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EXAMINING THE INTERPLAY BETWEEN CLIMATE CHANGE AND WATER RESOURCES MANAGEMENT IN WARD 24, RUSHINGA DISTRICT, ZIMBABWE

A DISSERTATION SUBMITTED TO BINDURA UNIVERSITY IN PARTIAL FULLFILMENT OF THE REQUIREMENTS OF THE BACHELOR OF SCIENCE HONOURS DEGREE IN SUSTAINABLE DEVELOPMENT

BY

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DECLARATION

I Tadiwa E Chisiya, B224909B declare that this dissertation is the product of my own work with only exception of the references which have been credited to their sources. The work was not copied from any source without acknowledged of the publisher.

Signed 

Date 20 May 2026

APPROVAL FORM

The undersigned certify that they have supervised the student Tadiwa E Chisiya's dissertation entitled **Examining The Interplay Between Climate Change and Water Resources Management in Ward 24, Rushinga District, Zimbabwe.** Submitted in partial fulfillment of Bachelor of Science Honours Degree in Development Studies.

Bachelor of Science Honours Degree in Development Studies.

Supervisor: Dr H Musarandega 

Chairperson: 

DEDICATION

I offer my sincere gratitude and dedication to God for his protection during this research journey. Special dedication also goes to my parents for inspiring me through my educational career, by providing emotional, spiritual and physical support from the beginning. I also give special dedication to my all friends.

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ABSTRACT

Global climate change has profoundly disrupted hydrological cycles, intensifying water scarcity and accelerating the frequency of severe hydrological extremes. In semi-arid regions of Zimbabwe, this vulnerability is amplified by a high dependence on rain-fed systems and constrained institutional infrastructure. While national frameworks advocate for adaptive planning, there remains an acute lack of localized, empirical research on how community-based water management strategies are practically adjusted to shifting climatic variables at the grassroots level. This study addresses this gap by examining the interplay between climate change and water resource management within Ward 24 of the Rushinga District. Utilising a qualitative phenomenological research design anchored on the lived experiences of 20 purposefully and snowball-sampled participants, data collection was triangulated via semi-structured key informant interviews, focus group discussions, and environmental field observations. The findings reveal that recurrent droughts have severely undermined hydrological reliability, desiccating surface streams and forcing acute borehole dependency that disproportionately burdens women and children. Critically, an institutional technological mismatch exists: while local water point committees are trained to repair traditional Bush Boreholes, they lack the technical capacity to maintain newer solar-powered installations, resulting in fragmented governance and an unregulated water-vending market that excludes impoverished households. These insights directly benefit rural development policymakers, non-governmental organisations (NGOs), and water authorities by providing an actionable framework to bridge technological capacity gaps and reduce socio-economic inequalities. Ultimately, the study concludes that current local water frameworks remain highly reactive; achieving long-term climate resilience demands an immediate shift from short-term crisis management to sustained institutional investment and proactive adaptive governance.

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ACRONYMS

ADB: Asian Development Bank

AGRITEX: Department of Agricultural, Technical and Extension Services

EEA: European Environment Agency

FAO: Food and Agriculture Organisation

FGDs: Focus Group Discussions

IPCC: Intergovernmental Panel on Climate Change

IWRM: Integrated Water Resource Management

NGOs: Non-governmental Organisations

OECD: Organisation for Economic Co-operation and Development

QGIS: Quantum Geographic Information System

SADC: Southern African Development Community

UNEP: United Nations Environment Programme

UNESCO: United Nations Educational, Scientific and Cultural Organisation

USGS: United States Geological Survey

WRM: Water Resource Management

ZIMSTAT: Zimbabwe National Statistics Agency

ZINWA: Zimbabwe National Water Authority

CHAPTER 1: INTRODUCTION

1.1 Introduction

The problem of climate change has been growing to the control and access to water, especially in rural regions, which are at risk, such as Ward 24, Rushinga District, in Zimbabwe. The changes in the pattern of rainfall, frequent droughts, and the rise in temperature have affected conventional sources of water, which has endangered agriculture, livelihoods, and social lives. This paper aims to research the interactions between climate change and water resource management practices in Ward 24, Rushinga District and the opportunities as well as challenges that the communities experience. It aims to learn about local practices, institutional reaction as well as resource planning systems that could lead to improved water security. The study will eventually seek to give recommendations on useful and context-based interventions that will contribute to resilient water management and community development.

1.2 Background of the Study

The subject of climate change has significantly interfered with the water systems around the world, has completely changed the hydrological cycle, and increased water scarcity in various parts of the world. In recent studies, the warming of the planet, changes in the precipitation patterns, and evaporative processes are the primary agents of a reduction in the freshwater levels and consistency, leaving growing discrepancies between supply and demand of water on a global scale (Ciampittiello, Marchetto and Boggero, 2024). The changes not only deplete renewable freshwater resources but also escalate the occurrence and severity of hydrological extremes like droughts and floods, which threaten current water management systems and governance systems of the world (UN-Water, 2024). The existence of water gaps, or water demand surpassing its sustainable supply, is further emphasised in global modelled scenarios, and will keep on increasing in the case of future warming conditions, according to which an adaptive water management strategy addressing the requirement needs to be resilient to climatic unpredictability (Rosa & Sangiorgio, 2025). It is upon this background that the interaction of climate change with water management is increasingly emerging as a menace to water security, as well as offering prospects of recasting governance and adaptation mechanisms towards resilience and sustainable development.

In the Southern part of Africa, and in Zimbabwe, in particular, the effects of climate change on water resources are current and even more intense because of high climatic sensitivity, the significance of rain-fed agriculture, and the restrictions on water storage and infrastructure. The high rainfall has become more erratic and extended dry spells, coupled with the frequency of drought events in the southern part of Africa, threatening the surface water flows and recharge of groundwater systems and putting the water supply under heavy strain, causing demands on agriculture, domestic, and industrial demands (Climate Newsroom, 2025). Climate variability in Zimbabwe has been experienced through frequent droughts, a shrinking level of dams, and decreased groundwater recharging, adding to the already existing water infrastructure and institutional capacity, as well as fair distribution (Climate Newsroom, 2025; CANZIM, 2025). The idea of policy discourses and national programs to enhance water governance with the tools of integrated planning, climate-sensitive predictions, and an increase of irrigation and water reservoirs has all attempted to empower more rural and smallholder communities, but still have several obstacles to implementing water management efforts. These local processes demonstrate that climate change and water resource management are two indistinguishable parts that require a unified approach to adaptation that helps to promote resilience on bureaucracy levels, as well as local and national levels.

The global and regional trends meet at the local scale in Ward 24, Rushinga District, where climate change is having a direct impact on the water availability, local water control and livelihood security of a semi-arid region that is already resource-limited. The water systems of the area, mainly season-based on rain patterns, low rivers and insufficient groundwater systems, are becoming more stressed due to changes in rain patterns and prolonged periods of dry conditions, which inhibit water availability to Ward 24, Rushinga District, affecting the agricultural sector, and the water an individual requires day by day. Studies in related situations in Zimbabwe have shown that the competition over scarce resources increases with climate-induced water stress and the necessity of climate-congruent water management systems using the combination of local knowledge, community action, and enabling institutionalization (Manyakaidze, 2024). There is also local research that highlights that unless there is a robust strategy for adaptation i.e. rainwater harvesting, better storage facilities, and integrated planning, then the ability of rural communities to deal with climatic extremes is on the brink, and the socio-economic implications of water insecurity are intensified. Consequently, a deep analysis of the interaction between climate change

and water resource management in Rushinga not only helps to discover the distinctive issues of the rural communities in Zimbabwe but also outlines the possibilities of the specific interventions promoting sustainable water management and increasing the adaptive capacity within the selected community.

1.3 Problem Statement

In rural districts such as Ward 24, Rushinga District, communities frequently experience water shortages, erratic rainfall and prolonged dry periods, all of which are exacerbated by climate change. While water resource management frameworks emphasise adaptive planning (Zinhumwe & Ncube, 2020), the development and distribution of water resources, it remains unclear how these processes are being implemented and adjusted at the local level in response to climate change and variability Furthermore, there is a limited understanding of how local communities and institutions in Rushinga are responding to these changing climatic conditions and what challenges or opportunities exist within current water management practices.

Although various studies have examined climate change impacts on water resources (Sukanya & Joseph, 2023; Raju & Kumar, 2018), there is insufficient localised research focusing specifically on how community-based water resource management practices in Ward 24, Rushinga District, have been adjusted to suit the transforming condition of climate. In particular, there is a gap in knowledge regarding how planning, distribution and management strategies have evolved in response to climate change and how communities are coping with or adapting to these changes. This lack of context-specific knowledge makes it difficult to design effective and sustainable water management interventions for the area. Therefore, this study seeks to examine the interplay between climate change and water resource management in Ward 24, Rushinga District by investigating how water planning, distribution and management practices have changed under shifting climatic conditions, as well as how communities and institutions are responding to these changes.

1.4 Aim

This study aims to examine the interplay between climate change and water resource management systems in Ward 24, Rushinga District, Zimbabwe, in order to identify the key challenges affecting water security and explore opportunities for strengthening adaptive and sustainable water governance.

1.5 Objectives

i. To assess the nature and extent of climate change-related pressures affecting water availability and reliability in Ward 24, Rushinga District.
ii. To examine how existing water resource management systems in Ward 24, Rushinga, respond to and interact with climate variability and change.
iii. To identify key institutional, infrastructural, and socio-economic challenges and opportunities for strengthening adaptive and sustainable water governance in Ward 24, Rushinga District.
iv. To propose practical strategies for improving adaptive planning, development, distribution and efficiency of water resources.

1.6 Research Questions

i. What climate change-related pressures are influencing water availability and reliability in Ward 24, Rushinga District?
ii. How do existing water resource management systems in Ward 24, Rushinga District interact with and respond to climate variability and change?
iii. What are the key challenges and opportunities for enhancing adaptive and sustainable water resource management in Ward 24, Rushinga District?
iv. What strategies can be adopted to improve adaptive water resource management practices in response to climate change in Ward 24, Rushinga district?

1.7 Justification

Knowledge on the intricate relationship between climate change and water resource management in Rushinga ward 24, Zimbabwe, is of key importance due to the increasing vulnerability of water security to climate variability and the risks of precipitation changes, global warming, and increased frequency of droughts, which overload freshwater system, disrupt hydrological processes, and aggravate the dependence of scarce water resources. Globally, research on climate variations and its effects indicates that climate change damages agricultural productivity by lowering crop yields, impairs human health, and reduced ecosystem services. Southern Africa is not an exception, as it experiences regular droughts, unpredictable precipitation, and water shortages, which compromise traditional water governance and demand new adaptive management strategies to in turn introduce climate resilience into policymaking and planning processes (Climate Newsroom, 2025; Mokone,

2025). Climate change has been broadly understood in Zimbabwe in particular as a cause of deteriorating water availability, and mounting pressure on already fragile water infrastructure. However, there is a general gap in the localised empirical evidence on how these two climatic changes can affect the local water management practices, institutional reactions, and adaptive potentials, particularly in rural districts like Rushinga, which largely rely on climate-sensitive water sources to sustain their livelihoods (Kupika et al., 2024; Ndlovu, 2025). This study will provide evidence-based information to policy-makers and enhance the adaptive capacity to one of problem reduction in Rushinga, ward 24. This will be achieved through providing evidence based information on how people and institutions in Rushinga ward 24 are managing water resources in line with changes in climate.

1.8 Definition of key terms

Climate Change - An environmental change in the long-term in temperature, precipitation, and weather patterns due to natural and human activities, which influence water availability and ecosystem (IPCC, 2023).

Water Resource Management - This is planning, development, and sustainable utilization of water in order to address human, agricultural and ecological requirements (Mokone, 2025).

Effective Global Water Partnership defines ***Water Resource Management (WRM)*** as the planning, development, distribution and management of water resources in a sustainable and efficient manner in order to meet human, economic and environmental needs (2019).

Water Security - Access to this water, where there is dependable access and adequacy of safe water to the populace as well as the ecosystems, is resilient to climatic and environmental hazards (Rosa and Sangiorgio, 2025).

Interplay: An interaction or relationship

Community resilience: The ability of communities to adjust to, react to, and recuperate ecological and climatic issues as well as maintain livelihoods (Manyakaidze, 2024).

Semi-AR: Regions that have low and intermittent rainfall, high evaporative conditions, and a prone to drought where the water management strategy must be adaptive (Kupika et al., 2024).

1.9 Organisation of the Study

Chapter 1: Introduction

In this chapter, the background of the study is presented. It describes the statement of the problem, the purpose of the research, research questions, rationale and definition of key terms used.

Chapter 2: Literature Review

The chapter is a review of international, regional and local literatures on climate change and management of water resources. It locates the gaps in research and research paradigms.

Chapter 3: Research Methodology.

In this chapter, research design, population, sampling methods used, data collection methods and data analysis procedures have been explained.

Chapter 4: Results and Discussion.

In this chapter, the findings of the research are provided. It analyses the data and talks about the findings based on literature and research objectives.

Chapter 5: summary, conclusion, and recommendation.

This chapter is an overview of the study. It makes inferences, identifies shortcomings and gives policy and future research recommendations.

1.10 Chapter Summary

Chapter 1 presents the research work on the relationship that exists between climate change and water management in Ward 24, Rushinga, Zimbabwe. It brings to light the role of climate change through the increase in temperatures, unpredictable rains, and frequent droughts in contributing to water scarcity that has posed threats to livelihoods, agriculture, and the general well being of communities in semi-arid rural regions. The chapter gives some background information during both the global, regional and local levels as well as illustrating the vulnerability of the water systems in Ward 24, Rushinga and determining the adaptive approaches that should be applied in managing such. It identifies the problem statement, research aim, objectives and questions; it is concerned with comprehending the issues of challenges and opportunities of sustainable water

governance. The chapter reasons the study by emphasizing the essence of setting-specific evidence to enhance the resilience and policy and community adjustment. Such terms as climate change, water resources management, water security, community resilience, and semi-arid areas are presented, and the structure of the research based on five chapters is outlined briefly.

CHAPTER TWO: LITERATURE REVIEW

2.0 Introduction

This chapter reviewed the existing body of the study on the relationship between climate change and water resources management, with a focus on the challenges and opportunities in Ward 24, Rushinga District, Zimbabwe. The purpose of the literature review was to situate the study within broader debates on climate variability, water governance, and rural livelihoods, while identifying gaps that justify the present research. The review was guided by three objectives, namely to assess the nature and extent of climate change-related pressures affecting water availability and reliability in Ward 24, Rushinga, to examine how existing water resource management systems respond to and interact with climate variability and change, and to identify key institutional, infrastructural, and socio-economic challenges and opportunities for strengthening adaptive and sustainable water governance. To achieve this, the chapter started by outlining the theoretical framework that informs the study, including definitions of climate change and water resource management, and the theoretical lens through which the research is anchored. It then organised the literature review around the research's objectives, with each objective broken down into themes that highlight climate pressures, management responses, and governance challenges. Within these sections, the discussion moves from global perspectives to regional and national contexts, before narrowing to the local realities of Ward 24, Rushinga District. The chapter concludes by identifying knowledge gaps in existing literature and linking these to the rationale for the current study. In this way, the literature review provided both a synthesis of existing knowledge and a foundation for the qualitative exploration that follows in Chapter 3.

2.1 Theoretical Framework

This research utilised the Adaptive Governance Theory, developed by Folke, Hahn, Olsson, and Norberg in 2005, it emphasises the need for flexible, learning-oriented institutions that can respond to complex socio-ecological challenges. The framework highlights collaboration across multiple governance levels, integration of diverse knowledge systems, and the capacity for self-organisation in the face of uncertainty. Scholars have applied this theory to water management, forestry, and fisheries, showing how adaptive governance enhances resilience by enabling communities and institutions to cope with variability and change (Chaffin et al., 2014; Steelman, 2022). One of its critical strengths is its inclusivity, as it values both scientific and local knowledge, and its emphasis

on adaptability, which is crucial in contexts of climate uncertainty (Cosens and Gunderson, 2018). However, limitations have also been noted, particularly the difficulty of operationalising adaptive processes within rigid bureaucratic systems and the challenge of sustaining collaboration across diverse stakeholders over time (Huitema et al., 2009).

Besides these limitations, the framework was highly relevant to this study because climate change presents unpredictable pressures that require governance systems to move beyond rigid, top-down approaches toward adaptive, participatory, and resilient strategies. By focusing on institutional flexibility, community participation, and knowledge integration, Adaptive Governance Theory shaped the study's exploration of both challenges and opportunities for strengthening sustainable water governance in Ward 24, Rushinga District.

2.2 Understanding Climate Change and Water Resources

Climate change refers to long-term shifts in temperature, precipitation, and weather patterns, largely driven by human activities such as greenhouse gas emissions (Raizada et al., 2022). According to Kundewicz et al. (2018), these changes have profound implications for water resources, which are highly sensitive to climatic variability. Globally, climate change has been linked to altered rainfall regimes, increased drought frequency, flooding, and shifts in groundwater recharge, all of which affect the availability and reliability of water supplies (Riedel and Weber, 2020). Ofori et al. (2021) mentioned that, in Sub-Saharan Africa, where livelihoods are heavily dependent on rain-fed agriculture, climate variability has intensified water stress, leading to reduced crop yields, declining pasture quality, and heightened competition for scarce water resources.

Zimbabwe, like many countries in the region, has experienced declining rainfall, recurrent droughts, and rising temperatures, which have disrupted both surface and groundwater systems (Mwadzingeni et al., 2022). These pressures are particularly acute in most rural districts such as Mutoko, where communities rely on boreholes, rivers, and small dams for domestic and agricultural use (Mugambiwa and Rukema, 2020). Understanding climate change in relation to water resources therefore requires examining how variability in rainfall and temperature translates into reduced water reliability, how droughts undermine both household and agricultural resilience, and how local ecosystems are affected by shifts in hydrological cycles. This section sets the stage

for analysing the extent of climate-related pressures on water availability in Ward 24, Rushinga, while also highlighting the broader regional and global patterns that shape local experiences.

2.3 Climate Change Pressures on Water Availability and Reliability

This section provides literature on climate change pressures that influence water resources, focusing on three themes that include climate variability and rainfall patterns, drought frequency and its impact on water reliability, and shifts in surface and groundwater resources under climate stress. Together, these themes provided a better understanding of how climate change affects water availability and reliability.

2 3.1 Drought Frequency and Its Impact on Water Reliability

Worldwide, droughts are widely recognised as one of the most severe climate-related pressures on water systems. According to the World Meteorological Organisation (2022), drought frequency has increased by nearly 30% since 2000, reducing both surface and groundwater supplies. The Intergovernmental Panel on Climate Change (IPCC, 2023) emphasised that droughts are becoming more prolonged and intense due to rising global temperatures, with cascading effects on hydrological systems. Gleeson et al. (2020) argued that recurrent droughts not only reduce water reliability but also accelerate groundwater depletion, creating long-term sustainability challenges. Makaya et al. (2020) noted that droughts exacerbate water governance difficulties, as institutions struggle to allocate scarce resources equitably. Scholars generally agree that droughts are no longer isolated events but recurring phenomena that fundamentally reshape water availability worldwide (UNEP, 2021).

In Asia, recurrent droughts have become a defining feature of climate risk, particularly in regions dependent on monsoon rains and glacier-fed rivers. Rasul and Sharma (2019) highlighted that South Asia has experienced prolonged dry spells that undermine agricultural productivity, forcing farmers to rely more heavily on irrigation systems that are themselves vulnerable to depletion. Liu et al. (2021) noted that China's northern provinces have faced recurrent droughts that reduce river flows and groundwater recharge, threatening both food security and industrial water supply. Micklin (2020) argued that Central Asia has witnessed droughts that accelerate the desiccation of water bodies such as the Aral Sea, highlighting the long-term ecological consequences of recurrent water stress. These experiences demonstrate how droughts are not merely temporary crises but

structural challenges that reshape water governance, agricultural systems, and regional stability (FAO, 2022).

Latin America has also faced recurrent droughts with far-reaching consequences. Marengo et al. (2020) observed that Brazil's northeast region, known as the "sertão," has endured prolonged droughts that undermine rural livelihoods and force migration to urban centres. Boisier et al. (2018) noted that in Chile, droughts have reduced river flows and compromised hydropower generation, prompting debates about water rights and allocation. According to CONAGUA (2021), Mexico has faced recurrent droughts that exacerbate water scarcity in semi-arid regions, undermining both agriculture and domestic supply. Scholars highlight that recurrent droughts in Latin America reveal the intersection of climate pressures with socio-economic vulnerabilities, as communities with limited infrastructure and weak governance struggle to adapt (World Bank, 2022). These experiences underscore the need for adaptive water management strategies that can respond to recurrent droughts as a long-term reality rather than isolated events (IPCC, 2023).

In North America, recurrent droughts have become a persistent challenge, particularly in the western United States. Udall and Overpeck (2017) argued that the Colorado River basin has experienced declining flows due to reduced snowmelt and prolonged dry spells, creating difficulties for water allocation among states and sectors. Diffenbaugh et al. (2018) highlighted that California has faced recurrent droughts that undermine agricultural productivity, increase reliance on groundwater, and expose weaknesses in water governance systems. Wheaton et al. (2021) noted that Canada has also experienced droughts that affect agricultural regions, highlighting the interconnectedness of climate variability and food security. Scholars argue that recurrent droughts in North America illustrate how climate pressures interact with governance challenges, as institutions struggle to balance competing demands under conditions of scarcity (USGS, 2022).

Europe presents a contrasting picture, with Mediterranean countries such as Spain, Italy, and Greece experiencing recurrent droughts that undermine agricultural productivity and increase reliance on groundwater. García-Ruiz et al. (2020) emphasised that these droughts have reduced river flows, compromised hydropower generation, and heightened competition for scarce resources. Northern Europe, while traditionally wetter, has also faced droughts that affect agriculture and water supply, highlighting the spatial unevenness of climate pressures (EEA, 2021).

Scholars argue that recurrent droughts in Europe reveal the limitations of traditional water management systems, which often fail to cope with prolonged scarcity (Stahl et al., 2020). Adaptive governance frameworks are increasingly recognised as essential to respond to recurrent droughts, yet implementation remains uneven across contexts (European Commission, 2022).

Sub-Saharan Africa has been disproportionately affected by recurrent droughts. Conway et al. (2021) argued that southern Africa has experienced some of the most severe droughts in recent decades, reducing hydrological reliability and forcing communities to rely on emergency water sources. Archer et al. (2017) noted that droughts in the region have undermined agricultural productivity, increased poverty levels, and heightened competition for scarce water resources. Hadebe and Dube (2024) highlighted that droughts exacerbate existing vulnerabilities by reducing dam inflows and groundwater recharge, thereby weakening both domestic and agricultural water supplies. Vincent and Conway (2021) emphasised that recurrent droughts are a defining feature of climate risk in southern Africa, with profound implications for water governance and rural livelihoods.

The impacts of recurrent droughts extend beyond agriculture into domestic water supply and urban systems. Declining dam levels and shrinking river flows have reduced the reliability of piped water systems in many cities, while rural communities increasingly depend on boreholes and small reservoirs that are themselves vulnerable to drought (van Koppen et al., 2020). Scholars have noted that recurrent droughts undermine traditional water-sharing practices, as communities struggle to allocate scarce resources equitably (UNEP, 2021). This has heightened competition for water, sometimes leading to conflict between households, villages, and sectors (World Bank, 2022). Conway et al. (2021) further emphasised that recurrent droughts are strongly correlated with reduced hydrological reliability, undermining not only agricultural productivity but also domestic water supply and broader governance systems.

Recurrent droughts also interact with socio-economic vulnerabilities across Sub-Saharan Africa. Poverty, limited infrastructure, and weak institutions exacerbate the impacts of drought, leaving communities with few options for adaptation (Niang et al., 2022). Makaya et al. (2020) highlighted that recurrent drought exacerbates water governance difficulties, as institutions struggle to allocate scarce resources equitably. Archer et al. (2017) noted that drought frequency has increased significantly in southern Africa, reducing both surface and groundwater supplies. These findings

underscore the urgent need for adaptive governance frameworks that can respond to recurrent droughts and support communities in building resilience (IPCC, 2023). Scholars argue that recurrent droughts are not simply climatic phenomena but structural challenges that interact with poverty and governance weaknesses, deepening vulnerability across the region (Serdeczny et al., 2019).

Locally, Zimbabwe has faced recurrent droughts, particularly in the past two decades. According to Manyakaidze (2023), droughts in 2015–2016 and 2019–2020 severely reduced dam levels and borehole yields, undermining both agricultural and domestic water supplies. Mpala and Simatele (2024) argued that droughts have disrupted traditional farming systems, forcing communities to adopt coping strategies such as reliance on groundwater and small-scale irrigation. Nyamwanza (2018) in the study carried out in Mbire District noted that recurrent droughts have exposed weaknesses in Zimbabwe's water governance systems, particularly the inability of institutions to maintain infrastructure and allocate water equitably during times of scarcity.

Recurrent droughts also interact with governance challenges in Zimbabwe. In the study carried in Mudzi District, institutions responsible for water management often struggle to plan and allocate resources under conditions of scarcity (Chigavazira and Zandamela, 2021). Matamanda et al. (2025) argued that recurrent droughts have exposed weaknesses in water governance systems, particularly the inability of institutions to maintain infrastructure and ensure equitable access to water. In districts such as Chiredzi, local authorities face difficulties in managing boreholes and small dams, leaving communities vulnerable to scarcity (Bowora, 2018). These governance challenges highlight the need for adaptive frameworks that can respond to recurrent droughts and support communities in building resilience. Without such frameworks, droughts will continue to undermine water security and exacerbate socio-economic vulnerabilities in Zimbabwe and districts such as Ward 24, Rushinga as well.

2.3.2 Shifts in Surface and Groundwater Resources Under Climate Stress

Globally, scholars agree that climate change has significantly altered hydrological cycles, leading to shifts in both surface and groundwater resources. Gleeson et al. (2020) highlighted those prolonged dry spells and rising temperatures have reduced groundwater recharge rates worldwide, while increasing reliance on aquifers to meet water demand. Famiglietti (2014) argued that satellite observations show declining groundwater storage in many regions, particularly in areas where

surface water flows are shrinking due to reduced rainfall. The Intergovernmental Panel on Climate Change (IPCC, 2023) emphasised that climate-induced hydrological changes are compounded by human pressures such as over-extraction, resulting in unsustainable water use. These findings illustrate that climate stress is not only reducing the availability of surface water but also undermining the long-term sustainability of groundwater systems (UNEP, 2021).

In Asia, climate stress has profoundly altered the balance between surface and groundwater resources. Bolch et al. (2019) noted that the retreat of Himalayan glaciers has reduced long-term water availability for millions who depend on glacier-fed rivers, while short-term meltwater surges increase flood risks. Immerzeel et al. (2020) argued that rising temperatures have accelerated evapotranspiration, reducing soil moisture and aquifer recharge. In India and Pakistan, declining river flows have heightened reliance on groundwater, which is increasingly over-extracted to sustain agriculture (Shah, 2021). Scholars emphasise that this reliance is unsustainable, as aquifers are being depleted faster than they can be replenished (Rodell et al., 2018). The evidence suggests that climate stress in Asia is reshaping hydrological systems in ways that undermine both agricultural productivity and long-term water security (FAO, 2022).

Latin America has also experienced significant hydrological shifts under climate stress. Vuille et al. (2018) highlighted that the Andes have seen accelerated glacier retreat, reducing water availability for agriculture, hydropower, and domestic use. Marengo et al. (2020) noted that prolonged dry spells and rising temperatures in Brazil have reduced river flows, undermining hydropower generation and rural livelihoods. In Mexico, declining aquifer recharge rates have been exacerbated by over-extraction to meet urban and agricultural demand (CONAGUA, 2021). Scholars argue that climate stress in Latin America has intensified competition between surface and groundwater resources, forcing communities to rely more heavily on aquifers that are themselves under pressure (World Bank, 2022). These experiences underscore the need for adaptive water management strategies that can respond to long-term hydrological shifts (IPCC, 2023).

North America has faced pronounced shifts in surface and groundwater systems under climate stress. Mote et al. (2019) observed that the western United States has experienced declining snowpack levels, reducing natural reservoirs that feed rivers and aquifers. Udall and Overpeck (2017) argued that reduced snowmelt has undermined water availability for agriculture,

hydropower, and domestic use, while higher temperatures have increased evapotranspiration and water demand. Famiglietti et al. (2015) noted that satellite observations show declining groundwater storage in regions such as California's Central Valley, where aquifers are being depleted to sustain agriculture during prolonged droughts. Scholars emphasise that these hydrological shifts illustrate how climate stress interacts with governance challenges, as institutions struggle to balance competing demands under conditions of scarcity (USGS, 2022).

Europe presents a contrasting picture, with Mediterranean countries experiencing prolonged droughts that reduce river flows and aquifer recharge, while northern regions face increased flooding that overwhelms drainage systems. García-Ruiz et al. (2020) highlighted that in Spain and Italy, rising temperatures have intensified evapotranspiration, undermining agricultural productivity and increasing reliance on groundwater. Stahl et al. (2020) noted that in northern Europe, climate stress has altered rainfall patterns, creating challenges for water management systems that must cope with both excess and scarcity. Scholars argue that hydrological shifts in Europe highlight the limitations of traditional water management frameworks, which often fail to respond effectively to long-term climate pressures (EEA, 2021). Adaptive governance is increasingly recognised as essential to sustain both surface and groundwater resources (European Commission, 2022).

Sub-Saharan Africa has experienced pronounced hydrological shifts. MacDonald et al. (2012) noted that groundwater resources in Africa are extensive but highly vulnerable to climate variability, with recharge rates declining in semi-arid zones. Taylor et al. (2013) argued that rainfall variability directly affects aquifer replenishment, making groundwater less reliable during prolonged droughts. Calow et al. (2010) highlighted that surface water bodies across southern Africa have shown declining flows, while reservoirs are shrinking due to reduced rainfall and higher evaporation rates. Scholars generally agree that climate stress is altering the balance between surface and groundwater resources, forcing communities to depend more heavily on aquifers that are themselves under pressure (Niang et al., 2022).

Southern Africa has been particularly affected by shifts in hydrological systems under climate stress. Prolonged dry spells have reduced inflows into major reservoirs such as Kariba and Cahora Bassa, undermining hydropower generation and water reliability (Mupotola & Manzungu, 2021). Rising temperatures have accelerated evaporation rates, further reducing the availability of surface

water (IPCC, 2023). Communities have increasingly turned to groundwater as a fallback resource, yet aquifer recharge has been inconsistent due to rainfall variability (Mpandeli et al., 2020). Scholars argue that this reliance on groundwater is unsustainable, as extraction often exceeds replenishment, leading to declining yields and borehole failures (World Bank, 2022). These hydrological shifts highlight the interconnectedness of climate pressures and socio-economic systems, underscoring the need for adaptive water management strategies (UNEP, 2021).

Zimbabwe has witnessed significant shifts in both surface and groundwater systems. Manyakaidze et al. (2024) noted that boreholes in rural districts such as Chirwdzi and Zvishavane which resembles Chipinge are increasingly failing due to reduced recharge and overuse, while dam inflows have declined sharply during drought years. Pachowa (2023) observed that river flows have become increasingly seasonal, undermining the reliability of surface water supplies. Gona et al. (2022) argue that groundwater has become the primary fallback resource during droughts, yet its sustainability is threatened by declining recharge rates. Scholars agree that these hydrological shifts are undermining the sustainability of water supplies in Zimbabwe, highlighting the urgent need for adaptive management strategies that can respond to long-term climate stress.

Surface water systems in Zimbabwe have also been significantly affected by climate stress. Declining dam inflows have reduced the reliability of reservoirs, which are critical for both agriculture and domestic supply (Masimba et al., 2022). In Rushinga, small dams and rivers have become increasingly seasonal, drying up during prolonged droughts and leaving communities without reliable sources of water (BINDURA, 2018). From the above studies, scholars noted that these shifts have exposed weaknesses in Zimbabwe's water infrastructure, which is often poorly maintained and unable to cope with prolonged scarcity. The impacts on surface water systems underscore the need for adaptive management strategies that can sustain reservoirs and rivers under changing climatic conditions.

2.4 Responses of Water Resource Management Systems to Climate Variability and Change

This section reviewed literature on how water resource management systems respond to climate variability and change. It focuses on three themes: institutional and policy responses to climate-induced water challenges, community-level adaptation and coping strategies in water use, and infrastructure performance under climate variability.

2.4.1 Institutional and Policy Responses to Climate-Induced Water Challenges

Globally, institutions have increasingly recognised the need to adapt water governance frameworks to climate variability. UNESCO (2023) noted that integrated water resource management (IWRM) has been promoted as a key policy approach to address climate risks, emphasising coordination across sectors and scales. Pahl-Wostl (2017) argued that adaptive governance frameworks are essential for building resilience in water systems, stressing flexibility, learning, and stakeholder participation. Cosens and Gunderson (2018) highlighted that institutional responses must move beyond rigid, top-down models to embrace adaptive, multi-level governance. Scholars generally agree that institutional adaptation is critical, but they also emphasise challenges in operationalising adaptive governance within bureaucratic systems (OECD, 2021).

Across Asia, institutional responses to climate-induced water challenges have varied widely, reflecting diverse governance structures and socio-economic contexts. India's National Water Policy emphasises sustainable management and climate resilience, yet implementation has been hindered by fragmented institutions and competing priorities (Government of India, 2020). China has invested heavily in large-scale infrastructure projects, such as the South–North Water Transfer Project, but scholars argue that these initiatives often prioritise engineering solutions over adaptive governance (Liu & Yang, 2019). Southeast Asian nations have promoted community-based water management, yet institutional support remains uneven (ADB, 2021). The evidence suggests that while policy frameworks increasingly recognise climate risks, institutional fragmentation and limited capacity continue to undermine effective responses (FAO, 2022).

In Latin America, institutional responses have focused on balancing water governance with socio-economic development. Brazil has integrated climate adaptation into its National Water Resources Policy (Law No. 9.433/1997), which emphasises basin-level management and stakeholder participation, and resilience to droughts and rainfall variability through institutions such as the Sao Francisco River Basin Committee (Marengo et al., 2020). However, recurrent droughts in the northeast have exposed weaknesses in institutional capacity, particularly in rural areas (World Bank, 2022). Chile has pursued market-based water allocation systems, yet scholars argue that these frameworks often exacerbate inequalities under climate stress (Boelens & Vos, 2019). Mexico has attempted to strengthen institutional coordination through national adaptation plans,

but implementation remains constrained by limited resources and political fragmentation (CONAGUA, 2021). Scholars highlight those institutional responses in Latin America reveal the tension between ambitious policy frameworks and the realities of governance under climate variability (UNEP, 2021).

North America presents contrasting experiences, with the United States and Canada adopting different approaches to institutional adaptation. In the United States, water governance is highly decentralised, with states and local agencies responsible for managing resources (Cosens et al., 2017). Adaptive governance frameworks have been promoted, yet institutional fragmentation often undermines coordination (USGS, 2022). The Colorado River Compact illustrates the challenges of balancing competing demands under climate stress, as recurrent droughts strain interstate agreements (Udall & Overpeck, 2017). Canada has emphasised integrated water management and climate adaptation, yet scholars note that institutional responses remain uneven across provinces (Renzetti & Dupont, 2020). The evidence suggests that institutional adaptation in North America is critical but constrained by governance complexity and competing priorities (OECD, 2021).

Europe has promoted adaptive governance frameworks to address climate-induced water challenges, particularly through the European Union's Water Framework Directive (Directive 2000/60/EC, which introduced integrated river basin management, ecological protection, and stakeholder participation as key principles (European Commission, 2000; Santos, 2025). This policy emphasises integrated management, stakeholder participation, and climate resilience (European Commission, 2022). Mediterranean countries such as Spain and Italy have adopted basin-level management strategies, yet recurrent droughts continue to expose weaknesses in institutional capacity (García-Ruiz et al., 2020). Northern European nations have invested in flood management and adaptive infrastructure, highlighting the importance of proactive governance (EEA, 2021). Scholars argue that while Europe has made significant progress in institutional adaptation, challenges remain in operationalising frameworks across diverse contexts (Stahl et al., 2020). The evidence suggests that adaptive governance is essential but requires sustained commitment and resources (UNEP, 2021).

Globally, scholars emphasise that institutional adaptation is critical for building resilience in water systems under climate stress. Pahl-Wostl (2017) argued that adaptive governance frameworks

must prioritise flexibility, learning, and stakeholder participation. Cosens and Gunderson (2018) highlighted the need to move beyond rigid, top-down models to embrace multi-level governance. UNESCO (2023) noted that integrated water resource management has been promoted as a key policy approach, yet implementation remains uneven. The evidence suggests that while institutions increasingly recognise climate risks, operationalising adaptive governance within bureaucratic systems remains a significant challenge (OECD, 2021). Scholars agree that institutional responses must evolve to address the complex pressures of climate variability and change (IPCC, 2023).

Sub-Saharan Africa has adopted various policy frameworks to address climate-related water challenges. Van Koppen et al. (2020) noted that many countries have integrated climate adaptation into national water policies, though implementation remains uneven. Muller (2018) argued that institutional fragmentation and limited capacity hinder effective responses, while regional cooperation through initiatives such as the Southern African Development Community (SADC) water protocols has been highlighted as critical (SADC, 2021). Archer et al. (2017) emphasised that institutional responses in southern Africa often fail to anticipate long-term climate risks, focusing instead on short-term crisis management.

Southern Africa has been at the forefront of regional policy experimentation, yet institutional responses remain constrained by capacity and resources. South Africa has adopted integrated water resource management frameworks, embedding climate adaptation into national strategies (Department of Water and Sanitation, 2020). However, scholars argue that implementation has been hindered by bureaucratic inertia and fragmented governance structures (Muller, 2018). The SADC water protocols have promoted regional cooperation, yet enforcement remains weak, with member states often prioritising national interests over collective resilience (SADC, 2021). The evidence suggests that while policy frameworks increasingly recognise climate risks, institutional fragmentation continues to undermine effective responses (UNEP, 2021).

Zimbabwe has attempted to integrate climate considerations into water governance. Mazivarimwe (2020) observed that while policies such as the National Water Policy recognise climate risks, implementation has been constrained by institutional capacity and resource limitations. Taonmeso et al. (2022) argued that fragmented governance structures and limited coordination among agencies undermine effective responses. In rural districts such as Rushinga, institutional weaknesses are particularly evident (Munyede, 2016). According to Kusena et al. (2017) local

authorities often lack the resources and technical capacity to maintain boreholes and small dams, leaving communities vulnerable to water scarcity during droughts. The above studies showcased that governance systems are often reactive, focusing on short-term crisis management rather than long-term resilience. This has left households dependent on informal coping mechanisms, such as traditional water-sharing arrangements, which are insufficient to address prolonged climate pressures. The impacts of institutional weaknesses at the local level highlight the urgent need for stronger governance frameworks that can support community resilience.

Institutional fragmentation has also undermined coordination among agencies responsible for water governance in Zimbabwe (Ngubane et al., 2026). Mumvuma (2016) argued that, overlapping mandates and limited communication between institutions have created inefficiencies and gaps in service delivery. In districts such as Rushinga, this fragmentation has left communities without reliable support during periods of scarcity (Munyede, 2016). Kurehwatira (2025) emphasise that fragmented governance structures undermine effective responses, leaving water systems vulnerable to climate variability. The above evidence suggests that institutional adaptation is critical but constrained by governance weaknesses and limited capacity.

Chanza (2017) mentioned that, financial and resource limitations further constrain institutional responses to climate-induced water challenges in Zimbabwe. Chanza (2017) further explained that, agencies such as ZINWA and Council which are responsible for water governance often lack the funding needed to maintain infrastructure and implement adaptation strategies. This led to limited investment which has left boreholes and small dams poorly maintained, reducing their reliability during droughts in many rural districts especially in Ward 24, Rushinga. Mazivarimwe (2020) argued that, institutional weaknesses have left water governance systems reactive rather than proactive, limiting their ability to address climate variability effectively. These findings underscore the need for sustained investment in institutional capacity and infrastructure to build resilience against climate pressures.

2.4.2 Community-Level Adaptation and Coping Strategies in Water Use

Globally, communities have developed diverse coping strategies to deal with climate variability. According to Adger et al. (2003), local adaptation often involves traditional knowledge, flexible water use practices, and diversification of livelihoods. Berkes (2017) emphasised that community-based adaptation is critical for resilience, particularly in rural areas where formal institutions may

be weak. Scholars generally agree that community-level adaptation complements institutional responses, providing localised resilience against climate pressures (UNEP, 2021).

In Asia, community-level adaptation has been shaped by centuries of reliance on traditional water management systems. According to Agarwal and Narain (2019), farmers in India and Nepal have long practised rainwater harvesting and small-scale irrigation, which remain vital coping strategies under climate stress. In Bangladesh, communities have adapted to recurrent flooding by constructing raised homesteads and floating gardens, demonstrating the integration of local knowledge into resilience practices (Islam & Walkerden, 2017). Scholars argue that these strategies highlight the importance of community innovation, yet they also note that poverty and limited institutional support constrain their effectiveness (FAO, 2022). The evidence suggests that while communities demonstrate remarkable resilience, their coping strategies often require stronger institutional backing to be sustainable in the long term (IPCC, 2023).

Latin American communities have also developed diverse adaptation strategies, particularly in regions vulnerable to droughts and floods. According to Marengo et al. (2020), households in Brazil's northeast rely on cisterns to store rainwater, while rural cooperatives promote collective action to manage scarce resources. Indigenous communities in the Andes have preserved traditional irrigation systems, such as qanats and terraces, which enhance resilience under climate variability (Boelens & Vos, 2019). Scholars highlight that these practices demonstrate the value of traditional knowledge, yet they also emphasise the need for integration with modern technologies and institutional support (World Bank, 2022). The evidence suggests that community-level adaptation in Latin America is essential but constrained by socio-economic inequalities and governance weaknesses (UNEP, 2021).

In North America, community-level adaptation has often involved technological innovation and collective action. According to Diffenbaugh et al. (2018), rural communities in the western United States have adopted water conservation practices, such as drip irrigation and xeriscaping, to cope with recurrent droughts. Indigenous communities have preserved traditional water management practices, integrating them with modern technologies to enhance resilience (Chief et al., 2020). Scholars argue that community-level adaptation in North America illustrates the importance of combining traditional knowledge with technological innovation, yet they also note that institutional support is critical for scaling up these practices (USGS, 2022). The evidence suggests

that community resilience is strongest when local adaptation is complemented by supportive governance frameworks (OECD, 2021).

European communities have also demonstrated diverse coping strategies under climate variability. According to García-Ruiz et al. (2020), households in Mediterranean countries have adopted water-saving technologies and drought-tolerant crops to cope with prolonged dry spells. Northern European communities have focused on flood management, constructing raised infrastructure and promoting collective action to manage excess water (EEA, 2021). Scholars emphasise that community-level adaptation in Europe highlights the importance of localised resilience, yet they also note that institutional support is critical for sustaining these practices (Stahl et al., 2020). The evidence suggests that community adaptation is essential but requires integration with broader governance frameworks to be effective (European Commission, 2022).

Globally, scholars agree that community-level adaptation is critical for building resilience under climate stress. Adger et al. (2003) highlighted the importance of traditional knowledge and flexible water use practices, while Berkes (2017) emphasised the role of community-based adaptation in rural areas. The evidence suggests that community resilience is strongest when local adaptation is complemented by institutional support, yet poverty, limited resources, and governance weaknesses often constrain effectiveness (UNEP, 2021). Scholars argue that community-level adaptation is not only a coping mechanism but also a critical component of sustainable water management under climate variability and change (IPCC, 2023).

Regionally, Sub-Saharan communities have adopted strategies such as rainwater harvesting, small-scale irrigation, and reliance on drought-tolerant crops. According to Nyahunda et al. (2021), community-based adaptation is widespread but often constrained by poverty and limited access to technology. Vincent et al. (2017) argued that social networks and collective action play a crucial role in enabling communities to cope with water stress. Archer et al. (2017) noted that community resilience is often undermined by weak institutional support, leaving households to rely on informal coping mechanisms.

Across southern Africa, community-level adaptation has become a defining feature of resilience under climate variability. Rural households frequently rely on rainwater harvesting, storing water in tanks or small reservoirs to bridge periods of scarcity (Mpandeli et al., 2020). Small-scale

irrigation schemes, often managed collectively, provide a buffer against erratic rainfall, enabling households to sustain crop production during dry spells (Mupotola & Manzungu, 2021). Scholars highlight that these practices demonstrate remarkable ingenuity, yet they are often constrained by poverty and limited access to modern technologies (World Bank, 2022). Communities rely heavily on traditional knowledge, but without institutional support, these strategies remain reactive rather than transformative (UNEP, 2021). The evidence suggests that while community adaptation is widespread, its sustainability is undermined by structural inequalities and weak governance frameworks (Niang et al., 2022).

Overall, scholars agree that community-level adaptation in Sub-Saharan Africa is essential for building resilience under climate stress. Nyahunda et al. (2021) highlighted the widespread adoption of coping strategies such as rainwater harvesting and small-scale irrigation, yet poverty and limited access to technology constrain effectiveness. Vincent et al. (2017) emphasised the importance of social networks and collective action, while Archer et al. (2017) noted that weak institutional support undermines resilience. The evidence suggests that community adaptation is critical but requires stronger institutional backing to be sustainable (IPCC, 2023). Scholars argue that community-level adaptation is not only a coping mechanism but also a vital component of sustainable water management under climate variability and change (FAO, 2022).

Locally, Zimbabwean communities have developed coping strategies such as reliance on boreholes, traditional water-sharing arrangements, and small-scale irrigation schemes (Muchemwa-Munasirei, 2018). Chifamba (2013) noted that these strategies by the local people are often reactive rather than proactive, reflecting limited resources and institutional support. Chifamba (2013) also added that, while communities demonstrate resilience, their coping strategies are insufficient to address long-term climate pressures. Therefore, the above scholars showcased that community-level adaptation in Zimbabwe is essential but requires stronger institutional support to be sustainable.

Traditional water-sharing arrangements remain an important coping strategy in Zimbabwean communities (Shoko and Naidu, 2018). Households often share water from wells and boreholes, particularly during periods of scarcity. These practices reflect strong social networks and collective resilience, yet they are increasingly strained under prolonged droughts. Musarandega et al. (2018) argued that, while traditional arrangements provide short-term relief, they are insufficient to

address long-term climate pressures. Kusenda et al. (2017), In Gweru, competition for water has sometimes led to conflict, highlighting the limitations of informal coping mechanisms. The evidence suggests that community resilience is strongest when traditional practices are complemented by institutional support and investment in infrastructure.

Small-scale irrigation schemes have also been adopted by communities in Zimbabwe such as the Panganai Irrigation Scheme in Bikita District, which was there to cope with rainfall variability (Chazovachii, 2012). Farmers in districts such as Murehwa, Masvingo and Makonde often use simple technologies such as treadle pumps and bucket irrigation to sustain crop production during dry spells (Mugiyo, 2024). These practices demonstrate ingenuity and adaptability, yet they are constrained by limited access to modern technologies and financial resources. Mhembwe et al. (2019) noted that, small-scale irrigation provides critical resilience, yet its effectiveness is undermined by poverty and weak institutional support. The evidence suggests that while communities demonstrate remarkable resilience, their coping strategies require stronger institutional backing to be sustainable.

2.4.3 Infrastructure Performance Under Climate Variability

Globally, infrastructure such as dams, reservoirs, and irrigation systems has been challenged by climate variability. Kundzewicz et al. (2018) argued that climate change has reduced the reliability of traditional water infrastructure, requiring new approaches to design and management. According to UNESCO (2023), infrastructure must be climate-resilient, incorporating flexibility and adaptive capacity. Scholars generally agree that infrastructure performance is central to water security under climate stress (OECD, 2021).

In Asia, climate variability has exposed the vulnerabilities of large-scale water infrastructure. According to Liu and Yang (2019), countries such as India and China have relied heavily on dams and irrigation systems to sustain agricultural productivity, yet recurrent droughts and erratic rainfall have undermined their reliability. Scholars note that reservoirs often fail to provide consistent water supplies during prolonged dry spells, while irrigation systems struggle to cope with declining river flows (Shah, 2021). In South Asia, monsoon variability has created challenges for infrastructure designed around predictable rainfall cycles (FAO, 2022). The evidence suggests that traditional infrastructure is increasingly inadequate under climate stress, highlighting the need for adaptive designs that can respond to variability and extremes (IPCC, 2023).

Latin America has also faced significant challenges in infrastructure performance under climate variability. According to Marengo et al. (2020), Brazil's reliance on hydropower has been undermined by declining reservoir levels during droughts, exposing the vulnerability of energy systems to climate pressures. In Chile, irrigation infrastructure has struggled to cope with declining river flows, while reservoirs have been affected by reduced inflows and higher evaporation rates (Boelens & Vos, 2019). Scholars argue that infrastructure resilience is critical but often overlooked in regional water governance (World Bank, 2022). The evidence suggests that investments in infrastructure must account for climate risks, yet many projects continue to prioritise short-term gains over long-term sustainability (UNEP, 2021).

North America presents contrasting experiences, with infrastructure performance shaped by diverse climatic conditions. According to Mote et al. (2019), declining snowpack levels in the western United States have reduced natural reservoirs that feed dams and irrigation systems, undermining water reliability. Scholars note that infrastructure designed around historical hydrological patterns is increasingly inadequate under climate stress (Udall & Overpeck, 2017). In Canada, flood management infrastructure has been challenged by more frequent and intense rainfall events, highlighting the need for adaptive designs (Renzetti & Dupont, 2020). The evidence suggests that infrastructure resilience is critical for sustaining water security, yet governance systems often fail to prioritise long-term adaptation (USGS, 2022).

Europe has promoted climate-resilient infrastructure through policies such as the European Union's Water Framework Directive. According to García-Ruiz et al. (2020), Mediterranean countries such as Spain and Italy have faced declining reservoir levels and reduced irrigation reliability during prolonged droughts. Northern European nations have invested in flood management infrastructure, yet scholars note that drainage systems are often overwhelmed by extreme rainfall events (EEA, 2021). The evidence suggests that infrastructure performance in Europe highlights the importance of proactive governance, yet implementation remains uneven across contexts (European Commission, 2022). Scholars argue that infrastructure resilience is essential but requires sustained investment and institutional support (Stahl et al., 2020).

Globally, scholars emphasise that infrastructure performance is central to water security under climate stress. Kundzewicz et al. (2018) highlighted the limitations of traditional infrastructure, while UNESCO (2023) emphasised the need for climate-resilient designs. The evidence suggests

that infrastructure must incorporate flexibility and adaptive capacity to cope with variability and extremes (OECD, 2021). Scholars agree that infrastructure resilience is critical but often overlooked in water governance, leaving systems vulnerable to climate pressures (IPCC, 2023). The findings underscore the urgent need for investments in climate-resilient infrastructure to sustain water security under changing climatic conditions (UNEP, 2021).

Southern Africa has experienced declining dam levels and reduced irrigation reliability due to climate variability. Love et al. (2010) observed that both climate pressures and poor maintenance undermine infrastructure performance. Muller (2018) argued that infrastructure investments often fail to account for climate risks, leading to reduced effectiveness. According to Archer et al. (2017), infrastructure resilience is critical but often overlooked in regional water governance.

Across southern Africa, the performance of dams and reservoirs has been severely compromised by recurrent droughts and rising temperatures. Major reservoirs such as Kariba have experienced significant declines in water levels, undermining hydropower generation and agricultural irrigation (Mupotola & Manzungu, 2021). Scholars note that poor maintenance and limited investment exacerbate these vulnerabilities, leaving infrastructure unable to cope with prolonged scarcity (World Bank, 2022). Irrigation schemes, which are critical for sustaining agricultural productivity, often fail during droughts due to reduced inflows and inadequate management (Mpandeli et al., 2020). The evidence suggests that infrastructure resilience is essential but remains constrained by governance weaknesses and resource limitations (UNEP, 2021).

Zimbabwe's water infrastructure has been severely affected by climate variability. Duker et al. (2020) noted that, dams and boreholes frequently fail during droughts, undermining both agricultural and domestic water supplies. Chanza (2017) argued that poor maintenance and limited investment exacerbate the vulnerability of water infrastructure to climate pressures. Mokone (2025) emphasised that water infrastructure performance in Zimbabwe is inadequate, highlighting the need for climate-resilient investments. According to Masimba et al. (2022), small dams and reservoirs in Zimbabwe have also struggled to cope with climate variability. In Muzarabani, inflows into small dams have declined sharply during drought years, while rising temperatures have accelerated evaporation rates (Chanza, 2015). The evidence highlights the urgent need for climate-resilient investments in dam infrastructure to sustain water security under changing climatic conditions.

Overall, Mwadzingeni et al. (2022) agreed that, water infrastructure performance in Zimbabwe is critical for sustaining water security under climate stress. Duker et al (2020)highlighted the frequent failure of dams and boreholes, while Chanza (2017) emphasise the challenges of poor maintenance and limited investment. Chanza (2015) note that infrastructure performance remains inadequate, underscoring the need for climate-resilient investments. The evidence suggests that infrastructure resilience is essential but requires stronger institutional support and sustained investment to be effective.

2.5 Challenges and Opportunities for Strengthening Adaptive and Sustainable Water Governance

This section reviewed literature on the challenges and opportunities that shape adaptive and sustainable water governance under climate variability. It focuses on three themes: institutional and governance challenges in water management, infrastructural and socio-economic barriers to sustainable water use, and opportunities for adaptive governance and community resilience.

2.5.1 Institutional and Governance Challenges in Water Management

Globally, institutions face significant challenges in adapting water governance to climate variability. According to the IPCC (2023), fragmented governance structures and rigid bureaucracies often hinder adaptive responses. Pahl-Wostl (2017) argued that institutional inertia prevents timely adaptation, while Cosens and Gunderson (2018) emphasised that opportunities lie in adopting adaptive governance frameworks that prioritise flexibility, learning, and stakeholder participation. Scholars generally agree that institutional reform is essential for resilience, but they highlight difficulties in operationalising adaptive governance within traditional systems (OECD, 2021).

Across Asia, institutional challenges in water governance are deeply rooted in the complexity of managing diverse hydrological systems under climate stress. According to Shah (2021), countries such as India and Pakistan struggle with fragmented governance structures, where multiple agencies oversee water resources with little coordination. This fragmentation undermines adaptive responses, leaving systems reactive rather than proactive. In China, centralised governance has enabled large-scale infrastructure projects, yet rigid bureaucratic systems limit flexibility and stakeholder participation (Liu & Yang, 2019). Southeast Asian nations face similar challenges, with governance systems often prioritising short-term crisis management over long-term resilience

(ADB, 2021). The evidence suggests that institutional reform is critical but constrained by entrenched bureaucratic practices and competing political priorities (FAO, 2022).

Latin America presents a contrasting picture, with countries adopting ambitious policy frameworks yet struggling with implementation. Brazil has integrated climate adaptation into national water policies, emphasising basin-level management and stakeholder participation (Marengo et al., 2020). However, institutional fragmentation and limited capacity undermine effectiveness, particularly in rural areas (World Bank, 2022). Chile's market-based water allocation system has been criticised for exacerbating inequalities under climate stress (Boelens & Vos, 2019). Mexico has attempted to strengthen institutional coordination through national adaptation plans, yet implementation remains constrained by limited resources and political fragmentation (CONAGUA, 2021). The evidence suggests that institutional challenges in Latin America highlight the tension between ambitious policy frameworks and the realities of governance under climate variability (UNEP, 2021).

In North America, institutional challenges reflect the complexity of decentralised governance systems. According to Cosens et al. (2017), the United States relies on a patchwork of federal, state, and local agencies to manage water resources, yet this fragmentation undermines adaptive responses. The Colorado River Compact illustrates the difficulties of balancing competing demands under climate stress, as recurrent droughts strain interstate agreements (Udall & Overpeck, 2017). Canada has promoted integrated water management, yet institutional responses remain uneven across provinces (Renzetti & Dupont, 2020). Scholars note that governance systems often prioritise short-term crisis management rather than long-term resilience, leaving communities vulnerable to climate pressures (USGS, 2022).

Europe has promoted adaptive governance frameworks through policies such as the European Union's Water Framework Directive. According to García-Ruiz et al. (2020), Mediterranean countries such as Spain and Italy face recurrent droughts that expose weaknesses in institutional capacity, while northern European nations struggle with flood management under increasingly intense rainfall events (EEA, 2021). Scholars argue that while Europe has made significant progress in institutional adaptation, operationalising frameworks across diverse contexts remains difficult (European Commission, 2022). Institutional inertia and bureaucratic rigidity often hinder timely adaptation, leaving systems reactive rather than proactive (Stahl et al., 2020). The evidence

suggests that institutional reform is essential but requires sustained commitment and resources (OECD, 2021).

Globally, scholars emphasise that institutional challenges in water governance are critical constraints on resilience under climate stress. The IPCC (2023) highlighted the limitations of fragmented governance structures, while Pahl-Wostl (2017) emphasised the need for adaptive frameworks that prioritise flexibility, learning, and stakeholder participation. Cosens and Gunderson (2018) argued that opportunities lie in embracing multi-level governance, yet operationalising these frameworks within traditional systems remains difficult. The evidence suggests that institutional reform is essential but constrained by bureaucratic inertia, limited capacity, and competing priorities (UNEP, 2021).

Sub-Saharan Africa has struggled with institutional weaknesses in water governance. Van Koppen et al. (2020) noted that while many countries have adopted integrated water resource management (IWRM), implementation remains uneven due to limited capacity and resources. Muller (2018) argued that institutional fragmentation and lack of coordination undermine effective responses to climate variability. Opportunities exist in regional cooperation through initiatives such as the Southern African Development Community (SADC) water protocols, which promote shared governance of transboundary water resources (SADC, 2021).

Southern Africa has been particularly affected by institutional challenges in water governance. Countries such as South Africa have adopted IWRM frameworks and integrated climate adaptation into national water policies, yet scholars argue that implementation remains constrained by bureaucratic inertia and fragmented governance structures (Department of Water and Sanitation, 2020). The SADC water protocols have promoted regional cooperation, yet enforcement remains weak, with member states often prioritising national interests over collective resilience (SADC, 2021). Scholars note that institutional fragmentation undermines effective responses, leaving water governance systems reactive rather than proactive (UNEP, 2021).

Overall, scholars emphasise that institutional challenges in Sub-Saharan Africa are critical constraints on resilience under climate stress. Van Koppen et al. (2020) highlighted the uneven implementation of IWRM frameworks, while Muller (2018) emphasised the challenges of institutional fragmentation and lack of coordination. The evidence suggests that while policy

frameworks increasingly recognise climate risks, operationalising adaptive governance within bureaucratic systems remains a significant challenge (UNEP, 2021). Scholars agree that addressing institutional challenges is essential for building resilience in water systems under climate variability and change (IPCC, 2023).

Zimbabwe faces institutional challenges such as weak policy implementation, limited coordination among agencies, and inadequate resources (Nyabumbo and Rurinda, 2012). Mubaya and Mafongoya (2017) observed that while policies recognise climate risks, institutional capacity remains insufficient to address them effectively. Kurehwatira et al. (2025) argued that fragmented governance structures undermine adaptive responses, while Matamanda et al. (2025) emphasised that institutional weaknesses have left water governance systems reactive rather than proactive.

At the national level, Zimbabwe's water governance framework has sought to align with international principles such as Integrated Water Resource Management (IWRM) (Musingafi, 2013). Policies such as the National Water Policy acknowledge climate risks and promote sustainable management, yet Nyagumbo and Rurinda (2012) argued that, implementation remains weak due to limited institutional capacity and financial constraints. According to Matamanda et al. (2025), agencies responsible for water governance often operate in silos, leading to duplication of efforts and gaps in coordination. This fragmentation undermines the effectiveness of institutional responses, leaving water governance systems reactive rather than proactive. The evidence suggests that while policy frameworks recognise climate risks, operationalising adaptive governance remains a significant challenge.

Institutional fragmentation has also undermined coordination among agencies responsible for water governance in Zimbabwe.Vangani (2025) argued that, overlapping mandates and limited communication between institutions have created inefficiencies and gaps in service delivery. Mwadzingeni et al. (2022) emphasise that fragmented governance structures undermine effective responses, leaving water systems vulnerable to climate variability. The evidence suggests that institutional adaptation is critical but constrained by governance weaknesses and limited capacity.

Overall, scholars agree that institutional challenges in Zimbabwe are critical constraints on resilience under climate stress. Chanza (2017) highlighted the recognition of climate risks in national policies, yet implementation remains constrained by institutional capacity and resource

limitations. Makunde et al. (2018) emphasised the challenges of fragmented governance structures, while Matamanda et al. (2025) noted that, institutional weaknesses have left water governance systems reactive rather than proactive. The evidence suggests that while policies increasingly acknowledge climate risks, operationalising adaptive governance within bureaucratic systems remains a significant challenge.

2.5.2 Infrastructural and Socio-Economic Barriers to Sustainable Water Use

Globally, water infrastructure such as dams, reservoirs, and irrigation systems has been increasingly challenged by climate variability. Recent studies emphasise that climate change has reduced the reliability of traditional water infrastructure, requiring new approaches to design and management that incorporate resilience and flexibility (Kundzewicz et al., 2018; UNESCO, 2023). At the same time, socio-economic barriers such as poverty, inequality, and limited access to technology exacerbate vulnerability, restricting communities' ability to secure reliable water supplies (World Bank, 2022).

In Asia, infrastructural and socio-economic barriers are particularly evident in regions dependent on large-scale irrigation systems. India's reliance on canal irrigation has been undermined by declining river flows and erratic rainfall, while unsustainable groundwater extraction has intensified due to overuse and poor recharge (Shah, 2021). Smallholder farmers often lack access to modern technologies and financial resources, limiting their adaptive capacity (FAO, 2022). In China, large-scale projects such as the South–North Water Transfer Scheme have attempted to address scarcity, yet critics argue that these initiatives prioritise engineering solutions over equity and community resilience (Liu & Yang, 2019).

Latin America has also faced significant infrastructural and socio-economic barriers. Brazil's dependence on hydropower has been undermined by declining reservoir levels during droughts, exposing the vulnerability of energy systems to climate pressures (Marengo et al., 2020). Rural communities often lack access to reliable water supplies, with poverty and inequality constraining adaptation (World Bank, 2022). In Chile, irrigation infrastructure has struggled with declining river flows, while market-based water allocation systems have exacerbated inequalities under climate stress (Boelens & Vos, 2019).

North America presents contrasting experiences. In the western United States, declining snowpack has reduced natural reservoirs that feed dams and irrigation systems, undermining water reliability (Mote et al., 2019). Infrastructure designed around historical hydrological patterns is increasingly inadequate under climate stress (Udall & Overpeck, 2017). Socio-economic barriers also constrain adaptation, as poorer households often lack access to reliable water supplies (USGS, 2022). In Canada, flood management infrastructure has been challenged by more frequent and intense rainfall events, while socio-economic inequalities exacerbate vulnerability in marginalised communities (Renzetti & Dupont, 2020).

Europe has promoted climate-resilient infrastructure through policies such as the European Union's Water Framework Directive, yet challenges remain. Mediterranean countries such as Spain and Italy face declining reservoir levels and reduced irrigation reliability during prolonged droughts (García-Ruiz et al., 2020). Socio-economic barriers, including poverty and inequality, constrain adaptation in rural areas (EEA, 2021). Northern European nations have invested in flood management infrastructure, yet drainage systems are often overwhelmed by extreme rainfall events (Stahl et al., 2020). Sustainable water use is strongest when infrastructural adaptation is complemented by socio-economic resilience, but implementation remains uneven across contexts (European Commission, 2022).

The Sahel has faced significant infrastructural and socio-economic barriers to sustainable water use. Small dams and reservoirs, which are critical for storing water during dry spells, often fail due to reduced inflows and high evaporation rates (Lemoalle & Bader, 2020). Boreholes provide essential resilience, yet they are increasingly vulnerable to failure due to declining recharge and poor maintenance. Poverty and limited access to technology constrain adaptation, while weak institutional support leaves communities dependent on informal coping strategies (Serdeczny et al., 2019). Strengthening infrastructure resilience in the Sahel requires integration with policies that address socio-economic vulnerabilities.

Southern Africa has experienced declining dam levels and reduced irrigation reliability due to climate variability. Recent studies show that recurrent droughts and rising temperatures have undermined the performance of major reservoirs such as Kariba, reducing hydropower generation and agricultural irrigation (Mupotola & Manzungu, 2021). Infrastructure investments often fail to account for climate risks, while poor maintenance exacerbates vulnerabilities. At the same time,

socio-economic barriers such as poverty and limited access to technology constrain adaptation, leaving communities reliant on informal coping mechanisms (World Bank, 2022).

Zimbabwe's water infrastructure has been severely affected by climate variability. Chanza (2015) noted that dams and boreholes frequently fail during droughts, undermining both agricultural and domestic water supplies. Chanza (2017) argued that poor maintenance and limited investment exacerbate the vulnerability of infrastructure to climate pressures. Socio-economic barriers such as poverty, food insecurity, and limited access to resources further undermine adaptive responses. Chanza and Makombe (2025) emphasised that, while communities demonstrate resiliencence, infrastructural and socio-economic constraints limit their ability to cope with long-term climate pressures.

Water infrastructures such as small dams and reservoirs in Zimbabwe have also struggled to cope with climate variability, which led to water scarcity (Nyamwanza, 2018). Masimba et al. (2022) mentioned that, in Manyame catchment area inflows into small dams have declined sharply during drought years, while rising temperatures have accelerated evaporation rates. Nhapi (2015) argued that, poor maintenance and limited investment exacerbate these vulnerabilities, leaving infrastructure unable to provide reliable water supplies. Mwadzingeni et al. (2022) mentioned that, irrigation schemes dependent on these reservoirs often fail during prolonged dry spells, undermining agricultural productivity and household resilience. The evidence highlights the urgent need for climate-resilient investments in dam infrastructure to sustain water security under changing climatic conditions.

According to Mpofu and Mawanza (2026), socio-economic barriers further constrain sustainable water use in Zimbabwe. Chifamba (2020) explained that, poverty and food insecurity undermine the ability of households to invest in maintenance and adaptation. Chifamba (2020) further mentioned that, in Chipinga district, households often rely on informal coping mechanisms, such as fetching water from distant sources, when infrastructure fails. Mabeza (2016) argued that, these reactive measures provide short-term relief but undermine long-term resilience. Limited access to technology and financial resources constrains adaptation, leaving households vulnerable to climate pressures. The evidence suggests that socio-economic resilience is critical but requires integration with broader governance frameworks to be effective.

2.5.3 Opportunities for Adaptive Governance and Community Resilience

Globally, scholars emphasise that opportunities for adaptive governance lie in integrating institutional reform, infrastructure investment, and socio-economic resilience. Recent studies highlight that socio-economic resilience is critical for adaptive water governance, while community-based adaptation offers pathways to strengthen social-ecological systems under climate stress (Berkes, 2018; IPCC, 2023).

In Asia, opportunities for adaptive governance and community resilience are increasingly recognised in the integration of traditional knowledge with modern technologies. Farmers in India and Nepal continue to practise rainwater harvesting and small-scale irrigation, which remain vital coping strategies under climate stress. These practices can be strengthened through institutional support and investment in climate-resilient infrastructure (FAO, 2022). In Bangladesh, community-based adaptation has been promoted through initiatives that integrate local knowledge with scientific approaches, such as floating gardens and raised homesteads (Islam & Walkerden, 2017). Evidence suggests that resilience is enhanced when traditional practices are combined with modern innovations, supported by flexible governance frameworks.

Latin America has also demonstrated opportunities for adaptive governance and community resilience. Indigenous communities in the Andes have preserved traditional irrigation systems, such as terraces and canals, which enhance resilience under climate variability (Vuille et al., 2018). Brazil has promoted basin-level management strategies that emphasise stakeholder participation, while Mexico has attempted to strengthen institutional coordination through national adaptation plans (World Bank, 2022). Opportunities for resilience lie in integrating traditional knowledge with modern governance frameworks, supported by sustained investment in infrastructure and capacity building.

In North America, opportunities for adaptive governance and community resilience are evident in the integration of technological innovation with traditional knowledge. Indigenous communities have preserved water management practices, combining them with modern technologies to enhance resilience (Chief et al., 2020). In the western United States, water conservation practices such as drip irrigation and xeriscaping provide opportunities for resilience under recurrent droughts (Diffenbaugh et al., 2018). Scholars argue that collective action and institutional support

are essential for scaling up these practices and embedding them within governance frameworks (USGS, 2022).

Europe has promoted opportunities for adaptive governance through policies such as the European Union's Water Framework Directive, which emphasises integrated management, stakeholder participation, and climate resilience (European Commission, 2022). Mediterranean countries such as Spain and Italy have advanced basin-level management strategies, while northern European nations have invested in flood management infrastructure (EEA, 2021). Opportunities for resilience lie in combining institutional reform with infrastructure investment and community adaptation. Scholars emphasise that adaptive governance requires sustained commitment and resources, yet opportunities exist in promoting social-ecological resilience through community-based adaptation (Stahl et al., 2020).

Globally, scholars agree that opportunities for adaptive governance and community resilience are critical for building resilience under climate stress. The evidence suggests that resilience is strongest when institutional reform, infrastructure investment, and socio-economic adaptation are integrated into governance frameworks (OECD, 2021). Adaptive governance is essential for sustainable water management under climate variability and change, but opportunities must be supported by institutional commitment and sustained investment (UNEP, 2021).

Sub-Saharan Africa has significant opportunities to strengthen adaptive governance and community resilience. Regional cooperation, investment in climate-resilient infrastructure, and support for community adaptation are widely recognised as critical pathways. Recent studies argue that regional initiatives can enhance resilience, while integrating social and ecological dimensions into governance frameworks provides opportunities for long-term sustainability (Conway et al., 2021; Niang et al., 2022).

Overall, Sub-Saharan Africa has considerable opportunities for adaptive governance and community resilience. Regional initiatives highlight the potential for cooperation, while community-based adaptation underscores the importance of integrating social and ecological dimensions into governance. The evidence suggests that resilience can be strengthened through institutional reform, infrastructure investment, and community adaptation, but these opportunities must be supported by sustained commitment and resources (UNEP, 2021).

Zimbabwe has opportunities in strengthening local governance structures, investing in climate-resilient infrastructure, and promoting community-based adaptation (Chirisa et al., 2021). Brooke and Fenner (2023) noted that local governance reforms could enhance resilience, while Matamanda et al. (2025) argued that, community participation is essential for sustainable water governance. Mavhura (2017) emphasised that, opportunities exist in integrating traditional knowledge with scientific approaches, promoting community resilience, and diversifying livelihoods.

At the national level, opportunities for adaptive governance lie in reforming institutional frameworks to enhance coordination and capacity (Mubaya and Mafongoya, 2017). Mazuva rimwe (2020) argued that, Zimbabwe's National Water Policy provides a foundation for resilience, yet implementation remains weak. Opportunities exist in strengthening institutional capacity, promoting stakeholder participation, and integrating climate risks into governance frameworks. Nyamwanza (2018) noted that, reforms could enhance resilience by promoting flexibility, learning, and collective action. The evidence suggests that institutional reform is critical for building resilience, yet opportunities must be supported by sustained investment and political commitment.

Socio-economic opportunities further enhance resilience in Zimbabwe (Mathe, 2025). Nyahunda et al. (2020) argued that, diversifying livelihoods, promoting food security, and strengthening social networks can enhance community resilience under climate stress. In Chimanimani, households often rely on informal coping mechanisms, yet opportunities exist in promoting community-based adaptation and integrating traditional knowledge with scientific approaches (Mudavanhu et al., 2025). Mwadzingeni et al. (2022) noted that, socio-economic resilience is critical for adaptive governance, yet opportunities must be supported by institutional commitment and sustained investment. The evidence suggests that promoting socio-economic resilience provides critical opportunities for sustainable water governance under climate variability.

2.6 Knowledge Gaps and Challenges in Literature

Although climate change and water governance have been widely studied at global and regional levels, there is a clear gap when it comes to localised, district-level qualitative studies in rural areas such as Rushinga. Most existing research in Zimbabwe has concentrated on national policy frameworks, large river basins, or urban water systems, leaving smaller rural districts underrepresented. Studies that document rainfall variability, droughts, and institutional

weaknesses provide valuable insights, but they often rely on quantitative data or broad regional assessments that fail to capture the lived realities of households and communities in specific districts. This creates a practical gap: there is insufficient qualitative evidence that explores how climate pressures directly affect water availability and governance in Rushinga, where communities depend heavily on boreholes, small dams, and traditional water-sharing practices. Without such localised studies, the unique challenges faced by rural households including erratic rainfall, recurrent droughts, and weak institutional support, remain invisible in the broader literature. This study therefore intended to bridge that gap by providing district-level qualitative insights that highlight the everyday experiences of communities in Rushinga, ensuring that water governance research reflects rural realities and contributes to more adaptive and sustainable management strategies.

2.7 Summary

Chapter two has reviewed literature on climate change pressures, water resource management, and governance challenges with a focus on Rushinga District. It began with an introduction outlining the purpose and scope of the review, followed by conceptual and theoretical frameworks that defined climate change, variability, and water resource management, and situated the study within Adaptive Governance Theory. The chapter then examined literature based on the research objectives: first, assessing climate pressures such as rainfall variability, drought frequency, and hydrological shifts; second, exploring institutional, community, and infrastructural responses to climate variability; and third, identifying institutional, infrastructural, and socio-economic challenges alongside opportunities for adaptive governance. Finally, the review highlighted a key gap, the lack of district-level qualitative studies in Rushinga, which this study intended to bridge by providing localised insights into how rural communities experience and respond to water scarcity. This chapter created a foundation for the following chapters.

CHAPTER 3: RESEARCH METHODOLOGY

3.0 Introduction

This chapter provided the methodology that was used in executing the research on the interaction between climate change and water resource management within the Rushinga District in Zimbabwe. The research methodology has several components including the study area, research design, target population, sampling procedures, data collection instruments, data collection procedures, data analysis techniques and ethical principles. Each of these components was carefully explained to provide clarity and justification for the chosen methods, ensuring the validity and reliability of the findings.

3.1 Study Area

The research was undertaken in Ward 24, Rushinga District, which is a rural and semi-arid area in the northern region of the country of Zimbabwe. The ward was chosen because it is very susceptible to variations of climate, and it has always faced water scarcity, which was the appropriate choice to investigate the connection between climate change and water resource management. Recurrent droughts, unequal distribution of rain, and gradual increase in temperature had been described as the attributes of Ward 24 that had caused decreasing water supplies and decreasing reliance on the surface and groundwater sources. These were climatic conditions that were in line with greater regional trends recorded in Southern Africa where climate change has increasingly been linked to water stress and environmental degradation (Nyikadzino and Dube, 2023).

The figure below shows the study area map. The map was created using QGIS, using shape files which were downloaded from the internet.

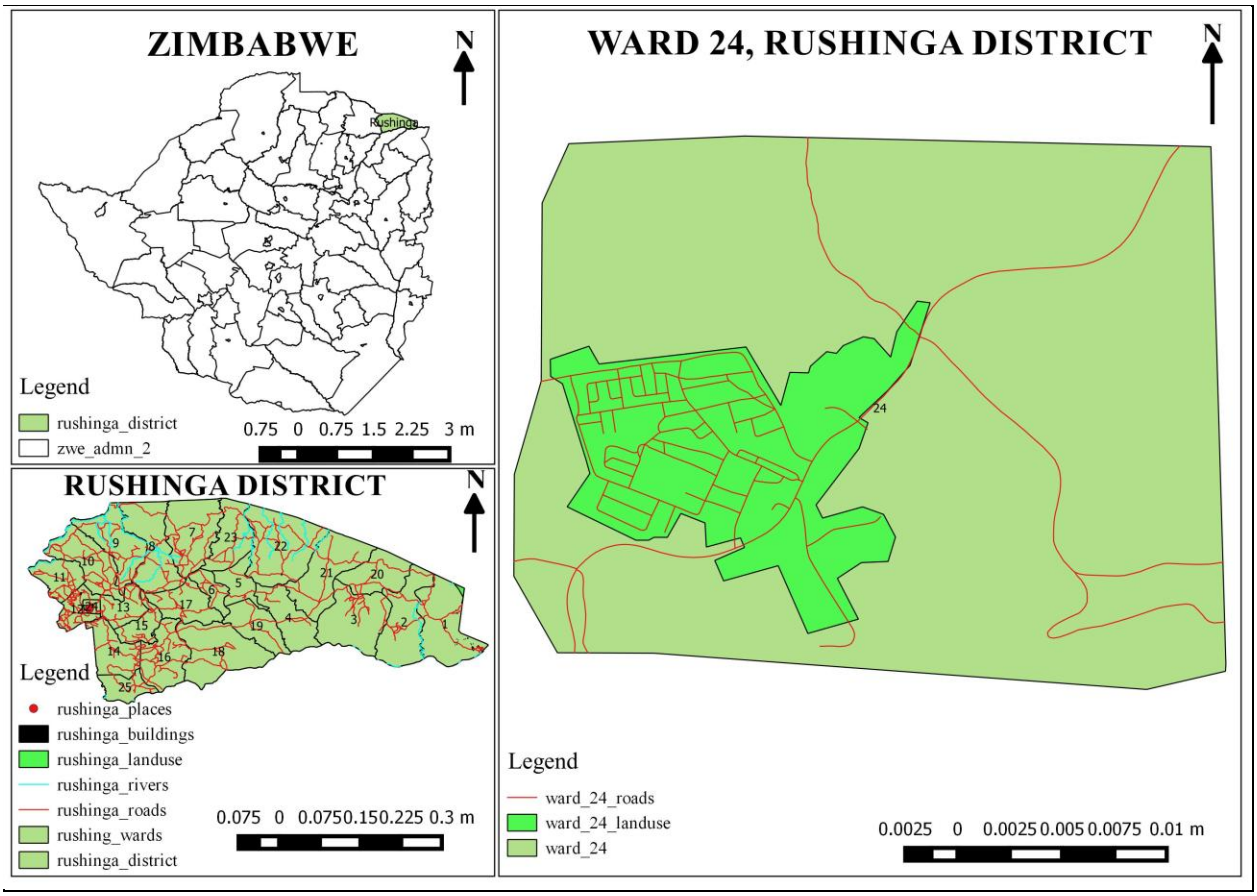


Figure 3.1 The research study area map (Ward 24, Rushinga District), (Source: Author).

3.2 Research Design

The research utilised phenomenology as the research design, a qualitative approach focused on exploring and understanding individuals' lived experiences and the essence of those experiences. Phenomenology digs deeper into the subjective meanings that people attach to their experiences, aiming to uncover the core of phenomena as perceived by individuals (Eberle, 2014). This design emphasises engagement with participants through methods such as in-depth interviews to gather rich, nuanced and contextual insights. Phenomenology has been widely utilised in recent qualitative research to explore the depth of lived experiences. For example, Adeniran and Tayo-Ladega (2024), critically explored the application of phenomenological research design across management, humanities, and social sciences, emphasising its ability to capture the essence of participants' realities. Similarly, Gupta and Zieske (2024), employed arts-based phenomenological

methods in Qualitative Psychology to investigate experiences such as joy, pregnancy loss, and erotic power, demonstrating how subjective meaning-making can be richly uncovered through this approach. Oluka (2025), outlined descriptive and interpretive phenomenological strategies in F1000Research, providing a methodological framework for researchers to generate nuanced insights in human experiences. These studies highlighted the versatility and rigor of phenomenology in uncovering the essence of phenomena as perceived by individuals.

Adeniran and Tayo-Ladega (2024) mentioned that, the strengths of phenomenology include its ability to capture in-depth and context-specific understandings of respondents' experiences and its focus on the subjective meanings that individuals attach to those experiences, while phenomenology has limitations, which include the potential for the researcher's bias and challenges in generalising findings of larger populations. Phenomenology has shaped this study by providing an overview for understanding the lived experiences, cultural interpretations and adaptive strategies of community members in response to climate change and water resource management. This design allowed the study to focus on the essence of the community's experiences, as it highlighted the depth and richness of their responses to climatic challenges and water resource management. Despite its limitations, this study was anchored on phenomenology because it enabled a thorough exploration of socio-cultural dimensions often overlooked in quantitative research. The insights gained were crucial for developing culturally sensitive and context-specific interventions to enhance the resilience and well-being of rural communities.

3.3 Target Population

The target population for this research involved community members in Ward 24, Rushinga District, who are directly impacted by climate change and water resource management. ZIMSTAT (2022), Ward 24 has approximately 1 003 households and a total population of 3 594. They consisted of rural families, traditional leaders, and local authority officials, the representatives of the Zimbabwe National Water Authority (ZINWA), agricultural extension agents, and the representatives of community water committees. These groups were targeted since they were directly or indirectly involved in water access, governance and environmental management. Having them on board meant that both community-level experiences and institutional views were included in the study and these were critical in grasping the complexity of water governance within a semi-arid setting. Ultimately, this group provides valuable insights into localised vulnerabilities

and coping mechanisms, offering a unique perspective that can inform context-specific and evidence-based interventions aimed at enhancing agricultural sustainability and community well-being.

3.4 Sampling Procedures

The sampling procedures for this research were designed to ensure a diverse and representative understanding of how different community members in Ward 24, Rushinga District, are impacted by climate change. The sample size has been deliberately kept manageable while representing the diversity of Ward 24, Rushinga District to reflect their unique vulnerabilities and adaptive strategies.

3.4.1 Sample Size

Coming up with the best sample size is important for ensuring that the study captures diverse perspectives while remaining feasible for data collection. This research employed the Rule of Thump method to justify the sample size

Rule of Thump Method for Size Section

According to Sharma et al. (2024), the Rule of Thumb method is widely used in research to determine sample size based on practical considerations rather than strict statistical calculations. In qualitative research, this approach emphasizes adequacy of information and thematic saturation rather than representativeness, with smaller but information-rich samples often being sufficient (Guest, Namey, & Chen, 2020). In quantitative research, the Rule of Thumb is applied to ensure statistical validity, where proportions of the population are used to estimate sample size. For example, Creswell and Creswell (2018) and Saunders et al. (2019) note that 1–3% of large populations may be sampled, while up to 10% is often applied for smaller populations below 100 to ensure adequate representation.

For this study, the Rule of Thumb was adopted within a qualitative framework because the aim is to capture diverse perspectives and reach thematic saturation rather than to generalize statistically. Given the population size of 1003 households in Ward 24, applying 2% of the total population resulted in a sample size of approximately 20 households. This choice balances methodological rigor with practical feasibility, ensuring that the sample is large enough to capture variation in experiences while remaining manageable for in-depth qualitative data collection.

Applying this method to Ward 24, Rushinga District's population of 1 003 households:

- 2% of 1 003= 20 participants

Table 3.1: Sample Size Distribution Plan

Category	**Organisation/Role**	**Number**	**Gender (M/F)**	**Notes**
Key Informants (8)	Local leaders (Village Head, Ward Councillor)	2	1M/1F	Government perspective
	NGO representatives (Water/Climate NGOs)	2	1M/1F	External support role
	Government ministries (AGRITEX, Water Dept.)	2	2M	Technical expertise
	Local Council (Water Department representatives)	1	1F	Local institutional role
	Community Elder	1	1M	Traditional/local knowledge
FGDs (12)	Group 1 (6 participants)	6	3M/3F	Mixed household perspectives
	Group 2 (6 participants)	6	3M/3F	Gendered water roles

The research has to engage a total of 20 participants, which has to be distributed equally across Ward 24, Rushinga District, to ensure a balanced representation of their unique experiences with climate change and water management. From the 20 participants selected, 8 were engaged as key informants, including local leaders, NGO representatives, government ministries such as AGRITEX, a representative from the local council's water department, and other influential community figures. The remaining 12 participants were divided into two focus group discussions (FGDs) of 6 participants each. This size was chosen in line with methodological recommendations that FGDs should comprise between 6–10 participants to ensure diversity of views while maintaining manageability (Krueger & Casey, 2015; Morgan, 1997; Guest, Namey, & Chen, 2020). This structured approach ensures comprehensive coverage of their specific experiences with climate change and water resource management. The sample size was justified based on the principle of data saturation, where no new themes or significant insights emerged with the inclusion of additional participants. This ensures that the sample was not only adequate for exploring the research questions but was also feasible given the logistical and geographical challenges in Ward 24, Rushing District. Engaging participants from different households, made the data collected comprehensive and it reflected the unique vulnerabilities and resilience mechanisms employed by different people.

3.4.2 Sampling Techniques

The study utilised purposive sampling and snowball sampling to ensure a better and more efficient selection of participants. Purposive sampling serves as the primary method, targeting participants with direct experiences of climate change and water and active involvement in water resource management to ensure the collection of relevant and insightful data (Rai and Thapa, 2015). Snowball sampling complements this by expanding the participant pool through recommendations from initial participants, which is especially helpful for identifying individuals with unique or less accessible experiences (Parker et al., 2019). Together, these methods created a well-rounded approach that balances practical considerations that were needed for diversity and inclusivity. This ensured that the collected data effectively reflected the varied realities of community members in the district.

3.5 Data Collection Instruments

The study used qualitative data collection instruments, which were notably chosen to help gather rich detailed and context-specific data on climate change and water resource management in the Rushinga District. The research used an interview guide, a focus group discussion guide, and an observation guide. Such tools were selected due to their efficacy in inquiring about intricate environmental and social phenomena in which human experience and the process of institutions are at the heart of the notion (Chikodzi et al., 2021; Maviza and Ahmed, 2021).

3.5.1 Interview Guide

According to Naz et al. (2022), an interview guide is a structured tool that contains pre-determined questions aimed at guiding interviews to gather relevant and focused data from participants. It was used during one-on-one interviews, allowing the researcher to engage deeply with participants and explored their personal narratives (Eppich et al., 2019). The guide ensured a consistency in data collection across respondents while allowing flexibility to probe into specific themes that emerge during the interviews. This approach uncovered detailed, firsthand accounts of how community members respond to climate change and manage water sources. The study interviewed 8 participants namely 1 Ward Extension Officer (locally known as *Mudhumeni* or *Murimisi*), 1 representative from 1 ZINWA, Ward Councilor, 2 representatives from Ward Water Committee, and 2 traditional leaders. The interview guide was structured into several thematic sections. The first theme collected information about demographic characteristics, which captured key background details of participants, followed by climate change pressure, which influences water resources. The third one was on how water resource management systems respond to climate variability and change. It focuses on institutional and policy responses to climate-induced water challenges, community-level adaptation and coping strategies in water use, and infrastructure performance under climate variability. This instrument covered information about the challenges and opportunities that shape adaptive and sustainable water governance under climate variability. It focuses on institutional and governance challenges in water management, infrastructural and socio-economic barriers to sustainable water use, and opportunities for adaptive governance and community resilience.

3.5.2 Focus Group Discussion Guide

A focus group discussion guide is a framework used to structure group discussions, ensuring they remain focused on the research objectives while encouraging the sharing of diverse perspectives (O. Nyumba et al., 2018). It is designed to explore shared experiences, community-level challenges and collective adaptation strategies to a certain problem (Uddin and Anjuman, 2013). During the research, the FGD guide was used to guide discussions, ensuring that the conversation remains focused on key themes while encouraging open dialogue among participants. This instrument captured group dynamics, contrasting viewpoints and community consensus, providing insights into how community members collaborated and adapted collectively towards climate change and water resource management. The study conducted 2 FGDs with each group having 6 partcipants. The FGD guide was organized into the following themes, Understanding of climate change, and it dives into other themes that were mentioned in the interview guide.

3.5.3 Observation Guide

This study used an observation guide to document non-verbal and contextual information, such as visible impacts of climate change and water management practices in Ward 24. This instrument was used during site visits to capture details that did not emerged during FGDs and interviews, such as physical signs of climate change on both farms and in households and to see water resource management that were being employed in Ward 24. The observation guide complements the verbal data by adding a visual and environmental dimension to the study, ensuring a holistic understanding of the people's realities. During the field visits the environment was also observed following the structure. The checklist was structured into the following themes: Environmental Indicators which tracks water availability, vegetation changes, and visible climate changes, Household and Community Indicators which assessed housing conditions, water resource management, and communal resource-sharing.

3.6 Piloting the Instruments

According to Green (2020), piloting is the process of testing the study instruments on a small subset of respondents to ensure their suitability, clarity, and effectiveness in collecting the intended data. This crucial step helps to identify potential weaknesses in the instruments, allowing for revisions before the main data collection begins.

In this study, the piloting process included testing the interview guide and the focus group discussion (FGD) guide with a small group of 5 respondents who shared same characteristics with the targeted population. The observation guide was also tested when the researcher was visiting the gatekeepers such as Ward Councilor and the Headman (Muchinda waMambo). These participants were selected from Ward 24, Rushinga District to reflect the diversity of the actual study population. Piloting the interview guide helped assess whether the questions are clear, relevant and capable of eliciting detailed responses. Similarly, the FGD guide was tested to ensure that it promotes productive group discussions without diverging from key themes.

The feedback gathered during piloting was used to refine the instruments by addressing any issues such as unclear questions, or gaps in content. For example, respondents found that certain questions in the interview guide were too broad, and they were rephrased to improve focus and specificity. This process made the instruments be aligned with the study objectives and effectively collected better and reliable data during the main research. In addition, piloting built the researcher's familiarity with using the instruments and it contributed to a smoother and more consistent during data collection process.

3.7 Validity of the Instruments

Validity is the extent to which an instrument measures what it is intended to measure and ensures the reliability of the outcomes (Clark and Watson, 2019). In this study, the validity of the instruments was established through several measures to ensure the data gathered was both accurate and relevant. Face validity was addressed by piloting the instruments, as discussed in Section 3.6. The piloting process helped to identify and address any ambiguities; it ensured that the questions were clear and understandable to respondents. Triangulation also contributed to the validity of the study. By using multiple instruments namely interview guide, focus group discussion guide and observation guide, helped the research to crosscheck findings from different sources to ensure consistency and accuracy. Content validity was ensured by aligning the questions in the interview guide, focus group discussion guide and observation guide with the study's objectives. This approach strengthened the credibility of the data and helped to minimize biases.

3.8 Reliability of the Instruments

Reliability refers to the consistency and dependability of an instrument in measuring what it is intended to measure across different contexts and over time (Mohamad, 2015). In this research,

measures were taken to ensure the reliability of the interview guide, focus group discussion (FGD) guide and observation guide guide. Consistency was maintained by using standardised guides for all data collection activities. The interview and FGD guides included clearly defined questions and prompts, which ensured that each participant or group was asked the same core questions in a consistent manner. The observation guide included pre-determined categories for documenting contextual details; it made the researcher consistently record relevant environmental and non-verbal data. Additionally, researcher training was undertaken to enhance reliability. The researcher practiced the use of the instruments during the piloting phase (as outlined in 3.6), and the researcher gained familiarity and minimised inconsistencies during the main data collection process. This step helped to reduce variability in how the instruments were applied. The reliability of the instruments was also strengthened through peer review; the institution supervisor reviewed all guides, which made them to be clear, concise and capable of producing consistent results. This measure ensured the instruments to be dependable and suitable for the study's objectives.

3.9 Data Collection Procedure

This study followed a systematic data collection process that ensured efficient and thorough gathering of data relevant to the research objectives. Before data gathering begins, the researcher obtained ethical approval from Bindura University of Science Education and Rushinga District Development Coordinator. There was the preparatory phase which also involved piloting the instruments, as outlined in Section 3.6, where tools were refined and ensure their clarity and effectiveness. Participants were recruited using the sampling techniques discussed in Section 3.4.2 this included purposive sampling to targeted individuals with direct experiences of climate change and water resource management, snowball sampling which identified additional participants through recommendations. This recruitment process ensured a diverse representation of participants from Rushinga District.

The data gathering involved three activities guided by the instruments explained in Sections 3.5.1 to 3.5.3 One-on-one interviews were conducted using the interview guide, which explored participants' personal narratives on their experiences, coping mechanisms and water resource management strategies. Focus group discussions were facilitated using the FGD guide to capture shared challenges, community-level responses and collective adaptations. These discussions were

moderated to ensure active participation and focused dialogue. The observation guide was also used at the same time.

All gathered data was securely managed to protect participant confidentiality. Interviews and FGDs were recorded with respondents' consent and transcribed for analysis; while observed data was systematically recorded in an organized format. Post-collection, the researcher reviewed and cleaned the data to ensure accuracy and completeness, addressing any ambiguities through follow-up conversations. This structured procedure ensured an ethical data collection, efficient and comprehensive, that enabled the study to generate meaningful insights into the effects of climate change and water resource management strategies employed by community members in Rushinga District.

3.10 Data Analysis Methods

Thematic analysis was used as the main data analysis technique in the conducted study. This process was deemed to be suitable since it allowed the systematization of the discovery, tabulation, and meaning of qualitative data collected through interviews, focus groups, and documents (Terry et al., 2017). The thematic analysis had several steps, which included familiarisation with data, code the raw data, and the similar codes category, as well as the establishment of more general themes that targeted the main issues of discussion (Riger and Sigurvinsdottir, 2016). Such topics were water scarcity, effects of climate variability, institutional issues and community adaptation measures.

This analysis started with familiarising, where the researcher reviewed transcripts of interviews, focus group discussions, and document review notes. Audio recordings of the interviews and FGDs were replayed to capture the nuances such as tone, emphasis and context that was not evident in written transcripts. This thematic analysis reflected the depth and richness of respondents' narratives. Coding used, which involved assigning labels to key phrases of the data that present specific ideas, experiences, or patterns. Both inductive coding (themes emerging in the data) and deductive coding (themes guided by research objectives) were employed. The identified codes were grouped into broader categories during the theme development phase. Themes were refined to ensure that they are coherent, distinct and representative of the data. This will be done in chapter 4.

Therefore, a narrative synthesis integrated the themes with the research objectives and existing literature, this offered a coherent account of the findings. Triangulation further ensured the credibility and reliability of the analysis by cross-referencing data from interviews, FGDs, and observation guide, including audios. The integrative approach enhanced the depth and robustness of the findings, ensuring that the data collected comprehensively addresses the research objectives.

3.11 Limitations of the Study

Conducting interviews and FGDs in Ward 24 was not an easy task, to gather important participants such as Village heads and others to participant. However, the District Development Coordinator from The Ministry of Local Governance and Public Works helped by going with the researcher to their meetings with Chiefs, Headmen, and Villages. This helped a lot to meet all important participants in the ward in a short period. These meetings have many government institutions, NGOs, Ward Councillor, and the researcher met with the local people since these meeting were mostly held at local growth points and at community halls.

Interviewing government officals was a bit difficult, because most of the time they are busy with the officer duties. The researcher managed to interview them by utulising their launch time and printed interview guides with spaces to write answers during their spare time. This made the researcher to succeed in data collection.

3.12 Ethical Principles

Ethical principles refer to the fundamental guidelines and standards that ensured that the research was conducted in a way that respects the rights, dignity, and well-being of respondents (Khan, 2024). These principles provide a framework for maintaining the integrity of the study process and fostering trust between the researcher and respondents. One key principle is informed consent, which ensures that participants voluntarily agree to participant in the research after being fully informed about its objectives, methods, potential risks and benefits. In this research, informed consent were obtained through signed forms and participants were aware of their right to withdraw at any stage without any repercussions. Another critical principle is confidentiality and anonymity. The study protected participants' identities by anonymising all collected data, including interview transcripts and focus group recordings. Personal identifiers did not appeared in any reports or publications, and all data was securely stored to prevent unauthorized access.

Cultural sensitivity guided the research process. Respecting the customs, traditions and social norms of the community in Ward 24, Rushinga District, made participants to feel valued and understood. Finally, the study adhered to the principles of integrity and ethical compliance as outlined by institutional and professional guidelines. Ethical approval were sought from relevant review boards such as Bindura University and all research activities complied with these standards to safeguard the credibility of the research. Adhering to these ethical principles, the study ensured that all research activities were carried out responsibly and respectfully, protecting the rights and dignity of participants while maintaining the highest standards of academic integrity.

3.13 Chapter Summary

This chapter outlined the research methodology, which helped in carrying out the research regarding the relationship between climate change and water management in Ward 24, Rushinga district, Zimbabwe. It was a thorough description of the qualitative research design. The data collection tools, sampling, and data analysis methods that were used in the chapter described analytical methods that were used in order to collate results in a systematic and rigorous manner. The reliability and validity concerns were addressed regarding such strategies as triangulation and member checking that helped to increase the credibility of the research. Lastly, the chapter also outlined the main limitations such as the generalisability of the results or sample, data constraints, and possible bias as well as discussed the steps the authors used to enhance the overall quality of the research.

CHAPTER 4: DATA PRESENTATION, INTERPRETATION, AND DISCUSSION

4.1 Introduction

Chapter 4 presents the data, interpretation, and discussion of the research findings on climate change and water governance in Ward 24, Rushinga District. The chapter begins with the response rate and demographic characteristics of participants, followed by the presentation of findings. After the data is presented, the chapter provides an interpretation and discussion of the results, and it concludes with a summary of the key insights.

4.2 Response Rate

The study targeted a total of 20 participants. All 20 participants who were selected took part in the study, resulting in a 100% response rate. This strong engagement ensured that the data collected was comprehensive and reflected diverse perspectives from households, local leaders, government representatives, and NGOs.

Table 4.1 Response Rate

Data category	**Targeted Participants**	**Actual Participants**	**Response Rate (%)**
Key informants	8	8	100
Focus Group Discussions	12	12	100
Total	20	20	100

[Source: Primary data]

The 100% response rate minimised the risk of bias and strengthened the validity of the conclusions drawn from participant responses. It also demonstrated strong community willingness to engage with the study, reflecting the importance of water governance and climate change issues in Ward 24.

4.3 Demographic Characteristics

This section presents the demographic profile of the study participants, offering insights into gender distribution, age groups, and years of experience in water-related issues. These characteristics reflect the social structure of Ward 24, highlighting the diversity of perspectives that shape community engagement with climate change and water governance.

Table 4.2: Demographic Profile of Participants

Variable	Category	Frequency (n=20)	Percentage (%)
Gender	Male	12	60
	Female	8	40
Age Group	20-29 years	7	35
	30-39 years	2	10
	40-49 years	4	20
	50-59 years	3	15
	60+ years	4	20
Years of Experience	Less than 10	6	30
	10-20	7	35
	Over 20	7	35

[Source: Primary Data]

The gender distribution shows that male participants (60%) slightly outnumbered female participants (40%). This reflects the involvement of both men and women in water governance, with women's participation particularly visible in focus group discussions, where they play a central role in household water management. Age distribution indicates a balanced mix, with participants ranging from their 30s to over 60 years. The inclusion of elders and traditional leaders provided long-term perspectives on climate variability, while younger participants contributed

insights into current household coping strategies. Years of experience in water-related issues varied, with 35% of participants having over 20 years of involvement, offering historical depth, while others with less than 10 years brought contemporary experiences. This diversity enriched the findings by combining long-term observations with current realities.

4.4 Climate Change Pressures on Water Availability and Reliability

This section presents findings on how climate change pressures, particularly droughts, affect water availability and reliability in Ward 24. The themes are derived from qualitative analysis, combining insights from interviews, focus group discussions (FGDs), and field observations to provide a comprehensive understanding of participants' lived experiences.

4.4.1 Drought Frequency and Its Impact on Water Reliability

This theme focuses on the increasing frequency of droughts and their impacts on water reliability in Ward 24. Respondents consistently described droughts as more common and prolonged than in the past, with rainfall patterns becoming highly irregular.

During interviews, participants shared their lived experiences. A community elder mentioned that:

> *"...Rains are no longer steady. They come late, sometimes too heavy, and sometimes not at all. Droughts dry boreholes and rivers, forcing people to walk long distances or buy water."*

The Ward Councilor supported this view, he said that:

> *"...Droughts reduce water in dams and boreholes, and families are left without water for irrigation or livestock."*

NGO representatives echoed similar concerns, noting that:

> *"...Droughts dry boreholes and rivers, forcing people to walk long distances or buy water. It also affects livestock and crops."*

Focus group participants collectively emphasized the same challenges, mentioning that:

> *"...Boreholes are the main source, but when they dry, people fetch from rivers, buy from lorries, or harvest rainwater."*

Field observations confirmed these accounts, showing boreholes under pressure from increased demand, with long queues forming during dry spells.



Photograph 4.1: Villagers queuing for water at a local borehole in Ward 24, Rushing District (Source: Primary Data)

The findings reveal that droughts now occur with greater frequency, transforming water scarcity from an occasional challenge into a recurring crisis. This undermines the reliability of boreholes and wells, forcing households into coping mechanisms such as walking long distances, rationing water, or purchasing from vendors. The impacts are multidimensional: physical hardship in fetching water, economic strain from buying water, and agricultural losses that deepen vulnerability.

The evidence shows that drought frequency has reshaped everyday life in Ward 24. Water collection has become a time-consuming and exhausting activity, particularly for women and children. Farming households face reduced yields and livestock losses, which directly threaten food security. The community's reliance on boreholes highlights both their importance and their fragility under climate stress. Overall, drought frequency has become the defining pressure undermining water reliability, with cascading effects on livelihoods, household wellbeing, and community resilience.

4.4.2 Shifts in Surface and Groundwater Resources Under Climate Stress

This theme focuses on how climate stress has altered the reliability of both surface and groundwater resources in Ward 24. Respondents explained that rivers, dams, and boreholes have all been affected, with water sources becoming less dependable due to changing rainfall patterns and prolonged dry spells.

During interviews, participants shared their lived experiences. An AGRITEX officer explained that:

> *"…Rivers that used to flow throughout the year now dry up quickly, and dams no longer hold enough water for irrigation or household use."*

A council representative added:

> *"…Boreholes are breaking down more often because of overuse, and sometimes they produce very little water during drought periods."*

A community elder emphasised the same issue, noting that:

> *"…Surface water is disappearing faster, and boreholes are under pressure from too many people depending on them. Communities are forced to rely on shallow wells, which are unsafe."*

Focus group participants collectively highlighted these challenges, mentioning that:

> *"…We used to fetch water from rivers and dams, but now they dry early. Boreholes are the only option, but they are crowded, and sometimes we wait for hours to get water."*

Field visits confirmed these accounts. Boreholes were visibly under pressure, with long queues of women and children waiting to collect water. This was captured in photographs showing boreholes crowded during peak hours, reflecting the community's heavy reliance on groundwater as surface sources diminish.

The findings reveal that climate stress has caused significant shifts in both surface and groundwater resources. Surface water sources such as rivers and dams have become unreliable, drying earlier in the season and failing to sustain irrigation or domestic needs. Groundwater sources, particularly

boreholes, have become the primary lifeline but are increasingly strained by overuse, mechanical breakdowns, and reduced yields during droughts.

Communities that once relied on multiple sources are now forced to depend almost entirely on boreholes, creating pressure points that lead to long waiting times, conflicts, and reliance on unsafe alternatives like shallow wells. The shift from diverse water sources to a single, fragile system highlights the vulnerability of Ward 24 to climate stress and underscores the urgent need for sustainable water management strategies.

4.5 Responses of Water Resource Management Systems to Climate Variability and Change

This section presents findings on how water resource management systems in Ward 24 respond to climate variability and change. The themes highlight institutional and policy measures, community-level coping strategies, and infrastructure performance under climate stress.

4.5.1 Institutional and Policy Responses to Climate-Induced Water Challenges

This theme focuses on the role of institutions and policies in addressing water challenges caused by climate variability. Respondents highlighted both the strengths and weaknesses of government, local authorities, and NGOs in managing water resources.

During interviews, participants shared their perspectives. A council representative explained that:

> *"…Government has drilled boreholes in some areas, but they are not enough, and maintenance is slow when they break down."*

An AGRITEX officer added:

> *"…Policies encourage water harvesting and conservation, but implementation is weak. Communities are left to find their own solutions."*

NGO representatives emphasised their role, noting that:

> *"…We have supported communities with solar-powered boreholes and water tanks, but without strong government support, these efforts remain limited."*

Focus group participants collectively mentioned that:

"…We see boreholes being drilled, but they are few, and sometimes they break down for months. People end up relying on unsafe wells or buying water."

Field visits confirmed these accounts. A solar-powered borehole was observed in Ward 24, showing NGO and government efforts to provide sustainable water solutions. However, queues at the borehole highlighted that demand far exceeds supply, and maintenance remains a challenge.

Photograph 4.2 (a) and (b) Solar-powered boreholes in Ward 24, Rushing District (Source: Primary Data)



The findings reveal that institutional and policy responses exist but remain inadequate in scale and sustainability. Government interventions such as borehole drilling provide relief but are limited in coverage and often undermined by poor maintenance. Policies promoting water harvesting and conservation are present but weakly enforced, leaving communities vulnerable. NGOs play a critical role by introducing innovations like solar-powered boreholes and water tanks, yet these efforts cannot fully substitute for systemic government action.

Overall, institutional responses show a fragmented approach: interventions are reactive rather than proactive, and coordination between government and NGOs is limited. This leaves communities exposed to recurring water insecurity, with coping strategies filling the gaps where policy and institutional support fall short.

4.5.2 Community-Level Adaptation and Coping Strategies in Water Use

This theme focuses on how communities in Ward 24 adapt and cope with water challenges brought by climate variability. Respondents described a range of strategies, from relying on alternative sources to adopting new practices that help households survive during droughts and water shortages.

During interviews, participants shared their lived experiences. A community elder explained that:

> *"…When boreholes dry, families walk long distances to fetch water from rivers or shallow wells, even though the water is not always safe."*

A council representative added:

> *"…People now depend on water vendors who deliver using lorries, but the prices are high, and poor families cannot afford it."*

An NGO officer highlighted community innovation, noting that:

> *"…We encourage households to harvest rainwater and store it in drums and small containers, which helps during dry spells."*

Focus group participants collectively emphasised these coping mechanisms, mentioning that:

> *"…We carry buckets on our heads, children fetch water in small containers, and sometimes we share water from neighbours' tanks. It is not easy, but we try to survive."*

Field visits confirmed these accounts. A lorry with a water tank was observed delivering water to households, showing reliance on vendors. Women were seen carrying buckets on their heads, while children queued at boreholes. At some homesteads, drums and small 2-litre bottles were used for water storage, reflecting rainwater harvesting and household-level coping strategies.



Photograph 4.3 (a) and (b) a lorry carrying water and small containers (Source: Primary Source)

The findings reveal that communities have developed multiple coping strategies to deal with unreliable water supply. These include walking long distances, purchasing water from vendors, harvesting rainwater, and storing it in drums or small containers. While these strategies provide short-term relief, they also highlight inequalities: wealthier households can afford vendor water and tanks, while poorer families rely on unsafe sources or small-scale storage. Community-level adaptation demonstrates resilience but also exposes vulnerability. Coping mechanisms are reactive and labor-intensive, often placing a heavy burden on women and children. The reliance on vendors and informal storage systems underscores the absence of sustainable, institutional solutions. Overall, these strategies show how households in Ward 24 navigate water insecurity daily, balancing survival with limited resources.

4.5.3 Infrastructure Performance Under Climate Variability

This theme focuses on how water infrastructure in Ward 24 performs under conditions of climate variability. Respondents highlighted the strengths and weaknesses of boreholes, wells, and other water systems, noting how they cope with increased demand and climate stress.

During interviews, participants shared their perspectives. A council representative explained that:

> *"…Boreholes are the main infrastructure we rely on, but they break down often, and repairs take too long. During droughts, they cannot meet the demand."*

An AGRITEX officer added:

> *"…Dams and wells are no longer reliable. Boreholes are better, but they are overstretched, and sometimes the water yield is very low."*

A community elder emphasised the same issue, noting that:

> *"…Solar-powered boreholes help, but they are few. People still queue for hours, and when they break down, the whole community suffers."*

Focus group participants collectively mentioned that:

> *"…We wait in long queues at boreholes, sometimes from morning until afternoon. Wells are drying, and dams are empty, so boreholes are the only option."*

Field visits confirmed these accounts. A solar-powered borehole was observed in Ward 24, showing efforts to improve infrastructure through renewable energy. However, long queues of women and children highlighted that demand far exceeds supply, and the infrastructure struggles to cope with climate variability.

The findings reveal that water infrastructure in Ward 24 is under severe strain from climate variability. Boreholes, while central to water access, are overstretched, prone to breakdowns, and unable to meet rising demand during droughts. Solar-powered boreholes represent innovation and adaptation, but their limited number and high usage show that infrastructure solutions remain inadequate.

This situation demonstrates that infrastructure performance is reactive rather than resilient. Communities depend on boreholes as the only reliable system, yet their fragility under climate stress exposes households to prolonged water insecurity. The reliance on a single type of infrastructure highlights both progress and vulnerability: while solar-powered boreholes improve access, they cannot fully address the systemic challenges posed by climate variability.

4.6 Challenges and Opportunities for Strengthening Adaptive and Sustainable Water Governance

This section presents findings on the institutional, infrastructural, and socio-economic barriers that hinder sustainable water use, as well as opportunities for adaptive governance and community resilience.

4.6.1 Institutional and Governance Challenges in Water Management

This theme focuses on the institutional and governance challenges that affect water management in Ward 24. Respondents emphasised weak coordination, poor maintenance systems, and limited policy enforcement as major barriers to sustainable water governance.

During interviews, participants shared their perspectives. A council representative explained that:

> *"…Government drills boreholes, but when they break down, repairs take months. Communities are left without water, and there is no clear accountability."*

An AGRITEX officer added:

> *"…Policies exist on water conservation, but they are not enforced. People continue to misuse water, and institutions lack the capacity to monitor."*

A water committee member specifically aired out the challenge of governance structures, noting that:

> *"…We were trained to repair the Bush Boreholes with hand pumps, but now most boreholes are solar-powered. When these break down, we do not have the skills or spare parts to fix them. This leaves the community stranded for weeks, waiting for outside help."*

A community elder highlighted governance gaps, saying:

> *"…We are told to conserve water, but there is no support. Leaders talk about solutions, but on the ground, nothing changes."*

Focus group participants collectively mentioned that:

"…We see boreholes breaking down, and no one comes quickly to fix them. Sometimes we contribute money ourselves to repair, but the committees cannot handle solar systems. Waiting for the government takes too long, so we end up improvising."

Field visits confirmed these accounts. Water tanks were observed in some areas, provided through institutional support, but many households relied on improvised storage such as drums and small 2-litre bottles. This reflected both the presence of external interventions and the gaps in governance, where communities had to create their own coping systems due to weak institutional follow-through.

The findings reveal that institutional and governance challenges are central to water insecurity in Ward 24. While Zimbabwe has established water point committees responsible for managing and restoring boreholes, especially the traditional Bush Boreholes, these structures are struggling to cope with newer technologies such as solar-powered boreholes. Committees lack the technical skills and resources to maintain solar systems, leaving communities vulnerable to prolonged breakdowns.

Governance challenges also include slow response times, weak accountability, and poor coordination between government departments, local councils, and NGOs. Policies on water conservation and harvesting exist but are not enforced, leaving households to improvise. Communities often resort to self-financing repairs or relying on NGOs, which highlights resilience but also exposes institutional failure.

Overall, water management in Ward 24 is undermined by fragmented governance: committees are under-resourced, policies are weakly implemented, and institutional support is reactive rather than proactive. Strengthening committee training, ensuring timely maintenance, and aligning institutional structures with modern technologies are essential steps toward adaptive and sustainable water governance.

4.6.2 Infrastructural and Socio-Economic Barriers to Sustainable Water Use

This theme focuses on the infrastructural limitations and socio-economic barriers that hinder sustainable water use in Ward 24. Respondents highlighted the strain on boreholes, the lack of alternative infrastructure, and the economic inequalities that shape access to water.

During interviews, participants shared their perspectives. A council representative explained that:

> *"…Most boreholes are overstretched. They were designed for fewer households, but now entire villages depend on them. The infrastructure cannot cope with the demand."*

An AGRITEX officer added:

> *"…Dams and wells are drying, and boreholes are breaking down. Without investment in new infrastructure, communities will continue to struggle."*

A community elder emphasised the socio-economic dimension, noting that:

> *"…Water vendors charge high prices. Poor families cannot afford to buy water, so they walk long distances or use unsafe sources."*

A teacher in the community aired out the burden on households, saying:

> *"…Children spend hours queuing at boreholes instead of being in school. Women carry heavy buckets on their heads every day. This shows how water scarcity affects education and health."*

Focus group participants collectively mentioned that:

> *"…We share boreholes with many villages, and sometimes we wait the whole day. Those with money buy water from lorries, but the rest of us suffer."*

Field visits confirmed these accounts. Women were observed carrying buckets on their heads, while children queued at boreholes for hours. These images captured the heavy burden placed on households, particularly women and children, who bear the responsibility of water collection. The reliance on manual labour and informal storage systems highlights the infrastructural gaps and socio-economic inequalities in water access.



Photograph 4.4 (a) women carrying buckets and (b) children at a borehole in Ward 24, Rushinga District (Source: Primary Data)

The findings reveal that infrastructural and socio-economic barriers are deeply intertwined in shaping water insecurity in Ward 24. Boreholes, though central to water access, are overstretched and prone to breakdowns. The absence of reliable dams and wells leaves communities dependent on fragile infrastructure. At the same time, socio-economic inequalities determine who can afford vendor water and who must rely on unsafe or labour-intensive sources.

These barriers create a cycle of vulnerability: women and children spend hours fetching water, reducing time for education and income-generating activities; poor households face health risks from unsafe sources; and communities remain locked into survival strategies rather than sustainable solutions. The evidence shows that without investment in resilient infrastructure and equitable access mechanisms, socio-economic disparities will continue to deepen water insecurity in Ward 24.

4.6.3 Opportunities for Strengthening Adaptive and Sustainable Water Governance

This theme focuses on the opportunities available to strengthen water governance in Ward 24, despite the challenges posed by climate variability. Respondents highlighted the potential of institutional reforms, community participation, and technological innovations to improve water security.

During interviews, participants shared their perspectives. A council representative explained that:

"…If government strengthens water point committees and trains them on solar borehole maintenance, communities will be able to respond faster to breakdowns."

An AGRITEX officer added:

"…There is an opportunity in promoting rainwater harvesting and household storage. If supported with tanks and training, families can reduce dependence on boreholes."

An NGO officer emphasised innovation, noting that:

"…Solar-powered boreholes and water tanks are sustainable solutions. If scaled up and maintained properly, they can transform water access in rural areas."

A community elder expressed optimism, saying:

"…We already have committees and people willing to work. If institutions support us with resources and training, we can manage our water better."

Focus group participants collectively mentioned that:

"…We see opportunities in rainwater harvesting, solar boreholes, and stronger committees. If these are expanded, we will not suffer as much during droughts."

Field visits confirmed these accounts. Water tanks and a solar-powered borehole were observed in Ward 24, showing practical opportunities for sustainable water governance. These infrastructures, though limited in number, demonstrate how renewable energy and household-level storage can strengthen resilience if scaled up and supported by institutions.



Photograph 4.5 Water storage tanks in ward 24, Rushinga [Source: Primary Data]

The findings reveal that Ward 24 has significant opportunities to strengthen adaptive and sustainable water governance. Institutional reforms, particularly the training of water point committees, could bridge the gap between traditional Bush Borehole maintenance and the newer solar-powered systems. This would ensure that communities are not left stranded when modern infrastructure fails. At the household level, rainwater harvesting and storage in tanks or drums present a practical way to diversify water sources, reducing pressure on boreholes and enhancing resilience during droughts. Technological innovations such as solar-powered boreholes demonstrate that sustainable solutions are possible, but they require scaling up and consistent maintenance to be effective.

Community participation remains a critical opportunity, as respondents expressed willingness to take responsibility if provided with adequate support. The presence of committees and household-level initiatives shows that the foundation for adaptive governance already exists. What is needed is stronger institutional backing, investment in infrastructure, and coordination between the government and NGOs to transform these opportunities into long-term resilience. In this way, Ward 24 can move from reactive coping strategies to proactive water governance that secures livelihoods and strengthens community resilience against climate variability.

4.7 Discussion

This section discusses the research findings in relation to the broader literature on climate-induced water stress and governance, highlighting similarities and differences with existing studies. It examines possible explanations for the differences, such as geography, institutional capacity, and methodological focus. The discussion is structured according to the study objectives.

4.7.1 Climate Change Pressures on Water Availability and Reliability

The findings from Ward 24 revealed that recurrent droughts have severely reduced the reliability of both surface and groundwater resources. Rivers and small dams have become increasingly seasonal, drying up during prolonged dry spells, while boreholes are overstretched and prone to breakdowns. Communities reported that water shortages force them to queue for long hours, improvise storage in drums and bottles, and rely on unsafe sources when boreholes fail. These experiences highlight the heavy burden placed on households, particularly women and children, who are responsible for water collection.

These outcomes align with global literature that emphasises how recurrent droughts undermine hydrological reliability. The IPCC (2023) and World Meteorological Organisation (2022) noted that drought frequency has increased globally, reducing both surface and groundwater supplies. Similar to Gleeson et al. (2020), Ward 24 households face declining groundwater recharge and borehole failures, reflecting broader sustainability challenges. Regional studies in Sub-Saharan Africa (Conway et al., 2021; Archer et al., 2017) also emphasised that recurrent droughts reduce dam inflows and groundwater yields, leaving communities dependent on emergency sources. Locally, Manyakaidze (2023) and Nyamwanza (2018) observed that Zimbabwe's recurrent droughts have exposed weaknesses in water governance and infrastructure, consistent with the Ward 24 findings.

However, differences emerge in the specific local context. While broader literature often highlights large-scale hydrological shifts such as declining reservoir inflows (Masimba et al., 2022; Mupotola & Manzungu, 2021), Ward 24 findings emphasise the reliance on boreholes as the primary water source. The mismatch between traditional Bush Boreholes and newer solar-powered systems is a distinctive challenge not widely discussed in global studies. This reflects how technological transitions in rural Zimbabwe create unique governance and capacity gaps. Thus, Ward 24's experiences both confirm global patterns of recurrent drought and water scarcity, while also

contributing new insights into the localised pressures of borehole dependence and institutional adaptation.

4.7.2 Responses of Water Resource Management Systems to Climate Variability and Change

The findings from Ward 24 revealed that water resource management systems are struggling to respond effectively to climate variability. Institutions such as local councils and ZINWA were reported to lack resources and technical capacity, leaving boreholes poorly maintained and communities dependent on informal coping mechanisms. Water point committees exist but are limited in scope, as they were trained to repair Bush Boreholes but lack skills for solar-powered systems. Communities have therefore relied on improvisation, pooling money for repairs, and adopting household-level strategies such as rainwater harvesting and storage in drums. Infrastructure such as dams and rivers has become increasingly unreliable, while solar-powered boreholes, though promising, remain few and poorly integrated into governance frameworks.

These outcomes align with global literature that emphasises the challenges of institutional adaptation under climate stress. UNESCO (2023) and Pahl-Wostl (2017) highlighted the importance of adaptive governance frameworks, yet noted that bureaucratic inertia and fragmentation often undermine effective responses. Ward 24 findings resonate with Van Koppen et al. (2020) and Muller (2018), who observed that Sub-Saharan institutions often fail to anticipate long-term risks, focusing instead on short-term crisis management. Locally, Mazivarimwe (2020) and Chanza (2017) noted that Zimbabwe's National Water Policy recognises climate risks but suffers from weak implementation and poor resource allocation, consistent with the institutional weaknesses observed in Ward 24.

Community-level adaptation in Ward 24, such as rainwater harvesting, household storage, and collective action through committees, reflects broader patterns identified by Adger et al. (2003) and Berkes (2017), who emphasised the importance of traditional knowledge and social networks in resilience building. Similar practices have been documented in southern Africa, where households rely on rainwater harvesting and small-scale irrigation to cope with variability (Mpandeli et al., 2020; Mupotola & Manzungu, 2021). However, Ward 24 findings highlight a distinctive reliance on boreholes as the primary water source, with vendor water creating socio-

economic inequalities. This differs from other regions where irrigation schemes or cisterns play a larger role.

Infrastructure performance in Ward 24 also mirrors broader challenges. Boreholes frequently fail, dams and rivers dry up, and solar-powered systems remain underutilised due to governance gaps. These findings align with Kundzewicz et al. (2018) and UNESCO (2023), who argued that traditional infrastructure is increasingly inadequate under climate stress. Locally, Duker et al. (2020) and Masimba et al. (2022) highlighted that Zimbabwe's dams and boreholes often fail during droughts due to poor maintenance and limited investment, consistent with Ward 24's experiences. The distinctive difference lies in the mismatch between old and new technologies: committees trained for Bush Boreholes cannot manage solar systems, creating a governance gap not widely emphasised in broader literature.

Overall, Ward 24's findings confirm global and regional patterns of institutional weakness, community resilience, and infrastructural fragility under climate variability, while also contributing unique insights into the localised challenges of borehole dependence and technological transitions.

4.7.3 Challenges and Opportunities for Strengthening Adaptive and Sustainable Water Governance

The findings from Ward 24 revealed that adaptive and sustainable water governance is constrained by institutional weaknesses, infrastructural fragility, and socio-economic inequalities, yet opportunities exist for strengthening resilience. Local governance structures such as water point committees are active but limited in scope, as they lack training for solar-powered boreholes and depend on external support for repairs. Institutional fragmentation and resource shortages leave communities vulnerable, forcing reliance on informal coping mechanisms such as water-sharing and vendor purchases. Infrastructure such as dams and rivers has become unreliable, while boreholes frequently fail under pressure. Despite these challenges, opportunities were identified in community resilience, NGO support, and the potential integration of traditional knowledge with modern technologies.

These findings align with global literature that highlights institutional and governance challenges under climate stress. The IPCC (2023) and Pahl-Wostl (2017) emphasised that fragmented

governance structures and bureaucratic inertia hinder adaptive responses, consistent with Ward 24's experiences of weak institutional support. Similar to Van Koppen et al. (2020) and Muller (2018), Ward 24 illustrates how Sub-Saharan institutions often remain reactive, focusing on short-term crisis management rather than long-term resilience. Locally, Nyagumbo and Rurinda (2012) and Matamanda et al. (2025) noted that Zimbabwe's water governance systems recognise climate risks but suffer from poor implementation and limited coordination, reflecting the institutional weaknesses observed in Ward 24.

Infrastructural and socio-economic barriers in Ward 24 also mirror broader patterns. Boreholes and dams frequently fail, while poverty and inequality constrain households' ability to adapt. These outcomes resonate with Kundzewicz et al. (2018) and UNESCO (2023), who argued that traditional infrastructure is increasingly inadequate under climate variability. The socio-economic burdens observed in Ward 24, particularly the reliance on vendor water and the disproportionate burden on women and children, align with findings from the World Bank (2022) and Chanza (2017), who highlighted how poverty and limited resources undermine resilience in Zimbabwe. However, Ward 24 findings add nuance by showing how vendor reliance creates new inequalities, with poorer households excluded from safe water access, a dimension less emphasised in broader studies.

Opportunities for strengthening adaptive governance and resilience in Ward 24 reflect global and regional insights. Community-level adaptation, such as rainwater harvesting and collective action, aligns with Berkes (2018) and Nyahunda et al. (2020), who emphasised the importance of social networks and traditional knowledge in resilience building. NGO support and the potential integration of solar technologies highlight pathways for adaptive governance, consistent with Chirisa et al. (2021) and Mavhura (2017), who argued that combining traditional practices with modern innovations enhances sustainability. However, Ward 24 findings underscore that these opportunities require stronger institutional commitment and investment, echoing UNEP (2021) and Mubaya & Mafongoya (2017), who noted that adaptive governance frameworks remain constrained without political will and resources.

Overall, Ward 24's findings confirm global and regional patterns of institutional weakness, infrastructural fragility, and socio-economic vulnerability under climate stress, while also contributing unique insights into the localized challenges of borehole dependence, vendor

inequalities, and technological transitions. At the same time, they highlight opportunities for resilience through community adaptation, NGO support, and the integration of traditional knowledge with modern governance frameworks.

4.8 Summary

Chapter 4 presented and discussed the research findings in relation to the broader literature. It highlighted how climate change pressures on water availability and reliability have intensified recurrent droughts, reducing both surface and groundwater resources. The chapter examined responses of water resource management systems to climate variability and change, showing institutional weaknesses, community-level coping strategies, and infrastructural fragility. It further analyzed infrastructural and socio-economic barriers to sustainable water use, emphasizing poverty, inequality, and the burden on women and children. Finally, it explored challenges and opportunities for strengthening adaptive and sustainable water governance, noting governance fragmentation but also opportunities in community resilience, NGO support, and integrating traditional knowledge with modern approaches. Overall, the chapter demonstrated both the alignment of Ward 24 findings with global and regional literature, and the unique local insights into borehole dependence, vendor inequalities, and technological transitions.

CHAPTER 5: SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

5.1 Introduction

Based on the study's findings presented in Chapter 4, this chapter provides the conclusions and recommendations of the research. Each objective is revisited, with conclusions drawn from the evidence, and recommendations proposed to address the challenges identified. The chapter highlights the lived experiences of communities under climate-induced water stress in Ward 24, Rushinga District, and offers practical suggestions for NGOs, government, and policymakers to strengthen resilience and adaptive water governance.

5.2 Summary

This section summarises the key outcomes of the research based on the study objectives.

5.2.1 Climate Change Pressures on Water Availability and Reliability

The study revealed that communities in Ward 24, Rushinga District are heavily affected by recurrent droughts, which have reduced the reliability of rivers, dams, and boreholes. Water scarcity has placed a disproportionate burden on women and children, who spend long hours queuing or walking long distances to collect water. Coping strategies such as rainwater harvesting, household storage, and reliance on unsafe sources were common, reflecting the community's struggle to secure reliable water under climate stress.

5.2.2 Responses of Water Resource Management Systems to Climate Variability and Change

Institutional responses were found to be weak and fragmented. Borehole committees exist but lack adequate training, particularly for solar-powered systems, leaving communities dependent on improvisation and external support from NGOs. Infrastructure such as dams and boreholes frequently failed, while rivers dried up during prolonged droughts. Communities responded through collective action, rainwater harvesting, and informal water-sharing, but these measures remained reactive and insufficient to address long-term climate pressures.

5.2.3 Challenges and Opportunities for Strengthening Adaptive and Sustainable Water Governance

The study highlighted that governance fragmentation, poor maintenance, and socio-economic inequalities undermine resilience in Ward 24. However, opportunities exist in strengthening local

governance structures, promoting community collaboration, and integrating traditional knowledge with modern technologies. NGO support and investment in climate-resilient infrastructure were identified as critical pathways to enhance adaptive capacity. Sustained institutional commitment and resource allocation remain essential for building long-term resilience.

5.3 Conclusion

This section presents the conclusions of the study based on the research objectives.

5.3.1 Climate Change Pressures on Water Availability and Reliability

The study concluded that communities in Ward 24, Rushinga District, are highly vulnerable to recurrent droughts, which have reduced the reliability of rivers, dams, and boreholes. Water scarcity has become the most pressing challenge, with women and children bearing the greatest burden of water collection. Coping strategies such as rainwater harvesting, household storage, and reliance on unsafe sources highlight both resilience and vulnerability, showing that while communities adapt, their responses remain reactive and insufficient to ensure long-term water security.

5.3.2 Responses of Water Resource Management Systems to Climate Variability and Change

The research found that institutional responses are constrained by weak capacity, fragmented governance, and poor infrastructure maintenance. Borehole committees exist but lack adequate training for solar-powered systems, leaving communities dependent on improvisation and NGO support. Infrastructure such as dams and boreholes frequently fail, while rivers dry up during prolonged droughts. Overall, water resource management systems remain reactive, focusing on short-term coping rather than proactive adaptation, which undermines resilience under climate stress.

5.3.3 Challenges and Opportunities for Strengthening Adaptive and Sustainable Water Governance

The study concluded that governance fragmentation, socio-economic inequalities, and limited resources undermine adaptive water governance in Ward 24. However, opportunities exist in strengthening local governance structures, promoting community collaboration, and integrating traditional knowledge with modern technologies. NGO support and investment in climate-resilient

infrastructure provide pathways to enhance resilience, but these opportunities require sustained institutional commitment and political will.

5.4 Recommendations

Based on the study's findings and conclusions, the following five key recommendations are proposed to strengthen resilience and adaptive water governance in Ward 24, Rushinga District:

- Revitalise water infrastructure by rehabilitating dams, repairing boreholes, and expanding rainwater harvesting systems to ensure reliable water supply during prolonged droughts.
- Strengthen institutional capacity through training of water point committees, particularly in managing solar-powered boreholes, and improving coordination among local councils, ZINWA, and NGOs.
- Promote community-based adaptation by supporting collective initiatives such as small dam rehabilitation, water-sharing arrangements, and knowledge exchange on drought-resistant crops.
- Integrate traditional knowledge with modern technologies, combining indigenous drought prediction methods with scientific forecasting to enhance preparedness and resilience.
- Ensure sustained investment and political commitment, with government and NGOs providing affordable loans, subsidies, and targeted support to vulnerable households to reduce socio-economic inequalities in water access.

5.5 Further Research Implications

The study was conducted in Ward 24, Rushinga District, and while it provided valuable insights into climate-induced water stress and governance challenges, further research is necessary to broaden and deepen understanding. Future studies should explore similar dynamics in other wards and districts to capture variations in institutional capacity, socio-economic conditions, and community-level adaptation strategies. Comparative research across different agro-ecological zones would help identify context-specific vulnerabilities and resilience pathways. There is also a need for longitudinal studies that track the long-term effectiveness of adaptive strategies such as borehole committees, rainwater harvesting, and integration of solar-powered systems. Additionally, research focusing on gendered impacts and youth participation in water governance

could provide critical insights for inclusive policy design. Finally, examining the role of NGOs and government interventions across multiple districts would strengthen evidence for scaling up sustainable water governance frameworks nationwide.

References

Adeniran, A. O., & Tayo-Ladega, O. (2024). Critical analysis of phenomenological research design in a qualitative research method. Management Analytics and Social Insights, 1(2), 186–196.

Adger, W. N., Arnell, N. W., & Tompkins, E. L. (2003). Successful adaptation to climate change across scales. Global Environmental Change, 15(2), 77–86.

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

Agarwal, A., & Narain, S. (2019). Traditional rainwater harvesting in India: Lessons for climate resilience. Centre for Science and Environment.

Archer, E. R. M., Landman, W. A., Tadross, M. A., Malherbe, J., Weepener, H., Maluleke, P., & Marumbwa, F. M. (2017). Understanding the evolution of drought risk in southern Africa: Moving the science forward. International Journal of Climatology, 37(Suppl 1), 179–188.

Archer, E., et al. (2017). Drought impacts, vulnerability and resilience in southern Africa. Climate and Development, 9(5), 383–398.

Armstrong, C. (2021). Key methods used in qualitative document analysis. OSF Preprints, 1(9), 1-9.

Asian Development Bank (ADB). (2021). Water governance and climate resilience in Southeast Asia. ADB Report.

Berkes, F. (2017). Environmental governance for the Anthropocene? Social-ecological systems, resilience, and adaptive management. Sustainability, 9(7), 1232.

Berkes, F. (2017). Environmental governance for the Anthropocene? Social-ecological systems, resilience, and adaptive management. Global Environmental Change, 52, 1–6.

Berkes, F. (2018). Sacred ecology: Traditional ecological knowledge and resource management (4th ed.). Routledge.

Bhaga, T. D., Dube, T., Shekede, M. D., & Shoko, C. (2020). Impacts of climate variability and drought on surface water resources in Sub-Saharan Africa using remote sensing: A review. Remote Sensing, 12(24), 4184.

Bindura University of Science Education (BUSE). (2018). Community water infrastructure and climate resilience in Rushinga District, Zimbabwe. Bindura University Press.

Boelens, R., & Vos, J. (2019). The politics of water governance in Latin America. Water International, 44(2), 166–182.

Boisier, J. P., Rondanelli, R., Garreaud, R., & Muñoz, F. (2018). Anthropogenic and natural contributions to the Southeast Pacific drought (2010–2018). Climate Dynamics, 52(1–2), 109–125.

Bolch, T., Shea, J. M., & Immerzeel, W. W. (2019). Glaciers and climate change in the Himalayas. Nature Reviews Earth & Environment, 1(1), 44–58.

Bowora, J. (2018). Local water governance and drought resilience in Chiredzi District, Zimbabwe. Water Policy, 20(6), 1125–1138.

Brooke, A., & Fenner, R. A. (2023). Improving urban water management and building water supply resilience in the city of Harare, Zimbabwe–a systems view. Civil Engineering and Environmental Systems, 40(4), 195-228.

Calow, R., MacDonald, A., Nicol, A., & Robins, N. (2010). Groundwater security and drought in Africa: Linking availability, access, and demand. Ground Water, 48(2), 246–256.

Calow, R., MacDonald, A., Nicol, A., Robins, N., & Kebede, S. (2010). Groundwater security and drought in Africa: Linking science and policy. Hydrogeology Journal, 18(1), 211–220.

CANZIM, 2025. Climate variability and water resources in Zimbabwe: Adaptation strategies for rural communities. Harare: CANZIM Publications.

Chaffin, B. C., Gosnell, H., & Cosens, B. A. (2014). A decade of adaptive governance scholarship: Synthesis and future directions. Ecology and Society, 19(3), 56.

Chanza, N. (2015). Climate variability and water infrastructure performance in Zimbabwe: Evidence from Muzarabani District. Physics and Chemistry of the Earth, 89–90, 58–66.

Chanza, N. (2017). Climate change and water governance in Zimbabwe: Institutional challenges and resource constraints. Journal of Environmental Management, 203, 1036–1045.

Chanza, N., & Makombe, T. (2025). Socio-economic constraints and community resilience under climate stress in Zimbabwe. Climate and Development, 17(2), 210–223.

Chanza, N., & Musarurwa, C. (2020). Climate change and variability in southern Africa: Impacts and adaptation strategies. Climate and Development, 12(5), 389–402.

Chazovachii, B. (2012). The impact of small-scale irrigation schemes on rural livelihoods: The case of Panganai Irrigation Scheme in Bikita District, Zimbabwe. Russian Journal of Agricultural and Socio-Economic Sciences, 11(11), 13–21.

Chief, K., Meadow, A., & Whyte, K. (2020). Indigenous climate adaptation in the United States: Combining traditional knowledge and science. Climatic Change, 156(1), 1–17.

Chifamba, E. (2013). Community coping strategies for climate variability in Zimbabwe: Reactive versus proactive approaches. Journal of Sustainable Development in Africa, 15(4), 1–12.

Chifamba, E. (2020). Strategies for coping with household food insecurity in Chipinga District of Zimbabwe (Doctoral dissertation).

Chigavazira, S., & Zandamela, J. (2021). Institutional challenges in water governance under recurrent droughts: Evidence from Mudzi District, Zimbabwe. International Journal of Water Resources Development, 37(5), 789–804.

Chikodzi, D. (2020). Spatial-temporal analysis of drought occurrences in Zimbabwe. Theoretical and Applied Climatology, 141(3–4), 1181–1195.

Chikodzi, D., Nhapi, I. and Mutowo, G. (2021) *Water governance and climate variability in semi-arid regions of Zimbabwe*. Harare: University of Zimbabwe Press.

Chirisa, I., Gumbo, T., Gundu-Jakarasi, V. N., Zhakata, W., Karakadzai, T., Dipura, R., & Moyo, T. (2021). Interrogating climate adaptation financing in Zimbabwe: Proposed direction. Sustainability, 13(12), 6517.

Chirisa, I., Nyamadzawo, L., & Chanza, N. (2016). Climate change, water resources and rural livelihoods in semi-arid Zimbabwe. Journal of Sustainable Development in Africa, 18(4), 45–60.

Ciampittiello, F., Marchetto, A. & Boggero, G., 2024. Global impacts of climate change on water resources: Hydrological shifts and resource management. Environmental Science Review, 32(2), pp.115–134.

CILSS. (2021). Regional drought control and climate adaptation strategies in the Sahel. Permanent Interstate Committee for Drought Control in the Sahel.

Clark, L. A., & Watson, D. (2019). Constructing validity: New developments in creating objective measuring instruments. Psychological assessment, 31(12), 1412.

Climate Newsroom, 2025. Southern Africa climate and water resource stress: Current trends and policy interventions. [online] Available at: https://www.climatenewsroom.org/southern-africa-water [Accessed 13 February 2026].

CONAGUA. (2021). National adaptation plan for water management in Mexico. Comisión Nacional del Agua.

CONAGUA. (2021). Reporte de sequías en México. Comisión Nacional del Agua.

CONAGUA. (2021). Reporte de sequías y acuíferos en México. Comisión Nacional del Agua.

Conway, D., van Garderen, E. A., Deryng, D., Dorling, S., Krueger, T., Landman, W., ... & Ringler, C. (2021). Climate and southern Africa's water-energy-food nexus: Opportunities for resilience. Nature Climate Change, 11(8), 651–659.

Conway, D., Vincent, K., & Archer, E. (2021). Climate risks and water governance in southern Africa. Climate and Development, 13(7), 593–606.

Conway, D., Vincent, K., & Archer, E. (2021). Climate risks to water security in southern Africa. Climate and Development, 13(6), 509–522.

Corada-Fernandez, C., Lara-Martín, P. A., & González-Mazo, E. (2017). Urban flooding and drainage challenges in northern Europe. Science of the Total Environment, 601–602, 1632–1640.

Cosens, B. A., & Gunderson, L. H. (2018). Practical panarchy for adaptive water governance: Linking law to social-ecological resilience. Ecology and Society, 23(2), 34.

Cosens, B., & Gunderson, L. (2018). Adaptive governance of water resources. Environmental Science & Policy, 87, 1–4.

Cosens, B., Gunderson, L., & Craig, R. K. (2017). Water governance in the United States: Fragmentation and adaptation. Ecology and Society, 22(4), 31.

Cosgrove, W J. & Loucks D P. Water management: Current and future challenges and research directions. Water resources research 51 (6), 4823-4839.

Creswell, J. W., & Creswell, J. D. (2018). Research Design: Qualitative, Quantitative, and Mixed Methods Approaches. Sage.

de Souza Dias, B. F., Paim, M., & Silva, R. (2018). Hydropower generation under rainfall variability in Brazil. Renewable Energy, 122, 29–41.

Department of Water and Sanitation (South Africa). (2020). National Water and Sanitation Master Plan. Pretoria: Government of South Africa.

Diffenbaugh, N. S., Swain, D. L., & Touma, D. (2018). Anthropogenic warming has increased drought risk in California. Proceedings of the National Academy of Sciences, 115(13), 3931–3936.

Dinku, T., Funk, C., & Maidment, R. (2022). Rainfall variability and water security in Sub-Saharan Africa. Environmental Research Letters, 17(4), 045012.

Duker, A. A., Ndlovu, M., & Nyoni, B. (2020). Rainfall variability and rural water supply reliability in Zimbabwe. Physics and Chemistry of the Earth, 115, 102812.

Eberle, T. S. (2014). Phenomenology as a research method. The SAGE handbook of qualitative data analysis, 184-202.

Economic Community of West African States (ECOWAS). (2021). Water protocols and climate resilience in West Africa. ECOWAS Secretariat.

ECOWAS. (2021). Water protocols and climate resilience in West Africa. Economic Community of West African States.

Eppich, W. J., Gormley, G. J., & Teunissen, P. W. (2019). In-depth interviews. In Healthcare simulation research: A practical guide (pp. 85-91). Cham: Springer International Publishing.

European Commission. (2000). Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for Community action in the field of water policy. Official Journal of the European Communities, L327, 1–73.

European Commission. (2022). EU drought and water management report. Brussels: European Union.

European Commission. (2022). EU Water Framework Directive: Climate adaptation progress. Brussels: European Union.

European Environment Agency (EEA). (2021). Climate change impacts and adaptation in Europe. EEA Report.

Famiglietti, J. S. (2014). The global groundwater crisis. Nature Climate Change, 4(11), 945–948.

Famiglietti, J. S. (2014). The global groundwater crisis. Nature Climate Change, 4(11), 945–948.

Famiglietti, J. S., Lo, M., Ho, S. L., Bethune, J., Anderson, K. J., Syed, T. H., ... & Rodell, M. (2015). Satellites measure recent rates of groundwater depletion in California’s Central Valley. Science, 331(6020), 1400–1402.

FAO. (2022). Drought risk management in Asia. Food and Agriculture Organisation of the United Nations.

Federal Ministry of Water Resources (Nigeria). (2020). National Water Policy of Nigeria. Abuja: Government of Nigeria.

Folke, C., Hahn, T., Olsson, P., & Norberg, J. (2005). Adaptive governance of social-ecological systems. Annual Review of Environment and Resources, 30(1), 441–473.

Food and Agriculture Organisation (FAO). (2022). Community-based water adaptation in Africa. FAO Report.

Food and Agriculture Organisation (FAO). (2022). Infrastructure resilience and climate adaptation in Africa. FAO Report.

Food and Agriculture Organisation (FAO). (2022). Infrastructure resilience and climate adaptation in Africa. FAO Report.

Food and Agriculture Organisation (FAO). (2022). Managing water under climate stress in Asia. FAO Report.

Food and Agriculture Organisation (FAO). (2022). Water and climate resilience in East Africa. FAO Report.

Food and Agriculture Organisation (FAO). (2022). Water governance and climate resilience in Asia. FAO Report.

García-Ruiz, J. M., López-Moreno, J. I., Vicente-Serrano, S. M., Lasanta, T., & Beguería, S. (2020). Mediterranean droughts: Trends, impacts, and adaptation. Water, 12(2), 321.

Gaye, C. B., & Tindimugaya, C. (2019). Groundwater and climate change in Africa. Environmental Research Letters, 14(9), 095004.

Gaye, C. B., & Tindimugaya, C. (2019). Groundwater and climate change in Africa.

Gleeson, T., Befus, K. M., Jasechko, S., Luijendijk, E., & Cuthbert, M. O. (2020). Groundwater depletion and climate change. Nature Climate Change, 10(6), 517–529.

Gleeson, T., et al. (2020). Groundwater depletion and climate change. Nature Climate Change, 10(6), 517–529.

Global Water Partnership. (2019). Integrated water resources management: A new way forward. Stockholm: GWP.

Gona, P., Moyo, T., & Dube, T. (2022). Groundwater reliance and sustainability challenges in semi-arid Zimbabwe. Sustainability, 14(12), 7456.

Government of India. (2020). National Water Policy of India. Ministry of Jal Shakti.

Green, R. (2020). Pilot testing: Why and how we trial. In The Routledge handbook of second language acquisition and language testing (pp. 115-124). Routledge.

Guest, G., Namey, E., & Chen, M. (2020). A simple method for assessing and reporting thematic saturation in qualitative research. PLoS ONE, 15(5), e0232076.

Gupta, N., & Zieske, S. (2024). Arts-based phenomenological research: Theory and praxis. Qualitative Psychology, 11(2), 123–135.

Hadebe, S. B. H., & Dube, L. T. (2024). Climate variability over Southern Africa and implications for water resources: A review. Advances in Hydrology and Meteorology. Iris Publishers.

Hadebe, S. T., & Dube, T. (2024). Drought impacts on water security in southern Africa: Emerging challenges and adaptation pathways. Water Policy, 26(1), 45–61.

Hayashi, Y., Yamamoto, T., & Matsumoto, K. (2018). Rainfall variability and rice production in Southeast Asia. Agricultural Systems, 165, 1–12.

Heerspink, B., Brienen, R., & Phillips, O. (2020). Amazon basin rainfall variability and hydrological impacts. Global Change Biology, 26(7), 3829–3842.

Huitema, D., Mostert, E., Egas, W., Moellenkamp, S., Pahl-Wostl, C., & Yalcin, R. (2009). Adaptive water governance: Assessing the institutional prescriptions of adaptive (co-)management from a governance perspective and defining a research agenda. Ecology and Society, 14(1), 26.

Immerzeel, W. W., Lutz, A. F., & Droogers, P. (2020). Climate change impacts on the hydrology of Asian river basins. Hydrology and Earth System Sciences, 24(2), 602–620.

Intergovernmental Panel on Climate Change (IPCC). (2022). Climate Change 2022: Impacts, adaptation, and vulnerability. Cambridge University Press.

Intergovernmental Panel on Climate Change (IPCC). (2023). Climate Change 2023: Impacts, Adaptation, and Vulnerability. Cambridge University Press.

IPCC, 2023. Climate Change 2023: Impacts, Adaptation and Vulnerability. Cambridge: Cambridge University Press.

IPCC. (2023). Climate Change 2023: Impacts, Adaptation, and Vulnerability. Cambridge University Press.

Islam, R., & Walkerden, G. (2017). Community resilience to climate change in Bangladesh. Climate and Development, 9(1), 55–68.

Kahinda, J. M., Rockström, J., Taigbenu, A. E., & Dimes, J. (2018). Rainwater harvesting to enhance water productivity of rain-fed agriculture in Sub-Saharan Africa. Physics and Chemistry of the Earth, 33(8), 106–111.

Kennedy-Asser, A. T., James, R. A., & Richard, G. (2026). Do climate models agree on seasonal rainfall patterns and future changes over Southern Africa? Theoretical and Applied Climatology.

Khan, N. (2024). Research ethics in education and training. Ethical frameworks in special education: a guide for researchers, 2, 79.

Krueger, R. A., & Casey, M. A. (2015). Focus groups: A practical guide for applied research (5th ed.). Sage Publications.

Kundzewicz, Z. W., et al. (2018). Flood risk and climate change: Global and regional perspectives. Hydrological Sciences Journal, 63(1), 1–25.

Kundzewicz, Z. W., Krysanova, V., Benestad, R. E., Hov, Ø., Piniewski, M., & Otto, I. M. (2018). Uncertainty in climate change impacts on water resources. Environmental Science & Policy, 79, 1-8.

Kundzewicz, Z. W., Krysanova, V., Benestad, R. E., Hov, Ø., Piniewski, M., & Otto, I. M. (2018). Uncertainty in climate change impacts on water resources. Environmental Science & Policy, 79, 1–8.

Kurehwatira, T., Nyamwanza, A., & Mpala, T. (2025). Fragmented governance and climate resilience in Zimbabwe's water sector. Climate and Development, 17(2), 210–223.

Kusena, W., Manzungu, E., & Machiridza, R. (2017). Local water governance and community resilience in Gweru, Zimbabwe. Water Policy, 19(6), 1125–1138.

Lemoalle, J., & Bader, J. C. (2020). Water resources and climate change in the Sahel. Ambio, 49(1), 15–24.

Liu, J., & Yang, H. (2019). Water governance in China: Challenges and opportunities. Water International, 44(2), 147–165.

Liu, J., Zhuang, D., Luo, D., & Xiao, X. (2021). Drought impacts on water resources in northern China. Journal of Hydrology, 598, 126–134.

Loo, Y. Y., Billa, L., & Singh, A. (2015). Effect of climate change on seasonal monsoon in Asia. Climate Research, 64(1), 1–14.

Love, D., Uhlenbrook, S., Twomlow, S., & van der Zaag, P. (2010). Changing hydroclimatic and discharge patterns in the northern Limpopo basin, Zimbabwe. Hydrology and Earth System Sciences, 14(5), 941–951.

Love, D., Uhlenbrook, S., Twomlow, S., & van der Zaag, P. (2010). Climate variability and water resources in southern Africa. Physics and Chemistry of the Earth, 35(13–14), 779–786.

Lundqvist, J., & Falkenmark, M. (2010). Adaptation to rainfall variability and unpredictability: New dimensions of old challenges and opportunities. International Journal of Water Resources Development, 26(4), 595-612.

Mabeza, C. M. (2016). Marrying water and soil: Adaptation to climate by a smallholder farmer in Zvishavane, rural Zimbabwe.

MacDonald, A. M., Bonsor, H. C., Dochartaigh, B. É. Ó., & Taylor, R. G. (2012). Quantitative maps of groundwater resources in Africa. Environmental Research Letters, 7(2), 024009.

MacDonald, A. M., Bonsor, H. C., Dochartaigh, B. É. Ó., & Taylor, R. G. (2012). Quantitative maps of groundwater resources in Africa. Environmental Research Letters, 7(2), 024009.

Mahdi, S., Kumar, R., & Singh, S. (2015). Monsoon variability and agricultural productivity in India. International Journal of Climatology, 35(9), 2151–2163.

Makaya, E., Nhamo, G., & Mpandeli, S. (2020). Drought and water governance in southern Africa. Water SA, 46(4), 635–644.

Makaya, E., Rohse, M., Day, R., Vogel, C., Mehta, L., McEwen, L., ... & Van Loon, A. F. (2020). Water governance challenges in rural South Africa: Exploring institutional coordination in drought management. Water policy, 22(4), 519-540.

Makunde, T., Dube, T., & Mudzonga, E. (2018). Institutional fragmentation and water governance challenges in Zimbabwe. Water Policy, 20(6), 1125–1138.

Mangeya, P. (2017). Water governance challenges in rural Zimbabwe: Lessons from Rushinga District. Water Policy Review, 19(2), 234–248.

Manyakaidze, P. (2023). Drought impacts on water security in Zimbabwe: Lessons from 2015–2016 and 2019–2020. African Journal of Environmental Science and Technology, 17(4), 145–156.

Manyakaidze, P., 2024. Community resilience and water security under climate variability in Zimbabwean semi-arid regions. Harare: Zimbabwe Environmental Research Institute.

Manyakaidze, P., Chikodzi, D., & Mudzonga, E. (2024). Borehole failures and declining dam inflows in drought-prone districts of Zimbabwe. African Journal of Environmental Science and Technology, 18(3), 145–158.

Marengo, J. A., Torres, R. R., & Alves, L. M. (2020). Drought in Brazil: Past, present, and future. Theoretical and Applied Climatology, 141(1–2), 167–183.

Masimba, O., Gumindoga, W., Mhizha, A., & Rwasoka, D. T. (2022). Impacts of climate change on streamflow and reservoir inflows in the Upper Manyame sub-catchment of Zimbabwe. Water Sa, 48(4), 359-368.

Masimba, T., Nyamwanza, A., & Mpala, T. (2022). Climate stress and surface water reliability in Zimbabwe: Reservoirs and agricultural supply. Water Policy, 24(5), 789–803.

Matamanda, A. R., Gambe, T. R., Bhanye, J. I., Maramura, T. C., & Annastacia Khoza, O. (2025). Conclusions and Future Directions: Pathways for Resilient and Sustainable Water Governance in Zimbabwe. In Urban Water Governance in Postcolonial Zimbabwe: A Resilience and Sustainability Perspective (pp. 187-204). Cham: Springer Nature Switzerland.

Matamanda, A. R., Mudzonga, E., & Chikodzi, D. (2025). Recurrent droughts and water governance challenges in Zimbabwe: Towards adaptive frameworks. Climate and Development, 17(2), 210–223.

Mathe, P. (2025). An Assessment of the Socio-Economic Effects of Climate Change induced Water Scarcity on Young Women in Sikalenge Ward, Binga Zimbabwe: Challenges and Sustainable Solutions. Medicon Agriculture & Environmental Sciences, 8, 39-48.

Mavhura, E. (2017). Applying a systems-thinking approach to community resilience analysis using rural livelihoods: The case of Muzarabani district, Zimbabwe. International Journal of Disaster Risk Reduction, 25, 248-258.

Maviza, A. and Ahmed, F. (2021) ‘Interpretivist approaches in environmental and water governance research’, *African Journal of Social and Environmental Studies*, 9(1), pp. 44–60.

Mazivarimwe, L. (2020). Assessing the Effectiveness of Zimbabwes Water Sector Framework In Addressing Climate Change Induced Impacts: Need For Adapting the Water Sector? (Doctoral dissertation, 서울대학교 대학원).

Mazivarimwe, P. (2020). Integrating climate risks into Zimbabwe's National Water Policy: Challenges and opportunities. African Journal of Environmental Science and Technology, 14(9), 245–256.

Mazvimavi, D. (2010). Investigating changes over time of annual rainfall in Zimbabwe. Hydrology and Earth System Sciences, 14(12), 2671–2679.

Mhembwe, S., Chitamba, J., & Dube, T. (2019). Small-scale irrigation and rural livelihoods in Zimbabwe: Opportunities and constraints. Sustainability, 11(21), 6063.

Micklin, P. (2020). The Aral Sea disaster. Annual Review of Earth and Planetary Sciences, 48, 105–129.

Mohamad, M. M., Sulaiman, N. L., Sern, L. C., & Salleh, K. M. (2015). Measuring the validity and reliability of research instruments. Procedia-Social and Behavioral Sciences, 204, 164-171.

Mokone, S. (2025). Climate-resilient water infrastructure in Zimbabwe: Challenges and investment needs. Climate and Development, 17(2), 210–223.

Morante-Carballo, F., López-Maldonado, V., & Hernández, J. (2022). Rainfall variability and water scarcity in Mexico and Central America. Water, 14(12), 1895.

Morgan, D. L. (1997). Focus groups as qualitative research (2nd ed.). Sage Publications.

Mote, P. W., Li, S., Lettenmaier, D. P., Xiao, M., & Engel, R. (2019). Declining mountain snowpack in western North America. Nature Climate Change, 9(1), 48–52.

Mpala, T., & Simatele, D. (2024). Coping with drought in Zimbabwe: Groundwater reliance and small-scale irrigation strategies. Sustainability, 16(7), 3125.

Mpandeli, S., Naidoo, D., Mabhaudhi, T., Nhamo, L., & Modi, A. T. (2020). Climate change adaptation through water-energy-food nexus planning in southern Africa. Sustainability, 12(16), 6785.

Mpofu, N., & Mawanza, W. (2026). Socio-economic barriers to adopting pre-paid water meters in Bulawayo, Zimbabwe. Development in Practice, 1-12.

Mubaya, C. P., & Mafongoya, P. (2017). The role of institutions in managing local level climate change adaptation in semi-arid Zimbabwe. Climate Risk Management, 16, 93-105.

Mubaya, C. P., & Mafongoya, P. L. (2017). The role of institutions in climate change adaptation in Zimbabwe. Climate and Development, 9(5), 405–414.

Muchemwa-Munasirei, C. (2018). Community-level adaptation strategies to climate change in Zimbabwe: Boreholes, water-sharing, and irrigation. African Journal of Environmental Science and Technology, 12(9), 345–354.

Mudavanhu, C., Chanza, N., & Kasimba, R. (2025). Community Based Resilience to Climate Change in Chimanimani District, Zimbabwe. In Disaster Risks and Hazards: Practice for Resilience-Case for Zimbabwe (pp. 25-46). Singapore: Springer Nature Singapore.

Mugabe, F. T., et al. (2021). Rainfall variability and its implications for smallholder agriculture in Zimbabwe. African Journal of Agricultural Research, 16(5), 678–689.

Mugambiwa, S. S., & Rukema, J. R. (2020). Climate change and variability discourse among community members and smallholder farmers in Mutoko District, Zimbabwe. The Mankind Quarterly, 61(2).

Mugiyo, H. (2024). Smallholder irrigation technologies and climate resilience in Zimbabwe: Evidence from Murehwa, Masvingo, and Makonde Districts. Sustainability, 16(7), 3125.

Mujuru, F. (2018). Adaptive water management in semi-arid Zimbabwe: Institutional and community perspectives. Zimbabwe Journal of Environmental Studies, 12(1), 10–27.

Muller, M. (2018). Lessons from water governance in South Africa. Water Alternatives, 11(3), 789–804.

Muller, M. (2018). Lessons from water management in South Africa: 1994–2018. International Journal of Water Resources Development, 34(5), 687–704.

Munyede, C. (2016). Institutional weaknesses and water governance challenges in Rushinga District, Zimbabwe. Physics and Chemistry of the Earth, 95, 102–110.

Mupotola, M., & Manzungu, E. (2021). Reservoir inflows and climate variability in southern Africa: Implications for hydropower. Water SA, 47(4), 455–467.

Musarandega, T., Nyamwanza, A., & Mpala, T. (2018). Traditional water-sharing arrangements and community resilience in Zimbabwe. International Journal of Climate Change Strategies and Management, 10(5), 689–704.

Musingafi, M. C. C. (2013). Integrated water resources management in Zimbabwe: Challenges and opportunities. International Journal of Development and Sustainability, 2(2), 1034–1047.

Mwadzingeni, L., Mugandani, R., & Mafongoya, P. (2022). Risks of climate change on future water supply in smallholder irrigation schemes in Zimbabwe. Water, 14(11), 1682.

Mwadzingeni, L., Mugandani, R., & Mafongoya, P. (2022). Risks of climate change on future water supply in smallholder irrigation schemes in Zimbabwe. Water, 14(11), 1682.

Mwadzingeni, L., Mugandani, R., & Mafongoya, P. L. (2022). Socio-demographic, institutional and governance factors influencing adaptive capacity of smallholder irrigators in Zimbabwe. Plos one, 17(8), e0273648.

Mwadzingeni, L., Mupangwa, W., & Dube, T. (2022). Water infrastructure performance and climate resilience in Zimbabwe. Sustainability, 14(21), 13985.

Naz, N., Gulab, F., & Aslam, M. (2022). Development of qualitative semi-structured interview guide for case study research.

Ndebele-Murisa, M. R., & Mubaya, C. P. (2015). Climate change and variability: Impacts on water resources in Zimbabwe. African Journal of Ecology, 53(2), 175–185.

Ndlovu, F., 2025. Climate change and rural water resource challenges in Zimbabwe: Opportunities for integrated adaptation. Harare: University of Zimbabwe Press.

Ndlovu, M., Dube, T., & Moyo, P. (2020). Rainfall variability and smallholder farming systems in semi-arid Zimbabwe. Sustainability, 12(14), 5674.

Ngubane, S., Dlamini, P., & Zandamela, J. (2026). Institutional fragmentation and climate adaptation in Zimbabwe's water governance. Water International, 51(1), 45–61.

Nhapi, I. (2015). Challenges for water supply and sanitation in developing countries: case studies from Zimbabwe. In Understanding and managing urban water in transition (pp. 91-119). Dordrecht: Springer Netherlands.

Niang, I., Ruppel, O. C., Abdrabo, M. A., Essel, A., Lennard, C., Padgham, J., & Urquhart, P. (2022). Africa. In Climate Change 2022: Regional impacts. Cambridge University Press.

Nile Basin Initiative (NBI). (2020). Cooperation for climate resilience in the Nile Basin. NBI Report.

Nyagumbo, I., & Rurinda, J. (2012). Conservation agriculture and climate change adaptation in Zimbabwe: Institutional perspectives. African Journal of Agricultural Research, 7(7), 944–952.

Nyahunda, L., Makhubele, J. C., FK, M., & Mabvurira, V. (2020). Resilience strategies of rural people in the face of climate change in Mazungunye Community, Ward 4, Bikita District, Masvingo Province Zimbabwe: a social work perspective. Gender and Behaviour, 18(2), 15511-15520.

Nyahunda, L., Tirivangasi, H. M., & Chikadzi, V. (2021). Community-based adaptation to climate change in rural Africa: Evidence from Zimbabwe. Jàmbá: Journal of Disaster Risk Studies, 13(1), a1020.

Nyahunda, L., Tirivangasi, H. M., & Chikadzi, V. (2021). Community-based adaptation to climate change in Sub-Saharan Africa. Climate and Development, 13(8), 693–704.

Nyamwanza, A. M. (2018). Local institutional adaptation for sustainable water management under increasing climatic variability and change: A case in the mid-Zambezi Valley, Zimbabwe. International Journal of Climate Change Strategies and Management, 10(3), 453-471.

Nyamwanza, A. M. (2018). Recurrent droughts and water governance in Mbire District, Zimbabwe. Journal of Southern African Studies, 44(3), 421–437.

Nyikadzino, T. and Dube, T. (2023) 'Climate variability and water scarcity in semi-arid districts of Zimbabwe', *Journal of Arid Environments and Water Studies*, 11(2), pp. 67–85.

O. Nyumba, T., Wilson, K., Derrick, C. J., & Mukherjee, N. (2018). The use of focus group discussion methodology: Insights from two decades of application in conservation. Methods in Ecology and evolution, 9(1), 20-32.

O'Brian, K. (2019). Rainfall variability and water stress in Europe: Contrasting northern and Mediterranean experiences. Regional Environmental Change, 19(6), 1623–1635.

Ofori, S. A., Cobbina, S. J., & Obiri, S. (2021). Climate change, land, water, and food security: Perspectives from Sub-Saharan Africa. Frontiers in Sustainable Food Systems, 5, 680924.

Olaka, L. A., Odada, E. O., & Trauth, M. H. (2019). Climate variability and water resources in East Africa: Impacts on lakes and livelihoods. Hydrological Sciences Journal, 64(6), 673–687.

Oluka, A. (2025). Phenomenological research strategy: Descriptive and interpretive approaches [version 1; peer review: 2 approved with reservations]. F1000Research, 14, 725.

Organisation for Economic Co-operation and Development (OECD). (2021). Water governance in a changing climate. OECD Publishing.

Pachawo, T. (2023). Rainfall unpredictability and water security in semi-arid districts of Zimbabwe. Journal of Southern African Studies, 49(3), 421–437.

Pachowa, T. (2023). Seasonal river flows and water security in Zimbabwe's semi-arid districts. Journal of Southern African Studies, 49(3), 421–437.

Pahl-Wostl, C. (2017). Governance of the water-energy-food security nexus: A multi-level coordination challenge. Environmental Science & Policy, 92, 356–367.

Pahl-Wostl, C. (2017). Governance of water in a changing world. Water Resources Management, 31(10), 3023–3041.

Parker, C., Scott, S., & Geddes, A. (2019). Snowball sampling. SAGE research methods foundations.

Rai, N., & Thapa, B. (2015). A study on purposive sampling method in research. Kathmandu: Kathmandu School of Law, 5(1), 8-15.

Raizada, A., Sharma, S., & Srivastava, N. (2022). Climate change-an overview. Journal of Mountain Research, 17(2), e23.

Raju, K S. & Kumar. D N. (2018). Impacts of climate change on water resources. Clim. Chang. Model. Plan. Policy Agric, 219-231.

Rasul, G., & Sharma, B. (2019). Droughts and climate risks in South Asia. Environmental Development, 32, 100–110.

Renzetti, S., & Dupont, D. (2020). Water policy and governance in Canada. Canadian Water Resources Journal, 45(1), 1–12.

Riedel, T., & Weber, T. K. (2020). The influence of global change on Europe's water cycle and groundwater recharge. Hydrogeology Journal, 28(6), 1939-1959.

Riger, S. T. E. P. H. A. N. I. E., & Sigurvinsdottir, R. A. N. N. V. E. I. G. (2016). Thematic analysis. Handbook of methodological approaches to community-based research: Qualitative, quantitative, and mixed methods, 33-41.

Rodell, M., Famiglietti, J. S., Wiese, D. N., Reager, J. T., Beaudoing, H. K., Landerer, F. W., & Lo, M. H. (2018). Emerging trends in global freshwater availability. Nature, 557(7707), 651–659.

Rosa, E. & Sangiorgio, R., 2025. Adaptive water management in a warming world: Addressing scarcity and resilience. Water Policy Journal, 27(3), pp.221–240.

Santos, R. (2025). Adaptive governance frameworks for rainfall variability in Europe. Climate Policy, 25(3), 421–437.

Santos, R. (2025). Adaptive governance frameworks for rainfall variability in Europe. Climate Policy, 25(3), 421–437.

Saunders, M., Lewis, P., & Thornhill, A. (2019). Research Methods for Business Students. Pearson.

Serdeczny, O., Adams, S., Baarsch, F., Coumou, D., Robinson, A., Hare, W., & Schaeffer, M. (2019). Climate change impacts in Sub-Saharan Africa: From physical changes to their social repercussions. Regional Environmental Change, 19(6), 1623–1638.

Shah, T. (2021). Groundwater governance in South Asia: Challenges and opportunities. Water International, 46(3), 289–306.

Sharma, S. K., Mudgal, S. K., Gaur, R., Chaturvedi, J., Rulaniya, S., & Sharma, P. (2024). Navigating sample size estimation for qualitative research. Journal of Medical Evidence, 5(2), 133-139.

Shoko, D., & Naidu, M. (2018). Social networks and traditional water-sharing practices in Zimbabwean communities. Community Development Journal, 53(3), 421–437.

Southern African Development Community (SADC). (2021). Water protocols and climate adaptation strategies. SADC Secretariat.

Stahl, K., Kohn, I., & Blauhut, V. (2020). Drought risk in Europe: Past experiences and future challenges. Hydrology and Earth System Sciences, 24(2), 602–620.

Steelman, T. (2022). Adaptive governance. In Handbook on Theories of Governance (pp. 580–591). Edward Elgar Publishing.

Sukanya. S & Joseph. S. (2023). Climate change impacts on water resources: An overview. Visualisation techniques for climate change with machine learning and artificial intelligence, 55-76.

Tanner, T., Mitchell, T., & Wilkinson, E. (2015). Rainfall variability and livelihoods in Asia: Governance implications. Development Policy Review, 33(5), 647–664.

Taonmeso, K., Nyamwanza, A., & Mpala, T. (2022). Governance fragmentation and climate resilience in Zimbabwe's water sector. Sustainability, 14(21), 13985.

Taylor, R. G., et al. (2013). Ground water and climate change. Nature Climate Change, 3(4), 322–329.

Taylor, R. G., Scanlon, B., Doll, P., Rodell, M., van Beek, R., Wada, Y., ... & Treidel, H. (2013). Groundwater and climate change. Nature Climate Change, 3(4), 322–329.

Terry, G., Hayfield, N., Clarke, V., & Braun, V. (2017). Thematic analysis. The SAGE handbook of qualitative research in psychology, 2(17-37), 25.

Thurow, R. (2024). Erratic monsoon behaviour and coping strategies in South Asia. Journal of Climate and Development, 16(2), 210–225.

Tindimugaya, C. (2020). Water governance and climate resilience in Uganda. Water Policy, 22(3), 423–439.

Udall, B., & Overpeck, J. (2017). The twenty-first century Colorado River hot drought and implications for the future. Water Resources Research, 53(3), 2404–2418.

Uddin, M. N., & Anjuman, N. (2013). Participatory rural appraisal approaches: an overview and an exemplary application of focus group discussion In climate change adaptation and mitigation strategies. International Journal of Agricultural Research, Innovation and Technology (IJARIT), 3(2), 72-78.

UNEP. (2021). Global drought risk and water security. United Nations Environment Programme.

UNESCO. (2023). Integrated water resource management and climate resilience. UNESCO Report.

UNESCO. (2023). United Nations World Water Development Report 2023: Partnerships and Cooperation for Water. Paris: UNESCO Publishing.

United Nations Environment Programme (UNEP). (2021). Global drought risk and water security. UNEP Report.

United Nations Environment Programme (UNEP). (2021). Global water governance under climate stress. UNEP Report.

United Nations Environment Programme (UNEP). (2021). Water security and climate resilience in Africa. UNEP Report.

United States Geological Survey (USGS). (2022). Climate stress and water resources in North America. USGS Report.

United States Geological Survey (USGS). (2022). Community water adaptation in North America. USGS Report.

United States Geological Survey (USGS). (2022). Drought impacts in North America. USGS Report.

United States Geological Survey (USGS). (2022). Infrastructure resilience and climate adaptation in North America. USGS Report.

United States Geological Survey (USGS). (2022). Water governance and climate adaptation in North America. USGS Report.

UN-Water, 2024. Water scarcity and climate change: Global assessment report. Geneva: United Nations.

Van Koppen, B., et al. (2020). Water governance in Sub-Saharan Africa: Policy and practice. Water Alternatives, 13(3), 493–512.

Van Koppen, B., Schreiner, B., & Fakir, T. (2020). Water governance and climate resilience in southern Africa. Water Policy, 22(3), 423–439.

Vangani, T. (2025). Institutional fragmentation and climate adaptation in Zimbabwe's water governance. Water International, 50(1), 45–61.

Vincent, K., & Conway, D. (2017). Adaptation to climate variability in southern Africa: Lessons from drought management. Climate Risk Management, 31, 100–115.

Vogelmann, J. E., Zuniga, J., & Morales, A. (2022). Rainfall unpredictability and agricultural productivity in Latin America. Environmental Research Letters, 17(8), 084012.

Vuille, M., Carey, M., Huggel, C., Buytaert, W., Rabatel, A., Jacobsen, D., ... & Soruco, A. (2018). Rapid decline of glaciers in the Andes. Earth-Science Reviews, 176, 195–213.

Wheaton, E., Kulshreshtha, S., & Wittrock, V. (2021). Drought impacts on Canadian agriculture. Canadian Journal of Agricultural Economics, 69(2), 215–232.

World Bank. (2021). Building resilience to climate change in Sub-Saharan Africa. World Bank Publications.

World Bank. (2022). Climate resilience in Latin America and Sub-Saharan Africa. World Bank Publications.

World Bank. (2022). Climate resilience in Latin America. World Bank Publications.

World Bank. (2022). Climate resilience in Sub-Saharan Africa. World Bank Publications.

World Meteorological Organisation (WMO). (2022). Global Drought Report 2022. Geneva: WMO.

World Meteorological Organisation (WMO). (2022). Global drought report. Geneva: WMO.

Zimbabwe National Statistics Agency (ZIMSTAT). (2022). 2022 Population and Housing Census. Preliminary report on population figures.

Ziti, T. (2020). Borehole reliability and household water security in Masvingo District, Zimbabwe. Water Policy, 22(5), 789–803.

Zuniga, J., Morales, A., & Vogelmann, J. E. (2021). Rainfall variability and energy security in Latin America. Energy Policy, 156, 112456.

APPENDICES

Appendix 1: Approval Letter from Bindura University of Science Education

SUSTAINABLE DEVELOPMENT DEPARTMENT

BINDURA, ZIMBABWE
WhatsApp: +263773281212
E-mail: jbowora@buse.ac.zw

BINDURA UNIVERSITY OF SCIENCE EDUCATION

CHAIRPERSON'S OFFICE

Tuesday 24 March 2026

TO WHO IT MAY CONCERN

Dear Sir/Madam

RE: RESEARCH SUPPORT LETTER FOR SUSTAINABLE DEVELOPMENT STUDENT

I am writing on behalf of the Sustainable Development Department requesting your collaboration on the research of our fourth-year student, TADIWA E CHISIYA REGISTRATION NUMBER B224909B. The student is studying for a 4-year Bachelor of Science (Honours) Degree in Development Studies (HBSc.DG).

In the fourth year of study, students are required to do field research which require them to do their data collection for research purposes.

Kindly accord her the due cooperation she truly deserves.

Yours faithfully,

.....
DR. J. BOWORA (CHAIRPERSON)
SUSTAINABLE DEVELOPMENT DEPARTMENT

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Appendix 2: Approval Letter from Ministry of Local Government and Public Works (Rushing District)

All correspondence to be addressed The District Development Coordinator
Reference:

Telephone:- 2392 (066212)
Email:ddcrushinga@gmail.com

ZIMBABWE

MINISTRY OF LOCAL GOVERNMENT AND PUBLIC WORKS
OFFICE OF THE DISTRICT DEVELOPMENT COORDINATOR
RUSHINGA DISTRICT
P BAG 2110
RUSHINGA

28 APRIL 2026

To whom it may concern

REF: PERMISSION TO CARRY OUT ACADEMIC RESEARCH ON TOPIC ENTITLED: EXAMINING THE INTERPLAY BETWEEN CLIMATE CHANGE AND WATER RESOURCES MANAGEMENT IN WARD 24 RUSHINGA DISTRICT ZIMBABWE-TADIWA E CHISIYA B224909B.

The above subject refers:

Please be advised that permission is hereby granted for you to carry out a research on a topic outlined "**EXAMINING THE INTERPLAY BETWEEN CLIMATE CHANGE AND WATER RESOURCES MANAGEMENT IN WARD 24 RUSHINGA DISTRICT ZIMBABWE.**" Permission is granted STRICTLY on condition that the research is for academic purposes only in pursuit of your degree in Development Studies (HBSc.DG). The data collected should not be shared to third parties.

You are kindly requested to submit a copy of your final research document to the Department of Administration upon completion as your research has a bearing to the Department's mandate.

Yours faithfully

LR.DUBE
DISTRICT DEVELOPMENT COORDINATOR- RUSHINGA

DISTRICT DEVELOPMENT COORDINATOR
RUSHINGA DISTRICT OFFICE
28 APR 2026
P. BAG 2110, RUSHINGA
MASHONALAND CENTRAL

Appendix 4: Interview Guide (Key Informants)

Good day, my name is Tadiwa Elizabeth Chisiya, and I am conducting a study on climate change and water governance in Zimbabwe. I am a student from Bindura University of Science Education. This research aims to understand how climate change affects water availability and how communities and institutions respond. Your participation is voluntary, and all information will be kept confidential. You may choose not to answer any question or withdraw at any time. The insights you provide will be used for academic purposes only. For further communication, call me on +263787658932 or emailChisiyatadiwa237@gmail.com

Section A: Demographic Information

i. Age

ii. Gender

iii. Occupation/role in community or institution

iv. Years of experience in water-related issues

Section B: Understanding of Climate Change and Water Resource Management

i. What is your understanding of climate change?

ii. How do you think climate change affects the amount of and whether people can get water when they need it in Zimbabwe?

iii. How do you define water resource management in your context?

Section C: Climate Variability and Rainfall Patterns Affecting Water Supply

iv. How have rainfall patterns changed in your area over the past decade?

v. What impacts have recurrent droughts had on water reliability?

vi. How have surface and groundwater resources shifted under climate stress?

Section D: Responses of Water Resource Management Systems

vii. How effective are current policies in addressing climate-induced water challenges?

viii. What do people in the communities do when there is no enough water?

ix. How would you assess the performance of water infrastructure under climate variability?

Section E: Challenges and Opportunities for Strengthening Governance

x. What problems in local offices, councils, or government make it hard to manage water well?

xi. What money or everyday life problems make it hard for people to use water well?

xii. What opportunities exist for strengthening adaptive governance and community resilience?

Thank you very much for taking part in this interview. Your insights are important and will contribute to the understanding on how Zimbabwe can strengthen water governance under climate stress.

Appendix 5: Focus Group Discussion Guide (Community Members)

Good day, my name is Tadiwa Elizabeth Chisiya, and I am conducting a study on climate change and water governance in Zimbabwe. I am from Bindura University of Science Education. The purpose of this discussion is to learn from your experiences about rainfall variability, water availability, and coping strategies. Participation is voluntary, and your views will remain confidential. There are no right or wrong answers; we are interested in your experiences and opinions. For further communication, call me on +263787658932 or email Chisiyatadiwa237@gmail.com

Section A: Understanding of Climate Change and Water Resource Management

1. What is your understanding of climate change?
2. How do you think climate change affects water availability in your community?
3. What does water resource management mean to you?

Section B: Climate Variability and Rainfall Patterns Affecting Water Supply

4. How have you experienced changes in rainfall and drought frequency?
5. What sources of water do you rely on during droughts?
6. How have surface and groundwater resources changed in your area?

Section C: Community-level Adaptation and Coping Strategies

7. What coping strategies do households use to manage water scarcity?
8. How reliable are boreholes, wells, and small dams in your community?
9. How do you perceive the role of local authorities or NGOs in supporting water access?

Section D: Challenges and Opportunities for Strengthening Governance

10. What challenges do you face in accessing or maintaining water infrastructure?

11. How do poverty and limited resources affect your ability to cope with water scarcity?

12. What opportunities do you see for improving resilience in your community?

Thank you for sharing your experiences and views. Your contributions will help us understand community resilience and how water governance can be improved.

Appendix 6: Observation Guide

1. Objective of the Observation

To systematically document the physical, social, and environmental impacts of climate change on water availability and management practices, as well as the coping mechanisms employed by households and communities in Ward 24, Rushing District.

2. Key Areas of Observation

Table 1: Observation Guide

Broad Concept	Sub-concept	Yes	No	Comment
Environmental Indicators	Conditions of farmland (soil moisture, erosion, crop stress)			
	Water sources (boreholes, wells, dams, rivers)			
	Vegetation changes (drought stress, crop diversity, deforestation)			
Household and Community Indicators	Water Storage Facilities (tanks, drums, rainwater harvesting systemes)			
	Household water use practices (rationing, reuse, conservation)			
	Coping infrastructure (small irrigation, solar pumps, mulching)			
Socio-Economic Indicators	Marketplaces (water trading, availability of farm produce like maize			

	and vegetables)			
	Housing conditions (adaptations for water storage, resilience)			
	Community interactions (cooperation/conflict over water access)			
Governance and Social Dynamics	Roles and responsibilities in water collection and management			
	Vulnerable groups (women, children, the elderly, disabled)			
	Evidence of local institutions/NGO/government interventions (new boreholes, tanks, committees)			