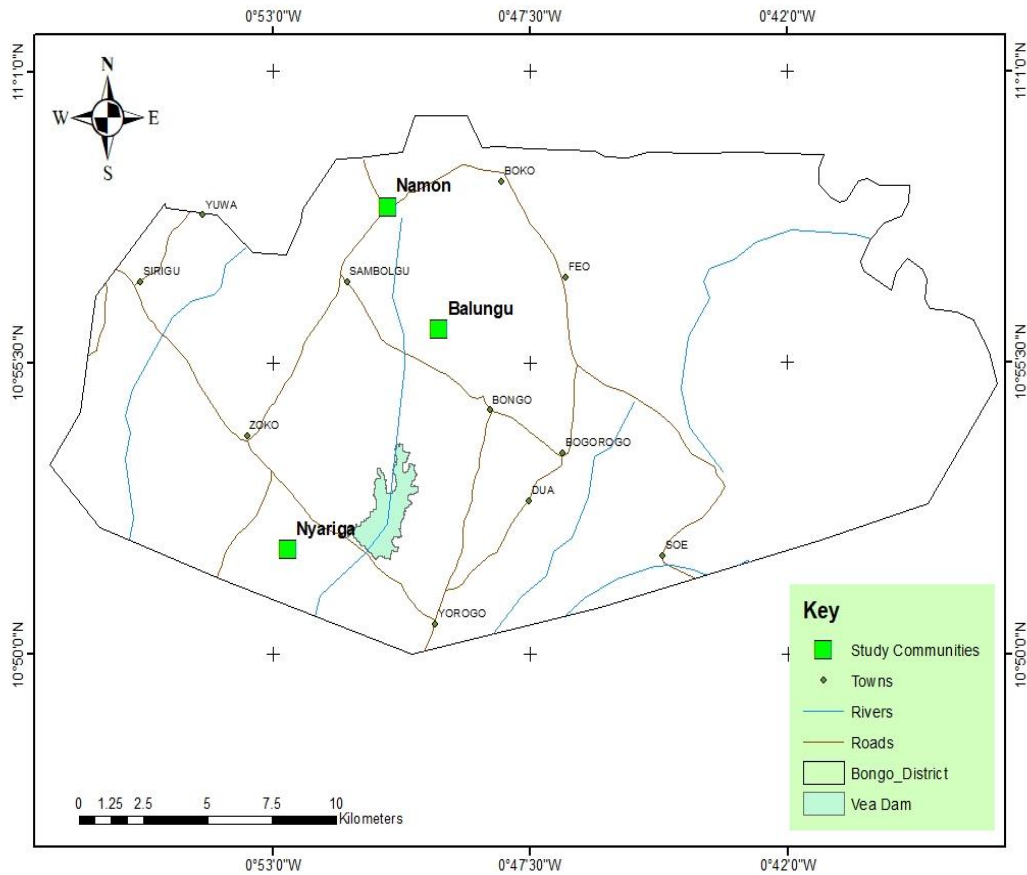
The district's vegetation is made up of short, commonly spaced deciduous trees and a ground flora of several species of tall and short bushes (GSS, 2012). The wet and dry

seasons are particularly notable in the region. In the rainy season, which lasts from April to August, the South-West Monsoon winds from the Atlantic Ocean bring downpours, while the North-East Trade winds come from the Sahara Desert during the dry season, which lasts from November to March. Rainfall totals for the year range from 840mm to 1400mm, respectively (GSS, 2012).

The district's soil type is reddish brown, fine blocky, and contains worn feldspar particles. It is also known as crumbly coarse sandy loam. The district's primary economic activity, accounting for around 86.0% of the local economy, is farming. Crop cultivation and animal rearing are two of the main agricultural operations. The majority of farmers cultivate a variety of crops. Commonly grown crops include maize, millet, cowpea, sorghum, rice, groundnuts, and beans (GSS, 2012).

The Black Volta and the Veia dam are the two biggest bodies of water in the Bongo District's collection of water resources. Other water resources in the district include Bongo, Gorogo, Gambrungu, Dua, Balungu, Yidongo, Adaboya, Atampinti, and Feo (Bongo District Assembly, 2012).

Figure 3.1: Bongo District Map Showing the Study Communities



Source: Author's Construct (December, 2022)

3.3 Total Population of the Study Subject

A research population is made up of all people or things (units of analysis) with the necessary characteristics (Bhattacharjee, 2012). The study adopted a reconnaissance survey to obtain a list of climate change-vulnerable communities within the Bongo District. A total 15 communities that are classified high risk in terms of climate related disasters as well as those with characteristics that suggest more vulnerability context to climate change stressors and socks. Afterwards, the three communities (Namon, Balungu and Nyagli) were randomly selected and the sum total of households (1,058) constitute the target population for the study.

The households consist of residents and household heads who know the matter under inquiry. Chiefs and clan heads, Tindanas, female leaders, youth and household heads, and members of the study communities are all included in the target population dynamics. The target population also captures organizations and governmental agencies that have roles to play regarding disasters and disaster management. These include the National Disaster Management Organization (NADMO), Bongo District Assembly (BDA), West African Science Centre for Climate Change and Land Use Adaptation (WASCCAL), and the Department of Agriculture of the Ministry of Food and Agriculture (MoFA). The rest include Ghana National Fire Service, Ghana Metrological Agency, and Environmental Protection Agency.

3.4 Research Philosophy

According to Bryman (2008), a philosophy is a collection of beliefs that governs what should be investigated, how research should be carried out, and how the results should be comprehended. They can be summed up as the researcher's overarching worldviews (Creswell, 2009). A researcher's philosophy, according to Lincoln and Guba (1985), includes his or her presumptions about how an investigation should be conducted, or methodology, as well as their definition of truth and reality, or positivism, and how they come to know those truths or realities, or epistemology. Therefore, a researcher's selection for a particular methodological approach is influenced by their philosophical views on positivism and constructionism (Collis and Hussey, 2003). Hiller (2016) argues that positivism is a component of the broader objectivist approach in scientific investigation. Hiller (2016) goes on to clarify that positivism represents a philosophical perspective that acknowledges only observable, measurable, or experimental experiences of the world as valid data for analysis, and the outcomes of such inquiries are regarded as definitive or comprehensive facts about reality. Consequently,

researchers treat the subjects of their studies as objects for analytical examination (Hiller, 2016).

It is crucial to note that, as Al Habil (2014) contends, some elements of realism may be present in positivist research. They are value-free or value-neutral, as scholars have stated (Hiller, 2016). Hiller (2016) added that the systematic and objective observation, description, and analysis of specific aspects of reality lead to facts (representations of how things are) that are devoid of any inherent values or biases (Hiller, 2016). This means that the researcher's viewpoints, biases, and views have no bearing on the methods or outcomes of the research. Again, for positivists, factual knowledge is the type of knowledge that is obtained through observation (using human senses) or measurement is considered to be more dependable. In practical terms, quantitative research methods are seen as the most reliable. Additionally, it is asserted that in positivist studies, the researcher's role is limited to collecting data and conducting impartial analysis and interpretation of those findings (Hiller, 2016).

The subjectivists embrace a subjectivist epistemology in their study and draw their inspiration from relativist ontology (Denzin & Lincoln, 2005). Subjectivism, according to Denzin and Lincoln (2005), is a type of scientific knowledge that is based on the idea that information is theorized through the lenses of factors together with race, class, language, ethnicity and other societal and cultural paradigms. Subjectivists appear to have a strong case for their position, which holds that knowledge is socially and culturally created rather than absolute, scientifically defined, and applicable to all situations (Levers, 2013).

Subjectivists do not reject the presence of an external world, but subjectivism-based epistemology regarded knowledge as being value-laden rather than neutral or free of

values. Beyond individual observations and creations, universal knowledge of the outside world is impossible, as Levers (2013) contends. Hence the researcher's perceptions can be greatly prejudiced by the subject or object, and vice versa (Levers, 2013).

In essence, Denzil and Lincoln (2005) and Levers (2013) hold that interpretivism models appear to be gradually replacing positivist and post-positivist paradigms in modern social research (Levers 2013). Al Habil, (2014), argues that what may be produced will lose a human touch if it is claimed that common sense, which every researcher possesses, must not be considered when conducting the study. The pragmatist philosophy, on the other hand, brings together two different philosophical ideas in one research. In Mixed Method Research, pragmatism is seen as a philosophical approach and a stance on the effectiveness of combining philosophical ideas (Creswell, 2003). For instance, Creswell (2003) combines constructivism and post-positivism alongside pragmatism as one of two schools of thinking. According to Creswell and Plano (2011), pragmatism is a philosophy that assigns "primary importance to the research questions that are asked". These enable researchers to use a different approach to address important research objectives. Many pragmatic researchers are ambivalent in this regard, relying on a variety of epistemological and methodological presuppositions to get what Maxcy (2003) refers to as functional knowledge about how research affects day-to-day practice.

A common feature among proponents of pragmatism in mixed method research is the pragmatic maxim, which "chooses the combination or blend of techniques and procedures that work best for solving specific research questions" (Johnson &

Onwuegbuzie, 2004). Biesta (2010) argues that "Pragmatism provides the logical underpinning for mixed methods research".

According to Diesing (2019), pragmatism suggests that constructionism and post-positivism are complementary rather than mutually exclusive, contrary to claims made by some writers that they are mutually exclusive (Levers, 2013). In light of the above, global social research will be improved by a cogent merger of both philosophical frameworks that are complementary rather than antagonistic (Diesing, 2019). The importance of pragmatism (mixed methods) has been the ability to conduct quantitative and qualitative research procedures concurrently, giving each methodology equal weight, assessing the two components separately, and integrating the results (Creswell & Pablo-Clark, 2011). Therefore, this study employs the pragmatic philosophy (mixed-method approach) for the study.

3.4.1 Research Design

The term "research design" refers to the "process for gathering, evaluating, interpreting, and reporting data in research investigations" (Creswell & Plano Clark, 2007). It is a generic method for connecting pertinent empirical findings to the subject of conceptual inquiry. To put it another way, the study design establishes how the required data is gathered, how it is processed, and how it is applied to the research question (Grey, 2014). According to Robson (2002), three different study design types might be used: exploratory, descriptive, and explanatory. Each design's ultimate objective is unique. Descriptive research could aim to describe a situation, a person, or an event, or it might show how different parts interact and happen spontaneously (Blumberg, Cooper, and Schindler, 2005). Contrarily, descriptive investigations are useful for a new or unexplored research topic but cannot explain why an event occurred (Punch, 2005).

Therefore, other study strategies like explanatory or exploratory procedures are preferred in the presence of a wealth of descriptive data.

3.4.2 Qualitative Approach

Garber (1996) describes qualitative research as a study methodology used to build hypotheses and comprehension. By observing events in their natural settings and attempting to make sense of or interpret them in terms of the meaning people attach to them, qualitative researchers aim to adopt an interpretive, naturalistic perspective on the world, according to Denzin and Lincoln's (2005) description of it. The focus of qualitative research is on non-verifiable practices and interpretations, as well as entity qualities.

According to Denzin, Lincoln, and Patton's definitions from 2005 and 2001, qualitative research is "a method that uses a naturalistic approach and seeks to understand phenomena in context-specific settings, such as real-world settings, where the researcher does not attempt to manipulate the phenomena of interest." In contrast to research that produces results by statistical methods or other ways of quantification, research is any sort of study that derives its findings from actual events in which the phenomena under study naturally occur.

According to Weinreich (2009), the goal of qualitative research is to give the researcher access to the target audience's point of view through absorption in a culture or context and direct interaction with the study subjects. This implies that the qualitative paradigm uses the researcher as a tool for gathering data and that the research's findings may differ significantly depending on the researcher. Examples of qualitative techniques include participant observation, participant record analysis, document analysis, and open-ended, unstructured interviewing.

In their definition of qualitative research, Worthen and Sanders state that it is "a method to the inquiry that is frequently conducted in natural settings, using the researcher as the major "instrument" in both data collection and interpretation" (Worthen and Sanders 1987). The advantages of qualitative research are inherent in its focus on "thick description," or acquiring genuine, rich, and deep data that sheds light on recognizable behavior and meaning patterns from the perspective of the individuals being investigated. This point of view emphasizes the importance of hearing the researcher's voice and learning about their unique experiences with the study's subject. In qualitative research, Participant interviews are one of many data-collection techniques employed. The wealth of specific data contained in the database is then used to derive concepts using an inductive approach of data analysis. According to Weinreich (2009), the significance of qualitative approaches is that they produce rich, detailed data that maintain the participant's perspective and give context for the event being examined. On the other hand, acquiring data via a qualitative approach could be time- and labor-intensive.

3.4.3 Quantitative Approach

A quantitative research methodology, according to Aliaga and Gunderson (2000), is a study that gathers quantitative data to be statistically examined to help explain a phenomenon. By using tools that produce statistical data and study procedures like surveys and trials, the researcher collects data during this process (Creswell, 2003).

Quantitative research is a technique for a study that tries to test hypotheses, establish facts, find correlations between variables, and forecast outcomes, according to Van der Merwe (1996). Methods from the natural sciences are used in quantitative research to assure objectivity, generalizability, and dependability (Weinreich, 2009). The importance of quantitative research is that its conclusions are exact, quantifiable, and

generalizable to a broad population (Marshall, 1996). It is also permissible to evaluate and validate prior created assumptions regarding how and why events occur while testing such a hypothesis. In quantitative research, interviews, an unbiased random selection of research participants from the study population, and other statistical techniques are used to evaluate predetermined hypotheses about the relationship between specific variables. Quantitative research is viewed as separate from the study itself, in contrast to the qualitative approach, where the researcher is valued as a research instrument because of their active participation in the research process. It is expected that the results should be replicable regardless of the researcher.

3.4.4 Mixed Method

In some or all study phases, such as sample design, data collection and analysis, findings synthesis, integration, and reporting, the mixed method combines quantitative and qualitative methodologies (Tashakkori and Teddlie, 1998). The collection, analysis, and synthesis of numerical, textual, visual and multimedia data will all take place (Tashakkori and Creswell, 2013).

Mixed method inquiry, a method for investigating the social world, "ideally involves several methodological traditions, and consequently, numerous ways of knowing, as well as multiple sorts of procedures for gathering, analyzing, and expressing human occurrences, all for improved understanding" (Johnston et al., 2007). Being able to conduct quantitative and qualitative research processes simultaneously, giving each technique equal weight, examining the two components individually, and merging the results have been the significance of mixed methods (Creswell & Pablo-Clark, 2011). Therefore, a mixed-method approach was adopted for the study. The approach is illustrated in Fig. 3.2 below;

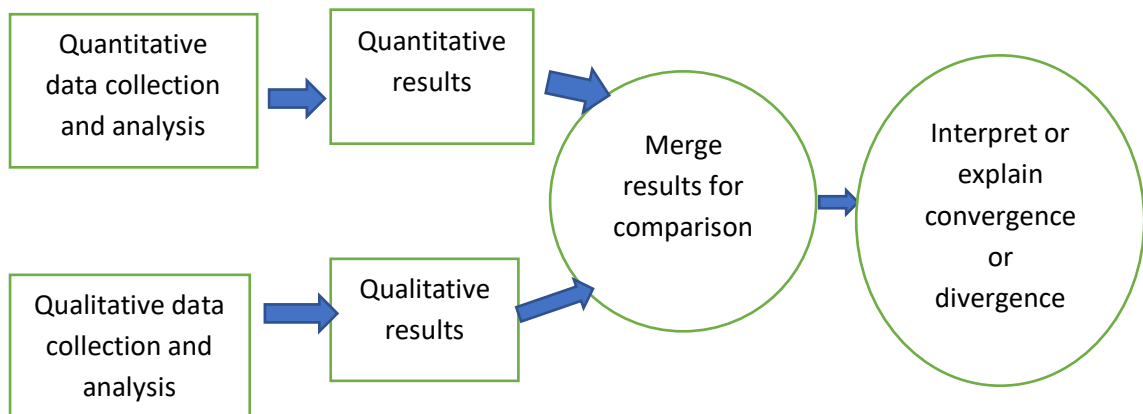


Figure 3.2: Diagram of Convergent Parallel Mixed Methods

Source: Authors Construct (February 2022)

3.5 Sampling Techniques

According to Fraenkel, Wallen and Hyun (2012), sampling refers to the process of selecting participants for study. In accordance with the goals of the study, the amount of cash, time, and effort available, as well as other factors, David (2005) and Mercado (2006) define sampling as the simple process of choosing a population representative from the wider population. Gill and Johnson (2002) use the term "sampling" but did not define it clearly; they viewed sampling as the act of choosing the research population "which will give the information required for addressing the original research issue."

Non-probability sampling and probability sampling are the two main types of sampling (David, 2006; Fraenkel, Wallen, & Hyun, 2012; Mercado, 2006). Probability sampling is defined as a sampling method where "every member of the population presumably has an equal chance of being selected," according to Fraenkel, Wallen, and Hyun (2012). David (2005) asserts that the idea of random selection, which ensures that every member of the population has an equal chance of being chosen as a sample unit, is the basis for probability sampling. The participants in Gill and Johnson's (2002) probability

sampling constitute a representative sample of the research community, therefore it is envisaged that the results can be confidently extrapolated to the target population.

According to Mercado (2006), "choosing the sample by chance" is the definition of probability sampling. The findings/results in this instance are generalizable to the entire community. Probability sampling, as defined by Sevilla et al. (2006), is "a process of selecting a sample size from a study population where each member of the population has an equal chance of being included in the sample and that all possible combinations of size have an equal chance of being selected as the sample."

According to Tejero (2006), not everyone in the population has an equal probability of being selected, and some people have no chance (Fraenkel, Wallen & Hyun, 2012). Non-probability Sampling is a sort of subjective sampling. Every person of the population does not have an equal chance of getting chosen for the sample. The risk of bias is a drawback of this sampling approach. A bias is an enhanced chance that a certain kind, class, or element will be present in the sample that was selected (David, 2005). Additionally, non-probability sampling is arbitrary (non-random) and typically subjective, (Cooper and Schindler 2005). Sample cases are chosen by data collectors "as they wish" or "as they find them."

3.5.1 Simple Random Sampling

The study used straightforward simple random sampling technique to obtain respondents at the community level. The lottery method was used to draw names from the respondents. The method by acquiring a list of addresses for each household in the sample community to avoid bias. After then, the names or addresses were written on paper, folded, and placed in a bowl this process was repeated until the total sample for the communities was achieved.

3.5.2 Purposive Sampling

Purposive sampling approaches the non-probability sampling strategy was used. Key informants for the study were found using a purposeful sampling technique. People who have sufficient relevant knowledge of the study topic were selected to participate in this sampling approach. Purposive sampling, according to Leedy and Ormrod (2010), enables researchers to select the people who will produce the pertinent data on the subject under investigation.

Officials from these institutions and agencies: National Disaster Management Organization (NADMO), the Bongo District Assembly (BDA), the West African Science Center for Climate Change and Land Use Adaptation (WASCCAL), and the Department of Agriculture of the Ministry of Food and Agriculture (MoFA) were sampled as key informants. Other agencies were: Ghana National Fire Service, Ghana Metrological Agency, and Environmental Protection Agency. The choice of these agencies and organizations results from the fact that their oversight responsibilities include certain functions and responsibilities which are chiefly related to disasters and disaster management. The choice of the communities was based on their vulnerability context to disaster or experiences of some form of disaster occurrences as they classified as Disaster Prone communities.

Table 3.1: Sampled of Key Informants to be Interviewed

S/N	Name of Institutions or Informant	Roles / Responsibilities	Expected Number
1	Bongo District Assembly (Department of Planning)	Leading political and development and planning processes in the district	One Official
2	NADMO	Coordinating, planning, and implementing Disaster mitigation plans and Strategies	One Official
3	MoFA (Department of Agriculture)	Promoting sustainable agriculture and thriving agribusiness through research and development and ensuring effective adaptation practices to overcome disaster	One Official
4	WASCAL	Coordinating high-quality or impactful, evidence-based research for the creation and promotion of climate change adaptation strategies in Ghana and West Africa that draw on scientific and traditional knowledge systems	One Official
5	Ghana National Fire Service (GNFS)	Responsible for fire prevention, education, and conducting inspections and certification of a building that meets fire safety requirement	One Official
6	Environmental Protection Agency	In charge of hazardous waste management, restoration of lands, tree planting, and conducting Environmental Impact Assessment, including capacity building on disaster risk reductions	One Official
7	Ghana Metrological Agency	Providing efficient and reliable meteorological information by collecting, processing, archiving, analyzing, and disseminating findings/meteorological information to end users.	One Official

Source: Field Data (September 2022)

3.5.3 Sample Size Determination

The primary goal of sampling is representativeness, so the sample should be put together in a way that is representative of the population from which it was drawn (Jennings, 2001). Sampling is important since it is impossible to include every member of the population when dealing with a large number of respondents, hence it is necessary to obtain a fair representation of the population. However, the issue of the appropriate sample size in quantitative research affects not only new researchers but all social scientists. It deals with fundamental issues like how big or small the sample needs to be, in order to be representative (Sarantakos, 1997).

The size of a sample is one of the most frequent questions that survey methodologists receive, according to Fowler (1993). One common misunderstanding is that the proportion of the population represented in the sample has a significant impact on how adequate a sample size is. People who share this opinion, for instance, would assert that a sample is credible if it represents 1%, 5%, or any other percentage of the population. Fowler (1993) states that the vast majority of research samples only include a small portion of populations despite this defence. In such cases, it is argued that slight increases in the percentage of the population included in a sample will not affect the researcher's capacity to extrapolate conclusions.

An "analysis plan", according to Fowler (1993) is the first prerequisite for choosing a sample size. The most important part of the analysis plan is a list of subgroups within the overall population for which separate estimates can be made on confidence intervals for the entire sample. The idea is that the majority of sample size decisions are focused on the smallest sample sizes that can be accepted for the smallest subgroups of interest rather than estimates for the entire population (Tuffuor, 1996). The communities was

chosen on purpose because they are more prone to disasters than other communities in the study area. A simple random and purposive sampling technique was used to create the sample size for the study (NADMO, 2018).

Based on their physical location, the study district has been politically divided into area and town councils, and they were represented proportionally in the Assembly by an Assembly Member. Communities were formed from the Town Councils, and these communities served as the study's conduits for communicating the problems of the populace to the District Assembly. Out of the 39 communities in the Bongo District, nine communities are more vulnerable to disasters such as flood, wind storm, pest and drought every year (BDA, 2014). Given the homogeneity of the communities, the study sampled three at-risk-to-disaster communities with a total household size of 1,058 as population. The sample size was determined using the formula provided below, which was developed by Yamane (1967). $n = N / (1 + N(e)^2)$.

Where n = Sample Size,

N = Sample Frame

e^2 = error margin/confident level and 1 = constant.

But in the context of this research, given that; $n = ?$, $N = 1,058$, $1 = \text{constant}$, and the confidence level of 95% (0.05) thus 95% precision level.

Then, $n = 1,058 / (1 + 1,058(0.05)^2)$

thus, $n = 1,058 / 1 + 1,058(0.0025)$

thus, $n = 1,058 / 1 + 2.65$

thus, $n = 1,058 / 3.65$

thus $n = 351$

The Yamane equation takes a normal distribution as given $n = N / (1 + N(e)^2)$.

In terms of the parameters for interpretation of their judgments of the abilities necessary and implemented in practice, community members are presumed to be normally distributed. Therefore, selecting an adequate sample size could be done using the Yamane formula. In the Bongo District, 351 responses were sought from three communities. Since a 95% confidence interval is seen as appropriate, $z = 2$ statistically. P is the percentage of responses that would be pertinent to the investigation. Therefore, the sample size determined is 351 and distributed to the study communities as seen in (Table 3.1);

Table 3.2: Sample Size Determination

Area Council	Community	Number of Compounds in Communities	Number of Households	Sample Size by Proportion
Balungu	Balungu	68	497	$497/1,058*290= 154$
Valley	Namo	49	345	$345/1,058*290= 115$
Beo	Nyariga	31	216	$216/1,058*290= 82$
3	3	148	1,058	351

Source: Field Survey (September 2022)

Accordingly, using the Yamane (1967) representative sample size determination procedure and computations, using $N = 1,058$ and $"e" = 5\%$ as a result of the 95% confidence level, the total number of representative households sampled in the three selected communities is 351. Using the proportional sample method, each of the three sampled communities had a specific number of households that was sampled for the study. The distribution is as follows; Balungu (154 households) Namu (115 households) and Nyariga (82 households).

The selected name or address who meets the criteria for the sample unit or household head, women leader, youth who are 18 years of age or older, priest, opinion leader, women or men was interviewed. Up until the desired number is obtained, the procedure was repeated. The optimal method is this one since it guarantees that each sample unit has an equal chance of being chosen for the study and removes bias (Creswell, 2013).

3.6 Data Collection Methods and Tools

According to Seale, Giampietro, Gubrium and Silverman (2004), respondents and researchers collaborate to produce retrospective and prospective accounts or versions of their past or present behaviors, experiences, feelings, and thoughts. In-depth interviews, focus groups, and structured interviews were among the methods used to collect data for this study. The study employed focus groups, in-depth interviews, and structured interviews to collect data. The tools listed below were used to collect the data. This served as an interview guide, a key informant interview guide, and a focus group discussion guide. Details are provided below.

3.6.1 Structured Questionnaire

No qualitative interview, according to analysts, is complete without a framework (Jamshed, 2014). But the formality of this kind of interview is different. During structured interviews, the interviewee has less latitude to be adaptable and casual because the interviewer, who is in total control, has a lot of power (Stuckey, 2013). It is obvious from the basic principles of a structured interview that the interview environment is severely constrained and may intimidate participants into providing nonsensical replies. When conducting structured interviews, the researcher must go by a set of guidelines (Stuckey, 2013). Throughout the process, the researcher must follow

the order of the questions and the wording of the questions. No one is allowed to respond to another subject's questions while explaining the response.

Stuckey (2013) asserts that the researcher shouldn't agree, disagree, or provide a remedy. Notably, the issue of interpretation does not arise in structured interviews. The rules also address deviating from study procedure when doing so. Because of their rigid structure, structured interviews are disliked by qualitative research analysts (DiCicco-Bloom & Crabtree, 2006). The study employed an open-ended, multiple-choice, and dichotomous questionnaire that required the respondent to express an opinion and only allowed yes-or-no responses. Local knowledge systems, local adaptation techniques, disasters, disaster management, coping mechanisms, and the incorporation of local adaptation plans into disaster management plans were among the several forms of data. The sampled houses were given the structured interview guide, which focused on the following individuals: chiefs and/or clan heads, Tindanas, women leaders, youth, and household heads.

3.6.2 Focus Group Discussion

The main method for gathering data utilized in focus group discussions is semi-structured group interviews. A group leader typically oversees these groups. Focus groups may use a variety of data collection techniques (Creswell, 2013). The formation of different groups will depend on a number of factors, including the uniformity of the questions, the number of focus groups that are done, the number of participants in each group, and the degree of moderating required (Ladimeji, 2013). Each community (Balungu, Namoo and Nyariga) held one focus group discussion with locals, settlers (including women), and youth organizations. A total of 17 peoples in the study

communities who are knowledgeable about the topic or have experienced a form of disaster participated in the focus group discussion. The participants, who were selected for focus discussions did not participate in the interviews although they are part of household. This is to prevent boredom and fatigue, since focus group discussions take quite time given the probing of questions. With this strategy, the respondent will be free to voice out their views (Creswell, 2013). To gather comprehensive information on local knowledge systems, local adaptation techniques, disaster, disaster management, coping mechanisms, and difficulties related to the subject, this methodology was used. The facilitator used the focus group guide to examine the participants' worldviews about disaster management, local knowledge systems, coping mechanisms, and climate adaptation techniques.

3.6.3 In-Depth Interview

An in-depth interview involves a verbal interaction or face-to-face encounter where a research participant responds to a researcher on a subject under investigation. Unusually, it is a planned activity directed by the researcher to elicit information during an interview (Bogdan and Biklen, 1982). An in-depth interview's major objective is to demonstrate to the researcher how to understand the world from the interviewee's perspective. In-depth interviewing is a major research instrument for data collection (Botha, 2001). Fontana and Frey (1994) described it as the art and science of interviews. Kvale (1996), noted that it is an intriguing and relevant qualitative research tool, which aims at making it easy for the researcher to comprehend the participant's perspective of the world, to understand the significance of participants' experiences, and to reveal participants' lived experiences and reality before scientific explanations.

The major classification of key informants emphasizes knowledge and a readiness to offer information. According to Marshall (1996), They are "an expert source of information" who can "offer more knowledge and deeper insight into what is going on around them as a result of their abilities, or position within a society, they should possess expertise, be open to participation, communicate effectively, remain unbiased, and hold a position within the community or possess an understanding of the phenomenon in question, as outlined by Marshall in 1996. These individuals offer unique perspective that an external researcher may not have access to, as they possess limited information or insight into a concept, situation, group, culture, or topic but are willing to share their knowledge with the researcher.

Observations based on how they fit into the community of interest being studied can be quite informative (Adekannbi and Adeniran, 2017; Adekannbi and Dada, 2017; Innes, Jackson, Plummer and Elliott, 2017; Katiambo, 2015). Debono (2002) notes that key informants are people who have the competence and credibility on specific social influences given by a library" (p. 86); it is well accepted in the literature that key informants can reflect on and share the benefits of their astuteness. Key informants, also known as experts or specialized informants (Bogner, Littig, and Menz, 2009), are likely to be knowledgeable about a particular field, issue, or organization in some context (Bernard, 2018).

The information from these institutions among other things, their roles in disaster management, and how they incorporate local Knowledge systems on climate adaptation strategies into their medium-term development plans for disaster management.

3.7 Data Validity and Reliability

To ensure validity, data collected from the key informant interviews and the replies to the questionnaire administration was triangulated. Because several approaches were employed in the data collection process, triangulation was used to help widen and give a better understanding of the phenomenon that is being examined in order to boost accuracy and measure validity and to increase the credibility of the study.

3.8 Ethical Issues

The study obtained a letter of introduction from the SD Dombo University of Business and Integrated Development Studies (SDD-UBIDS). This was to institutions to seek permission before data collection.

Measures were put in place to ensure the study's legibility while adhering to strict ethical guidelines. Informed consent was issued by interpreting the objectives and methodology of the study, and subjects consented to participate by signing or thumb-printing a consent form. Additionally, participants were assured of a guarantee of privacy for their comments. The study ensured that contributions was used exclusively for the research and that no information was shared with third parties. Also, the privacy and identity of respondents was anonymous. The respondent's comfort is extremely important to the researcher; thus, availability and responsiveness questions are asked right away.

3.9 Data Analysis and Presentation

The quantitative data that were organized based on the objectives of the study. The data from this study were analyzed quantitatively, which included describing the data using descriptive statistic tools such as frequency, percentage, as well as using advanced statistical software such as the Statistical Package for Social Sciences (SPSS) to aid in the analysis. The study used tables, graphs, and charts, to present the data in a consistent

fashion that aligned with the study's goals and questions. To identify problems with local knowledge systems for disaster management in the sampled communities, an analysis of variance was carried out.

Thematic analysis was used to examine the qualitative data from focus group discussions and in-depth interviews. Data from NADMO, EPA, MOFA, Planning unit, and WASCAL collected for local knowledge, disaster preparedness, and local adaptation was analyzed by SPSS version 20 and displayed in the form of graphs. The reading and cleaning of the data was done before the analysis process begins to become familiar with the textual data. The information was then entered into SPSS version 20 and summarized, coded, organized, and structured per the objectives of the study. Each objective's emergent themes were tuned and matched together in codes to enable further categorization into substantive analytical themes. Direct quotes and figures were used to illustrate the emerging findings.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter is structured as follows: It starts with the presentation of the results of the study. The issues captured here include the results of the bio-data of respondents and the type of household size. It is followed by the presentation of results on the first objective which is on Harnessing Local Knowledge Systems for Climate Change Adaptation during Disaster. The second objective focused on identifying the local knowledge systems that are used for climate adaptation in times of disaster. The third objective examined climate change adaptation strategies used by local communities in times of disaster and the fourth objective was to explore the local adaptation practices that are integrated into disaster management plans.

4.2 Respondents' Bio-Data

The study analyzed the socio-demographic characteristics of the respondents. Relevant aspects of the characteristics that hinge on climate change adaptation practices that harness local knowledge systems in times of disaster, these include; sex and age distribution, marital status, educational level, and household size of respondent's status in the community.

Table 4.1 shows the distribution of male and female respondents by background characteristics. The respondents were male-dominant because 51% of the respondents were males whereas 49% of them were females. This distribution is not in tandem with national population dynamics which reflects a female dominant population. However, the observation made is attributable to an uncontrolled random selection of male participants in the study as household heads. In terms of age distribution, respondents aged 60 and above were 7%, 20- 39 were 48% and age group 40 to 59 were 45%. The

choice of the ages ranged 20 and above because; respondents in these categories had attained adulthood and are capable of expressing their independent opinions. The findings show the district had a youthful population base. The vast majority (44%) of respondents are married, 36% are single 13% of the respondents have lost their spouses and are widows and 7% of them have been separated from their partners. The study also revealed that about 45% of the respondents are literate and 55% are illiterate.

Table 4.1 Respondents' Bio-data

Response	Variable	Sex Distribution of Respondents		Total	Per cent
		Female	Male		
Age Category	20- and below	19	24	43	12
	21-29	22	27	49	14
	30- 39	36	42	78	22
	40- 49	68	60	128	36
	50- 59	12	19	31	9
	60 & above	9	13	22	7
Total		166	185	351	100
Marital Status	Single	58	69	127	36
	Married	70	86	156	44
	Widowed	40	28	68	13
Total		14	81	351	100
Household Size	Male headed with single or multiple wives	0	222	222	82
	Female headed Male/female headed divorce or widow	29	0	29	8
	Total	29	222	222	351
Educational Level of Respondents	Primary/JHS	41	83	124	35
	SHS/SSS	30	24	54	15
	Tertiary	7	12	19	5
	No formal Education	59	77	154	45
Total		14	81	351	100

Source: Field Survey (February 2023).

4.3 Climate Change Adaptation Strategies in times of Disaster in the Bongo District

This section looks at the climate change adaptation strategies that are used by communities in times of disaster. Information that was gathered is on the types and common occurrences of disaster, the experience of disaster, the changes in the local climate as well as respondents' views and knowledge about climate change.

4.3.1 Types of Disasters experienced in the Community

The occurrence of disaster in the Upper East region and that of Bongo district has become more intense than before. The undulating nature of the topography of the district makes most of the communities prone to disasters like floods, windstorms, drought/dry spells, outbreaks of diseases among humans and livestock and the infestation of pest and diseases of farms (armyworm) as the survey results reveal. The frequent occurrence of disasters in the district has become a major development issue as it affects lives, properties, and homes. The social and economic cost of disasters to individuals and households is becoming unbearable. In the survey 48% of the respondents indicated that flooding is the most frequent disaster, 32% of respondents pointed at drought/dry spell as the second major type of disaster that periodically disturbs them, and 14% of the sampled population mentioned windstorm as another type of disaster that occurs in their communities. The details are shown in the table below Table 4.3.

Table 4.2: Types of Disaster Experienced in the Community

Variables	Frequency	Percentage
Types of Disaster		
Floods	121	34
Drought	97	28
Pest Infestations	18	5
Disease Outbreak	36	10
Windstorm	79	23
Total	351	100

Source: Field Survey (February, 2023)

4.3.2 Frequency of the Experience of Disaster

From the survey, it came to light that about 76% of respondents in the Bongo district indicate that disaster affects them seasonally/annually. This results in the destruction of lives and properties including homes and sources of livelihood, with about 24% of the respondent population stating that they have never been hurt or affected by any form of disaster in their communities. The Details are shown in Fig. 4.1.

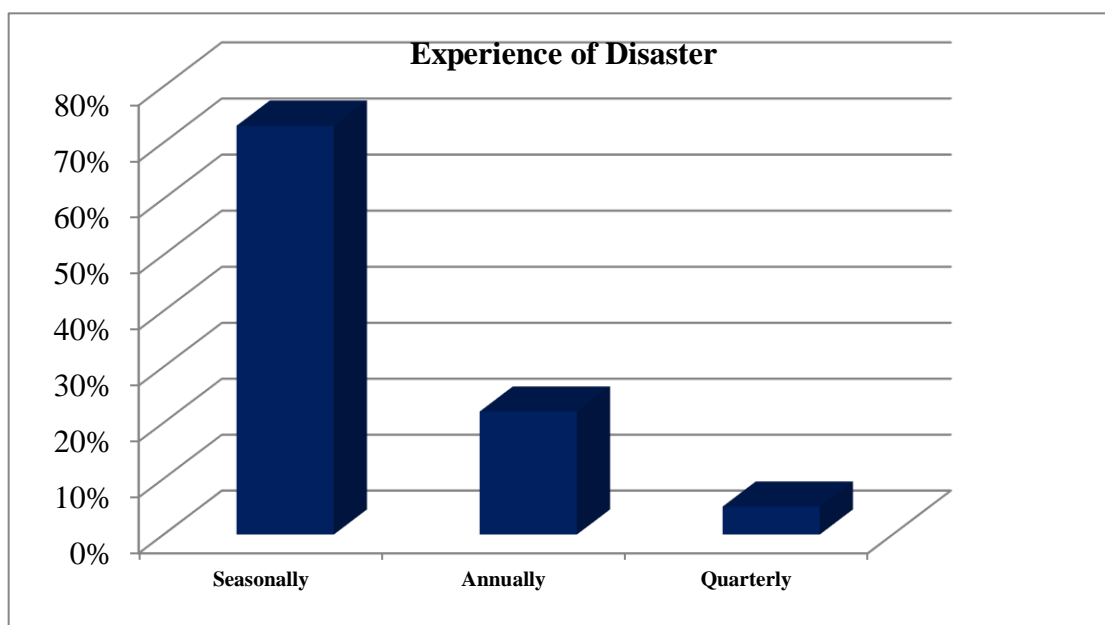


Figure 4.1: Experience of Disaster

Source: Field Survey (February 2023)

During a focus group discussion participants indicated as follows:

As for us and disasters, we are like families because there is no blessed rainy season that flood will not disturb our community by destroying farmlands and collapsing buildings. Looking behind the container can you see a building there but there was a house it was pulled down by flood as a result of heavy rain and the spillage of Bagre Dam from Burkina Faso the house owner is the man inside the lotto store but he is temporally living with a distant relative in Lungu (Discussants in an FGD).

Also, some discussants at a separate focus group discussion in Namo shared their experience on the rate at which they are hurt by the disaster in their community;

We the people in this community, drought and windstorms are our main problems because our place slopes, and so anytime it rains it easily dries up so if the rains fail to come frequently the drought becomes severe compared to other communities. I think it is because of the undulating nature of our place Windstorms easily uproot our homes and make us homeless. (Discussants in an FGD).

In a focus group discussion with the women's group, they shared their frustration on how drought periodically threatens their source of livelihood;

Hmmm, I don't even know what to say. In Balungu here drought disturbs our farm work and food production because we don't get the expected yield there is no rainy season and we don't experience drought or dry spell in this community I don't know if we are cursed. (Discussant in an FGD).

Further information obtained from key informant (Agriculture Extension Officer) interviews reveals that;

Disasters like floods, drought, windstorms, and armyworms among others periodically hurt the people in their communities, in fact, it sometimes renders some homeless. (Key Informant, Bongo District).

4.3.3 Participants' Knowledge of Climate Change

Respondents were asked whether they were aware of climate change, and 89% of them indicated yes, they were aware of climate change whilst 11% of the them said no, they were not aware of climate change. Respondents' knowledge was sought on what climate change is all about; the majority of the participants held the view that climate change is the prolonged changes in the weather pattern of a particular place over a period. Climate Change is the regional or global-scale changes in historical climate patterns arising from natural and/or man-made causes and resulting in intermittent but increasingly frequent extreme impacts. Similarly, others opine that climate change is all about the changes in the weather of a place. The group indicated that when there is drought then the climate changes.

The Details are shown in Table 4.3.

Table 4.3: Participants' Knowledge of Climate Change

VARIABLES	FREQUENCY	PERCENTAGE
Understanding Climate Change		
When there is a prolonged drought	153	44
Weather changing with rising temperature	88	25
Strange pests and diseases affecting both crops and humankind	36	10
Years of prolonged changes in the weather pattern	74	21
Total	351	100

Source: Field Survey (February 2023)

It was unanimously agreed, during a focus group discussion, that climate change is the prolonged dry season from November to April.

In another, focus group discussion participants indicated that:

The weather has changed, temperatures are rising, and farming is becoming unattractive because of how the rainfall pattern is now. Imagine that last year the rains started in June and by October the rain stopped; I don't know whether this year it will come early or not. The problem I have is that the rain comes with a storm which causes disaster. It blows off the roofs of people's homes and pushes down trees; all this is a result of climate change; I can say of late, there is a strange disease that attacks crop on our farms; some of these pests we use chemicals to kill but to no avail, so sometimes we just have to uproot the affected crops to prevent the spread of the disease. That's climate change (Focus Group Discussion)

Further information obtained from the Bongo District Best Farmer, for 2022 during a key informant interview revealed that;

Pest and diseases disturb farmers here The weather has changed and rainfall has reduced, I am not a meteorologist but if I ask them, they will tell me I have been here since 1996; temperatures were too high like this, and it used to rain early for farmers to farm; flooding was not common in fifteen years, ten years; but now a days when almost every raining season, the community experience floods and this is becoming an annual ritual; it is worrying; farms produce; house collapse and poor roads are rear consequences of flooding (Key Informant Interview, Bongo District).

4.3.4 Respondents' Views on Changes in Local Climate

Table 4.4 summarizes the opinions of respondents who were asked whether their local climate was changing or not. As shown in the table, 96% of respondents confirmed that indeed they have observed and experienced changes in their local climate. The Details as shown in Table 4.4

Table 4.4: Respondents' Views on Changes in Local Climate

VARIABLES	FREQUENCY	PERCENTAGE
Changes in Local Climate		
Shorter wet/rainy season	99	29
Rise in temperature	79	23
Increase in flood occurrence	130	37
Pest and disease infestation (Armyworm)	44	13
Total	351	100

Source: Field Survey (February 2023).

These findings were corroborated during a focus group discussion where participants shared their thoughts on changes in their local climate;

Participants held the view that the climate of communities in the Bongo district is relatively dry, many of the farmers reported they have noticed a decline in rainfall amounts recently. They added that, the average temperature in their localities has increased while rainfall amount has decreased in the past 10

years, and that perceptions of temperature change slightly across study communities. (Focus Group Discussion, Bongo District).

During a focus group discussion in the Balungu community, the participants in a focus group expressed their views on climate change similar to that of the above they indicated as follows:

Yes, our local climate here is changing due to the prolonged dry season, the late start of the rainy season, and the shorter rainy season. Changes that I have seen here in our local climate are the heat; the weather is very hot, people are just falling sick, and when it rains within a few days the environment becomes dry again as if it hasn't rained for months (Focus Group Discussion, Bongo District).

Further information obtained from a male leader of dry season farmers association during key informant interviews reveals that;

What I have observed is that climate-related disasters like floods, droughts, and windstorms have become so common that almost everyone suffers from one form of disaster or another. That is the change I have observed for the past ten years. (Key Informant, Bongo District).

He confirmed that they have actually noticed a decline in the number of rainfall patterns in the district for the past ten years and still counting.

4.4 Harnessing Local Knowledge Systems for Climate Change Adaptation During Disaster

This subsection presents the findings on local knowledge systems that are practiced among the communities within the study area.

4.4.1 Local Knowledge Systems in Practice

Local knowledge systems are a group's culture or indigenous customs that have been passed down from one generation to the next. Local knowledge systems are frequently articulated through practice, according to Ngenwi (2011), and they are connected to the cultures, values, norms, and beliefs of farmers. The study identified, changes in some local trees within the study area for example fruits on the 'Sissibi' tree, changes in the A-ara trees, sounds of the Nienen-bia (a rain-making bird), the application or spraying of crops with Neem extract or solution, and the cry of Lung or Kampone. Other signs the people observe are expressed in the local language as *Ta-ah n break* (when the Shea tree begins to bear fruits), *Saah han kou ge yeliga bu-ye kou bu-ta waa-re mbala zele* (when dark clouds gather and failed to produce rain more than two consecutive times drought has set in or is imminent), as the local knowledge systems that indigenes in Bongo use in the prediction and mitigation of disaster in their communities.

The findings revealed that only 5% of respondents engage in consultation or divination during a disaster, 24% farm on low land areas, 25% of the sampled population plants early maturing crops to escape the perineal flooding caused by heavy rains and the spillage of Bagre dam, 10% plants drought resistant crops to overcome drought, with about 8% of the respondent's plant water resistant crops.

The Details are shown in Fig. 4.2.

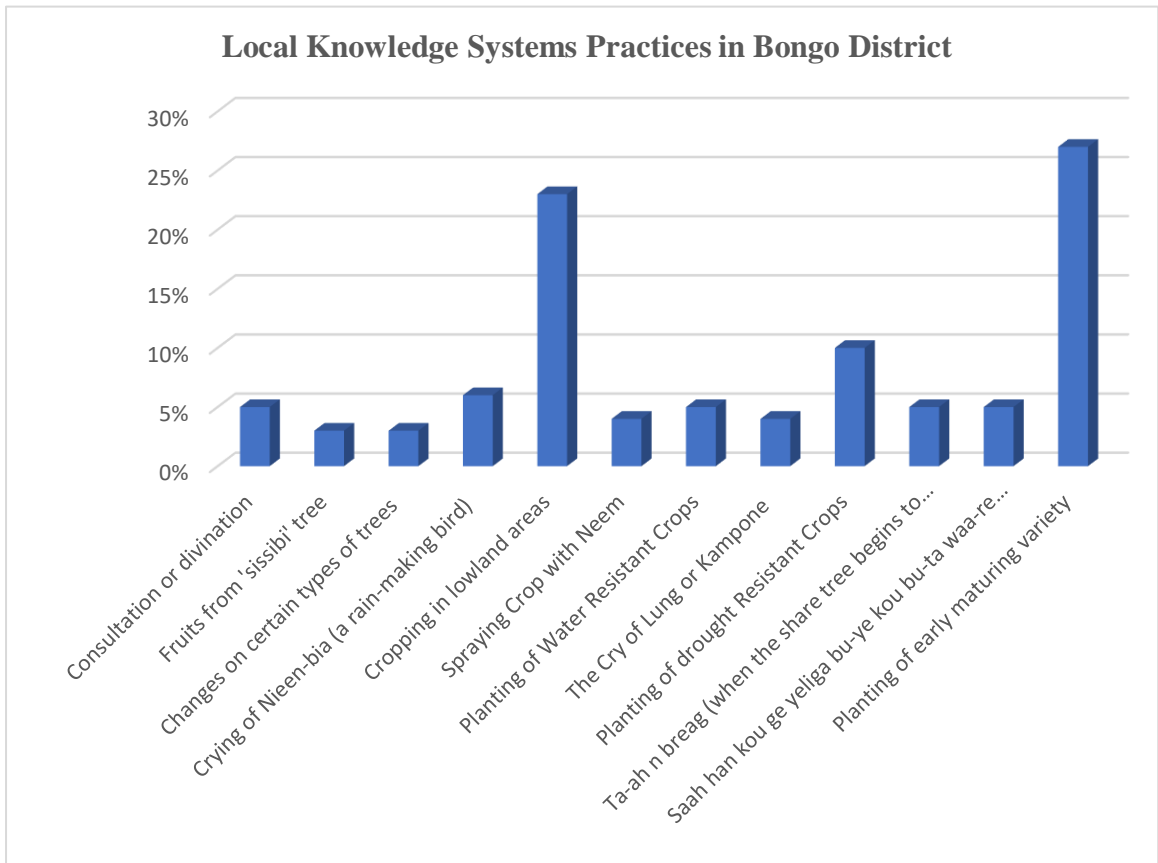


Figure 4.2: Local Knowledge Systems Practices in Bongo District

Source: Field Survey (February 2023).

Probing further on local knowledge systems in the study communities, participants during focus group discussions shared various opinions. Participants in a focus group discussion unanimously agreed that:

It is the knowledge that we grew up to meet; we grew up to know that it is a good thing to plant drought-resistant crops like the late millet in the upland because these crops; that is, late millet don't need much water to mature; this practice is common among farmers; every farmer is aware of this as a long age practice (Discussants in an FGD)

Furthermore, discussants in the Nyariga community in a focus group discussion affirmed that the local knowledge system is:

The knowledge our grandparents hand over to us and we continue to transmit these learned ideas to the younger generation. In appreciating local knowledge systems, we cultivate or plant rice in waterlogged areas or lowlands because rice is a water-resistant crop and will mature; as compared to groundnuts which does not require so much water and will fail to grow or mature if it is planted in waterlogged areas (Discussants in an FGD).

In a focus group discussion participants confirmed that they indeed do consultation or divination to obtain information from the gods regarding the beginning of an agricultural season whether it will be a good year or not and to gain more insights on what to expect in that particular year. Similarly, discussants in a focus group discussion further reveal that fruits from the 'Sissibi' tree and changes on the 'A-arra' trees signify the commencement of the agricultural or the rainy season.

During a key informant interview with a community chief in Namo, he expressed similar views to earlier opinions expressed by discussants in Nyariga the group added:

We use them to our advantage because when you use knowledge one benefits from it; for instance, when you plant groundnuts and millet and beans on the same piece of land- mixed cropping; the groundnuts and beans as legumes add nutrients to the soil which is good for all the crops; again, the beans also cover the soil and prevent soil erosion from occurring (KII, Nyariga Chief).

Further findings during key informant interviews also corroborate views held in focus group discussions and field-level interviews during questionnaire administration. The Assembly member for Bong-Namo had this to say:

Local knowledge systems refer to the understanding, skills, and philosophies developed by societies with long historical interactions with their natural

surroundings. It is the knowledge people in their various communities gather about how the climate is changing their surroundings (Key Informant Interview, Bongo District).

Another key informant (A women's leader) also had this to say about the local knowledge system: Local knowledge systems are mechanisms that indigenous people develop in their communities to ensure processes are well handled in the locale. This mechanism when properly followed reduces unforeseen problems. She added that;

Saah han kou ge yeliga bu-ye kou bu-ta waa-re mbala zele (when dark clouds gather and fail to produce rain more than two consecutive times drought has set in or is imminent), (Key Informant, Bongo District).

During a key informant interview with the Assembly member for Nyariga, he indicated that:

The crying of Nienen-bia (a rain-making bird) and that of Lung or Kampone is a sign that rain will fall that day and is enough for community members to prepare for rain (Key Informant, Bongo District).

4.5. Local Adaptation to Climate Change during Disaster

Local adaptation to climate change involves planning for the possibility of disasters brought on by extreme weather occurrences that may alter the production of resources at the ecosystem and landscape levels. Communities can modify their methods in agriculture, forestry, animal husbandry, land use, water use, and other natural resource systems with the support of local knowledge of natural and controlled ecosystems.

The study revealed that 43% of respondents practice mixed farming (crops and animal production) as a local adaptation strategy used by indigenes in Bongo; 22% of the respondents diversify their source of livelihood (off-farm activities), off-farm income

generating activities such as trading, construction work among others as an adaptation strategy to manage the impact of the disaster, 14% of respondents said due to their ability to predict disaster through early warning signs they can plant drought or flood-resistant crops and early maturing variety of crops to mitigate the adverse effects of disaster on their lives. About 12% of the respondents explained that they migrate to the southern sector anytime they are hurt by disaster to engage in menial jobs that can sustain them temporarily in order to recover from the shocks of disaster.

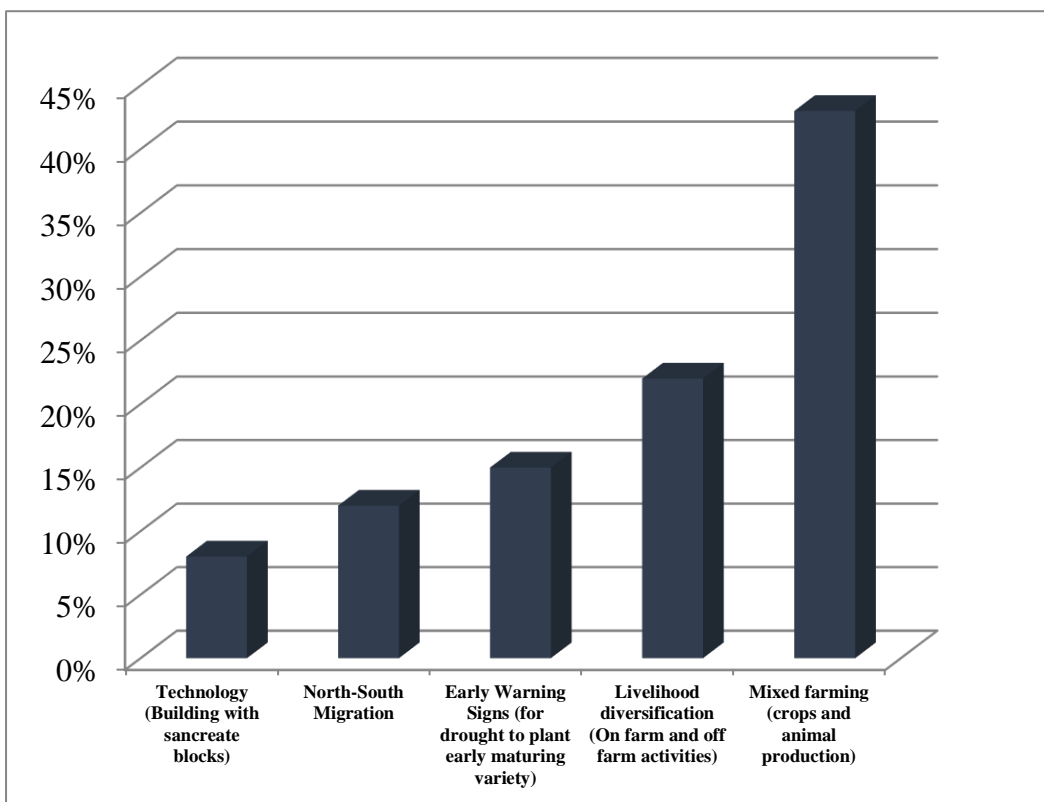


Figure 4.3: Local Adaptation to climate change during disaster

Source: Field Survey (February 2023).

Further investigation on community-level adaptation to climate change during a disaster in the study communities, participants during focus group discussions shared various opinions.

A participant in the indicated;

We practice mixed farming as an adaptation because when dealing with only crops and flood or drought occurs you are likely to lose your farm products. Similarly if you rear only animals and disease comes you can lose all your animals but engaging in mixed farming means that when any form of disaster hits you, you can still survive. In 2017 flood destroyed all my farm products on the farm; I did not harvest anything but thankfully I had seven cattle and a few sheep, so I sold some to feed my family until the next farming came for us to farm (FGD discussant).

In another focus group discussion, participants explained:

We are all full-time farmers but engage in other income-generating activities like masonry, carpentry, buying and selling of animals in the community market, welding and fabrication, etc. at the same time, so any time disaster hits us, we have something to do that can help me take care of our households (Focus Group Discussion, Bongo District)

Similarly, a key informant during an interview expressed a similar opinion. He had this to say:

I am a farmer and a trader in farm animals in the market as well. My farmland is at a low land area so I farm the early millet that matures only in 90 days, and rice which is a water-resistant crop. So, with the early millet, I will harvest before the flood comes but for the rice, by the time the rains come it will be grown and can't be destroyed again so it will be there until I harvest. When this fails me, I go to continue my animal-selling business to support my family. (A male key informant in Nyariga).

Another key informant also offered some explanations on the local knowledge system:

We do engage the communities to provide them with information on climate extremes (disasters) like when to expect heavy downpours and weather changes and they also have their local way of understanding these things (Key Informant, Bongo District).

4.5.1 Coping Mechanism in Times of Disaster

Local communities in Ghana and the Bongo district are more adaptable to environmental change because they have well-developed traditional local knowledge systems for environmental management and coping mechanisms. Table 4.5 presents the results of local coping strategies to deal with the frequent climate extreme events and calamities in Bongo.

The study revealed that about 23% of respondents who were farmers apply cattle dung on their farmlands to mitigate the effects of drought. Also, regarding the “use of drought-adapted seedlings” (*zea, naara, kare-en zie and kizie*) 17% of the respondents were engaged in these practices in the study communities. As part of the measures or coping strategies to mitigate drought, 19% of farmers within the study communities also place heaps of soil around crops and practice multi-cropping and crop rotation as their local coping strategies against drought. For flood coping mechanisms, 26% of the respondent’s resort to building flood barriers around farms and homes, with 16% of the respondents creating water channels in their farms and homes. Similarly, the study found that about 28% of the respondents were creating mud heaps around crops as a way of mitigating flooding. Wwindstorms’ have become common in the study area destroying properties and livelihood sources, from the removal of topsoil causing soil erosion to the damage of roofs among others. This has compelled residents to resort to the planting of trees around their communities to prevent the damage from storms, with

others also placing weights on their roofs to prevent them from being blown off by windstorms. According to the study, 43% of the participants were found to be planting trees around their homes to mitigate the impact of windstorms with 57% resorting to the placing of weights on top of their roofs.

Table 4.5: Flood, Drought, Windstorm, and Pest and Diseases Coping Mechanism

FLOOD	FREQUENCY	PERCENTAGE
Build flood-barriers	93	26
Create water channels in their farms	57	16
Make mud heap around mature crops	98	28
North-south migration	54	15
Living with relatives when a building collapse	49	14
Total	351	100
Drought	Frequency	Percentage
The application of cattle dung on their farms	80	23
Make soil heap around the crops	66	19
Practice multi-cropping and crop rotation	82	23
Use drought-adapted seedlings	59	17
Engage in galamsey	38	11
Charco burning to make an income	26	7
Total	351	100
Windstorm	Frequency	Percentage
Plant trees around houses	150	43
Place weights on Rooftops	201	57
Total	351	100
Pest and diseases	Frequency	Percentage
The spraying of crops with crushed neem solution	106	30
The application of animal dung on crops	63	18
Feeding of animals with mahogany leaves and solution	51	15
The mixing of grains and seedlings with crushed teak leaves	45	13
The mixing of grains with wood ash before storage	39	11
Sprinkling of wood ash on crops in the field or farms	47	13
Total	351	100

Source: Field Survey (February 2023)

These findings were corroborated in a community-level focus group discussion and key informants' interviews with local and external stakeholders in charge of disaster management.

On community-level coping mechanisms in times of disaster in the study communities, participants during focus group discussions shared their thoughts on the subject for discussion. Participants during a focus group discussion indicated:

To mitigate the impacts of floods, we build flood barriers made from the mud around our farms to prevent water from flooding the crops. You know floodwater usually submerges all crops, particularly in farms that are near the river. The fate of these crops generally depends on the flood's duration. Residents also create water channels in their farms to allow floodwater to circulate without washing away crops. Mud heaps are made around mature crops to prevent crops from being washed away. (FGD, Bongo District).

Also, in another focus group discussion, discussants explained as follows:

Now things have changed; you don't need to travel far just go to Galamsey even if you are not hurt by the disaster but you want work that can give you quick money go to Galamsey. If you don't want galamsey you can do by-day work, that is providing your service to help mix concrete and get paid by the end of the day. Apart from those who engage in galamsey and by-day work, others also burn trees into charcoal to sell and make their daily living (FGD, Bongo District).

During a key informant interview with a male dry season farmer, he also had this to say about the local coping mechanism:

Over here anytime a flood submerges people's homes we together with the community leadership assist them to relocate temporarily to public buildings like schools and maybe churches; some disaster victims may have distant relatives whom they relocate to stay with temporarily (Key Informant, Bongo District).

A key informant interview with the Imam in Balungu revealed that

“Communities permit cattle to graze and rest on fields before to planting. This is done to allow for the deposition of livestock dung (droppings) on the fields. To allow the soil and cattle manure to mix, the fields are later ploughed before planting. This is thought to be an alternative to inorganic fertilizers since it makes the soil more fertile. Additionally, it accelerates maturation and boosts resistance to brief droughts, giving crops a measure of resilience during drought periods. In our neighbourhood, farms are "weeded" when droughts are expected to keep the crop from competing with unwelcome weeds for moisture during a dry spell”. (Key Informant, District of Bongo).

4.5.2 Stakeholders in Disaster Management

The growing recognition of the value of traditional knowledge as a priceless and underutilized information repository provides developing nations, particularly those in Africa, with a potent tool for disaster management. In particular, local communities in Ghana have played a significant role in natural disaster management for millennia. These communities employ traditional knowledge to control the climate, monitor other natural systems, and create early warning indicators for both their benefit and that of future generations.

Proper disaster management reduces susceptibility and improves resiliency in homes and communities. The results of the research revealed that the communities in the Bongo district rely on traditional knowledge systems that have been passed down through generations to estimate potential occurrences and magnitude of disaster events rather than scientific resources to predict disasters. The practices that the people followed are ingrained in the local way of life and driven by spiritual beliefs and observations made over several years of living under challenging hydro meteorological conditions. According to the study, communities could only forecast droughts and floods.

4.5.3 Local Actors in the Management of Disasters

The data in Figure 4.4 reveal that local actors or stakeholders in the Bongo district play a very important role in managing disasters in their respective communities. It was discovered that chiefs, Tindanas, clan heads, soothsayers, Magazias, youth, women's groups, and disaster volunteers (Berentiaa) are the local stakeholders that are responsible for disaster management at the community level. With regards to the management of disasters, 55% of the study participants indicated that it is the chiefs and elders that lead in making the decision and rallying the support of community members to take a proactive decision in managing disaster in their communities; 14% of the participants explained that the Tindana/ Earth priest who serves as the link between the living and ancestors performs rituals to the gods to avert any form of disaster. The clan/ family head/ members, also take self-help initiatives to respond to issues of disasters in their homes and the community at large. They give directions to the youth on how to create canals for water to pass during a heavy downpour to prevent flooding, and 9% of the sample population indicated that the Magazias lead in

mobilizing women’s groups in the form of labor and preparation of meals to support in the management of disaster.

Soothsayers engage in divination in the spiritual realm and give the needed direction on how to avert an impending disaster. Youth groups mobilize the young energetic ones to take action regarding the management of disaster. They take instructions from the community leaders; for instance, they put weight on rooftops to prevent windstorms from blowing off the roofs, and they are the first point of call to rescue victims during a disaster. Details are shown in Table 4.4

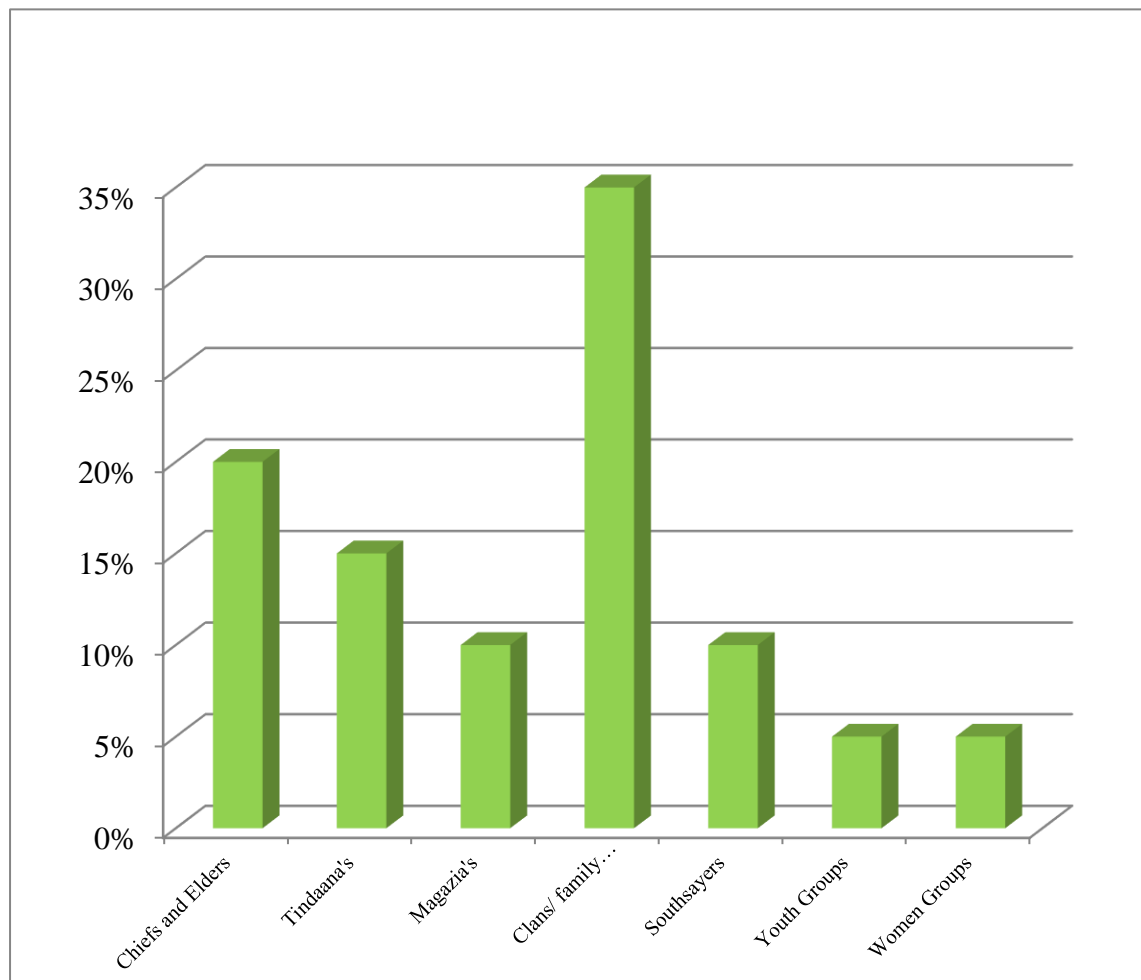


Figure 4.4: Local Stakeholders in the Management of Disaster

Source: Field Survey (February 2023).

Discussants during a focus group discussion explained:

For the management of disaster, we do our best; for instance, during a flood we create artificial water paths for the water to pass through so that it does not enter into people's homes or submerge farmlands to destroy food crops. Usually, it is the elders together with the chief and the assemblyman who organizes the community to do that. In instances where the flood comes unannounced and destroys homes, the community leadership provides support like foodstuffs and temporary shelter for the affected victims to live in until they can put themselves together. (FGD Discussants)

Other participants in an FGD had this to say:

Here in this community because we know our community is exposed to flood, we create some canals where we divert or direct the water into so that we use it for dry season farming. That is how we manage floods, but where the flood destroys people's homes our assemblyman calls on NADMO to come to our aid. (FGD Discussants).

A discussant shared a similar opinion;

We also experience flood and windstorm but our main challenge is drought. The extension officer who comes here has introduced us to new varieties of crops that are drought resistant and also mature early. In our community, the stakeholders in charge of managing disasters are the chief, elders, assemblymen, and the magazine. (FGD discussants)

In a key informant interview with the community, a local church leader confirmed some of the issues raised by other respondents in a focus group discussion. He said:

When we are hurt by disaster it is leadership that puts their heads together.

But he was quick to add that there is a local NGOs that operates within the community by name Tree Aid that has been supporting them to plant trees around their houses and water bodies.

4.5.4 External Stakeholders in the Management of Community Level Disaster

This section examines the role of external stakeholders in disaster management at the community level. These stakeholders exist due to the creation of specific acts or constitutional instruments that establish them. They could be the state's own establishment or private entities.

The National Disaster Management Organization (NADMO), Ministry of Food and Agriculture, Ghana Metrological Agency, Ghana National Fire Service, Environmental Protection Agency and the Bongo District Assembly, and Ghana Metrological Agency, are government institutions, while non-governmental organizations (NGOs) are formed by private individuals. These external stakeholders provide support in the form of education and sensitization to community members and opinion leaders within the various communities on disaster preparedness and mitigation, equipping them with the necessary skills to manage the disaster. MoFA provides technical assistance to local farmers and communities on climate change scenarios, how to plant drought and water-resistant crops, and the cultivation of early maturing crops in order to overcome disaster. NADMO builds community resilience to disasters such as floods and early warning signs, EPA enforces policies relating to environmental protection as well as working with stakeholders in disaster management.

The Bongo District Assembly enacts bylaws and engages in the provision of services such as community mobilization, education, and sensitization on disaster awareness,

preparation, and mitigation. The NGOs work closely with local-level actors and government agencies to empower local people in disaster preparedness and mitigation.

As revealed by the study, 45% of respondents indicated Non-Governmental Organizations (NGOs) as external stakeholders discharging their duties in the management of disasters, while 15% indicated the Ministry of Food and Agriculture (MOFA), whereas 13% mentioned the National Disaster Management Organization (NADMO), 11% of respondents indicated District Assembly (DA) as external stakeholders actively involved in the management of disaster, 6% of respondents indicated EPA and 8% of respondents mentioned GNFS respectively as external stakeholders actively involved in disaster management. (Refer Fig. 4.6).

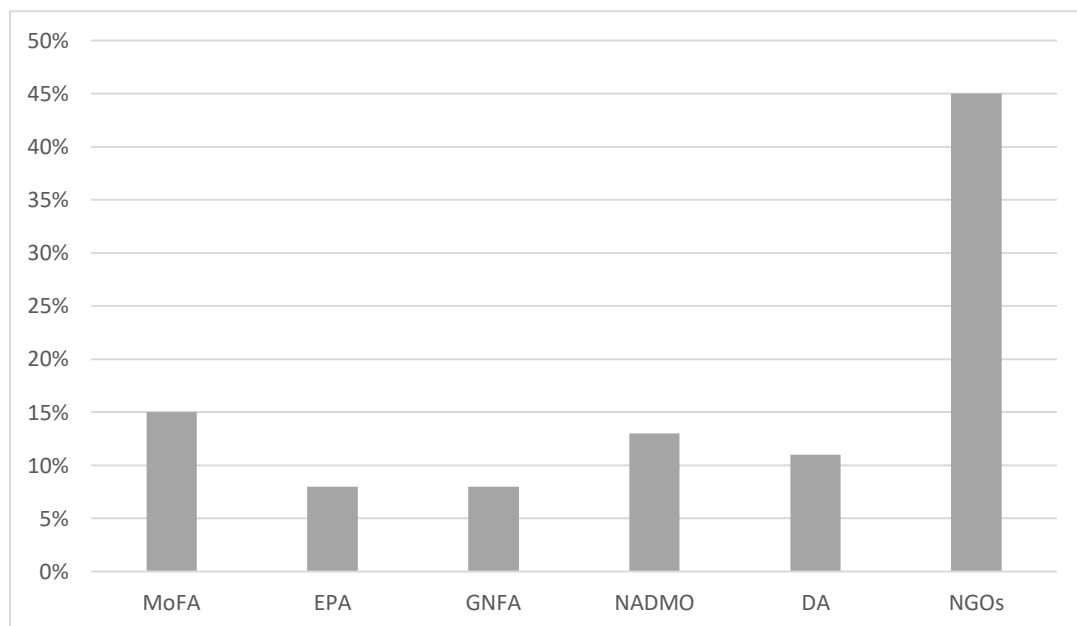


Figure 4.5: External Stakeholders in the management of community level disasters

Source: Field Survey (February 2023).

In a focus group discussion participant unanimously agreed that external support to disaster-affected communities is not sustainable. However, the discussants were quick to acknowledge the support they have received from NADMO, the Bongo District Assembly, and a local NGO called 'Tree Aid' in the past but added that it was not sufficient and unstable. The female participants said:

We remain grateful to organizations for their timely intervention. When our community was hit with a flood, we got some food items used clothing, mats, and mattresses. We thank them, but they can do more for us. (FGD Discussants).

This statement is an indication that communities still expect support from external stakeholders in disaster management. The Figure below shows the external stakeholders in disaster management at the community level.

4.6 Integration of Local Adaptation Systems into Disaster Management Plans (DMPs)

This subsection presents the results of the local coping and adaptation systems that are integrated into disaster management plans. Disasters are occurrences that mostly impact communities. No one is more interested in lowering the danger of a disaster than individuals whose survival and well-being are at risk.

Local adaptation strategies play a critical role in terms of disaster management at the local level hence the need to integrate them into disaster management plans (DMPs). During the survey participants indicated that, the planting of trees around homes or houses, placing weights on rooftops, the application of cattle dung on their farms, making soil heaps around the crops, practicing multi-cropping, using drought-adapted seedlings or cultivating drought-resistant crops, building flood barriers, spraying crops with crushed neem solution, the application of animal dung on crops, feeding of animals with mahogany leaves as a solution during an outbreak of anthrax disease, and

sprinkling of wood ash on crops in the field or farms were the local adaptation strategies that are practiced in Bongo.

The study revealed that about 28% of respondent's resort to the planting of trees around homes or houses to provide shade, reduce heat, and create a microclimate that is more comfortable for inhabitants. They further indicated that trees can also serve as windbreaks, reducing the impact of strong winds and protecting homes from damage during storms.

Also, 14% of participants indicated that the placement of weights, such as large stones or sandbags, on rooftops is a practice to prevent roofs from being blown away during strong winds. This helps stabilize the roof structure and prevents it from being lifted by the wind.

The study further revealed that about 5% of the participants use cattle dung and they added that it improves soil fertility by adding organic matter and nutrients, which enhance crop yields and soil water retention. The study discovered that 7% of the population creates soil heaps or mounds around crops which help improve water management and prevent flooding during heavy rains. This facilitates proper drainage and prevents flooding.

The results from the study indicates that 12% of the population practice multi-cropping as a local adaptation strategy because it helps to diversify their sources of food, reduces the risk of crop failure, and optimizes land use against climate extremism.

About 10% of the participants indicated that they use drought-adapted or resistant seedlings that requires less moisture and are able to withstand drought or dry spell. In flood-prone areas, communities construct barriers or embankments using locally

available materials like sandbags, earth, or stones to redirect floodwater away from homes and crops in order to minimize the impact of flooding on communities.

Participants indicated that neem is a natural insect repellent as such, the use of crushed neem solution to spray on crops deters pest from farms. Similarly, the study revealed that the application of cow dung on farms is a local practice which enhances soil moisture and fertility.

Respondents further explained that, though they have their own local adaptation strategies that aid them in mitigating the impact of disaster not all the strategies have been integrated into disaster management plans. The data gathered indicated that the planting of trees around houses, placing of weights on rooftops, the application of cattle dung on their farms, the use of drought-adapted seedlings, the building of flood-barriers, the spraying of crops with crushed neem solution, the application of animal dung on crops were the local adaptation strategies that have been integrated into their disaster management plans. These local coping and adaptation strategies are important for communities in the district to adapt to their specific environmental challenges. They highlight the creativity and resourcefulness of local communities in addressing the impacts of disasters emanating from climate extremisms.

Details are shown in table 4.6

Table 4.6 Local Coping and Adaptation Strategies that Are Integrated into Disaster Management Plans (DMPs)

VARIABLES	FREQUENCY	PERCENTAGE
Local Coping and Adaptation Strategies		
Plant trees around houses	98	28
Place weights on Rooftops	48	14
The application of cattle dung on their farms	18	5
	26	7
Make soil heap around the crops	43	12
Practice multi-cropping	36	10
Use drought-adapted seedlings	29	8
Build flood-barriers	17	5
The spraying of crops with crushed neem solution	5	1
The application of animal dung on crops	8	2
Feeding of animals with mahogany leaves and solution	10	3
Sprinkling of wood ash on crops in the field or farms		
Total	351	100

Source: Field Survey (February 2023).

4.7 Discussions

4.7.1 Local Knowledge System Harnesses Climate Change Adaptation in the Time of Disaster

This presents key results and discussions of major findings; Emphasis is placed on local knowledge systems that harness climate change adaptation in times of disaster. The results indicate that indigenes have their local knowledge systems that they use in the prediction and management of disasters such as flood, drought, windstorm and pest and diseases. The results identified, are changes in some local trees within the study area for example fruits on the 'Sissibi' tree, and the A-ara trees, Ta-ah n break (fruits on the Shea tree), indicates the commencement of the agricultural season. This view is similar

to the position of Chanza (2014), who stated that, local people use a variety of tree species, including the maungu (fruits of *Landolphia buchananii*), shumha (fruits of *Diospyros mespiliformis*), masau (fruits of *Ziziphus* spp.), and many (fruits of *Adansonia digitata*), to predict the beginning of the agricultural season or the rainy season.

In addition to the above, the findings further revealed that the people used the formation of dark clouds, the unsettledness of the rain-making bird to determine if the rains might result in flood. It was confirmed in a focus group discussion in Bongo that, the cry and unsettledness of certain animal species particularly birds; for example, the cry of Nien-bia (a rain-making bird) is an indication that heavy rains are anticipated.

The results further highlight that *saa ha nko biram-biram ko-sobege* (the formation of very dark clouds) is an indication that flood is eminent. The people added that when you see birds beginning to create their nests it is a sign that flood will soon occur. These results support Chinlapianga's (2011) research in Mizoram, northeastern India, which found that thick, black clouds arranged vertically to the sun's orbit foretell the impending arrival of torrential rains and flooding. In Swaziland, locals believe that the appearance of particular bird species in trees heralds the start of the rainy season, and floods may be forecast by how high birds build their nests from riverbanks (Domfeh 2007).

The study revealed that local communities modify the use of land to respond to climate change scenarios; the data indicate that rural communities in Bongo district plant and use drought adapted seedlings such as 'naara, zea', bambara beans and groundnuts as a way of mitigating the impact of drought. These findings could be married to the view of Derbile et al. (2016), who indicated that to minimize their sensitivity to drought

conditions farmers resort to the cultivation of drought-tolerant indigenous crops like 'naara and zea' seeds based on their findings. This is supported by the work of Mubaya (2010), who stressed that farmers prefer the cultivation of conventional crop varieties like sorghum, millet, beans, cowpeas, bambara groundnuts, and other crops as a method of coping with drought. Anik (2012) also noted that communities vary their strategies in agriculture, forestry, animal husbandry, land use, water use, and other natural resource systems with the support of local knowledge of natural and controlled ecosystems. Anika's (2012) work further revealed that community coping capacity and adaptation strategies in the face of climate change and other stressors are incremental changes to continuing practices as people have used their skills and beliefs to adapt to shifting social, economic, and ecological conditions over time. This view has been significant to the study findings giving the contributions of local knowledge systems to climate change adaptation strategies in the study area.

Again, the findings revealed that farmers plant early maturing crop varieties such as *naara*, *kiiziee*, and *kare-en-ziee* as coping or adaptation strategies. These findings bring to light the views of Fujieda (2013), who indicated that local communities in Africa were more adaptable to environmental change because they have well-developed indigenous local knowledge systems for environmental management and coping strategies for climate change. The findings also agree with the work of the UNESCO/UNU, (2013) study which revealed that people deal with frequent extreme events and calamities by adjusting their adaptation strategies. To UNESCO/UNU, (2013) individuals alter their living spaces, change the way they cultivate their crops, and diversify their sources of income to cope with the current challenges which confirms the study findings as 47% of respondents stated changing crops as a local adaptation strategy.

The study also indicates that local communities rely on local belief systems such as consulting rain gods as adaptation mechanisms. These findings are synonymous with the FAO (2009) which revealed that local expertise has been crucial in resolving issues for decades, particularly those relating to climate change. The FAO, (2009) argues further that Ghana's rural poor, whose main employment is farming, have developed several strategies to adapt to climate change by relying on local traditional knowledge and beliefs.

The findings further recognize the contribution of local knowledge to climate change adaptations, as it is in accord with the work of Alexander et al., (2011) which indicated that local knowledge frequently contributes to the understanding of the meaning of climate change beyond what is implied by statistically significant changes in livelihoods, attitudes, and ways of life. Although, the view held by Shaffer (2014) on the relevance of local knowledge such as the use of indicators like bird cries to anticipate the amount of rain for the day; the findings of the study provide evidence that the cry of 'Nein bia' the rain making bird is a form of local knowledge that could aid in determining the amount of rainfall in a day.

Findings on local strategies of adaptation to climate change including mixed cropping were established as respondents indicated clearly how helpful the practice of mixed cropping has been to them. This result supports the claim made by Garutsa et al. (2018) in his studies which revealed that intercropping is the primary local approach to producing food crops. Again, the findings are in line with Mugambiwa (2018) in his study focusing on farmers in Mutoko (Zimbabwe) which revealed that there has been a switch from growing maize to millet and sorghum, which enhanced farm output and decreased their level of susceptibility to climate change.

It is worth noting that, the findings of mixed cropping as a local adaptation strategy to climate change support the earlier view held by Theodore (2016). Applications like planting crops in wetlands make it easier to grow food crops in areas prone to drought and help farmers adjust to short-term rainfall patterns. Some of the recognized adaptive methods in Nigeria include constant weeding of cropped farmlands, early planting of crops like maize and cassava, and preservation and selection of seeds for the upcoming planting season (Nzeadibe et al., 2011). According to Gyampoh et al. (2009), Ghanaian farmers cultivate food crops that do well in the current environment.

In addition, the practice of mixed cropping as a local adaptation strategy is also in tandem with what Dazé (2007), worked on, which revealed that several coping strategies have been developed to respond to climate change: mixed farming, drought-tolerant crops or varieties, soil erosion control, planting and conserving trees, planting early-or late-maturing varieties, using chemical fertilizers, intensifying land use, agricultural diversification, expanding farming into marginal lands, cropping in moist valley bottoms, incorporating trees into crops, and raising livestock.

The findings further agree with the position of Ajayi and Mafongoya (2017) which has been that local farming techniques like mixed cropping and intercropping are being used by farmers in Sub-Saharan Africa's dryland farming systems to increase yields and protect the environment. Other relevant literature which is supported by the findings was a study by Gumo (2017), where coping with the extremes of climate change include praying and worshipping for rain during prolonged dry spells. This confirms the consultation and divination as a ritual to call for rain. Theodory (2021) reports that farmers in Tanzania's Ngono River Basin engage in similar activities of prayer and worship bringing to bear spirituality as a local adaptation strategy.

In a similar viewpoint, a study by Paul et al. (2008), shows that early planting has been a major adaptive approach to climate change; this was also evident in the study findings as the planting of early maturing varieties was identified as a common indigenous adaptation strategy; the data shows how respondents in the study communities cited the practice of planting early maturing varieties as an indigenous practice to climate change adaptation.

In terms of stakeholders in disaster management taking into consideration local strategies of adaptation to climate change, the study identified community actors including women and youth groups, earth priests, chiefs and opinion leaders had defined roles and responsibilities. These findings are synonymous with Arunotai's (2008) study which indicates that local peoples efficiently mobilize resources that help in disaster management in a more affordable, participatory, and sustainable way. The findings also concord with a study by Tibby et al. (2008) which revealed that dealing with disasters seems to be a top-of-the-line duty; this is because local communities are not powerless and always exhibit some capacities; it is not just the responsibility of those in positions of authority. The findings on local actors' involvement in the use of local knowledge system in disaster management share a similar position with Willison and Willison's (2004) argument that local communities take centre stage in mitigating the impact of disaster since they are directly affected.

4.7.2 Climate Change Adaptation Strategies in times of Disaster in the Bongo District

The findings from the data revealed that communities in the Bongo District practice climate change adaptation strategies and coping strategies. According to the study findings regarding climate changes which include respondents' perspective of climate change, they conceptualize it as a prolonged drought, observed changes in weather

patterns with rising temperatures, and the infestation of diseases on humankind and farm animals. These findings were confirmed in the literature. For instance, Nakashima et al. (2012) noted that the measure of climate change is mostly three decades or more and is considered to be long-term. The IPCC, (2017) also argued that, unlike year-to-year variability, which is rapid and abrupt, climate change is slow and gradual, making it challenging to detect without the aid of scientific records. Belo's (2010) view that climate change, in general, refers to modifications in the statistical distribution of meteorological variables over time ranging from decades to millions of years was also underscored in the literature.

Findings also indicate that the planting of early maturing varieties, drought-resistant crops, planting of trees around houses, placing weights on rooftops, application of cattle dung on their farms, making soil heaps around crops, the building of flood barriers and spraying of crops with crushed neem solution are local coping and adaptation practices.

The practice of multiple cropping among local communities is identified in the study as an adaptation strategy. The study further highlights that local communities continue to develop coping strategies for climate change. This finding could be tied to the views of Kpadonou et al. (2012) on the benefits of adaptation and mitigation initiatives influencing local communities and rural livelihoods. The view that farmers have developed their local reaction strategy in a variety of methods as a result of noting the diversity of climate change impacts which is held by Concha, (2018) was also confirmed in the literature.

The findings also revealed that intercropping or mixed cropping is one of the local adaptation strategies/approaches developed by the people. The people practice intercropping or mixed cropping in order to produce a greater yield on a given piece of land

by making use of resources that would otherwise not be utilized by a single crop. This confirms the work of Garutsa et al. (2018), which indicated that intercropping serves as the main local adaptation strategy for most food crop producers who are stressed by climate extremisms.

The study also identified crop rotation as one of the local adaptation strategies used by the people to overcome or minimize the impact of disaster. Farmers in Bongo rotate the crops they cultivate on a piece of land from time to time; for instance, one can substitute the cultivation of maize for sorghum or rice just to mitigate the occurrence of disaster. This finding is in line with the work of Mugambiwa (2018), who reported that farmers in Zimbabwe substituted maize cultivation with millet and sorghum, which increased their farm yield, and reduced their level of vulnerability to climate change.

The study revealed that respondents in Bongo use new technology (sandcrete blocks) in building their homes instead of mud, as a way of adapting to the occurrence of disaster in their communities. This confirms the work of Ahmed et al. (2013) who argued that technological options are key in terms of climate change adaptation. Ahmed et al., (2013) cited the use of sandcrete blocks as a technological option.

It must be noted that from the study findings climate change adaptation mechanism focused on local knowledge systems include planting of early maturing varieties, drought-resilient crops, and livelihood diversity as adaptation strategies in terms of reducing risk in agriculture productivity losses during the disaster were also established in the literature. These findings confirm the work of Moser and Ekstrom's (2010), that adaptation enables individuals and groups to make decisions and to strengthen their resilience in the face of socio-ecological change. The study findings further agree with the position of Nzeadibe et al. (2011), on adaptation as a proactive process that averts

prospective climate changes in the future. The views of Nzeadibe et al., (2011) on people's readiness to mitigate the impacts of climate change on the production of food crops are correlated with their capacity for adaptation, further highlighting the contributions of local knowledge on developing strategies of adaptation to climate change in terms of managing agriculture related stressors and shocks.

4.7.3 Integration of Local Adaptation Practices into Disaster Management Plans

The effects of climate change are being felt over the world, but they are particularly severe in developing nations because of their exposure to high vulnerability. Climate change and climate variability may present serious obstacles to national development unless drastic measures are taken and policies are carefully and methodically implemented to enhance resilience in development and reduce vulnerability. Governments, communities, and people all have to take actions that will minimize the effects of climate change, hence a new paradigm for incorporating local knowledge and adaptation plans into disaster management plans in order to minimize the level of vulnerabilities is needed.

Gaillard and Mercer (2012), contend that disaster management is an integrated process that requires a roadmap since it must be inclusive and not exclusive. Gaillard and Mercer (2012) acknowledge the existence of many types of knowledge that are beneficial in mitigating disaster risk. Tibby et al. (2008), argue that to lower the risk of disaster and assure prudent disaster management, activities at various scales, both from the top-down and the bottom-up, are required. Once more, Mercer (2012) advises that local knowledge should be thoroughly evaluated to make sure that it can be applied to help reduce disaster risk. This has been said in light of a growing emphasis on the application of local expertise in disaster management (Shaw et al., 2008, 2009).

The findings from the study reveal that due to periodic droughts, communities in Bongo either plant drought-resistant crops, change the type of crops they plant, or change their source of livelihood. These findings are in line with Nyong et al. (2007) who concluded that due to a long history of severe and regular droughts, rural communities in the African Sahel region are already accustomed to adapting to climate change. They provide an example of the advantages of incorporating local knowledge into regionally appropriate and sustainable agricultural climate change mitigation and adaptation techniques. For instance, farmers in Tanzania who are experiencing a drought change their crops, increase their farming, and look for alternate employment (Paavola, 2012). Derbile, (2010), and Gyampoh, (2011), opine that local knowledge can be used to address issues with weather, climate change adaptation, agriculture, and food.

Also, multi-cropping is practiced as a local strategy of adaptation to drought. Kolawole et al. (2014) in Botswana have shown that strengthening smallholder farmers' resilience as a process that starts with their ability to anticipate change and adjust their farming methods accordingly creates the foundation for strong food security, especially in light of climatic unpredictability and change is evident in the study as mixed cropping contributes to providing food sufficiency and security as farmers do not completely lose out in an event a particular crop fails. Garutsa et al. (2018), argue that intercropping and multi-cropping are the primary indigenous approaches to local food security. This suggests that unique indigenous practices have been adopted as adaptation strategies in various ecological zones.

The findings also reveal that communities in the study area are prone to disaster as a result they resort to the use of local coping and adaptation strategies such as mixed farming, the use of planting of early maturing crops or variety to help them manage and mitigate the impact of climate extremes such as floods. These findings are supported

by the work of Dazé (2007), which states that the following coping and adaptation strategies: mixed farming, water-resistant crops, soil erosion control, planting and conserving trees, planting early maturing varieties, intensifying land use, agricultural diversification, expanding farming into marginal lands, and incorporating trees into crops are used to response to climate change.

The findings reveal that the indigenes resort to the diversification of their livelihood sources, change of planting dates, and planting of trees in their farms and around their homes as a way of adapting to the occurrence of the flood. These findings agree with the work of Deressa et al. (2008), which showed that crop diversification, shifting planting dates, and planting trees are all examples of collective adaptation strategies for crop production in developing nations. Dakyaga et al., (2020); Adolph et al., (2020), justify the fact that most farmers understand how important it is to have trees on their properties to protect crops from harsh sunlight.

The findings reveal that there exist both local and external stakeholders who collaborate to play various roles or contribute to the management of disaster. These findings confirm the work of Ayers and Forsyth, (2009) which highlights that community-based adaptation is required because Community Adaptation, recognizes the value of local actors who use local knowledge systems to increase livelihood assets and security and address disparities, allowing locals to participate in adaptation planning in a participatory and collaborative manner through the fusion of scientific and local knowledge. This is supported by the work of Louis (2007), who argues that there has been a shift in worldwide disaster management from a top-down to a bottom-up strategy. Because of the employment of community-engagement-promoting participatory tactics, the bottom-up strategy has been successful (Louis 2007). The

result confirms that the bottom-up approach to international disaster management has been gaining ground in the top-down drive toward community engagement in disaster management. The adoption of participatory tactics that enable community participation and result in rural people being involved in the decision has made the bottom-up strategy successful. According to Campbel (2006), rural communities have historically been able to adapt and cope, but because of their remoteness, they are currently more vulnerable.

The need for integration is backed by an array of arguments, along with the need to adapt scientific knowledge and various technologies (disaster management) for local contexts (Mercer and Kelman 2009; Walshe and Nunn 2012), the need to mobilize community capacity (Tran et al. 2009), and the desire to "bank" on the advantages of both local and expert or professional knowledge. As the work of Mercer (2012), confirms the weaknesses of one knowledge system can be addressed by the advantages of the other, and vice versa.

These views agree with the fact that local predictions could be integrated into disaster planning to enhance broader mechanisms in terms of weather prediction in the context of scientific and local knowledge systems.

In conclusion, the integration of local adaptation practices into disaster management plans is a crucial step in building community resilience to disasters and climate change. It acknowledges the wisdom of local communities and empowers them to actively contribute to their own safety and well-being. This integration process is a dynamic and ongoing effort that involves collaboration between communities, local authorities, and disaster management agencies to develop more effective, context-specific disaster response and recovery strategies.

CHAPTER FIVE

SUMMARY, CONCLUSION, AND RECOMMENDATIONS

5.1. Introduction

This chapter of the study is focused on the summary of the study and major findings, conclusions, and recommendations.

The study examined climate change adaptation practices in Ghana with a specific focus on the role of local knowledge systems in times of disaster in the Bongo district of the Upper East Region. The specific research questions were: How does the local knowledge system enhance climate change adaptation in time of disaster in Bongo District? What are the local climate change adaptation strategies that are used in times of disaster in the Bongo District? What is the effectiveness of local knowledge systems that harness climate change adaptation? What local adaptation practices are integrated into disaster management plans in the Bongo District?

The study progressed with the development of a conceptual framework on Roger's Diffusion of Innovation Theory (Rogers, 1995). Drawing from literature and theory, the conceptual framework established that local knowledge is the ideas of a group of people that have been created to serve as the fiber of the community. These new ideas and inventions could be integrated into the community's adaptive capacity to respond to shocks and stress. The study adopted a mixed method approach using simple random and purposeful sampling, data collection, and analyses. Syntheses of the findings from empirical analyses are summarized in the ensuing section.

5.2 Summary of Major Findings

The Bongo district in the Upper East Region is disaster-prone due to climate variability and extremes. The vegetation of the district is characterized by short, commonly spaced

deciduous trees and a ground flora of several species of tall and short bushes. The wet and dry seasons are particularly notable in the region. Crop cultivation and animal rearing are two of the main agricultural activities that community members engage in but climate variability has further exposed them to disasters that affect lives and properties. Knowing how vulnerable they are, the indigenes make use of local knowledge systems that enable them to cope and adapt to the frequent occurrence of disasters.

Objective one of the study, sought to find out how the local knowledge system enhances climate change adaptation in times of disaster. This is because local knowledge systems are what the indigenes in Bongo use to predict the occurrence of disasters and to develop their own local coping and adaptation strategies to be used in mitigating the impact of disasters. The findings reveal that flooding, drought, pest and diseases and rise in temperature are disasters that affect the Bongo District.

Objective two of the study also sought to examine the local climate change adaptation strategies that are used in times of disaster. It focused, on how disasters are managed in the various communities, taking into consideration the stakeholders that are in charge of managing disasters in the communities and the district at large. To mitigate the impacts of climate change, the findings revealed that the planting of trees around homes or houses, placing weights on rooftops, the application of cattle dung on their farms, making soil heaps around the crops, practicing multi-cropping, using drought-adapted seedlings or cultivation of drought-resistant crops, building flood barriers, spraying of crops with crushed neem solution, the application of animal dung on crops, feeding of animals with mahogany leaves and solution during outbreaks of anthrax disease, sprinkling of wood ash on crops in the field or farms were some of the local coping,

adaptation, and knowledge systems Furthermore, the results revealed that we have both local and external stakeholders that manage disasters in the study area. The local stakeholders include chiefs, Tindanas, clan heads, soothsayers, Magazias, youth, and women's groups. While the external stakeholders exist due to the creation of specific acts or constitutional instruments; or it could be the state's own entities. The National Disaster Management Organization (NADMO), Ministry of Food and Agriculture, Ghana Metrological Agency, Ghana National Fire Service, Environmental Protection Agency and the Bongo District Assembly, and Ghana Metrological Agency, are government institutions and non-governmental organizations (NGOs).

Finally, objective three of the study, explores how the local adaptation practices are integrated into disaster management plans. This is because there is a growing concern about the need to incorporate or integrate local coping, adaptation, and knowledge systems into disaster management plans to enable them to mitigate the impact of disasters. The research findings indicated that the following practices were found to be effective: planting trees around homes or buildings, setting weights on rooftops, applying cattle dung on farms, creating soil heaps around crops, engaging in multi-cropping, using drought-adapted seedlings or cultivating drought-resistant crops, erecting flood barriers, applying animal dung on crops, feeding animals with mahogany leaves and solution during anthrax disease outbreaks, and sprinkling wood ash on crops in fields or farms. These local coping, adaptation, and knowledge systems that have been incorporated or integrated into the district disaster management plans.

5.3 Conclusion

Traditional and local knowledge plays a crucial role in boosting the resilience of local communities to properly predict and devise strategies for coping and adapting to climate extremes. Lessons can be learned from the coping and adaptation methods that

communities have used for a long time to deal with disasters. However, these knowledge systems must be comprehended and scientifically assessed to be incorporated into disaster management strategies (Payen et al. 2012). In the Bongo district of the Upper East Region, this study identified droughts, floods, windstorms, pests, and diseases as the main disaster occurrences that influence local livelihoods. Our findings showed that the recent disaster events with the most detrimental effects were droughts, floods, pests, and diseases.

Though there are traditional and local strategies for predicting droughts and floods, these methods fell short in this study's attempt to anticipate the presence of pests and diseases. Because the traditional and local sources of information for disaster management are deeply rooted in the research area, the residents of the study communities continue to be impacted by different disaster events. This is primarily due to the low levels of application (use) and perceived effectiveness of these local methods. A further major obstacle to implementing these interventions is a lack of resources. For instance, "applying cattle dung on fields" before planting is thought to be the most successful strategy to deal with droughts, but the actual application is constrained by the availability of cattle dung during the planting season. The creation of dugouts for the storage (or piling) of livestock dung for later use is advised for the communities. The knowledge inventory of local practices might also offer a starting point for integrating local practices into disaster management plans.

5.4 Recommendation

This section of the chapter captures the recommendations for policy makers who are duty bearers to lead and initiate policies that ensure that disasters are properly managed to minimize their impacts on communities.

Firstly, this study recommends that future studies can focus on the contribution of local knowledge system in the management of disaster

Also, future studies can be conducted on household's response to climate induced disaster in the Upper East Region of Ghana

Finally, research on the exploration of local knowledge system in disaster management will aid the understanding and the underlying environmental and climatic circumstances that motivate the use of local knowledge to mitigate the impact of disaster in disaster-risk communities is highly recommended.

5.5 Contribution to Knowledge

This research contributes to the growing body of knowledge on climate change adaptation by emphasizing the value of local knowledge in Ghana. By highlighting the strengths of local systems that are practiced in communities, this thesis informs policy decisions and facilitates a more holistic and community-driven approach to climate adaptation in the country.

Additionally, it will underscore the importance of engaging local communities in climate change discussions and adaptation planning, ensuring that their voices and knowledge are central to the development of sustainable solutions in the face of a changing climate.

5.6 Limitations of the Study

The study did not cover the contribution of local knowledge systems in disaster management. Therefore, future studies can focus on the contribution of local knowledge system in the management of disaster. As well, in-depth future studies can focus on the response of households to climate induced disaster in the Upper East Region of Ghana. Finally, the study did not focus on the exploration of local knowledge system in disaster

management. Hence, research on the exploration of local knowledge system in disaster management will aid the understanding and the underlying environmental and climatic circumstances that motivate the use of local knowledge to mitigate the impact of disaster in disaster-risk communities.

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APPENDIX A

STRUCTURED INTERVIEW GUIDE

(HOUSEHOLD QUESTIONNAIRE)

Introduction

Climate Change Adaptation Practices in Ghana: Harnessing Local Knowledge Systems
in time of Disaster in the Bong District of the Upper East Region

A. GENERAL INFORMATION

Time started..... Time Ended

Name of interviewer:..... Questionnaire No.....

Date of interview.....

District

Community

Address of the Interviewee

Section B: Background Characteristics of Respondents

1. Respondents Community

(a) Nyariga [] (b) Balungu [] (2) Namoo []

2. Household type

(a) Male headed with single wife []

(b) Male headed with multiple wives []

(c) Male-headed, divorced, single, or widowed []

(d) Female-headed, divorced, single, or widowed []

(e) Others, specify.....

3. Household size (A household is defined as a group of people who eat from the same pot)
4. Sex: (a) Male (b) Female
5. Age of Respondents:
 (a) 20 and below (b) 21-30 (c) 31-40
 (d) 41-50 (e) 51+ (f)
 Others Specify:.....
6. Marital status of respondent (a) Not married (b) Married (c) Divorced
 (d) Widowed (e) Separated (f) Cohabiting
7. Educational attainment:
 (a) None (b) Primary (c) JHS
 (d) SHS (e) Tertiary (f) Others Specify.....
8. Religious background of the respondent:
 (a) Traditional (b) Islamic
 (c) Christianity (d) others specify.....
 08=N.A { }

Section C: Local Knowledge Systems for Climate Change Adaptation Practices in Time of Disaster

9. Have you ever been hurt by a disaster in this community? Yes No
10. If yes, which type of a disaster were you hurt with?
 (a) Floods
 (b). Drought/Dry spell
 (c) Pest Infestations
 (d) Disease outbreak

(e) Others, specify

11. What forms of disaster are common in your community?

(a) Floods []

(b). Drought/Dry spell []

(c) Pest Infestations

(d) Disease outbreak []

(e) others, specify

12. Do you have any local knowledge systems that are used or practiced in the community?

a. Consultation or Divination []

b. Building in upland areas []

c. Sleeping outdoors []

d. Roofing with thatch []

e. Early planting of crops []

f. Change of crops []

g. Cropping in the lowland area []

h. Stop upland cropping []

i. Using 'neem' to spray on crops []

j. Stop using cow dung for plastering []

k. Planting of water-resistant crops []

l. Sitting under trees during heat season []

m. Practicing mixed cropping []

n. Planting of drought-resistant crops []

o. Uprooting of affected crops on the farmland []

p. Others, specify.....

S/N	Disasters	Local Knowledge Systems
13	Drought/Dry Spell	a. Cropping in the lowland area [] b. Stop upland cropping [] c. Practices mixed cropping [] d. Divination or Consulting rain gods [] e. Planting of drought-resistant crops [] f. Others, specify
14	Flood/High Rainfall Intensity	a. Building upland areas [] b. Planting of water-resistant crops [] c. Stopping the use of cow dung for plastering of houses [] d. Change of crop [] e. Others, specify
15	High Temperature/Heat	a. Sleeping outdoors [] b. Roofing with thatch [] c. Sitting under trees during the day [] d. Others, specify
16	Pest and Disease infestation (crop) e.g army fall worm	a. Using of 'neem' to spry on the crops [] b. The uprooting of affected crops on the farm [] c. Others, specify

Note: Please, kindly tick all that applies

17. Which of these local knowledge systems do you use during a disaster?

- a. Consultation or Divination []
- b. Building in upland areas []
- c. Sleeping outdoors []
- d. Roofing with thatch []
- e. Early planting of crops []
- f. Change of crops []
- h. Stop upland cropping []
- i. Using 'neem' to spry on crops []
- j. Stop using cow dung for []
- k. Planting of water-resistant crops []

- l. Sitting under trees during heat season []
- m. Practicing mixed cropping []
- n. Planting of drought-resistant crops []
- o. Uprooting of affected crops on the farmland []
- p. Others, specify.....

18. How frequently do you experience these disasters?

- a. Seasonal []
- b. Annually []
- c. Others, specify

19. Do you manage these disasters that periodically hurt your community?

- a. Yes [] b. No []

20. If yes, who manages disaster in your community?

- a. Chief and Elders []
- b. Tindanas []
- c. Magazias []
- d. Clans/family heads []
- e. Soothsayers/diviners []
- f. Youth groups []
- h. Others, specify []

21. What is their role in disaster management in your community?

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22. Apart from these categories of people are there others that help or support your community in managing disaster during a disaster? Yes [] No []

23. If yes, who are they

- a. MOFA []
- b. EPA []
- c. GNFS []
- d. NADMO []
- e. DA []
- f. NGOs []
- g. Others specify.....

24. What role do these categories of people mentioned in Q19 play in managing disasters in your community?

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Section D: Climate Change Adaptation and Coping Strategies used by Local Communities in Times of Disaster

25. Have you heard about climate change? Yes [] No[]

26. What is your opinion on climate change?

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27. Is your local climate here is changing?

- a. Yes [] b. No[]

28. What is the sign or evidence that your local climate here is changing?

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29. Do you think climate change is the cause of the disasters discussed above?

a. Yes [] b. No[]

30. In climate change scenario, what do you do to adapt or survive its impact on the community?

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31. Can you mention some of the strategies that you use in adapting to the changing climate in this community?

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32. Are they some coping mechanisms that you use in the community when hurt by a disaster?

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Section E: Effectiveness of local knowledge systems that harnesses climate change adaptation in during a disaster

S/ N	Extreme events/ Disasters	Local Knowledge Systems	Rating				
			Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
33	Drought/Dry spell	Cropping in the lowland area					
		Stop upland cropping					
		Practices mixed cropping					
		Planting of drought-resistant crops					
		Divination or Consulting rain gods					
34	High Temperature/ Heat	Sleeping outdoors					
		Roofing with thatch					
		Sitting under trees					
35	Flood/High Rainfall Intensity	Building upland areas					
		Planting of water-resistant crops					
		Change of building materials					
		36	Change of crop				
37	Pest and Disease infestation (crop) e.g army fall worm	Using 'neem' to spray on the crops					
		The uprooting of affected crops on the farm					

Section F: The Local Adaptation Strategies that are integrated into Disaster Management Plans (DMPs)

S/ N	The focus of LAS integration into DMPs	Local Adaptation Strategies (LAS)	Rating				
			Strongly Agree	Agree	Neutral	Disagree	Strongly disagree
38	Policy and Institutions	Traditional institutions such as chiefs, opinion leaders, youth leaders, and Magazias mobilizing support and sharing of food to vulnerable households					
39		Traditional institutions such as chiefs, opinion leaders, youth leaders, and Magazias provide temporary shelters to vulnerable households (taking them to their homes).					
40		Traditional institutions such as chiefs, opinion leaders, youth leaders, and Magazias create a haven for victims of disaster (e.g floods and fire).					
41		Norms, beliefs systems with a high degree of efficacy (e.g prediction of seasonal patterns of weather and rainfall).					
42	Capacity Building	Community self-initiatives in managing bushfires and other disasters					
43		Spraying to control pests, vectors, and disease					
44		Stop farming along or close to water bodies					
45	Improve indigenous	Construction and maintenance of houses (mud for plastering)					

46	Technol ogy	Prediction of weather and rainfall patterns					
47		Local materials for pest controls					
48	Early warning signs	Droughts					
49		Rainfall intensity					
50		Rise in temperature					
51		Pest, vector, and disease infestation					
52		Bush fires					
53	Financi ng	Income-generating activities such as craft making, weaving, etc.					
54	Manage ment and plannin g	Livelihood diversification (on and off-farm activities) including shea butter processing, pito brewing, fishing, etc.					

APPENDIX B

FORMAL INSTITUTION QUESTIONNAIRE

Introduction

Climate Change Adaptation Practices in Ghana: Harnessing Local Knowledge Systems in time of Disaster in the Bong District of the Upper East Region

GENERAL BACKGROUND INFORMATION.

Name of organization/institution

Designation of Participant

Date of interview

Key Informant Interview Guide

C. Local Knowledge Systems for Climate Change Adaptation Practices in Time of Disaster

1. What is your view on local knowledge systems?

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2. Do you have an idea of some or any local knowledge systems that people use during or in times of disaster?

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3. If yes, which of the local Knowledge systems is commonly used or practiced in times of disaster?

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D. Climate Change Adaptation and Coping Strategies used by Local Communities in Times of Disaster

4. What are the local adaptation practices commonly used in the community in a time of disaster?

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5. What are your views on the adaptation strategies used in the communities in terms of disaster?

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6. What form of coping strategies are commonly used in the communities in times of disaster?

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7. What are your views on the coping strategies used in the Bongo communities in terms of disaster?

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E. Effectiveness of Local Knowledge Systems that Harnesses Climate Change Adaptation in During a Disaster

9. Which of the local knowledge systems mentioned above do you apply or use during disaster?

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10. Why do you resort to the use of local knowledge systems during disaster?

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11. Are these local knowledge systems able to help you adapt to climate related disaster?

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12. Are you able to cope with the use of local knowledge system during disaster?

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F. The Local Adaptation Strategies that are integrated into Disaster Management Plans (DMPs)

13. What forms of disaster are common in the Bongo district?

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14. Who is/are responsible for the management of disaster in Bongo?

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15. Which type of disaster mentioned in Q8 does your organization manages/support its management?

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16. What support do you organization requires to help manage disasters in Bongo?

17. What is your organizational policy/ programmes / activities for the management of disasters in the district?

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18. When was this policy/programmes initiated?

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19. What objective or aim does this policy/programme seeks to achieve?

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20. Which of the Local Adaptation Strategies (LAS) mentioned in Q10 is/are integrated into Disaster Management Plans (DMPs)?

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21. When was it integrated into disaster management plans?

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22. What are the challenges that you face as a result of integrating local adaptation practices into disaster management plans?

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23. In what ways do you think disaster can be managed?

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24. In your opinion, what do you suggest for sustainable management for disaster in Bongo?

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APPENDIX C

FOCUS GROUP DISCUSSION GUIDE FOR MEN, WOMEN AND OPINION LEADERS

Section A: Local Knowledge Systems for Climate Change Adaptation Practices in Time of Disaster

1. What are local knowledge systems?
 - Do you have any local knowledge systems in your community?
 - What do you use these local knowledge systems for?
 - At what time or instances do you use these local knowledge systems in your community?
 - Do you get results any time you apply these local knowledge systems?
2. What is a disaster?
 - What are the types of disasters that you know?
 - What form of disaster is common in your community?
 - How often does this type of disaster occur in your community?

Section B: Climate Change Adaptation and Coping Strategies used by Local Communities in Times of Disaster

3. Have you heard about adaptation?
 - What do you do any time you are hurt by a disaster in this community?
 - How do you cope with the occurrence of disaster?
 - What are the strategies that you use in coping anytime disaster occurs?

Section C: Effectiveness of local knowledge systems that harnesses climate change adaptation in during a disaster

4. Which of the local knowledge systems mentioned above do you apply or use during disaster?
- Why do you resort to the use of local knowledge systems during disaster?
 - Are these local knowledge systems able to help you adapt to climate related disaster?
 - Are you able to cope with the use of local knowledge system during disaster?

Section D: The Local Adaptation Strategies that are integrated into Disaster Management Plans (DMPs)

5. How do you manage disaster? (Flood, drought/dry spell, high temperature, pest infestation, outbreak of diseases)
- What role do men play in managing disasters in your community?
 - What role do community leaders play in managing disaster in your community?
 - Are there any state/government institution that comes in to help manage disaster anytime it occurs?
 - What is the name of this state institution that helps you to manage disaster anytime it occurs?
 - What are the challenges that you face as a result of integrating local adaptation practices into disaster management plans?
 - In what ways do you think disaster can be managed?
 - In your opinion, what do you suggest for sustainable management for disaster in Bongo?