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OF SCIENCE AND ENGINEERING

DEPARTMENT OF DISASTER RISK REDUCTION



**APPLICATION OF EARLY WARNING SYSTEMS FOR ENHANCING
RESILIENCE AGAINST DISASTER RISK IN TSHOLOTSHO**

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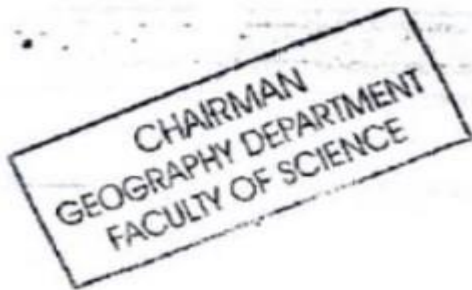
APPROVAL FORM

The undersigned hereby confirm that they have supervised the dissertation titled "The Application of Early Warning Systems for Enhancing Resilience Against Disaster Risk in Tsholotsho," authored by Trouble Mazheke. This work has been submitted in partial fulfillment of the requirements for the Bachelor of Science Honors Degree in Disaster Management Sciences at Bindura University of Science Education



Chairperson Dr Mavhura.....

Date...10 October 2025.....



DECLARATION

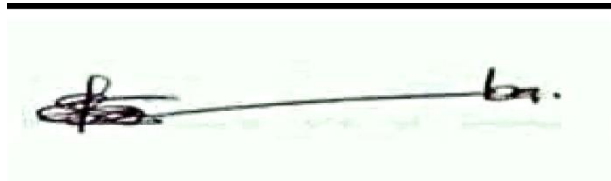
I hereby confirm that my dissertation is the result of my individual research and work, conducted solely by me for the purpose of this degree evaluation. It has not been submitted to any other institution or for any other qualification. All sources of information have been appropriately cited and acknowledged.

Student

Supervisor

TROUBLE MAZHEKE.

DR. MAPONGA



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Date. 18 / 06 / 25

Date. 9 October 2025

DEDICATION

To my family.

ACKNOWLEDGMENTS

I would like to extend my sincerest gratitude to my supervisor Dr Maonga, for his expert guidance and support throughout this research journey. I also appreciate my family for the love, encouragement and patience. I also would like to thank Tsholotsho District Civil Protection Committee and the community for participating in the research and also for allowing me the chance to do the research in the district.

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ABSTRACT

Given the ever-changing nature of vulnerability and the rising unpredictability of climate and environmental conditions characterized by more frequent and severe hazards decision-makers, communities, and disaster management professionals must take proactive measures to safeguard vulnerable populations and ecosystems (UN/ISDR, 2006). In recent years, the risks have disproportionately affected impoverished populations. In recent years, the Tsholotsho area in Matabeleland North, Zimbabwe, the study region, has seen an increase in the frequency of droughts and floods. This research aimed to determine what Disaster Risk Reduction programs, particularly Early Warning, are implemented and being carried out in Tsholotsho District. Primary data collected using Participatory Rural Appraisal techniques, including focus groups, in-depth interviews, and direct observations, is integrated with a review of prior research in this study. These techniques gave Tsholotsho residents profound insights into regional patterns, procedures, and decision-making. Findings reveal that while established EWS exist in Tsholotsho, they are insufficient to significantly reduce vulnerability or enhance resilience. The findings show that while formal early warning systems exist, their reach is limited, especially in remote areas. Traditional systems continue to play a significant role, particularly where technology and infrastructure are lacking. The overlap between formal and informal systems indicates both redundancy and gaps in coverage. The continued reliance on traditional systems suggests a need for integration, rather than replacement, of indigenous knowledge. The limited reach of formal EWS in remote areas underscores the importance of community-based dissemination channels and the need for improved infrastructure. The findings highlight the need for participatory approaches that empower communities to co-design early warning systems, ensuring both relevance and acceptance. At the same time as DRR initiatives may be expanded, they must be addressed. The community believed that one of the most important DRR tactics that might be used successfully and economically in the area is EWs. Accordingly, the study makes suggestions for further research as well as Early Warnings for practice and policy.

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CHAPTER 1: INTRODUCTION

1.1 Introduction

This chapter provides a comprehensive overview of early warning systems and their vital role in enhancing disaster risk resilience in Tsholotsho. It establishes the framework for the study, outlining the objectives and the significance of timely alerts and information for community empowerment in preparation for and response to disasters. This chapter highlights the increasing frequency of climate related disasters underscoring the urgency of effective early warning systems in vulnerable regions.

1.2 Background to the study

Zimbabwe like many other countries, has faced increasing natural hazards due to climate change, with droughts and floods causing recurrent disruptions. As a consequence of climate change, natural catastrophes have become more frequent and severe both globally and in Zimbabwe. Natural catastrophes that often cause significant disruption and devastation are two major events: floods and droughts. The nation has recently experienced severe droughts, which have increased emigration rates and the already low life expectancy. Natural disasters like as droughts, floods, and animal diseases may have a major impact on people's quality of life in the region where Tsholotsho is situated. Inadequate disaster preparation, restricted access to resources and information, and limited infrastructure all contribute to the district's vulnerability.

Therefore, pre-emptive measures that might lower the risk of disasters and improve community resilience are becoming more important. Early warning systems have been discussed as being important for disaster risk reduction plans. The present early warning systems in Tsholotsho are poorly financed, scattered, and not completely incorporated with local knowledge and practices, despite the fact that they are recognized to be essential for reducing the consequences of catastrophes and fostering community resilience.

There is need for risk reduction due to rampant fatal natural disasters similar to what happened to Chimanimani and Mozambique a sudden attack by cyclone Idai. Because of climate change natural disasters can happen any time, there is therefore need for early warning systems in target areas which prompted this study. Early Warning systems have emerged as cornerstone of disaster risk reduction efforts globally. Disaster risk reduction (DRR) is critical for

enhancing community resilience, particularly in regions highly susceptible to natural hazards like Tsholotsho, Zimbabwe.

1.3 Statement of the problem

Despite the recognized importance of early warning systems in reducing disaster impacts and enhancing community resilience, existing systems in Tsholotsho need to be assessed. Current systems in Tsholotsho often have to tackle community problems. Communities in Tsholotsho require mechanisms to prepare and contend with disaster risk. That would help bridge the gap between disaster preparedness and response among community members, The systems are critical for compliance and coordinated response. This study assesses early warning systems for disaster risk reduction, identify key obstacles to their optimal functioning, and explore the role of community engagement and indigenous knowledge for effective disaster reduction in the district.

1.4 Aim of the study

- To evaluate early warning systems in enhancing resilience against disaster risk in Tsholotsho.

1.5 Objectives

- To determine existing early warning systems for DRR in Tsholotsho.
- Assess effectiveness of EWs in DRR in Tsholotsho.
- To examine conditions for use of early warning systems for disaster risk resilience in Tsholotsho.

1.6 Research questions

- Which early warning systems are currently being used in Tsholotsho, and what are the reasons for their failure?
- What are the strengths and weaknesses of the existing early warning systems in Tsholotsho, and how do they impact community preparedness for natural disasters?
- What are the factors that might lead to the failure of the early warning system under investigation?
- How can local knowledge and cultural practices be integrated into the design of an effective early warning system that meets the needs of the Tsholotsho community?

- What role do communication barriers play in the effectiveness of early warning systems, and how can these barriers be mitigated to improve information dissemination?
- What conditions are necessary for the effective implementation of early warning systems in enhancing disaster risk resilience?

1.7 Scope/ delimitation of the study

This study focuses specifically on the application of early warning system in Tsholotsho examining their contribution to disaster risk resilience within the region. The study concentrated on community perspectives, particularly the experiences and challenges faced by local residents. The research concentrated within the Tsholotsho district of Zimbabwe, examining both urban and rural communities to capture a comprehensive view of the local context and variations in vulnerability. The study focused primarily on natural disasters that frequently affect the region, including droughts, floods, and other climate-related events. The research also involved a diverse range of stakeholders, including local government authorities, non-governmental organizations (NGOs), community leaders, and residents. Engaging these groups provided insights into the current challenges and potential solutions for improving early warning systems. Exploring the cultural practices and traditional knowledge systems of the Tsholotsho community, assessing how these can be integrated into modern early warning frameworks to enhance their effectiveness and acceptance. An evaluation of the technological infrastructure available for disaster monitoring and communication were conducted. This included assessing the accessibility of mobile and internet services, as well as the use of innovative technologies in early warning systems. Examination of existing capacity within the community to respond to early warning alerts. It also identifies training needs for local populations to improve their understanding and utilization of early warning information. The study also focused on both historical data regarding past disasters in Tsholotsho and current practices, while also considering future projections related to climate change impacts on disaster frequency and severity. By delineating these boundaries, the study aims to provide a comprehensive analysis of early warning systems in Tsholotsho, ultimately offering actionable recommendations for enhancing community resilience to natural disasters.

1.8 Significance of the study

Early warning systems guarantee safety for people and property. Potential benefits of this study include creating a more resilient and informed community in Tsholotsho, enhancing disaster preparedness and response while fostering collaboration and integrating local knowledge into formal systems. The findings of this study provided valuable insights into the effectiveness of early warning systems in Tsholotsho, contributing to improved disaster management strategies. By identifying gaps and necessary conditions for success the study aims to inform policymakers on disaster risk management and the integration of early warning systems into community planning, community empowerment through advocating for and participating in the development of early warning systems and lastly academic contribution by adding to the existing body of research on disaster risk resilience particularly in the context of rural and vulnerable communities Zimbabwe.

1.9 Definition of key terms

Early Warning systems; early warning system is defined by the United Nations Office for Disaster Risk Reduction as ‘An integrated system of hazard monitoring, forecasting and prediction, disaster risk assessment, communication and preparedness activities systems and processes that enables individuals, communities, governments, businesses and others to take timely action to reduce disaster risks in advance of hazardous events’ (UNDRR, 2022). In Tsholotsho, an early warning system is the combination of official alerts (such as radio broadcasts, SMS messages, and community meetings) and traditional community practices (like observing animal behaviour and weather patterns) that help residents anticipate and prepare for hazards such as droughts and floods.

Disaster risk resilience the capacity of a community to withstand, recover from and adapt to adverse events minimizing impact through preparedness and effective response strategies. In Tsholotsho, disaster risk reduction refers to all the strategies and actions both modern (like government-led preparedness programs) and traditional (such as community-based coping mechanisms) that local people and authorities use to minimize the impact of frequent hazards on their lives, property, and livelihoods.

Vulnerability the degree to which a community is susceptible to harm from hazards, influenced by factors such as socioeconomic status, infrastructure and access to information (Blum, 2023) In Tsholotsho, vulnerability describes the factors such as poverty, remoteness,

limited infrastructure, and lack of information that make certain groups or areas more likely to suffer harm from disasters.

Preparedness “The knowledge and capacities developed by governments, response and recovery organizations, communities and individuals to effectively anticipate, respond to, and recover from the impacts of likely, imminent or current hazard events or conditions.”(UNDRR, 2017)

In Tsholotsho, preparedness means the actions taken by families, communities, and local authorities such as storing food, planning evacuation routes, or holding awareness meetings to get ready for disasters before they happen.

Community-Based Disaster Risk Management (CBDRM)

“A process of disaster risk management in which at-risk communities are actively engaged in the identification, analysis, treatment, monitoring and evaluation of disaster risks in order to reduce their vulnerabilities and enhance their capacities.” (ADPC, 2004)

In Tsholotsho, CBDRM refers to local initiatives where community members work together often with support from NGOs or local authorities to identify risks, share information, and develop strategies for disaster preparedness and response.

1.10 Conclusion

This chapter establishes a foundation for comprehending the critical role of early warning systems in strengthening disaster risk resilience within Tsholotsho. It also highlights the significance of the study by outlining the problem statement, research aim and objectives, key questions, scope limitations, justification for the research, definitions of essential terms, and the overall structure of the study.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This chapter reviews the application of early warning systems as crucial tools for enhancing resilience against disaster risk in Tsholotsho. It outlines the theoretical framework that guides the study, examines the concept of early warning systems and discusses their role in promoting disaster resilience. Additionally, the chapter explores the conditions necessary for effectively implementing early warning systems, providing a comprehensive understanding of their significance in disaster risk reduction. The chapter also reviews the issues to do with effectiveness of early warning systems, the existing system's weaknesses and strengths.

2.2 Sendai Framework for Disaster Risk Reduction

The Sendai Framework for Disaster Risk Reduction (2015–2030) is an international policy embraced by United Nations member countries to direct actions aimed at minimizing disaster risks and fostering resilient communities. It focuses on four main priorities: gaining a comprehensive understanding of disaster risk, improving disaster risk governance, allocating resources towards risk reduction to enhance resilience, and boosting disaster preparedness to ensure efficient response and recovery. Tsholotsho, prone to floods and other climate hazards, benefits from the framework's emphasis on integrating scientific and indigenous knowledge for comprehensive risk understanding and management. Research in Tsholotsho has shown that indigenous knowledge plays a crucial role in flood prediction and local preparedness, complementing scientific methods such as GIS and remote sensing flood risk mapping. This aligns with the Sendai Framework's advocacy for using local knowledge to enhance early warning systems and risk governance, ensuring responses are culturally appropriate and community-specific.

Moreover, the framework's call for coordinated multi-stakeholder action is relevant in Tsholotsho, where local communities, government agencies, and development partners collaborate to develop flood hazard maps and early warning systems. Studies have highlighted the importance of community-driven early warning systems in Tsholotsho, which empower residents in risk-prone areas to anticipate and respond to flood hazards effectively, thus enhancing resilience as promoted by the Sendai Framework. The framework is widely used not only in Zimbabwe but also in countries such as Japan, Indonesia, Bangladesh, and Kenya, where it has informed national disaster risk management strategies and the development of

multi-hazard early warning systems. In the context of Tsholotsho, the Sendai Framework is highly relevant as it advocates for inclusive, community-based early warning systems that integrate both scientific and indigenous knowledge, address local vulnerabilities, and promote coordinated action among stakeholders. By aligning this study with the Sendai Framework, the research supports international best practices and underscores the importance of robust, people-centred early warning mechanisms for effective disaster risk reduction.

2.2.1 Community-Based Approaches

In Zimbabwe, practical experience shows that CBDRM empowers communities to leverage their indigenous knowledge alongside scientific methods, fostering resilience at the grassroots level. The approach involves community members identifying hazards, assessing vulnerabilities, and designing response plans that reflect their unique lived experiences and capacities, thus promoting ownership and accountability. (Dando & Dando, 2017). Community-Based Disaster Risk Management (CBDRM) is an approach that emphasizes the active involvement of local communities in disaster preparedness, response, recovery, and mitigation (Lawangen, 2023). It operates on the principle that communities are best positioned to understand their specific vulnerabilities and capacities, allowing them to develop tailored strategies for risk reduction. Thus, in Zimbabwe's context, particularly in vulnerable districts such as Tsholotsho, CBDRM stands out as a critical approach that aligns closely with global best practices while being deeply rooted in local knowledge systems and community empowerment.

Moreover, the literature highlights that existing early warning systems are often not people-centred and fail to account for the unique vulnerabilities and capacities of different social groups. There is also a lack of continuous evaluation and feedback mechanisms, which limits the ability to adapt and improve EWS in response to changing risks and community needs. Finally, while international frameworks like the Sendai Framework emphasize multi-hazard, inclusive, and community-based approaches, implementation at the local level is often weak, with limited adaptation of global best practices to local contexts. Ultimately, this approach not only aims to reduce the impacts of disasters but also contributes to sustainable development by fostering adaptive capacities and improving the overall well-being of communities (Haque, 2022). The figure below shows the processes involved in community-based disaster risk management.

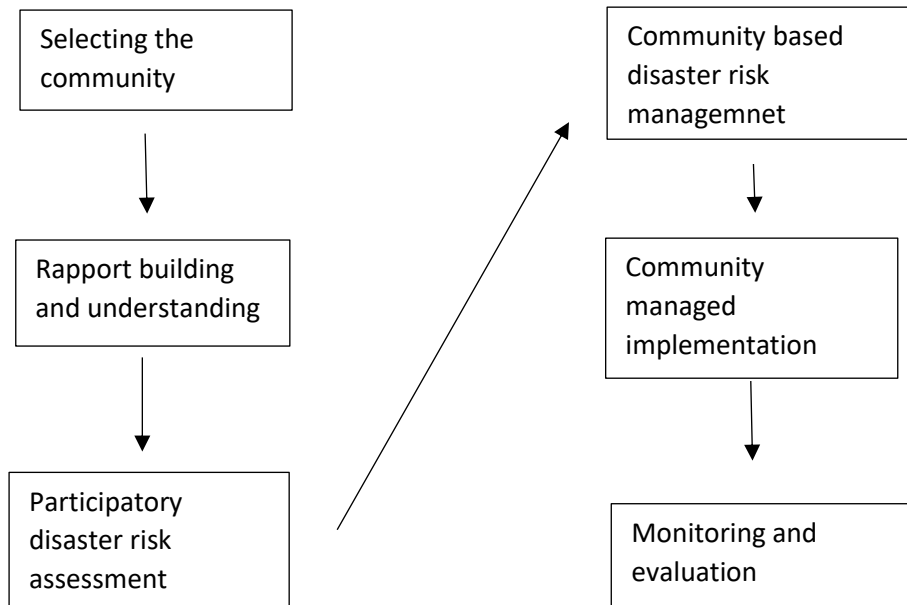


Figure 1: Community based disaster management process[Source: Dando and Dando 2017 and Lawangen 2023]

Figure 2 illustrates the comprehensive process involved in Community-Based Disaster Risk Management (CBDRM). This process typically includes key steps such as community identification and selection based on vulnerability and hazard exposure, followed by participatory hazard, vulnerability, and capacity assessments. These assessments inform the development of community-led disaster risk reduction plans that reflect local priorities. The implementation phase follows, supported by continuous monitoring and evaluation to adapt strategies over time. The figure emphasizes community participation at the center of all activities, ensuring that risk management is culturally appropriate, locally relevant, and empowering. It may also incorporate participatory tools like hazard mapping, vulnerability ranking, and capacity analysis to guide decision-making and build sustainable resilience.

2.2.2 Capacity Building

Building the capacity of individuals, communities, and institutions in Tsholotsho is critical for strengthening disaster risk reduction (DRR), especially given the district's vulnerability to recurrent floods and other climate-related hazards. Capacity building in this context involves targeted training programs for community members on flood preparedness, response strategies, and recovery processes, which leverage both scientific knowledge and local indigenous

practices. Educational initiatives help increase awareness about risk factors and early warning signals, enabling households to take timely protective actions.

2.2.3 Integration of Knowledge and Technology

DRR theory advocates for the integration of scientific knowledge, local knowledge, and technology (Sibanda & Matsa, 2020). This includes the use of early warning systems, data collection, and risk assessment tools to inform decision-making and enhance preparedness (Comes & Van de Walle, 2016).

2.2.4 Multi-Stakeholder Collaboration

Successful DRR requires collaboration among various stakeholders, including government agencies, NGOs, community organizations, and the private sector. Multi-stakeholder partnerships facilitate resource sharing, knowledge transfer, and coordinated responses to disasters.

2.2.5 Addressing Climate Change

As climate change exacerbates the frequency and intensity of disasters, DRR theory recognizes the need to link disaster risk reduction with climate change adaptation. This holistic approach addresses the underlying factors that contribute to vulnerability and promotes sustainable development (Sibanda & Matsa, 2020).

2.2.6 Sustainable Development Goals (SDGs)

DRR is closely aligned with the United Nations Sustainable Development Goals (SDGs), particularly Goal 11 (Sustainable Cities and Communities) and Goal 13 (Climate Action). Integrating DRR into sustainable development initiatives helps build resilient communities capable of withstanding future challenges (World Meteorological Organization (WMO), 2019).

Disaster Risk Reduction theory highlights the importance of understanding risk, community engagement, capacity building, and multi-stakeholder collaboration in creating resilient societies (Chisty, 2020). By adopting a comprehensive approach that integrates scientific knowledge, local practices, and sustainable development principles, communities can better prepare for and mitigate the impacts of disasters.

2.4 Disaster risk reduction cycle

The Disaster Risk Reduction (DRR) cycle provides a systematic framework for understanding and addressing disaster risks through continuous improvement. As illustrated in Figure 1, this cyclical process consists of four interconnected phases that collectively enhance community resilience when properly implemented.

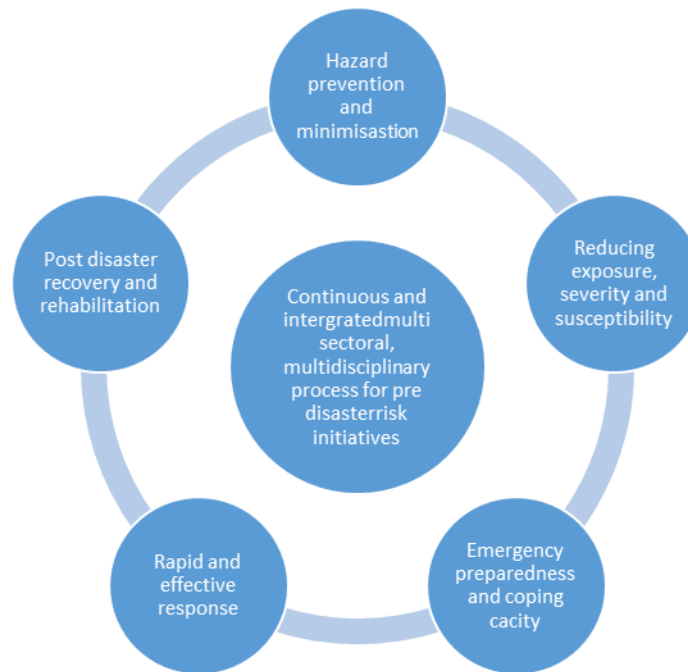


Figure 2 disaster risk reduction cycle [Source: Aker and Mbiti 2010, Bene et al 2012]

The Disaster Risk Reduction (DRR) Theory is a comprehensive framework that emphasizes proactive measures to minimize the impact of disasters through systematic planning and preparedness. Central to this theory is the understanding that disasters are not merely natural events but are exacerbated by social, economic, and environmental vulnerabilities (Aker & Mbiti, 2010). DRR advocates for a multi-faceted approach that includes risk assessment, prevention, preparedness, response, and recovery, promoting resilience in communities. It stresses the importance of integrating disaster risk considerations into development planning and policies, ensuring that communities are not only prepared for immediate threats but are also equipped to adapt to changing circumstances over time (Béné, et al., 2012).

Education and community engagement are critical pillars in Tsholotsho's DRR landscape. Community members have demonstrated deep indigenous knowledge of weather patterns and flood prediction, but the integration of this knowledge with formal early warning systems remains a challenge. Meaningful involvement of local people ensures risk communication is

culturally sensitive and tailored, increasing trust in warnings and enhancing timely protective actions. However, studies have pointed out gaps in participatory planning and the need to include social, cultural, and livelihood considerations in DRR strategies, especially in post-disaster recovery and relocation programs.

Ultimately, the DRR theory in Tsholotsho aims not only at reducing the frequency and severity of disaster impacts but also at sustaining development gains by empowering communities through knowledge, participation, and collaborative governance. This approach improves local capacities to anticipate, cope with, and recover from floods and other hazards, thus enhancing the overall well-being and resilience of the population.

Disaster Risk Reduction (DRR) theory encompasses a range of concepts, frameworks, and strategies aimed at minimizing the impact of disasters on communities and enhancing their resilience. Below are key components and principles of DRR theory:

2.5 Understanding Risk

At the core of DRR theory is the understanding of risk, which is often defined as the combination of hazard, vulnerability, and exposure. Hazard being a potentially damaging event (e.g., earthquakes, floods) that can cause harm. Vulnerability the susceptibility of a community to suffer harm due to hazards, influenced by factors such as social, economic, and environmental conditions. Exposure being presence of people, property, and infrastructure in hazard-prone areas (Ferdous, J., et al, 2015).

2.7 The concept of Early Warning System

The concept of Early Warning Systems (EWS) involves a systematic approach aimed at delivering prompt alerts about potential hazards, allowing communities to take preventive actions to reduce disaster-related risks (UNDRR, 2015). The effectiveness of Tsholotsho's EWS depends on integrating scientific data with indigenous knowledge, especially since many communities along rivers like Gwayi and Zambesi are highly vulnerable to seasonal floods. Indigenous practices, such as observing animal behaviours and natural indicators, complement formal warning mechanisms, facilitating more culturally relevant and locally trusted alerts. However, gaps persist in ensuring community members are equipped with the capacity to interpret and act on these warnings effectively.

Stakeholder cooperation including government agencies like the Civil Protection Unit, NGOs, community leaders, and local residents is crucial for improving EWS. Efforts to strengthen community participation, enhance communication channels, and adapt warnings to local socio-cultural contexts are ongoing challenges that need addressing.

While the development of early warning systems frequently emphasizes the scientific modelling of geophysical hazards, less attention is often given to assessing community vulnerability and enhancing response mechanisms (Basher, 2006). In practice, these systems tend to be managed by regional or national meteorological agencies, with minimal engagement of the local populations who are most at risk (Glantz and Baudoin, 2014). Consequently, the E2E framework tends to prioritize technological and monitoring aspects over building local capacity and preparedness.

Despite this, early warning systems are crucial in disaster risk management by promoting community readiness and resilience, thereby helping to minimize loss of life and property damage during emergencies (Agrawal, 2019). The success of an EWS depends heavily on the cooperation among diverse stakeholders—including government bodies, non-governmental organizations, local communities, and scientific experts—to ensure that accurate, timely, and actionable information reaches those who need it most (Setyawan, 2021).



Figure 3: Concept of early warning systems [Source: UNDRR 2015, Basher 2006]

2.8 Early Warning systems for DR resilience

Early Warning Systems (EWS) play a crucial role in strengthening disaster risk resilience by delivering timely and practical information that helps communities prepare for and respond to potential hazards. In Tsholotsho, ensuring community awareness and understanding of early warning systems (EWS) is crucial, especially as many vulnerable populations in remote areas rely heavily on timely, clear communication to act before flood disasters strike. Studies indicate that despite the presence of EWS, a substantial proportion of community members may hesitate to respond due to past experiences of false alarms, underscoring the importance of building trust through accurate and consistent warnings. Clear, accessible communication channels leveraging local radio, community leaders, and even indigenous knowledge signals are essential for enabling residents to interpret alerts correctly and take proactive measures, often well ahead of external help which can be delayed by hours or days. These systems facilitate effective risk communication by actively involving the intended recipients the end-users of the alerts. It is essential that communities are aware of the existence and operation of these systems, have easy access to risk warnings, and are able to correctly interpret the information provided (Chari & Novukela, 2023). Clear and understandable communication is vital to ensure that those exposed to risks, often the first victims and responders especially in remote areas affected by sudden events like flash floods can take appropriate action, sometimes before external assistance arrives, which may take hours, days, or even weeks (Glantz and Baudoin, 2014; Mercer et al., 2009).

Moreover, EWS contribute to building community resilience by promoting a preparedness culture, encouraging individuals and groups to develop personal and collective response plans based on the alerts they receive. Training sessions and simulation exercises typically accompany these systems to help community members understand how to interpret warnings and respond effectively (Blum, 2023).

In reality, early warning systems are often managed by regional or national meteorological agencies, with limited direct involvement of the local communities at risk (Glantz and Baudoin, 2014). The effectiveness of EWS improves significantly when local knowledge and traditional practices are incorporated, making the system more relevant and tailored to the specific context of the community. By connecting scientific data with community action, EWS not only lessen the immediate effects of disasters but also support long-term resilience by enhancing local capacities, speeding up recovery processes, and fostering adaptive

approaches that help communities sustain themselves amid ongoing environmental challenges (Becker et al., 2017).

2.9 Effective application of EWS in DRR

The effective application of Early Warning Systems (EWS) for Disaster Risk Reduction (DRR) is pivotal in bridging existing gaps in disaster management discourse, particularly in enhancing community resilience and preparedness. In Tsholotsho, the effective application of Early Warning Systems (EWS) for disaster risk reduction critically depends on integrating scientific forecasting with indigenous knowledge, ensuring warnings are both timely and culturally relevant. Local communities rely on traditional indicators such as dark clouds, specific bird behaviours, and tree leaf patterns to anticipate flooding alongside formal alerts from government agencies. This blend of knowledge fosters greater trust and willingness to act on warnings, overcoming challenges such as scepticism arising from past false alarms. This involves utilizing diverse communication channels such as mobile alerts, social media, and community radio to maximize reach and accessibility. Regular evaluation and adaptation of EWS are also essential, allowing systems to evolve based on feedback and changing environmental conditions (Hussain & Saddique, 2019).

In addition to technology-based early warning systems, there exist numerous traditional methods that rely less on modern technology (Mercer et al., 2009). For centuries, people have used observations of natural climate and weather patterns to anticipate natural hazards, especially in remote regions where technological early warning systems are often unavailable (Basher, 2006). Indigenous communities preserve hazard prediction and emergency response knowledge through oral traditions and storytelling (Mercer et al., 2009). This indigenous knowledge frequently incorporates bioindicators such as the behaviour of animals and insects or changes in plant life cycles to forecast climate-related hazards. These bioindicators are typically cost-effective, locally meaningful, and can foster community involvement in developing and sustaining early warning systems.

However, the reliability of bioindicators depends on their evaluation against factors like specificity, consistency, practicality, and relevance. They may not be precise enough to predict specific hazards and often provide limited advance notice since responses tend to occur after the hazard has already begun. Additionally, the accuracy of these indicators may decline as climate change alters environmental patterns (Comes & Van de Walle, 2016). Therefore, there

is a pressing need for comprehensive assessments of hazard-related bioindicators, including projections of how they might shift under global warming and strategies for integrating them into modern early warning frameworks (Zommers, 2014; Sibanda & Matsa, 2020).

2.10 Conditions for application of EWS for DRR

Early warning systems contribute to strengthening social resilience by keeping vulnerable populations informed about potential threat changes, promoting risk awareness, hazard detection, and response planning. Access to reliable technology is foundational for the success of EWS in Tsholotsho. Although the district's hazard monitoring infrastructure has limitations, telecommunications, local leadership, and support from NGOs contribute significantly to effective alert dissemination. Capacity-building efforts, including training sessions and regular simulation exercises, are essential for empowering both local authorities and community members with the skills to accurately interpret warnings and execute appropriate response actions. These preparedness initiatives promote a culture of readiness that can significantly reduce flood losses and protect livelihoods (United Nations, 2010). Regular drills and educational sessions help reinforce preparedness and ensure that lessons are retained.

Collaboration among various stakeholders is another key factor. Effective partnerships between government bodies, NGOs, and community groups enable the sharing of resources, expertise, and information, fostering a unified and efficient disaster management strategy. Moreover, continuous evaluation and feedback mechanisms are necessary to regularly assess the performance of early warning systems. These processes allow for adjustments based on community input and changing environmental conditions, ensuring that the systems remain effective and relevant over time. Education and preparedness programs are fundamental components of this effort (Alton et al., 2022).

Additionally, it is vital to have well-developed, practiced, and tested disaster management plans in place. Communities should be well-informed about safe behaviours, available evacuation routes, and strategies to minimize damage and property loss. By addressing these factors, early warning systems can greatly improve disaster risk reduction initiatives, helping to build communities that are better equipped to respond to a variety of hazards (Chisty, 2020).

2.11 Conclusion

This chapter has provided an in-depth exploration of the application of early warning systems in enhancing disaster risk resilience in Tsholotsho. It discussed the theoretical frameworks that underpin the study, defined the concept of EWS, and highlighted their contributions to disaster resilience. Additionally, the chapter examined the essential conditions for the effective implementation of EWS, emphasizing the importance of community engagement, technological access, and stakeholder collaboration. Understanding these elements is crucial for developing strategies that empower communities in Tsholotsho to better prepare for and respond to disasters, ultimately reducing vulnerability and enhancing resilience. This foundational knowledge will inform the subsequent chapters, which will focus on methodology, data collection, and analysis.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

The study area, research design, target population, sampling strategies, sample size, and data used both primary and secondary data are all explained at the beginning of this chapter. Additionally, it emphasized the use of questionnaires, interview guides, and observation checklists as data collection tools. The study continued by outlining techniques for gathering data, the process by which data was gathered, and strategies for analysing data. At the end of the chapter, there is a full summary, ethical considerations, and reliability and validation.

3.2 Description of the study area

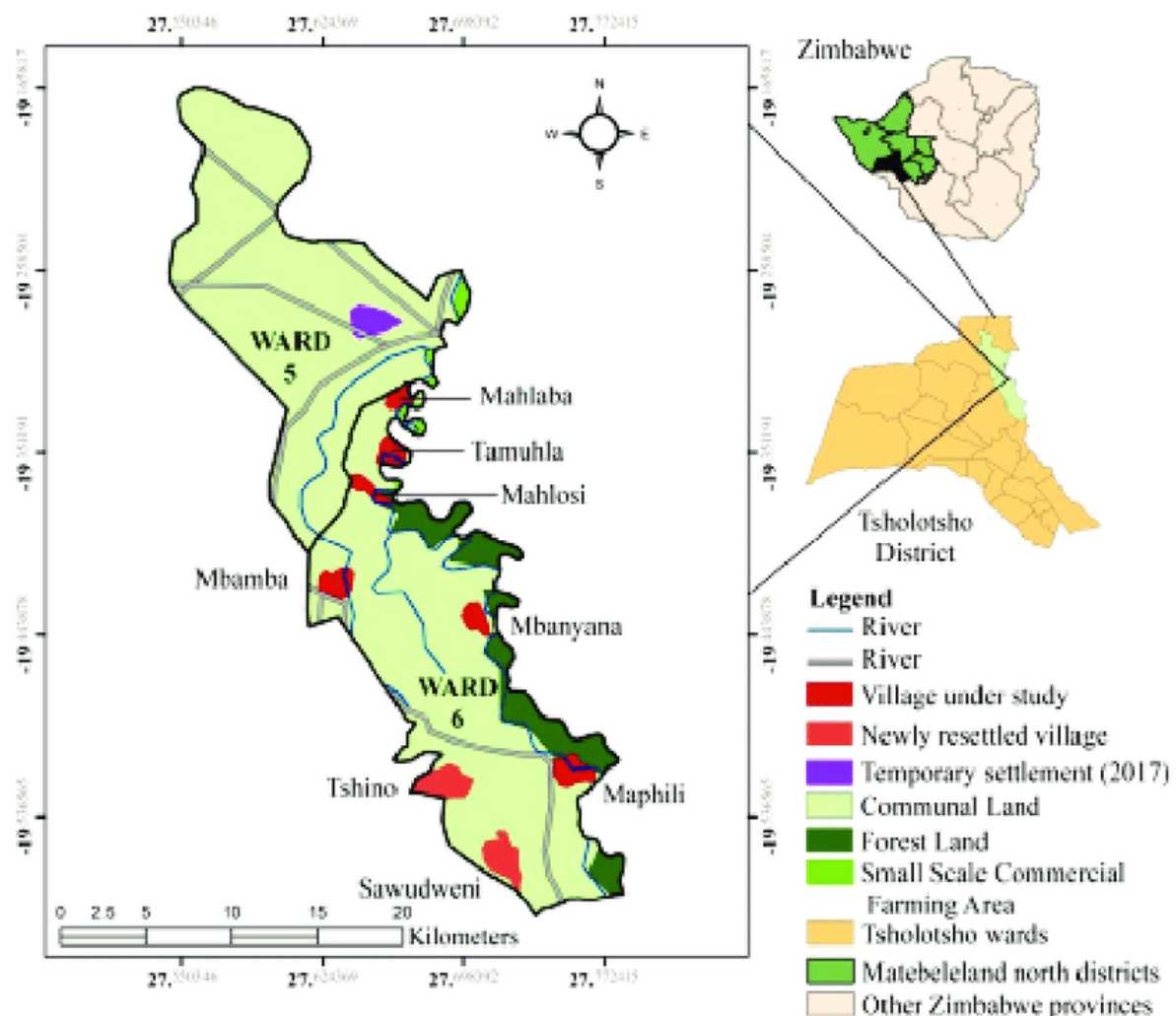


Figure 3.1 Location of Tsholotsho (Zimbabwe Google Satellite Maps, 2020)

The study was carried out in communal land of Tsholotsho, a district with unique geographical, cultural, and economic characteristics. Understanding these aspects is crucial for addressing the challenges faced by the community and promoting sustainable development in the region. The community of Tsholotsho lies in the South side of Matebeleland North Zimbabwe. It is situated approximately 60 kilometres northwest of Bulawayo, Zimbabwe's second-largest city. The district is bordered by several other districts, including Lupane to the north and Umguza to the south. The landscape of Tsholotsho is characterized by a mix of savannah and semi-arid terrain, with scattered hills and valleys. The area experiences a subtropical climate, with a distinct rainy season from November to March. The average annual rainfall is relatively low, typically ranging between 500 to 700 millimeters, which affects agricultural productivity. Tsholotsho has a diverse population, primarily composed of the Ndebele ethnic group, along with various other ethnic communities. The population is predominantly rural, with most residents engaged in subsistence farming and livestock rearing. Traditional leadership plays a significant role in community governance, and cultural practices are deeply rooted in the local society (Thebe, 2019).

The economy of Tsholotsho is largely based on agriculture, with maize, millet, and sorghum being the primary crops cultivated. Livestock farming, particularly cattle, goats, and sheep, is also common and serves as an important source of income and food security for many families. The district faces challenges such as drought, limited access to markets, and inadequate infrastructure, which hinder economic development (Phiri, et al., 2020).

Tsholotsho has limited infrastructure, with many rural communities lacking access to reliable roads, healthcare facilities, and educational institutions. The government and various NGOs have initiated programs to improve access to basic services, but challenges remain. Water scarcity is a significant issue, with many communities relying on boreholes and rivers for their water supply (Nzima, et al., 2017).

The cultural heritage of Tsholotsho is rich and diverse, with traditional dances, music, and ceremonies playing a vital role in community life. The district is known for its vibrant cultural festivals, which celebrate local traditions and promote community cohesion. The preservation of cultural practices is essential for fostering identity and resilience among residents (Nzima, et al., 2016).

Tsholotsho faces several challenges, including climate change, food insecurity, and limited economic opportunities. However, there are also opportunities for development, particularly through community-based initiatives, sustainable agriculture practices, and the promotion of eco-tourism. Enhancing disaster risk reduction strategies can help build resilience and improve the livelihoods of the people in Tsholotsho (Sibanda, et al., 2020).

3.3 Research Design

This study employed a mixed-methods design, integrating both quantitative and qualitative research methods. This is suitable for understanding the complexities of disaster risk reduction in Tsholotsho, as it allows for data collection and analysis. Planning the researcher's course of action, from developing the hypothesis and considering its operational ramifications to conducting the final data analysis, is the aim of the study design. A descriptive research design was employed in the study in an attempt to identify the features of a population or specific occurrence. Identifying disasters that had occurred before, the modal ones and the most fatal. The research also assesses the reaction of the community, to essentially establish and comprehend the source of nature, this design aids in the identification of patterns in a group's features. Through the use of a descriptive survey that included quantitative and qualitative methods, the research was able to critically examine the traits, frequency, and patterns of any form of disasters that are most likely to hit Tsholotsho.

3.5 Data collection methods

3.5.1 Primary data

Primary data was collected through questionnaires and interviews with key informants, enabling researchers to gain fresh, detailed, and context-specific insights into disaster risk and early warning systems. This approach allowed for the integration of scientific flood risk assessment methods, such as GIS and remote sensing, with indigenous knowledge systems recognized by the local communities like observing dark clouds and bird behaviours as reliable early indicators of flood hazards. Primary data collection was essential in understanding the vulnerability and preparedness of households, capturing local perceptions and experiences that secondary data could not provide. This rich, trustworthy information supports the development of culturally relevant, effective community-based disaster risk reduction strategies and early warning systems tailored to Tsholotsho's unique environmental and social context. The emphasis on primary research as foundational is supported by methodological literature

highlighting its value in disaster preparedness and response research (Norris, 2006; Khan, 2015; Wolbers et al., 2021).

3.5.2 Secondary data

Secondary data used in this study refers to information originally collected by others for purposes different from the current research but later reviewed, evaluated, and repurposed to support this study's objectives. This data type is important because it offers readily accessible, cost-effective resources such as published documents, clinical reports, government records, and previous research findings, which provide valuable background and broader contextual insights. Using secondary data enables comparison and triangulation with primary data to enhance the reliability and depth of the research outcomes. Despite its advantages, researchers must critically evaluate the relevance, accuracy, and timeliness of secondary data to mitigate potential biases or gaps (Scribbr, 2024; Indeed, 2025; Qualtrics, 2023; Formplus, 2020).

3.6 Sampling Strategy

Participants were picked from at random. A total of 200 participants were picked. A stratified random sampling method were used to select participants from various sectors of the community (e.g., farmers, local leaders, and residents). With probability sampling, the likelihood of each person being chosen at random from the population is known and equal. This makes it possible to draw statistical conclusions about the population and to generalize the findings with a known degree of confidence. Every member of the population has a chance of being chosen in this kind of sampling since randomness is used to choose participants rather than convenience or subjective opinion. Probability sampling was employed in this study to choose participants from the intended audience. Probability sampling is crucial for reducing bias, boosting the validity of statistical conclusions, and facilitating generalizations about the target population.

Purposive sampling will be employed to select key informants for interviews, including community leaders, NGO representatives, and disaster management officials. People with specific knowledge, skills, or insights who may offer insightful opinions are referred to as key informants. Considering skilled people such as teachers, counsellors, retired elders and elderly group. The elderly group was used as source of information through told stories.

To choose the key informants, non-probability sampling was used in the study. When using a non-probability sampling technique, it is unknown how likely it is that any given member of

the population will be chosen. This indicates that, unlike in probability sampling, the results cannot be confidently extrapolated to a wider population. Non-probability sampling selects participants for the sample using factors other than chance. Non-probability sampling was used in this study to choose healthcare practitioners who met the study's criteria and had relevant experience.

3.7 Sample size

I used a sample size of 200 people by randomly picking participants because it's enough to represent the population. Selecting a suitable sample size is a critical component of research design since it affects the validity, reliability, and generalizability of the study's conclusions. Several criteria must be considered to determine the right sample size, including the goals of the study, the predicted effect size, the desired level of statistical significance, and the expected rate of participant attrition. Sample size calculations in probability sampling are frequently based on statistical formulas that consider the population size, the predicted effect size, and the desired degree of confidence. While the population parameters may not be known when using non-probability sampling, determining the sample size is frequently more difficult. In these situations, rules, prior studies, or pragmatic factors may be used by researchers to establish the proper sample size.

3.8 Data Collection Methods

According to Gray (2004), there are a number of factors to consider when selecting data collection techniques, the most important of which are the type of information being sought and the degree of interaction one hopes to have with the participants. The researcher's goal in this study to obtain detailed data and a comprehensive understanding of the research participants' lived experiences. Taking this into account, the researcher collected data from the research participants through questionnaires, focused group discussions, key informant interviews and documentary analysis.

3.8.1 Questionnaire

In this study, standardized questionnaires were administered to community members, specifically targeting residents in flood-prone areas, to effectively collect quantitative data. These questionnaires included a mix of closed-ended, open-ended, and scaled questions designed to assess critical factors such as community knowledge of flood risks, previous flood experiences, access to early warning information, preparedness measures, and attitudes toward flood risk reduction strategies. The design of these questionnaires followed best practices in disaster research, ensuring clarity, cultural relevance, and unbiased framing to generate reliable

and actionable data (ACAPS, 2019; Supersurvey, 2007). This method enabled the collection of comprehensive and nuanced information vital for understanding community vulnerability and resilience in the context of Tsholotsho's flood hazard environment. The use of diverse question types facilitated a balanced capture of both statistical trends and personal insights, supporting well-rounded analysis for improving local disaster risk management interventions. In this study, standardized questionnaires were administered to community members in flood-prone areas to effectively gather quantitative data. The questionnaires comprised closed-ended, open-ended, and scaled questions designed to assess critical factors such as knowledge of flood risks, previous experiences with flooding, access to early warning information, preparedness behaviours, and attitudes toward flood risk mitigation strategies. The questionnaire design adhered to best practices in disaster research, ensuring clarity, cultural sensitivity, and unbiased wording to collect reliable and relevant data (ACAPS, 2019; Supersurvey, 2007). This approach allowed for comprehensive capture of both statistical trends and in-depth personal insights, providing valuable information to inform targeted disaster risk reduction strategies within the Tsholotsho context. Previous studies, such as Mavhura et al. (2013), have successfully used questionnaires to assess community disaster preparedness in Zimbabwe.

3.8.2 Focus Group Discussions

Focus group discussions (FGDs) were conducted with community members in flood-prone areas to gather qualitative data on local experiences, perceptions, and responses to flood hazards. The FGDs included open-ended questions and guided discussions designed to explore key topics such as community awareness of flood risks, the role of indigenous knowledge in early warning, accessibility and trust in existing warning systems, and collective preparedness strategies. FGDs were organized with diverse groups, including women, youth, farmers, and elders. Each session was facilitated using a discussion guide, and participants were encouraged to share their experiences and opinions on disaster warnings, preparedness, and response. FGDs addressed variables such as:

- Community perceptions of risk and vulnerability
- Effectiveness and accessibility of early warning messages
- Barriers to action and cultural influences
- Suggestions for improving EWS

FGDs are justified for their ability to generate interactive discussions and uncover shared norms and values influencing disaster response. This method has been effectively employed in

disaster studies, such as by Gwimbi (2009), who used FGDs to assess flood risk perceptions in southern Africa. Among the methods used, focus group discussions were particularly valuable for capturing the nuanced, collective experiences of community members and for revealing cultural and social factors that influence disaster response. FGDs allowed for the emergence of group consensus and highlighted differences in perspectives across demographic groups, providing insights that would not have been accessible through individual surveys or interviews alone. As demonstrated by Gwimbi (2009), FGDs are especially effective in rural African settings where oral communication is a preferred mode of knowledge sharing.

3.9 Data analysis techniques

Data analysis is a critical phase in any research study, involving systematic procedures to make sense of the collected information. According to Creswell (1998) and Stake (1995), as cited in Leedy and Ormrod (2001:150), data analysis generally follows five essential steps, all of which were applied in this study to ensure thorough examination of the data. The first step involves organizing the data. In this study, the information gathered from various respondents was carefully arranged in a logical and coherent order. This organization facilitates easier handling and review of the data, setting the foundation for deeper analysis. Once organized, the data was categorized into meaningful groups. By clustering related information, the study was able to identify trends and commonalities as observed by the respondents, providing a clearer understanding of the data's overall structure. The third step focused on the interpretation of individual cases. Each questionnaire was examined to determine its relevance and how it applied to the research problem. This detailed review helped ensure that the data used was pertinent and meaningful for addressing the study's objectives. Following this, the data was analyzed to identify patterns. By looking for recurring themes and relationships, the study aimed to uncover underlying issues or insights that could contribute to resolving the research problem. Finally, the synthesis and generalization step involved developing an overarching picture from the gathered data. This process allowed the researcher to draw preliminary conclusions and gain new insights, guiding further interpretation and understanding of the findings. To support the analysis of quantitative data, the study employed Predictive Analytic Software (PASW) Statistics version 18 formerly known as the Statistical Package for Social Sciences (SPSS) alongside Microsoft Excel. These tools facilitated efficient data processing and statistical analysis. Qualitative data, however, was analysed manually, allowing for a nuanced and context-sensitive interpretation of open-ended responses. Through this structured

approach to data analysis, the study ensured a comprehensive and systematic examination of the information collected, ultimately enhancing the reliability and validity of its conclusions.

3.10 Reliability and validity

More than one technique of data collecting was employed to guarantee the applicability of the study findings. One method to assure validity was to use a variety of data collection instruments, including questionnaires, observations, and interviews. To validate the results, these procedures were triangulated. Confidentiality was assured to the responders, as was the fact that the study was being done only for academic purposes. Because of this, individuals were able to submit information without hesitation, which raised the research's credibility. To make sure they meet the study's goals, the data and outcomes were constantly examined and confirmed. To guarantee consistency in data collection, a checklist was used throughout the field observations to make sure that every observation was completed carefully. The study had to be extremely confident that the interview guide and questions would be successful in gathering the needed data before distributing the questionnaires and conducting the interviews. The interview guide and the questionnaire were pilot-tested to get a high degree of confidence. As it aids in identifying possible problems and improving the research methods, the pilot study is a crucial stage in the research process. The primary goal of the pilot study was to enable an analysis of the respondents' responses to pinpoint the questionnaire and interview guide's shortcomings.

3. 11 Ethical Considerations

This study rigorously adhered to established ethical guidelines to protect the rights and confidentiality of all participants involved. Prior to data collection, informed consent was obtained from each participant, ensuring that they were fully aware of the study's purpose and procedures. Participants were also assured that their responses would be kept confidential and that their identities would remain anonymous throughout the research process. Furthermore, they were informed of their right to withdraw from the study at any point without facing any penalties or negative consequences. The importance of ethics in research is well documented. Kant (1785) described ethical issues as moral questions and challenges that arise during research, encompassing how participants are treated, how data is collected and analysed, and how research findings are utilized. Adhering to ethical principles is therefore paramount to conducting responsible and credible research. In this study, the researcher followed the guidelines outlined by Creswell (2005) and Flick (2004), who emphasize the significance of

ethics in safeguarding participants across all fields of study. Flick (2014) further stresses that ethical considerations are fundamental to protecting participants' welfare and dignity. The principle of autonomy, as articulated by Belmont (1979), underpins the ethical framework of this research. This principle asserts that participants have the right to make informed decisions about their involvement in a study. They must receive comprehensive information about the research, understand it fully, and participate voluntarily without any coercion or undue pressure. The researcher made every effort to meet these conditions, ensuring that informed consent was genuinely obtained. Protecting participants' privacy was another critical ethical concern. Lever (2000) highlights the necessity of maintaining confidentiality and anonymity, particularly when dealing with personal or sensitive data. To uphold this, the researcher used pseudonyms fictitious names to protect the identities of participants, thereby preventing any data from being traced back to individuals. Grey (2007) supports this approach, emphasizing the importance of safeguarding participants' identities throughout the research process. Finally, in line with Flick's (2014) assertion that researchers should avoid causing harm, the study was conducted in a manner that ensured no participant experienced any physical, psychological, or emotional harm. The researcher confidently confirms that all participants remained safe and unharmed during the entire research process. In summary, this study was guided by a strong ethical framework that respected participants' autonomy, ensured confidentiality, and prioritized their safety, thereby upholding the highest standards of research integrity.

3.12 Conclusion

This chapter has described the methodological framework for the study, detailing the research design, data sources, sampling strategies, data collection and analysis methods, and ethical safeguards. The chosen methodology ensures a rigorous and comprehensive approach to understanding the application of early warning systems for disaster risk resilience in Tsholotsho.

CHAPTER 4: RESULTS AND DISCUSSION

4.1 Introduction

This chapter systematically addresses each research objective by first identifying the existing early warning systems in the district, then evaluating their effectiveness in reducing disaster risks, and finally examining the conditions that enable or hinder their use. Through the analysis of both quantitative and qualitative data gathered from community surveys, interviews, and focus group discussions, this chapter interprets the findings in light of the local context and relevant literature. The discussion highlights key trends, challenges, and opportunities, offering insights into how early warning systems can be strengthened to build resilience and enhance disaster preparedness in Tsholotsho.

4.2 Demographic data

The study involved a total sample of 200 participants drawn randomly from Tsholotsho district population using a stratified random sampling approach to ensure representation across different community sectors farmers, local leaders and residents. The table below summarizes the demographic characteristics of the study participants from the flood-affected communities. It provides an overview of key attributes including gender, age distribution, community of residence, education levels, and occupation. This demographic profile helps contextualize the sample population's socio-economic and cultural background, which is vital for understanding their vulnerability and preparedness related to flood risks. Presenting these statistics enables clear visualization of participant diversity and supports subsequent analysis on how demographic factors influence disaster risk perception and response behaviours.

Demographic Variable	Categories	Number of Respondents	Percentage (%)
Gender	Male	91	53,8%
	Female	78	46,2%
Age Group (years)	18 – 25	24	14,2%
	26 – 35	42	24,9%
	36 – 45	36	21,3%
	46 – 55	35	20,7%
	56 and above	32	18,9%
Community	Ganaja	67	39,6%
	Gadumo	53	31,4%

	Adankolo	49	29%
Education level	No formal education	46	27,2%
	Primary school	69	40,8%
	Secondary school	40	23,7%
	Tertiary education	14	8,3%
Occupation	Farmer	88	52.1%
	Trader	45	26.6%
	Other	36	21.3%

4.2 Early warning systems in Tsholotsho

The study identified formal and informal early warning systems used in Tsholotsho. The major sources of EW information mentioned by the participants are presented below.

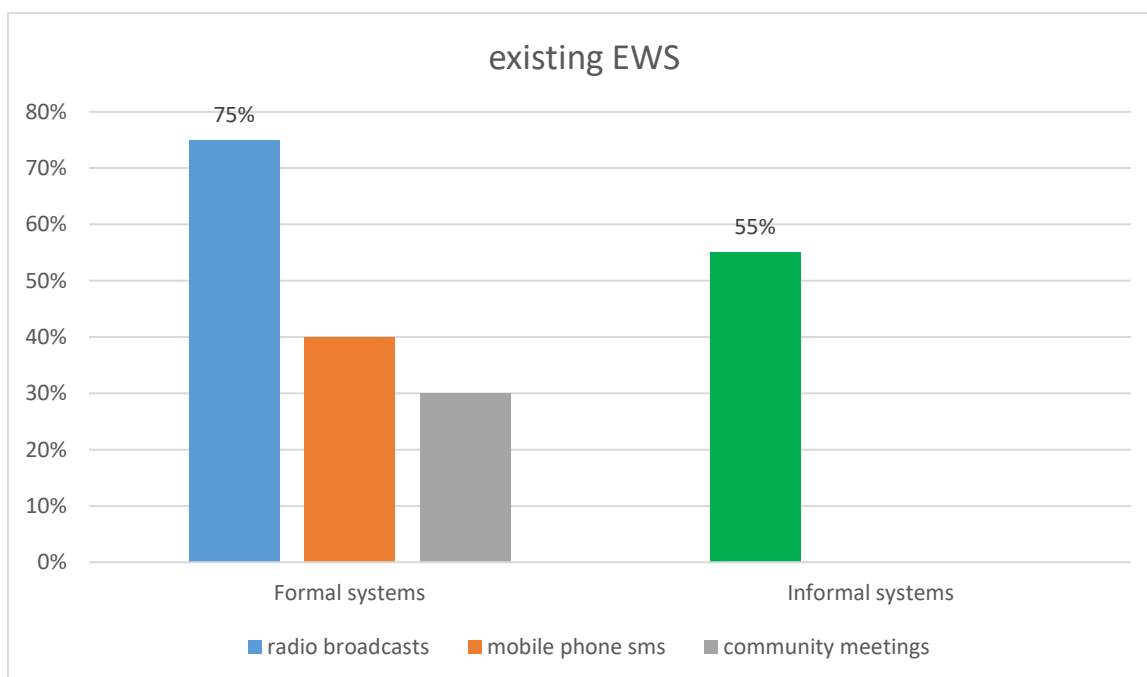


Figure 4 Existing EWS

The respondents indicated that numerous community meetings are regularly convened and facilitated by various stakeholders. Despite this, the information shared during these gatherings tends to be presented in a uniform manner, without tailoring to the specific needs of special interest groups such as people with disabilities, the elderly, and children. Additionally, considerations related to gender dynamics are often overlooked, which may limit the effectiveness and inclusivity of the communication within these meetings. The majority of respondents (65%) were aware of formal early warning systems, primarily those operated by

the Zimbabwe Meteorological Services Department (MSD) and the District Civil Protection Committee. Formal warnings are disseminated mainly through radio broadcasts (75%), mobile phone SMS (40%), and community meetings (30%). Only 20% of respondents had received direct alerts from local government or NGOs in the past year. 55% of participants reported using traditional indicators for predicting hazards, such as animal behaviour, indigenous weather observations, and local elders' advice. Community meetings and word-of-mouth remain important for warning dissemination, especially in remote areas with poor network coverage. There is uneven coverage, with remote wards less likely to receive timely warnings.

4.3 Assessment on Awareness of disasters

Awareness levels varied significantly across age groups. The table 1 below shows the data for the awareness of people on disaster risk reduction. The table was used to plot fig 6.

Age groups	0-12	13-25	26-40	40-60	60+
% Aware of disaster reduction	0	43	59	39	67
% Not aware	100	57	41	61	33

Table 1: disaster awareness assessments

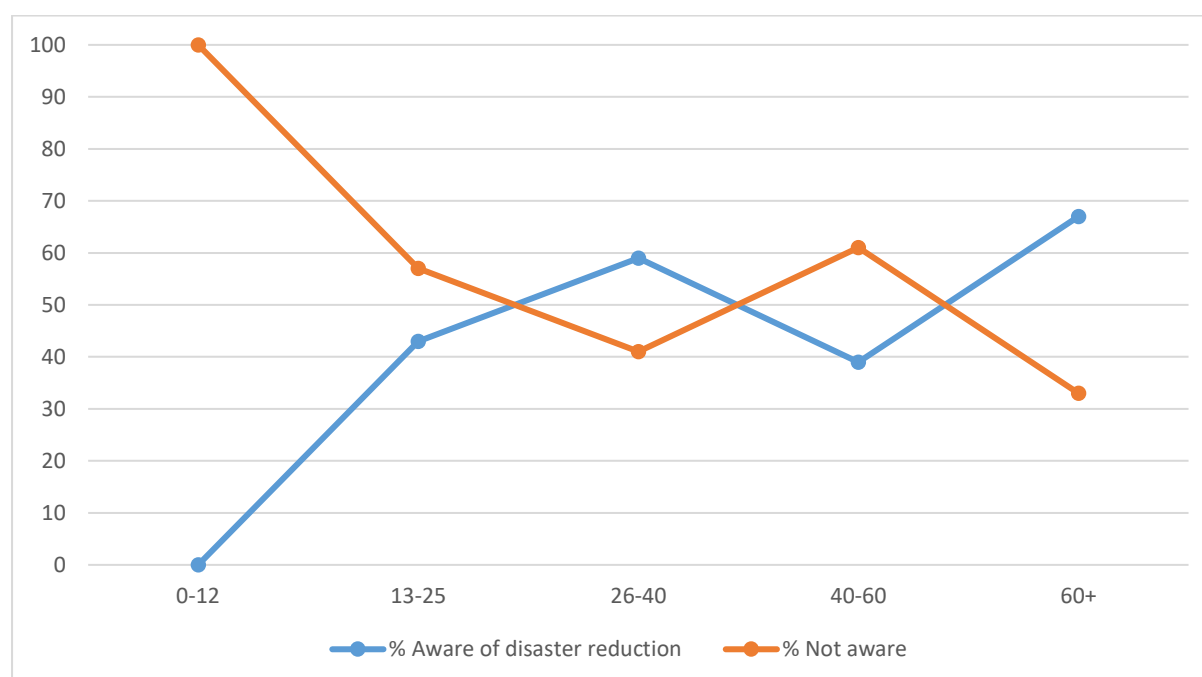


Figure 5: Awareness of Disaster

The graph shows that the age group 0-12 have not knowledge about disasters. This could be due to no experience about disasters and little education. Awareness generally increases with increase in age, this due to education and experience. Awareness in the 60+ age group is due to experience.

Conclusion drawn here is that people in Tsholotsho need educative campaigns on risk reduction and disaster awareness.

4.4 Adequacy of EWS

Findings revealed that a significant majority 76% of the sampled population considered the current EWS to be inadequate. Within this group, 87% reported that the early warning systems were largely inaccessible, while the remaining 13% noted that some warning mechanisms were implemented primarily at higher administrative levels, such as the provincial level, making them difficult to understand and apply locally. Conversely, 21% of respondents believed that the early warning systems themselves were adequate but identified the administrative structures responsible for enforcing these warnings as needing improvement. This group emphasized that revising administrative arrangements could enhance the effectiveness of EWS enforcement. A small portion, 3%, expressed indifference toward the adequacy of the early warning systems, which may reflect a limited awareness or understanding of the subject. The distribution of these perspectives is illustrated in the accompanying pie chart

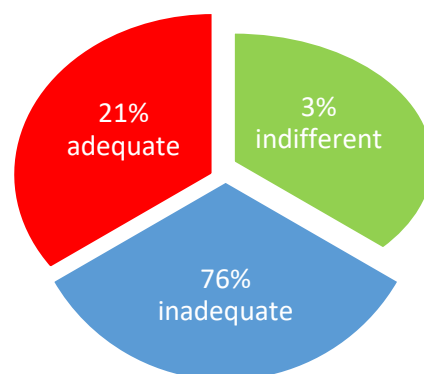


Fig 9. Adequacy of Early warning systems in Tsholotsho

4.5 Results from assessment of communication lines in Tsholotsho

Communication infrastructure was identified as critical bottleneck. Table 4 below show the results from assessment of communication lines that available in Tsholotsho.

Communication type	People who have the facility out of 10	Availability Rating out of 10	Comments
Mobile networks	5	6	Moderate coverage over town centre but patch or absent in Rural areas.
Internet Access	0.5	4	Slow speeds
Radio	1	9	Most reliable widely used
TV Signals	0.5	3	Poor reception in many areas
Satellite dish	0.5	6	Network available but few people can afford
Landline phone	0.05	2	Almost non-existent in the rural areas of Tsholotsho
Postal Services	0	3	Rarely used due to delays

Figure 8 below shows the availability of communication networks in Tsholotsho. Table 4 above was used to plot the graph in figure 8.

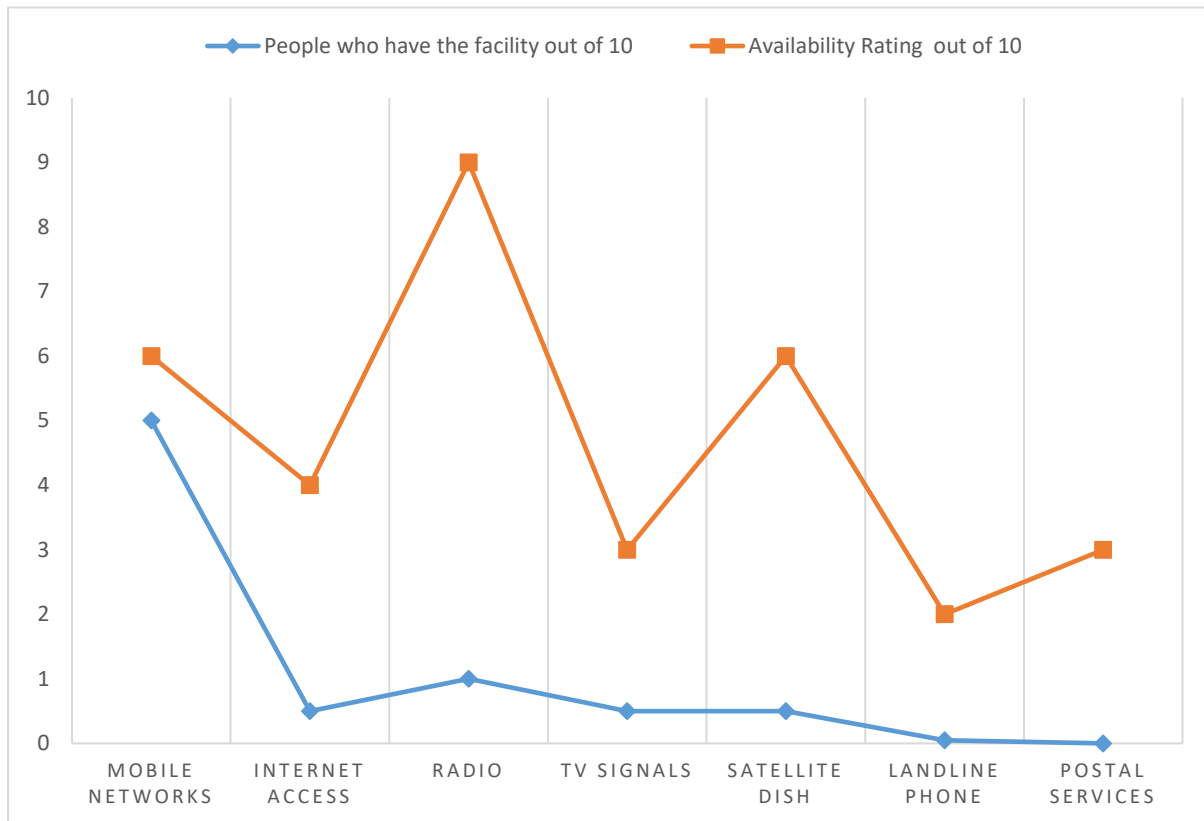


Figure 6: Availability of networks in Tsholotsho

The graph shows that there is a large number of people with mobile phones however, there is no reliable mobile network. There is good radio network however only few individuals use radio, as form of communication. Reliable communication, strong institutions, and community ownership are critical for building disaster resilience. The lack of regular drills and low trust in official warnings highlight the need for ongoing community education and feedback mechanisms.

4.6 Conclusion

This chapter has presented the analysis of data collected from the research done on the application of early warning systems for resilience-focused disaster risk reduction in Tsholotsho District. The findings indicate that while awareness of early warning systems among community members is growing, significant gaps remain in accessibility, responsiveness, and coverage. Mobile networks and radio broadcasts were identified as the most relied-upon communication channels, but issues such as poor signal strength and limited internet access still hinder timely dissemination of alerts. The data also revealed that local

preparedness and response capacity are directly influenced by the clarity, frequency, and reliability of warnings issued. These insights are vital for informing more targeted interventions and infrastructure improvements.

CHAPTER 5: STUDY SUMMARY, CONCLUSIONS AND RECOMMENDATIONS.

5.1 Introduction

This chapter presents a synthesis of the study findings, draws conclusions, and offers recommendations for enhancing early warning systems (EWS) for disaster risk reduction (DRR) in Tsholotsho.

5.2 Summary

The study identified a combination of formal and informal early warning systems (EWS) in Tsholotsho. Formal systems included meteorological alerts from the Zimbabwe Meteorological Services Department (MSD), radio broadcasts, mobile SMS, and community meetings facilitated by the District Civil Protection Committee and NGOs. However, these systems were limited in reach, particularly in remote areas due to poor infrastructure. Informal systems, such as traditional indicators e.g., animal behavior, indigenous weather observations, and elders' advice, were widely trusted but lacked integration with formal mechanisms. The coexistence of these systems highlighted a dual-track approach, though their disjointed operation reduced overall effectiveness.

The effectiveness of EWS was hindered by several challenges. Only 40% of respondents received timely alerts, and fewer (25%) acted on them due to mistrust, unclear messaging, and inadequate preparedness activities. Communication barriers, such as poor mobile network coverage and low internet penetration, further limited dissemination. While communities with prior disaster exposure showed better responsiveness, the lack of tailored warnings for vulnerable groups (e.g., elderly, disabled) and minimal community drills underscored systemic gaps. Traditional systems, though culturally relevant, were not scientifically validated, leading to potential inaccuracies.

Effective EWS implementation required robust communication infrastructure, institutional coordination, and community participation. Radios and mobile phones were primary channels, but coverage gaps persisted in rural areas. Fragmented stakeholder collaboration weakened warning coherence, while low community involvement in EWS design reduced trust and adoption. Key enabling conditions included integrating indigenous knowledge with scientific forecasts, gender-sensitive approaches, and capacity-building programs. Political will and policy support were also critical to sustain investments in infrastructure and training, ensuring long-term resilience.

5.4 Conclusions

This study set out to investigate the effectiveness of early warning systems (EWS) in enhancing disaster risk resilience in Tsholotsho, where recurrent natural hazards such as floods and droughts have severely impacted livelihoods. The central problem identified was the fragmented and under-resourced nature of the current EWS, combined with a lack of community integration and trust in the formal alert systems. Based on findings, it is evident that the ineffectiveness of these systems stems primarily from infrastructural weaknesses, poor communication channels, and insufficient community engagement.

The causative link between the limited reach of formal warning systems and high vulnerability is clear, communities in remote areas remain largely uninformed or misinformed during hazard events, increasing their exposure to risk. Similarly, the absence of coordinated efforts among stakeholders has resulted in disjointed messaging and reactive rather than proactive responses. The research also established that where disaster awareness and preparedness levels were high, community response to warnings improved significantly, indicating a direct correlation between public education and resilience.

Conclusively, the failure to effectively blend formal scientific systems with trusted local knowledge has undermined the reliability and cultural relevance of EWS in Tsholotsho. For EWS to truly serve their purpose, they must be community-centred, inclusive, and backed by robust institutional frameworks. This study underscores the urgent need for strategic investments in infrastructure, community training, and policy alignment to address the root causes of EWS ineffectiveness and to foster a culture of early action and risk-informed decision-making.

5.4 Recommendations

The study identified both formal and informal EWS operating in Tsholotsho, but their effectiveness is limited by fragmentation and infrastructure gaps. To strengthen these systems, policymakers and disaster management agencies should prioritize expanding communication networks, particularly in remote areas where mobile and internet coverage is weak. Investments in community radio stations, solar-powered alert systems, and last-mile communication technologies e.g., sirens, local messengers would ensure warnings reach all residents. Additionally, formalizing the integration of indigenous knowledge such as traditional weather forecasting methods into official EWS would enhance cultural relevance and trust. A centralized, real-time hazard monitoring database, accessible to government agencies, NGOs, and local leaders, should be established to improve coordination and data sharing.

The study found that even when warnings are issued, many community members do not act due to mistrust, unclear messaging, or lack of preparedness. To bridge this gap, regular disaster simulation drills and public awareness campaigns should be conducted to familiarize residents with response protocols. Warning messages must be simplified and tailored to different groups using visual aids for the illiterate, local languages for clarity, and targeted alerts for vulnerable populations (e.g., the elderly, disabled, and children). Trust in formal EWS can be strengthened by ensuring transparency in forecasting, involving community leaders in verification processes, and providing feedback mechanisms where residents can report false alarms or suggest improvements. Furthermore, partnerships with local schools and women's groups could enhance risk education and ensure broader societal engagement in disaster preparedness.

For EWS to be sustainable, institutional and policy frameworks must be reinforced. A district-level DRR coordination platform should be established, bringing together government agencies, NGOs, traditional leaders, and community representatives to streamline disaster response efforts. Capacity-building initiatives such as training local volunteers in emergency response, integrating DRR into school curricula, and conducting gender-sensitive disaster workshops would empower communities to take proactive measures. Finally, policymakers must advocate for dedicated funding for EWS maintenance, climate adaptation projects, and infrastructure upgrades, ensuring alignment with national strategies like the Sendai Framework. By addressing these structural and participatory gaps, Tsholotsho can build a more resilient and responsive early warning ecosystem.

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Appendices

Appendix 1: in depth interview guide

I am Trouble Mazheke, a student at Bindura University studying disaster management. Currently, I am conducting a research on application of early warning systems for enhancing resilience against disaster risk in Tsholotsho. I am appealing for your assistance, contribution and relevant information regarding to the research. The information gathered in this research will be solely used for academic purposes.

Interviewer _____ Date: _____ Start Time: _____

Respondent's Name: _____ Gender: _____ Age _____

Organisation and designation: _____

Geographical areas under respondent's jurisdiction: _____

Postal Address: _____ Tel No: Landline/s _____

Mobile _____ Fax: _____ E-mail _____ Can

you please describe your role in this community and the role of your organisation?

THEME	Question (s)	Response(s)
Disaster management and DRR practice.	• Major hazards in the area? And their frequency? • How does drought rank amongst the hazards? Internal capacities used in the event of drought occurrence? • External support usually received and from who? • How is the vulnerability and risk assessed?	

	• How is hazard assessment done? • What preparedness measures are put in place after the risk assessments?	
Linkage between development and utilisation of EWS	• Who develops DEWS? How are these reviewed? Who uses DEWS? • How are EW messages shared? By who? • How do the receivers of messages respond?	
Challenges in integration of EWS in DRR.	• What are the challenges faced in using all the EWS that are available? At district and local levels? • Which EWS are used more regularly and why? Which ones are not and why?	
Determine whether more EWS can improve DRR	• Are the EWS in the district adequate? If not, which EWS need improvement?	
Recommendations	• What can be done to improve DRR, EW and Drought Early warning in the district? • Which stakeholders are critical in this process? What resources are needed	

****Thank you for participation and ask if they have any questions****

Appendix 2: Questionnaire for Community Disaster Risk Management Study in Tsholotsho

I am Trouble Mazheke, a student at Bindura University studying disaster management.

Currently, I am conducting a research on application of early warning systems for enhancing resilience against disaster risk in Tsholotsho. I am appealing for your assistance, contribution and relevant information regarding to the research. The information gathered in this research will be solely used for academic purposes.

Section 1: Demographic Information

Age: _____

Gender: ☐ Male ☐ Female ☐ Other

Occupation: _____ (e.g., subsistence farming, informal trade)

Educational Level: ☐ No formal education ☐ Primary ☐ Secondary ☐ Tertiary

Length of residence in Tsholotsho community: _____ years

Section 2: Disaster Risk Perception in Tsholotsho

6. What types of disasters have most affected Tsholotsho? (Tick all that apply)

☐ Floods ☐ Drought ☐ Storms ☐ Other (specify): _____

7. How often do floods or other disasters occur in your area?

☐ Frequently ☐ Occasionally ☐ Rarely

8. How vulnerable do you feel your household is to flooding and related hazards?

☐ High ☐ Moderate ☐ Low

Section 3: Community Participation and Knowledge

9. Are you aware of any community disaster risk management programs or early warning initiatives in Tsholotsho? ☐ Yes ☐ No

10. Have you actively participated in any disaster preparedness, response, or recovery activities within your community?

☐ Yes ☐ No

11. Which sources do you trust for early warning information in Tsholotsho? (e.g., local leaders, radio stations, village messengers, traditional indicators)

12. How effective are these early warning systems in giving you enough time to prepare?

☐ Very effective ☐ Somewhat effective ☐ Not effective

Section 4: Indigenous Knowledge and Cultural Practices in Tsholotsho

13. Does your community use traditional methods or indigenous knowledge to predict floods or other disasters?

☐ Yes ☐ No

14. If yes, please describe some of the traditional indicators or practices used (e.g., animal behavior, weather patterns, signs in nature):

Section 5: Local Challenges and Recommendations

15. What challenges does Tsholotsho face regarding flood preparedness and disaster response? (e.g., limited resources, communication barriers)

16. What improvements would you suggest to make early warning systems and disaster management more effective in Tsholotsho?

Appendix 3: Focus Group Discussion Guide for Community Disaster Risk Management in Tsholotsho

I am Trouble Mazheke, a student at Bindura University studying disaster management.

Currently, I am conducting a research on application of early warning systems for enhancing resilience against disaster risk in Tsholotsho. I am appealing for your assistance, contribution and relevant information regarding to the research. The information gathered in this research will be solely used for academic purposes.

1. Community Disaster Experience and Awareness in Tsholotsho

- What types of disasters have recently impacted Tsholotsho, especially flooding?
- How do community members usually respond when floods or other hazards strike?

2. Local Early Warning Systems and Communication

- What early warning systems exist in Tsholotsho? How are warnings communicated?
- Are these warnings trusted and understood by all community members, including vulnerable groups (e.g., elderly, women, children)?
- Are warnings timely enough to allow adequate preparation?

3. Community Involvement in Disaster Risk Management

- How are local people involved in planning and implementing disaster preparedness activities?
- What roles do traditional leaders, community groups, and local government play in disaster risk management?

4. Indigenous Knowledge and Its Role

- What traditional knowledge is used by Tsholotsho people to anticipate floods or other hazards?
- How well is this traditional knowledge integrated with scientific early warning efforts?
- Are there any cultural beliefs that affect how people respond to warnings?

5. Barriers to Effective Disaster Risk Management

- What are the biggest challenges Tsholotsho faces in managing flood risks and disasters? Consider economic, social, infrastructural, and communication challenges.

- How do cultural factors influence disaster preparedness and response?

6. Suggestions for Improvement

- What measures could improve early warning systems and disaster management coordination in Tsholotsho?
- How can external agencies (government, NGOs) better support the community's disaster risk reduction efforts?