Effectiveness of Institutional Flood Adaptation Actions and Plans in Vhembe District Municipality, South Africa

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DECLARATION

I declare that **Effectiveness of Institutional Flood Adaptation Actions and Plans in Vhembe District Municipality, South Africa** is my work and all the sources that I have used or quoted have been indicated and acknowledged by means of complete references and that this work has not been submitted before for other degree at any other institution

Nwanamidwa Pfarelo . . . 27/01/2025

Full names **Date**

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DEDICATION

To myself, with most profound admiration for the resilience and courage that carried me through this challenging journey. I am incredibly proud of the person I have become.

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ACKNOWLEDGMENTS

Firstly, I thank God for knowledge, wisdom, and understanding, for strengthening me throughout my research, and for giving me the ability to stay positive and make it this far.

I am grateful for the SAF-ADAPT scholarship, which made my life easy, prevented me from having any financial challenges, and made sure that I am well-funded, and all my fees covered. I am thankful for my exposure during my academic years, showing me that there is more to do and achieve out there.

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ABSTRACT

The increasing frequency of climate-related disasters, including floods, can be attributed to a complex connection of environmental and anthropogenic factors. Proactive adaptation actions and plans are crucial for reducing flood risks and consequences, particularly in vulnerable rural communities. South Africa has made significant progress in flood risk reduction but face challenges in balancing structural measures with local adaptation strategies. Vhembe District Municipality experiences heavy rainfall, leading to floods, particularly in low-lying areas. This study, therefore analysed the perceived effectiveness of existing flood adaptation actions and plans used in response to flood disasters in Vhembe District Municipality and provide recommendations to enhance the effectiveness of the adaptation actions and plans. This study utilised a mixed-method approach, combining questionnaires, key informants interviews, and document reviews to comprehensively assess the effectiveness of flood adaptation actions and plans.The study identified various adaptation actions, measures, legal frameworks and acts used in response to flood disasters; this encompasses a range of measures, including structural, non-structural, and institutional approaches, such as the construction of flood barriers, and levees, early warning systems, and community response teams. The findings show that the nature of flood adaptation planning within Vhembe District Municipality is not inclusive; community members are not involved when planning, designing, and decision-making of the adaptation plans. The findings reveal that the perceived effectiveness of the existing adaptation actions and plans is inadequate and ineffective, which highlights that there is a significant need for improvement in the flood adaptation actions and plans. The findings suggest that Vhembe District Municipality improves its level of community engagement by including traditional leaders, local stakeholders, and residents in decision making. There is a need for improvement, which includes enhancing flood infrastructure, early warning systems, and drainage systems. These measures can strengthen communities' ability to withstand and recover from flood events.

Keywords: Adaptation, climate change, community engagement, disaster management

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LIST OF ACRONYMS/ABBREVIATIONS

CCA: Climate Change Adaptation

CCS: Carbon Capture and Storage

CSIR: Council for Scientific and Industrial Research (CSIR).

DEA: Department of Environmental Affairs

DEFF: Department of Environment, Forestry, and Fisheries

DRR: Disaster RisK Reduction

DWS: Department of Water and Sanitation

GCCSI: Green Climate Cities Sustainability Index

IDPs: Integrated Development Plans

IEA: International Energy Agency

IFRC: International Federation of Red Cross and Red Crescent Societies

IFRM: Integrated Flood Risk Management Framework

IPCC: Intergovernmental Panel on Climate Change

IRIN: Intagrated Regional Information Networks

NDMF: National Disaster Management Framework

SANBI: South African National Biodiversity Institute

SAWS: South African Weather Services

SDGs: Sustainable Development Goals

SPSS: Statistical Package for Social Sciences

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UN: United Nations

UNCCD: United Convention to Combat Desertification

UNDP: United Nations Development Programme

UNDRR: United Nations Office for Disaster Risk Reduction

UNESCO: United Nations Educational, Scientific and Cultural Organisation

UNFCCC: United Nations Framework Convention on Climate Change

VDM: Vhembe District Municipality

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CHAPTER 1: INTRODUCTION

1.1 Background to the study

Climate change has emerged as a critical concern globally, posing a significant threat to sustainable development and yielding far-reaching consequences worldwide (Dioha & Kumar, 2020). The escalating frequency and intensity of floods, illustrated by devastating events such as the 2011 Thailand floods, 2022 Pakistan floods and the 2022 floods in KwzazuLu-Natal, South Africa, are a consequence of climate change, resulting in catastrophic outcomes (IPCC, 2021). This surge in flooding has precipitated substantial human and economic losses, compromising access to potable water and underscoring the imperative for urgent action (UNDRR, 2020).

Climate change adaptation is a multifaceted and dynamic process, conceptualised by the Intergovernmental Panel on Climate Change (IPCC) as "the process of adjustment to current or projected climate change and its impacts, to minimise harm or capitalising on beneficial opportunities" (IPCC, 2019). This definition is corroborated by the Paris Agreement, which underscores the imperative of adaptation in enhancing global climate resilience and promoting sustainable development (UNFCCC, 2021). Furthermore, the significance of adaptation is reinforced by the United Nations Framework Convention on Climate Change (UNFCCC), which posits adaptation as a vital strategy for achieving its objectives.

Effective planning for climate change is essential, requiring actions that facilitate adaptation. These actions include generating and disseminating knowledge (IPCC, 2019), establishing supportive institutional frameworks (Agrawal et al., 2020), and implementing management systems and mechanisms, such as improved land management (Simpkin et al., 2020) and insurance schemes (Mechler et al., 2019).

In the South African context, the implementation of effective adaptation strategies is crucial to mitigate the impacts of climate change, thereby revitalising the health and economic well-being of citizens, fortifying social cohesion and spatial resilience, and enhancing the country's competitiveness in the global economy (Rogers et al., 2023). Local governments are implementing various adaptation measures, including planning and design initiatives, to counteract the impacts of climate change,

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decrease vulnerability to flood hazards, and promote sustainable development (CSIR, 2023). Specifically, flood adaptation strategies are being devised to alleviate the adverse effects of flooding on communities, infrastructure, and ecosystems, thereby enhancing resilience and adaptive capacity (Chilwane et al., 2024).

Adaptation actions and plans are essential for communities residing in areas susceptible to flooding to reduce the risks. Such adaptation actions and plans include institutional (policy/framework), structural (flood walls & drainage system), and non-structural (promotion of early warnings, land use management practices) measures (IPCC, 2019). The projected increase in infrastructure loss and environmental damage highlights the need for sustainable adaptation actions and plans in Vhembe District Municipality.

Climate change adaptation in South African local governments faces significant hurdles, including leadership, knowledge, and information gaps (Leck & Simon, 2018). Additional challenges encompass funding constraints, institutional divisions, and political ambiguity. South African municipalities frequently face significant challenges, including stringent budget constraints, competing demands, and intense expectations to provide essential services to their communities (Sibiya et al., 2023). Moreover, the imperative for climate adaptation is not explicitly mandated in local government policies or legislation, hindering the implementation of adaptation actions (Adom et al., 2023)

The integration of climate action into local governments' developmental agenda is crucial for achieving sustained progress in addressing climate change (Pieterse & Du Toit, 2024). Notably, Southern Africa has begun to acknowledge the salience of climate change, prompting numerous nations to develop and implement programmes and policies that facilitate adaptation (Sibiya et al., 2023). However, a significant impediment to the development and implementation of climate change adaptation strategies is often attributed to resource constraints (Shah et al., 2020).

Vulnerable communities in disadvantaged areas are disproportionately exposed to the consequences of climate change, primarily due to their dependence on climate-sensitive sectors such as agriculture, ecosystems, and water resources (Sibiya et al., 2022; IPCC, 2022). As the primary interface between government and local communities, municipalities are critical in developing and implementing climate

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change adaptation plans that address their constituents' unique needs and challenges (Gadu et al., 2024). Local municipal officials can collaborate with affected communities to craft context-specific adaptation strategies, addressing the most pressing implications of climate change and delivering tangible benefits to local populations (Mfitumukiza et al., 2020; Pieterse & Du Toit, 2024).

The disproportionate impact of climate change on impoverished populations is a pressing concern, as they rely heavily on climate-sensitive industries such as mining and agriculture for livelihoods and food security (Adom, 2024). Moreover, many individuals residing in poverty-stricken areas inhabit informal settlements characterised by inadequate access to essential services, including energy and water infrastructure. In this context, climate change has far-reaching implications that transcend environmental considerations, exacerbating developmental challenges that can undermine progress achieved in critical sectors such as infrastructure, food security, health, environment, and water (UNDP, 2020).

Local governments are instrumental in driving successful adaptation efforts, as they are uniquely positioned to mainstream climate change resilience into their policy frameworks, plans, and operational processes. A comprehensive approach is necessary to address flooding, where adaptation measures are seamlessly integrated into local development planning, informing every stage of the planning cycle and fostering transformative change (IPCC, 2022).

1.2 Research Problem

The effectiveness of flood management plans and strategies is a pressing concern globally, particularly in developing nations where socio-economic repercussions of flood events are severe (Echendu, 2020). For instance, floods in countries like Mozambique, Pakistan, and Bangladesh have resulted in significant loss of life and property damage, highlighting the vulnerability of developing nations. South Africa is also highly susceptible to catastrophic flood events, as evident in the 2022 Kwazulu-Natal floods and the 2019 floods in Eastern Cape, which caused widespread damage and displacement (Wale et al., 2022). Notably, various regions of the country, including Gauteng, Limpopo, Mpumalanga, and North West province have experienced devastating floods, resulting in loss of life and extensive property

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damage (Floodist, 2019; Bopape et al., 2021). The anticipated intensification of extreme weather events due to climate change further underscores the need for effective flood management plans and strategies on communities and livelihoods (Dube et al., 2021).

The development and implementation of effective plans and strategies for climate change adaptation are crucial for municipalities in South Africa. However, there is limited knowledge on the extent of the effectiveness of these plans and strategies, which hinders their ability to address service delivery demands. Municipalities in South Africa face significant challenges in this regard, including dysfunction, corruption, and the added burden of climate change (Gadu et al., 2024). The implementation of adaptation actions and plans is further hindered by resource barriers, including lack of locally relevant knowledge, funding, and human resources (Ngwenya & Simatele, 2020). To mitigate climate change impacts, researchers and decision makers must adopt innovative, coordinated, and sustainable strategies, integrating climate change adaptation into municipal planning (Shrestha et al., 2021).

The Vhembe District Municipality, located in Limpopo Province, is highly susceptible to climate change, with local communities bearing the brunt of flood events during the rainy season (Vhembe District Municipality, 2023 IDP Review). Despite the pressing need for robust adaptation strategies, the district continues to experience frequent and intense flooding, resulting in substantial losses and disproportionately affecting vulnerable communities. This underscores the necessity of evaluating existing adaptation actions and plans, identifying gaps and challenges, and areas for improvement in the Vhembe District Municipality, with a specific focus on flood adaptation strategies and their effectiveness in mitigating the impacts of flooding on local communities.

1.3 Aim, Specific Objectives, and Research Questions

1.3.1 Research Aim

The main aim of this study was to analyse the perceived effectiveness of the existing adaptation actions and plans in response to flood disasters in Vhembe District Municipality.

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1.3.2 Specific objectives

a. Examine the existing adaptation actions and plans implemented in response to flood disasters in Vhembe District Municipality, with a focus on their design and functionality.
b. Assess the level of community involvement in the design and implementation of adaptation actions and plans in response to flood disasters in Vhembe District Municipality; and
c. Establish the perceived effectiveness of the institutional, structural, and non-structural measures in response to floods.

1.3.3 Research questions

a. What are the adaptation actions and plans used in response to flood disasters in Vhembe District Municipality?
b. What is the nature of planning and how are communities involved in the designing of adaptation actions and plans?
c. How do communities perceive the effectiveness of the institutional, structural, and non-structural measures used in response to flood disasters?

1.4 Justification of the study

Climate change intensifies severe weather occurrences like floods, which now occur more frequently and with greater severity, putting communities and ecosystems at significant risk (IPCC, 2021). In Vhembe District Municipality, the rising frequency of floods has devastating consequences, including environmental degradation, infrastructure damage, property loss, and human fatalities, undermining sustainable development in rural and urban areas. This study is crucial in addressing the concerning issue of flood risk in Vhembe District Municipality, given the devastating consequences of floods on sustainable development. By investigating the effectiveness of adaptation measures, this research provides critical insights that can inform evidence-based strategies to enhance resilience and mitigate the impacts of floods. Thereby contributing to the sustainability of communities and ecosystems in the region.

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This study aimed to address this pressing issue by assessing the current adaptation measures and response plans for flood disasters in the district. The research focused on identifying gaps and challenges in existing adaptation strategies, thereby informing the development of more effective, sustainable, and resilient adaptation plans that cater to the unique needs of the Vhembe District Municipality. The findings of this study informed the development, implementation, and monitoring of climate change adaptation plans by the Vhembe District Municipality, local authorities, and surrounding areas.

This study contributed to the achievement of Sustainable Development Goal 13 (Climate Action), which aims to take urgent action to combat climate change and its impacts (Song & Jang, 2023). The study focused on assessing the effectiveness of flood adaptation actions and plans aligning with Target 13.1, which emphasises the importance of strengthening resilience and adaptive capacity to climate-related hazards and natural disasters. The findings of this study provided valuable insight into the development of climate-resilient infrastructure and communities, thereby supporting effort to reduce the impacts of flood disasters on communities and households.

Furthermore, this research contributed to expanding literature on climate change adaptation and disaster risk reduction, building upon and complementing existing research in this field (Mechler et al., 2019; Stringer et al., 2020). The study's outcomes increased community awareness and understanding of the impacts of climate change, highlighting the necessity of adaptation measures. As a result, community engagement and support for adaptation initiatives were enhanced. The research also laid the groundwork for future studies on climate change adaptation and disaster risk reduction, particularly in developing countries where the impacts of climate change are most severe.

1.5 Description of the study area

This research was conducted in the Vhembe District, a Category C municipality in northern Limpopo Province, South Africa. The district comprises four local municipalities: Collins Chabane, Makhado, Musina, and Thulamela. Geographically, the Vhembe District is distinguished by its international borders with Zimbabwe and

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Botswana to the northwest and Mozambique to the southeast, with the latter boundary traversing the Kruger National Park (Vhembe District Municipality, 2023/2024 IDP Review). Two specific study sites were selected within the district due to their vulnerability to floods. These sites included Tshakhuma community and Tshenzhelani community, as presented in Figure 1.1.

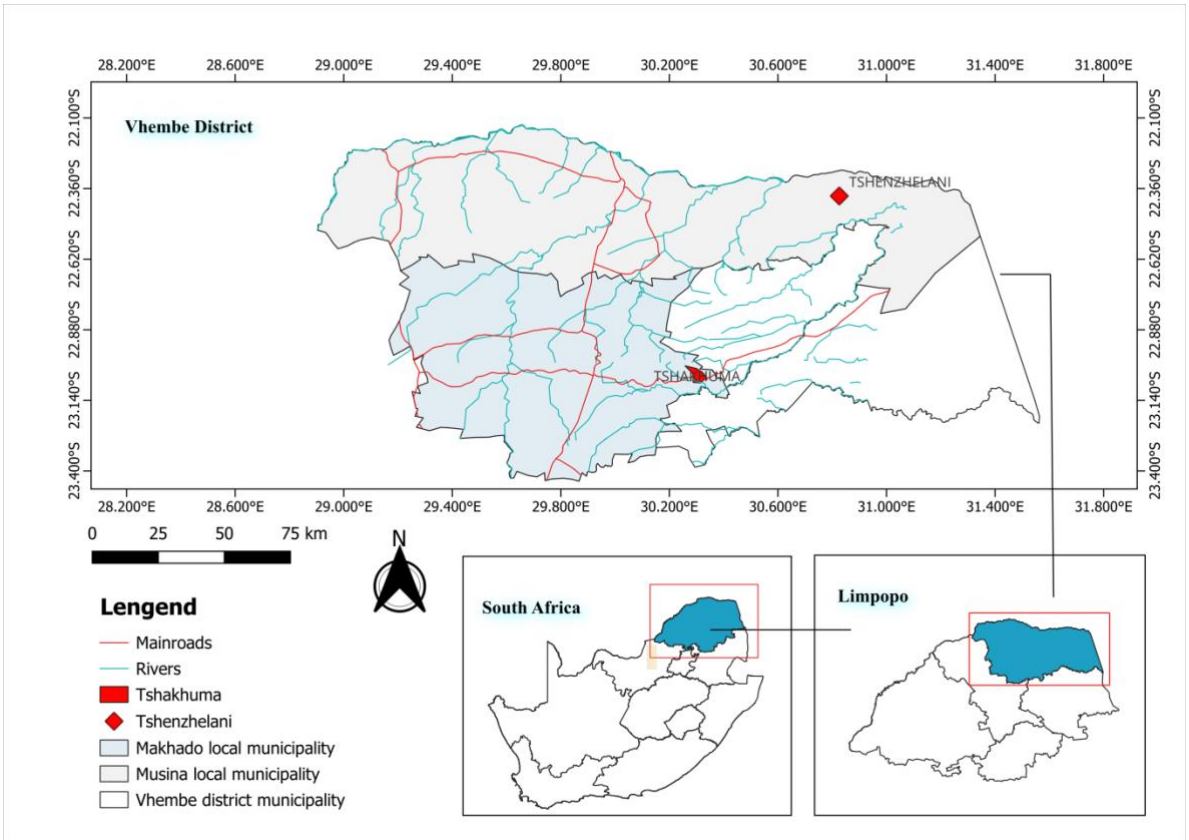


Figure 1: Map showing study sites in Vhembe District Municipality

1.5.1 Physical and Socioeconomic characteristics

1.5.1.1 Climate

The Vhembe District Municipality is in a semi-arid region with significant climate variability, making it vulnerable to extreme weather events such as floods and droughts (Nuwarinda, 2021). The district falls within the subtropical region, exhibiting mild, wet winters and warm, humid summers typical of the low-veld (Arid and Semi-Arid) region (Vhembe District Municipality, 2023). The annual rainfall averages around 500mm, with a pronounced seasonal pattern, where the majority (87.1%) of rainfall occurs between October and March. Notably, the rainfall distribution is

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influenced by the orographic effects of the Drakensberg Mountains and the Soutpansberg range, resulting in a westward decline in rainfall. Temperature fluctuations are notable, ranging from 10°C in winter to 40°C in summer, particularly in the Musina Local Municipality. Moreover, frequent droughts affect areas such as Thulamela and Musina Local Municipalities, which exhibit semi-arid characteristics (Vhembe District Municipality, 2023/2024 IDP Review).

1.5.1.2 Hydrology

The hydrological charactersistics of Vhembe District Muncipality are defined by its complex river systems, notably the Luvuvhu and Letaba River catchments (Takalani, 2022). River flow in the region is influenced by factors such as rainfall intensity, drainage patterns, and catchment topography, which can exacerbate flood risk (Juracek, & Fitzpatrick, 2022). The area's drainage system, comprising various rivers, streams, and wetlands, is susceptible to flooding due to heavy rainfall events, compounded by land use changes and infrastructure development (Alexander, 2018). Hydrological factors, including high run-off rates, soil saturation, and floodplain dynamics, contribute significantly to the regions's vulnerability to flooding (Mishra et al., 2022).

With limited ground and surface water supplies, Vhembe District Municipality faces significant water resource challenges. The area's catchment areas, such as the Luvuvhu and Letaba river catchments, are under strain due to increasing demand for water from various development activities, including agriculture, domestic use, and mining. Several factors compound the district's water management difficulties, including a mismatch between water supply and demand, the proliferation of invasive alien species, and unsustainable land use practices in river valleys (Nkosi et al., 2021). Several environmental and health concerns compound these issues, including the ecological repercussions of fertiliser and pesticide use, inadequate surveillance of water quality, and the prevalence of poorly maintained sewage systems (DWS, 2018). Furthermore, the high density of pit latrines and the increasing frequency of flood and drought events exacerbate the vulnerability of the region's water resources and pose significant risks to human health and the environment.

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1.5.1.3 Geology

The Vhembe District Municipality's geological composition is characterised by a diverse array of soils, including clay loam, sandy soil, and fertile clay soil, which have developed primarily on basalt, sandstone, and biotite gneiss (Materechera-Mitochi, 2023). The district's geological landscape is marked by an intricate mosaic of intrusive igneous, sedimentary, and metamorphic rocks, particularly pronounced in the Soutpansberg region (Vhembe district municipality, 2023). The Soutpansberg mountain range is notable geological feature, with a complex geological history dating back to Precambrian era. This geological diversity has significant implication for soil formation, land use, and ecosystem functioning in the region (Moffett, 2023).

1.5.1.4 Flora and Fauna

This unique geological setting, combined with the district's varied topography, supports a rich biological diversity, featuring numerous flora and fauna species. The district's vegetation is equally diverse, comprising various tree species, savannas, grasslands, and forests. The area's land cover is characterised by a diverse range of ecosystems, including wetlands and arable land, which are crucial for sustaining native specie. However, the proliferation of invasive alien species, such as *Lantana camara, Eichhornia crassipes, and Nicotiana glauca*, poses a significant threat, displacing native species in wetlands and colonising arable land (Nuwarinda, 2021).

1.5.1.5 Topography

The topographical diversity of the Vhembe District plays a pivotal role in shaping the local climatic conditions, influencing key factors such as temperature regimes, precipitation patterns, and hydrological processes. The district's terrain is characterised by a notable altitudinal range, encompassing the elevated peaks of the Soutpansberg mountain range and lower-lying areas exhibiting steep and gently sloping topographies, generating a complex microclimate mosaic. Notably, the Soutpansberg mountain range profoundly impacts the region's climate and weather patterns, contributing to its unique environmental characteristics. Due to the mountain range, flooding frequently occurs in Vhembe District because of heavy rainfall (Vhembe District Municipality, 2023/2024 IDP Review).

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1.5.1.6 Population

The Vhembe District's population has experienced notable growth, with the most recent estimates indicating a total population of approximately 1,528,087 individuals, this results in a relatively moderate population density, averaging 63.4 individuals per square kilometer (StatsSA, 2020). A comparative analysis of census data reveals a significant increase in population size, from 1,294,722 in 2011 (StatsSA, 2012) to 1,528,087 in 2020 (StatsSA, 2020), representing a growth of 233,365 persons over the nine years.

1.5.1.7 Socioeconomic characteristics

The economic structure of Vhembe District is characterised by a diverse range of sectors, encompassing primary industries such as agriculture and mining, secondary industries including electricity, construction, and manufacturing, and tertiary industries comprising trading, transport, tourism, finance, and community services (StatsSA, 2016). Notably, the district's economy exhibits a high degree of openness and integration, with an abundance of strategic resources and agricultural land. Furthermore, the local economy is enhanced by a thriving tourism industry, which capitalises on the district's unique natural attributes and advantageous geographical location, facilitating access to regional markets within the Southern African Development Community (SADC) (Zhou, 2024). The district's exceptional agricultural endowment, featuring extensive arable land and favorable climatic conditions, has established it as a significant hub for agricultural production, specialising in the cultivation of a diverse range of fruit and vegetable crops (National Agricultural Marketing Council, 2020).

The selection of Tshenzhelani and Tshakhuma was strategically informed by their distinct socioeconomic profiles, facilitating a comparative analysis that elucidates the diverse challenges and opportuntities inherent in rural and economically significant context. The socioeconomic growth of the two studied areas, Tshenzhelani and Tshakhuma, differs significantly. Tshenzhelani, a rural and remote community, is characterised by poor infrastructure, low income, and restricted access to basic services, whereas Tshakhuma is economically and socially significant, with a local economy driven by small-scale entrepreneurial activities. A significant proportion of

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the population in Tshakhuma relies on subsistence farming as their primary source of livelihood, highlighting the importance of agricultural activities in sustaining the local community (Stats SA, 2020). The nearby town of Thohoyandou, a significant commercial center, has a considerable influence over the socio-economic dynamics of the local population (Vhembe District Municipality, 2022/2023 IDP Review).

1.6 Organisation of the dissertation

Chapter 1 provides an introductory overview, situating the study's contextual background, articulating the research problem, and delineating its aim, objectives, and research questions. Furthermore, this chapter presents a justification for the study and describes the study area.

Chapter 2 presents a comprehensive review of extant literature relevant to the research topic, examining theoretical perspectives and conceptual frameworks that inform the study. This review provides a foundational understanding of the study's context and objectives, facilitating the development of a detailed research framework.

Chapter 3 provides the methodological approach employed in the study, encompassing the research design, sampling methods, data collection methods, and data analysis techniques. This chapter also addresses the ethical considerations that guided the research process, ensuring the integrity and rigor of the investigation.

Chapters 4, 5, and 6 present the study's findings, each addressing a specific objective. These chapters provide an in-depth analysis and discussion of the data, yielding insights that address the research questions and objectives outlined in Chapter 1. The findings are situated within the broader context of existing literature, facilitating a contextual understanding of the research topic.

Chapter 7 provides the broad conclusions, discusses the study limitations, and also provides significant recommendations for sustainable flood adaptation and recommendations for further research.

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CHAPTER 2: LITERATURE REVIEW

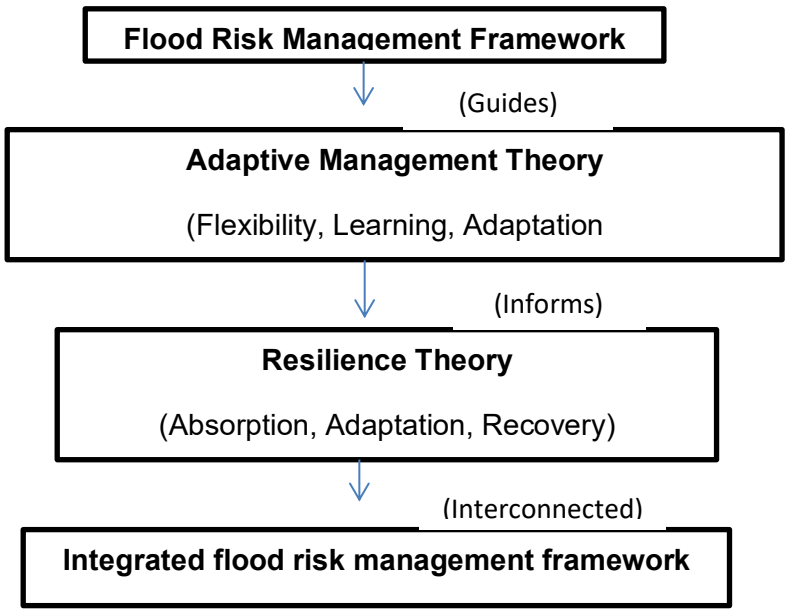
2.1 Introduction

Flooding is a prevelant and economically devastating natural hazard that affects communities worldwide, resulting in significant human suffering and economic losses (Jamshed et al., 2019). As the frequency and severity of flood events continue to increase, driven partly by climate change, the need for adequate flood adaptation measures and strategies has become increasingly urgent. This literature review aims to comprehensively examine existing research on flood adaptation measures and strategies, with a specific focus on the theoretical foundations of flood risk reduction, adaptation strategies, and sustainable development. The review will critically examine empirical studies on flood management in the Vhembe District Municipality, and other similar settings ti identify gaos, challenges, and opportunities for effective flood adaptation.

2.2 Theoretical framework

2.2.1 Flood risk management theories

This study employs a theoretical framework that integrates multiple theories and concepts. The framework consists of three main components: the Flood Risk Management Framework, Adaptive Management Theory, and Resilience Theory.



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Figure 2. 1: Integrated Flood Risk Management Theoretical Framework

The Flood Risk Management Framework is founded on sustainability, resilience, and adaptive management principles and recognises the complexity and multidimensionality of flood risk management (UNDRR, 2020; Kundzewicz et al., 2020). This framework is particularly relevant in Vhembe District Municipality, where flood risk management is critical due to the municipality's location in a flood-prone area.

The integration of Adaptive Management Theory and Resilience Theory substantially enhances the effectiveness of flood risk management plans and strategies. The emphasis on flexibility, learning, and adaptation inherent in Adaptive Management Theory facilitate a responsive approach to managing complex system, allowing for ingoing refinement through continuous monitoring and evaluation (Allen et al., 2011). Concurrently, Resilience Theory underscores the significance of cultivating community resilience through engagement, social capital, and institutional support, thereby augmenting the capacity for absorption, adaptation, and recovery from flood impacts (Folke et al., 2016). Together, these theories enhance the effectiveness of plans and strategies by fostering a dynamic, iterative, and community-centred approach to flood risk management, ultimately yielding more resilient and sustainable outcomes.

Building resilience in the face of flood risks requires more than technical solutions. It also necessitates community engagement, social capital, and institutional support (Kumar et al., 2022). Community engagement is critical for building trust and fostering stakeholder collaboration (Jonkman et al., 2020). Social capital, including social networks and norms, can facilitate collective action and cooperation (Dos Santos et al., 2022). Institutional support, including policies, laws, and regulations, is also essential for creating an enabling environment for resilience building (UNDRR, 2020).

The theoretical frameworks employed in this study provide a comprehensive understanding of flood risk management, recognising the complexity and multidimensionality of the issue. The frameworks also emphasise the importance of community engagement, social capital, and institutional support in building resilience

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and adapting to flood risks. However, the study could benefit from a more nuanced examination of the relationships between the theoretical frameworks and the empirical context of Vhembe District Municipality. In particular, the study could investigate the challenges associated with implementing adaptive management and building resilience in the face of flood risks, including the need for community engagement, social capital, and institutional support (Vhembe District Municipality, 2020).

The adopted theoretical framework proved highly relevant to this study. The Integrated Flood Risk Management (IFRM) approach provided a holistic foundation for examining flood risk management in Vhembe District Municipality, aligning seamlessly with the study's focus. Incorporating Adaptive Management Theory, which emphasises flexibility, learning, and adaptation in navigating complex systems (Allen et al., 2011), enabled the study to account for the unpredictable and constantly evolving dynamics of flood risks. The key tenets of Adaptive Management Theory, including iterative learning, experimentation, and continuous monitoring and evaluation, have been successfully applied in various studies (Lynch et al., 2022). For instance, Pahl-Wostl (2007) applied Adaptive Management Theory in managing water resources, while Williams et al., 2011 utilised it in ecosystem conservation (Pahl-Wostl, 2023; Alexandra, 2023). These studies demonstrate the suitability of Adaptive Management Theory in navigating complex systems.

Furthermore, Resilience Theory, which highlights the importance of absorption, adaptation, and recovery (Folke et al., 2016), informed strategies to build community resilience and enhance flood risk management. The core principles of Resilience Theory, including the ability to absorb disturbances, adapt to changing conditions, and transform in response to crises (Seeger et al., 2024), were instrumental in understanding community vulnerability. Studies such as Cutter et al. (2008) and Nelson et al. (2007) have applied Resilience Theory in assessing community vulnerability to natural disasters and developing climate change adaptation strategies, respectively (Tariq et al., 2021). These applications underscore the relevance of Resilience Theory in building resilient communities. The intergration of these theories provided a comprehensive understanding of flood risk management,

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enabling the development of effective strategies tailored to the specific context of the study area.

2.2.2 Climate change and flooding in South Africa

The relationship between climate change and flooding, where flooding refers to the overflow of water into normally dry areas resulting from heavy rainfall, storm surges, or dam failure (Kumar et al., 2022), in South Africa is complex and multifaceted. Climate change is defined by the United Nations Framework Convention on Climate Change (UNFCCC) (2015) as alterations in the climate system resulting from both anthropogenic activities and natural climate variability. In South Africa, climate change has far-reaching and detrimental consequences for various socio-economic sectors, exacerbated by the country's dependence on energy-intensive industries such as mining and agriculture (DEA, 2018). The intensification of extreme weather events, including floods, poses a significant threat to South Africa, where flooding is the most prevalent disaster (IPCC, 2014).

Studies reveals that the relationship between climate change and flooding in South Africa is influenced by interrelated factors such as geographical terrain, rapid urbanisation, population migration, informal settlements, and environmental degradation (Mansur et al., 2016; Glago, 2021). Rising temperatures alter precipitation patterns, resulting in more intense and frequent heavy rainfall events (DEA, 2016). This, combined with South Africa's geography and urbanisation, increases the risk of flooding (Van der Bank & Karsten, 2019). Furthermore, sea-level rise and coastal erosion exacerbate flood risk in coastal areas (DEA, 2018).

Understanding the intricate relationships between climate change and flooding is crucial for developing effective flood adaptation strategies in South Africa. An integrated, multidisciplinary approach is necessary to address the region's synergistic challenges of climate change and flooding, including enhancing disaster risk management protocols, upgrading infrastructure, and promoting climate-resilient development trajectories (IPCC, 2014; Van Staden, 2014). Addressing the socio-economic ramifications of climate change, such as poverty and inequality, is essential for cultivating resilience and alleviating the adverse impacts of flood risks,

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thereby promoting more equitable and sustainable outcomes (Van der Bank & Karsten, 2019).

The literature review highlights the need for more research on climate change impacts on flooding in Vhembe District Municipality. Additionally, there is a need for a more detailed examination of the implications of climate change for flood risk management in South Africa, including the need for climate-resilient infrastructure, early warning systems, and community-based adaptation initiatives. By addressing these knowledge gaps, this study aims to contribute to developing effective flood adaptation strategies in Vhembe District Municipality, thereby promoting sustainable development and reducing the risk of flooding.

2.2.3 Sustainable Development, Climate change, and Flood risk management: Integrated Approaches for Resilience

The principles of sustainable development emphasise the importance of integrating economic, social, and environmental considerations to ensure a viable future. This balance is further reinforced by the United Nations' Sustainable Development Goals (SDGs), which provide a structured framework grounded in core principles such as integration, equity, participation, precaution, efficiency, and sustainability (UN, 2015). Effective climate change mitigation requires a multifaceted approach, incorporating strategies such as transitioning to renewable energy sources, implementing enhanced energy efficiency measures, and adopting sustainable land use practices (IPCC, 2014; UNCCD, 2019; IEA, 2020).

Effective climate change adaptation is further supported by various strategies. Carbon capture and storage (CCS) technologies and climate-resilient infrastructure play critical roles in this endeavour (GCCSI, 2020; World Bank, 2020). Additionally, international cooperation, economic instruments such as carbon pricing, and social and behavioural change initiatives are essential for effective mitigation (UNFCCC, 2015; World Bank, 2019). The successful implementation of these strategies necessitates a multi-stakeholder approach, taking into account local contexts and promoting inclusive, equitable, and sustainable development (UNDP, 2020).

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This research endeavour aligns with the Sustainable Development Goals (SDGs), specifically SDG 11 (sustainable cities and communities) and SDG 13 (climate action), recognising the inherent link between flood risk management and sustainable development (UN, 2016). Flooding poses significant threats to urban resilience, infrastructure, and human settlements, emphasising the urgent need for concerted climate action and disaster risk reduction efforts (UN-Habitat, 2019). By addressing flood risk, this study contributes to the targets outlined in SDG 13, aimed at enhancing resilience and adaptive capacity in the face of climate-related hazards.

2.2.4 Flood adaptation strategies

The Intergovernmental Panel on Climate Change (IPCC) defines adaptation as adjusting to climate change's actual or expected impacts (IPCC, 2012). Strategic investments in adaptation measures yield a range of benefits, including mitigating flood-induced displacement, reducing mortality and property losses, and promoting the development of flood-resilient agricultural systems (Pickering & Rubbelke, 2014). Moreover, practical adaptation efforts can facilitate flood-resilient infrastructure creation, enhance flood-sensitive ecosystem protection, stabilise crop prices in flood-affected areas, and foster economic resilience among vulnerable populations, ultimately contributing to a more climate-resilient future (Khan, 2016).

Flood adaptation involves risk reduction strategies to minimise the impact of flood events. Adaptation strategies can be categorised into three phases: pre-flood, during-flood, and post-flood. These strategies can be applied across multiple scale, including individual, community, and citywide initiatives. Research on flood adaptation highlights the importance of infrastructure, such as embankments, to prevent floodwater from entering homes (Hamzat, 2021). Effective adaptation options for developing countries include policy reforms, innovative urban planning, and amendments to laws that exacerbate flood vulnerability (UN, 2020; IPCC, 2021).

Enhancing capacity is vital for mainstreaming climate change into urban planning processes, fostering community engagement, promoting public awareness, and ensuring inclusive decision-making. To effectively adapt to flood risks, strategies such as implementing vegetative buffers to mitigate runoff, terracing to regulate

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water flow, and managing artificial waterways to redirect floodwaters are necessary. Ultimately, a comprehensive approach to flood adaptation encompasses both structural and non-structural measures (Sakijege et al., 2014).

2.3 Flood adaptation in South Africa

2.3.1 National legislative frameworks and acts related to flood management in South Africa

The increasing frequency of floods worldwide, exacerbated by climate change and socioeconomic advancements, necessitates a shift in focus from response to preparedness and from traditional flood prevention to a comprehensive, risk-aware resilience strategy (Solik & Penning-Rowsell, 2017). In South Africa, floods have resulted in devastating consequences, including damage to infrastructure, property destruction, loss of life, and contamination of water supplies (Solik & Penning-Rowsell, 2017). This underscores the need for effective flood risk management and resilience strategies, which can be facilitated by national legal frameworks (Mehryar & Surminski, 2021).

The literature highlights the crucial role of national legal frameworks, policies, and guidelines in reducing flood risk and promoting resilience (Mehryar & Surminski, 2021). Studies have emphasised the importance of effective implementation of disaster management legislation and frameworks in enhancing flood resilience and reducing vulnerability of communiies and ecosystems (Mabasa et al., 2019; Mukwada et al., 2016). Studies highlights the importance of integrating flood risk management into development planning, ensuring community participation, and implementing strategies such as early warning systems, infrastructure upgrades, and ecosystem-based adaptation to build resilience (Mukwada et al., 2016; Moyo et al., 2020). Furthermore, the successful implementation of these strategies requires a coordinated approach that involves multiple stakeholders, including government agencies, local communities, and private sector organisations (Moyo et al., 2020).

2.3.1.1 South African Disaster Management Act 57 of 2002

The South African Disaster Management Act 57 of 2002 provides a foundational framework for disaster risk management, emphasising the integration of disaster risk

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reduction and management across all sectors of government (South Africa, 2002). The Act's effectiveness in addressing flood risk is notable, as it prompted the development of the National Disaster Management Framework in 2005 (Van Niekerk, 2014; Ziervogel et al., 2016). This framework has guided the country's disaster management efforts, facilitating a coordinated and proactive approach to mitigating and managing disaster risks (Zuma et al., 2012). However, the framework's implementation and effectiveness in reducing flood risk can be improved through enhanced intergovernmental coordination, increased resource allocation, and community engagement. Overall, the Disaster Management Act and the National Disaster Management Framework demonstrate a commitment to addressing flood risk in South Africa. Still, ongoing evaluation and refinement are necessary to ensure their effectiveness.

2.3.1.2 National Disaster Management Framework of 2005 (NDMF)

The National Disaster Management Framework (NDMF) of 2005 is a critical policy framework for disaster management in South Africa, emphasising a cohesive, transparent, and inclusive approach (RSA, 2005). The framework's effectiveness in addressing flood risk is evident in its comprehensive structure, which includes key performance areas such as disaster risk assessment, reduction, and response and recovery. South Africa's decentralised approach to disaster risk reduction, facilitated by the NDMF, has been recognised globally (Van Niekerk, 2014). The framework has also enabled effective disaster risk reduction in South Africa by establishing key performance indicators and auxiliary enablers (Kunguma, 2020). Specifically, the NDMF provides critical legislative guidance for mitigating and addressing flood impacts, particularly in vulnerable contexts such as informal settlements, through Key Performance Areas 3 and 4. Overall, the NDMF demonstrates a commitment to addressing flood risk in South Africa, and its effectiveness can be further enhanced through continued implementation and refinement.

2.3.1.3 National Disaster Risk Reduction Framework

The National Disaster Risk Reduction Framework (2019-2024) marks a significant step forward in South Africa's efforts to address flood risk, outlining a national strategy that prioritises the integration of early warning systems, community-based

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initiatives, and flood risk management (Department of Cooperative Governance and Traditional Affairs, 2019). This framework's effectiveness lies in its structured approach to mitigating disaster risks, promoting resilience, and fostering sustainable development. By emphasising community-based initiatives and early warning systems, the framework demonstrates a commitment to proactive and inclusive flood risk management (UNISDR, 2015).

Furthermore, its focus on promoting resilience and sustainable development suggests a long-term approach to addressing flood risk that prioritises the well-being of vulnerable communities and the environment (IPCC, 2014). The National Disaster Risk Reduction Framework (2019-2024) represents a critical component of South Africa's flood risk management strategy, and its implementation will be crucial in reducing the country's vulnerability to flood-related disasters (Spires & Diederichs, 2018).

2.3.1.4 National Adaptation Strategy (2019)

The National Adaptation Strategy (2019) represents a crucial step in South Africa's efforts to address flood risk, emphasising the importance of sectorial integration, community participation, and ecosystem-based adaptation (DEFF, 2019). This strategy's effectiveness lies in its recognition of the need for a coordinated approach to climate change adaptation, particularly in the context of flood risk management (Niang et al., 2020). By prioritising community participation and ecosystem-based adaptation, the strategy acknowledges the critical role that local communities and ecosystems play in mitigating and adapting to flood risk (IPCC, 2021).

Furthermore, the strategy's focus on sectorial integration highlights the need for a coordinated approach to flood risk management that brings together multiple stakeholders and sectors to address the complex challenges posed by flooding (Spires & Diederichs, 2020). The National Adaptation Strategy (2019) demonstrates a commitment to addressing flood risk in South Africa, and its implementation will be crucial in reducing the country's vulnerability to flood-related disasters.

Successful implementation of national policies relies on effective coordination, capacity building, and resource allocation by local governments (Twigg, 2015).

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However, challenges persist, including inadequate funding, limited capacity, and poor stakeholder coordination (Birkmann et al., 2019). Addressing these challenges is crucial for effective policy implementation. Additionally, international cooperation and knowledge sharing can enhance South Africa's flood resilience by leveraging global expertise and best practices (UNISDR, 2015).

2.3.2 Local government roles and responsibilities in Vhembe District Municipality

Local governments in Vhembe District Municipality are crucial in facilitating flood adaptation initiatives, particularly in vulnerable regions (Mabasa et al., 2019). As stipulated in the Disaster Management Act of 2002, local governments are responsible for developing and implementing local disaster management plans, conducting flood risk assessments, and establishing early warning systems (South Africa, 2002). Furthermore, they are also responsible for maintaining infrastructure, facilitating community engagement and education, and providing support for flood-affected communities (Vhembe District Municipality, 2018). Effective flood adaptation in Vhembe District necessitates strong institutional capacity, coordination, and community participation, which rely heavily on local government leadership and resource allocation (Mukwada et al., 2016).

The importance of intergovernmental partnerships in enhancing local government's capacity to implement flood adaptation initiatives cannot be overstated (Manyena et al., 2020). Such partnerships can provide critical funding and technical expertise from provincial and national authorities, thereby supporting local governments in developing and implementing effective flood adaptation strategies. Moreover, research highlights the importance of stakeholder engagement in fostering flood resilience, emphasising the need for local governments to engage with local communities, civil society organisations, and other stakeholders in developing and implementing flood adaptation initiatives (Spires & Diederichs, 2020).

Despite their critical role in facilitating flood adaptation initiatives, local governments in Vhembe District Municipality face significant challenges, including limited funding, capacity constraints, and inadequate data management (Vhembe District Municipality, 2018). Addressing these challenges necessitates innovative solutions,

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such as public-private partnerships, collaborative efforts with civil society organisations, and leveraging technological advancements to enhance early warning systems and community engagement (Twigg, 2015). The Vhembe District Municipality's Disaster Management Centre is crucial in coordinating flood adaptation efforts but requires support and resources to overcome its challenges.

2.4 Flooding in Vhembe District Municipality

2.4.1 Historical overview of flooding flood events in Vhembe District

Floods are catastrophic events that severely disrupt societal functioning, resulting in devastating human, material, and environmental consequences (Cutter, 2018). A disaster is formally declared when vulnerable individuals are exposed to a hazard, resulting in severe damage and disruption to their livelihood systems, necessitating external assistance for recovery (Ndah & Odihi, 2017). Heavy precipitation, frequently generated by convective storms, is identified as the primary cause of flooding, as it provides the requisite amount of water necessary for flood occurrence (Schumacher, 2017).

Vhembe District Municipality in South Africa is prone to flooding due to its location in the Limpopo River basin, characterised by intense rainfall and flash flooding (Mabasa et al., 2019). Historical records attribute flooding in the district to factors such as heavy rainfall, deficient drainage infrastructure, and ineffective land use planning (Mukwada et al., 2016). Climate change has been identified as a key factor exacerbating the rising frequency and severity of flooding events in the region (Moyo et al., 2020).

The district has experienced numerous devastating floods throughout its history, yielding severe humanitarian consequences, including loss of life and mass displacement, and economic damage. Notable flood events include the 2000 floods that affected over 10,000 people and caused R100 million in damages (Mukwada et al., 2016), the 2013 floods that resulted in 15 deaths and extensive infrastructure damage (Mabasa et al., 2019), and the 2017 floods that displaced over 1,500 people and caused significant damage to crops and infrastructure (SA News, 2017).

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To mitigate flood risk and foster resilience, comprehensive measures are necessary, including advanced early warning systems, infrastructure upgrades, and community-based adaptation initiatives (Twigg, 2015). Effective flood adaptation in the district requires strong institutional capacity, coordination, and community participation, as well as innovative solutions to address challenges such as limited funding, capacity constraints, and inadequate data management.

2.4.2 Flood vulnerability and risk factors in the Vhembe District Municipality

The Vhembe District's unique geography renders it vulnerable to flooding. Located within the Limpopo River basin, the district is prone to intense rainfall events and flash flooding due to its proximity to the Limpopo River (Mukwada et al., 2016). The area's low-lying terrain, poor drainage infrastructure, and impermeable soils exacerbate flood risk (Mabasa et al., 2019). Furthermore, the district's location in a subtropical region characterised by high rainfall intensity and frequency increases the likelihood of flooding (Moyo et al., 2020). The district's rugged topography also increases runoff and flood risk (Odipo et al., 2018).

The socio-economic profile of the Vhembe District further exacerbates its vulnerability to flood risks. Characterised by high poverty levels, restricted access to essential services, inadequate housing conditions, and a lack of social protection mechanisms, the population is disproportionately susceptible to the adverse impacts of flooding (Mabasa et al., 2019). The district's high population density and rapid urbanisation compound vulnerability (Vhembe District Municipality, 2018)

Infrastructure inadequacies, including inadequate flood protection measures, poor road conditions, and insufficient emergency services, hinder evacuation efforts and emergency response (Twigg, 2015). Anthropogenic factors, such as suboptimal waste management practices, ineffective land use planning, and inadequate enforcement of building regulations, increase the vulnerability of communities to flood hazards (Mukwada et al., 2016). Climate change also exacerbates flood risk, with projected increases in rainfall intensity and frequency (IPCC, 2014).

The district's limited financial resources, inadequate disaster preparedness, lack of community awareness and education on flood risk, and insufficient early warning

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systems also increase vulnerability (Moyo et al., 2020). Addressing these interconnected factors is critical to enhancing the district's resilience to flooding. Effective flood risk management requires a coordinated approach, incorporating infrastructure upgrades, community-based initiatives, and policy support (Birkmann et al., 2019).

2.5 Flood adaptation measures and community involvement in Vhembe District Municipality

2.5.1 Existing adaptation measures

The adaptation measures in Vhembe District Municipality demonstrate a commitment to addressing flood risk in the region. The Vhembe District Municipality's Flood Protection Scheme, which incorporates infrastructure developments, early warning systems, and community-based initiatives, is a notable strength (Vhembe District Municipality, 2018). The district's Integrated Development Plan (IDP) also incorporates flood risk management strategies, highlighting the importance of integrating flood adaptation with broader development goals (Vhembe District Municipality, 2018).

Furthermore, implementing structural measures, such as levees and floodwalls, and non-structural measures, such as flood-risk mapping and public awareness campaigns, has enhanced community resilience (Mukwada et al., 2016; Twigg, 2015). A collaborative effort between the South African Weather Service (SAWS) and the Limpopo Department of Cooperative Governance, Human Settlements and Traditional Affairs has led to the implementation of a flood forecasting and warning system, enhancing community preparedness and proactive response to flood events (SAWS, 2020).

However, despite these efforts, several weaknesses and areas for improvement have been identified. Inadequate funding, limited community engagement, and insufficient infrastructure maintenance are significant barriers to effective flood adaptation (Mabasa et al., 2019). Moreover, existing measures often focus on temporary fixes rather than sustainable, long-term solutions, highlighting the need for a more integrated and proactive approach to flood adaptation (Birkmann et al., 2019). To address these challenges, it is recommended that flood adaptation be

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integrated with broader development goals, such as sustainable development and climate change mitigation (IPCC, 2014; UNISDR, 2015). Additionally, enhancing community engagement and participation in flood adaptation efforts and leveraging technological advancements to improve early warning systems and flood-risk mapping are critical areas for improvement (Spires & Diederichs, 2020).

2.5.2 Community involvement and perception in flood adaptation

Effective flood adaptation relies on active community involvement and participation, with community-led initiatives enhancing resilience and reducing flood risk by leveraging local knowledge and experience (Kelman, 2015; Twigg, 2015). Community-based initiatives, such as flood-risk mapping and early warning systems, empower communities to take proactive measures, ultimately reducing flood damage (UNISDR, 2015). Research has demonstrated the efficacy of community-led flood mitigation initiatives, with a study in Bangladesh finding a 40% reduction in flood damage (Islam et al., 2013). Moreover, community perception and trust significantly influence the success of flood adaptation measures, with individuals' perceptions of flood risk determining their willingness to adopt adaptive strategies (Kreibich & Thieken, 2018). Trust in flood protection measures is also a crucial predictor of community flood preparedness, highlighting the need for effective communication and stakeholder engagement (Lindsay & Smith, 2017).

Community engagement and education are essential in enhancing flood awareness and promoting adaptive behaviors (Parker et al., 2020). However, socio-economic factors, including income and education, shape community perceptions of flood adaptation measures, and the social and economic context in which adaptation initiatives are implemented can significantly influence their effectiveness (Adger et al., 2013). Therefore, flood adaptation strategies must consider the complex interplay between social, economic, and environmental factors to ensure their success. Recent studies have emphasised the importance of integrating social and economic factors into flood adaptation planning, highlighting the need for a more nuanced understanding of community perceptions and needs (Manyena et al., 2020). By acknowledging the importance of community involvement, perception, and trust, flood adaptation initiatives can be designed to be more effective, sustainable, and equitable.

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2.5.3 Barriers to community involvement

Effective community involvement is crucial for successful flood adaptation, but several barriers hinder participation. Limited access to information, resource limitations, and institutional barriers are significant obstacles (Kelman, 2015; Twigg, 2015). Moreover, power dynamics and social inequalities can marginalise vulnerable groups, excluding them from decision-making processes (Adger et al., 2013). This exclusion can have severe consequences, as evidenced by a study in South Africa, which found that women and low-income households were often excluded from flood adaptation decision-making (Mertz et al., 2017).

To overcome these barriers and enhance community involvement, a participatory approach is essential. This approach acknowledges local knowledge and priorities, promoting inclusive decision-making processes (Kelman, 2015; Twigg, 2015). Strategies to achieve this include establishing community-led flood management committees, providing accessible information, and ensuring inclusive decision-making processes (UNDRR, 2019). By addressing these barriers and promoting inclusive adaptation strategies, flood resilience can be enhanced, and communities can effectively adapt to flood risks.

2.6 Effectiveness of flood adaptation strategies

Evaluating the effectiveness of flood adaptation strategies requires a comprehensive framework that incorporates multiple criteria, including resilience building, cost-effectiveness, sustainability, environmental effectiveness, social equity, and institutional capacity (Twigg, 2015; UNISDR, 2015). These criteria are relevant and comprehensive, as they consider the social, economic, and environmental aspects of flood adaptation. For instance, resilience building encompasses communities' capacity to absorb, recover, and adapt to flood impacts, fostering long-term sustainability and adaptive capacity (Moyo et al., 2020). On the other hand, cost-effectiveness evaluates flood adaptation measures' economic viability and efficiency, enabling decision-makers to prioritise strategies (Birkmann et al., 2019).

The criteria also consider the environmental and social implications of flood adaptation strategies. Environmental effectiveness, for example, evaluates the

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impact of flood adaptation strategies on ecosystems and biodiversity (Odipo et al., 2018). Social equity, on the other hand, assesses the distribution of benefits and risks among different social groups, prioritising vulnerable populations (Mabasa et al., 2019). Institutional capacity is also a critical criterion, as it evaluates the ability of local governments and institutions to implement, maintain, and sustain flood adaptation strategies (Vhembe District Municipality, 2018).

Recent studies have demonstrated the importance of integrating these criteria in evaluating flood adaptation strategies. For instance, a study by Moyo et al. (2020) highlighted the importance of resilience building and environmental effectiveness in assessing the success of flood adaptation measures in Mozambique. Similarly, a study by Birkmann et al. (2019) emphasised the need to consider cost-effectiveness and institutional capacity in evaluating flood adaptation strategies in South Africa.

The analysis of successful and unsuccessful flood adaptation measures also highlights the importance of considering local context, community engagement, and long-term sustainability. Effective flood adaptation measures, such as early warning systems, ecosystem-based adaptation, infrastructure upgrades, community-based initiatives, and flood-resistant construction, have demonstrated success in reducing flood risk and enhancing resilience (Mukwada et al., 2016; City of Cape Town, 2019; Flood Resilience, 2019). On the other hand, unsuccessful measures have highlighted the importance of considering local hydrology and ecology, community participation, and long-term sustainability (Moyo et al., 2020; IRIN, 2017; Odipo et al., 2018).

Furthermore, the importance of integrating flood adaptation with broader development goals, such as sustainable development and climate change mitigation, is also emphasised (IPCC, 2014; UNISDR, 2015). This requires a holistic approach considering the complex interplay between social, economic, and environmental factors. By integrating these criteria and considering local context, community engagement, and long-term sustainability, researchers and practitioners can comprehensively evaluate flood adaptation strategies and identify areas for improvement.

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2.6.1 Challenges and barriers preventing the effectiveness of adaptation strategies in Vhembe District Municipality

Flood adaptation efforts in Vhembe District Municipality face numerous challenges and barriers that hinder their effectiveness. Inadequate funding is a primary challenge, constraining the implementation of flood reduction and adaptation actions, with limited allocation of resources for flood risk management (Mabasa et al., 2019; Vhembe District Municipality, 2018). This funding constraint is exacerbated by governance issues, including a lack of coordination among stakeholders, inadequate institutional capacity, and poor policy implementation, further impeding effective flood adaptation (Birkmann et al., 2019; Twigg, 2015).

Limited public awareness and education on flood risk and adaptation measures also exacerbate vulnerability, particularly among rural communities (UNESCO, 2018; Moyo et al., 2020). Insufficient data and information management systems prevent practical flood risk assessment and decision-making (Odipo et al., 2018; UNISDR, 2015). The district's inadequate infrastructure, including poor road conditions and insufficient water drainage systems, further complicates flood adaptation efforts (Mukwada et al., 2016; World Bank, 2019).

Inadequate land use planning and management, exemplified by informal settlements and floodplain encroachment, heightens flood risk (Birkmann et al., 2019; IPCC, 2014). Climate change projections suggest increased flood frequency and severity, further complicating adaptation efforts (IPCC, 2014). Limited access to early warning systems and emergency services hampers response and recovery efforts (Twigg, 2015; IFRC, 2019).

Flood adaptation requires a comprehensive approach, considering the complex interplay between social, economic, and environmental factors (Mabasa et al., 2019; UNDP, 2019). This integrated approach is crucial for building resilient communities and reducing vulnerability to flood risks. Recent studies emphasise integrating flood adaptation with broader development goals, such as sustainable development, climate change mitigation, and disaster risk reduction (IPCC, 2014; UNISDR, 2015).

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Developing and implementing effective flood adaptation strategies that prioritise community resilience, ecosystem sustainability, and long-term effectiveness is essential to overcome these challenges. This requires strengthening institutional capacity, enhancing community engagement and participation, and leveraging technological advancements to improve early warning systems and flood-risk mapping (Manyena et al., 2020).

2.7 Conceptual framework: Integrating flood risk management, adaptation strategies, and sustainable development

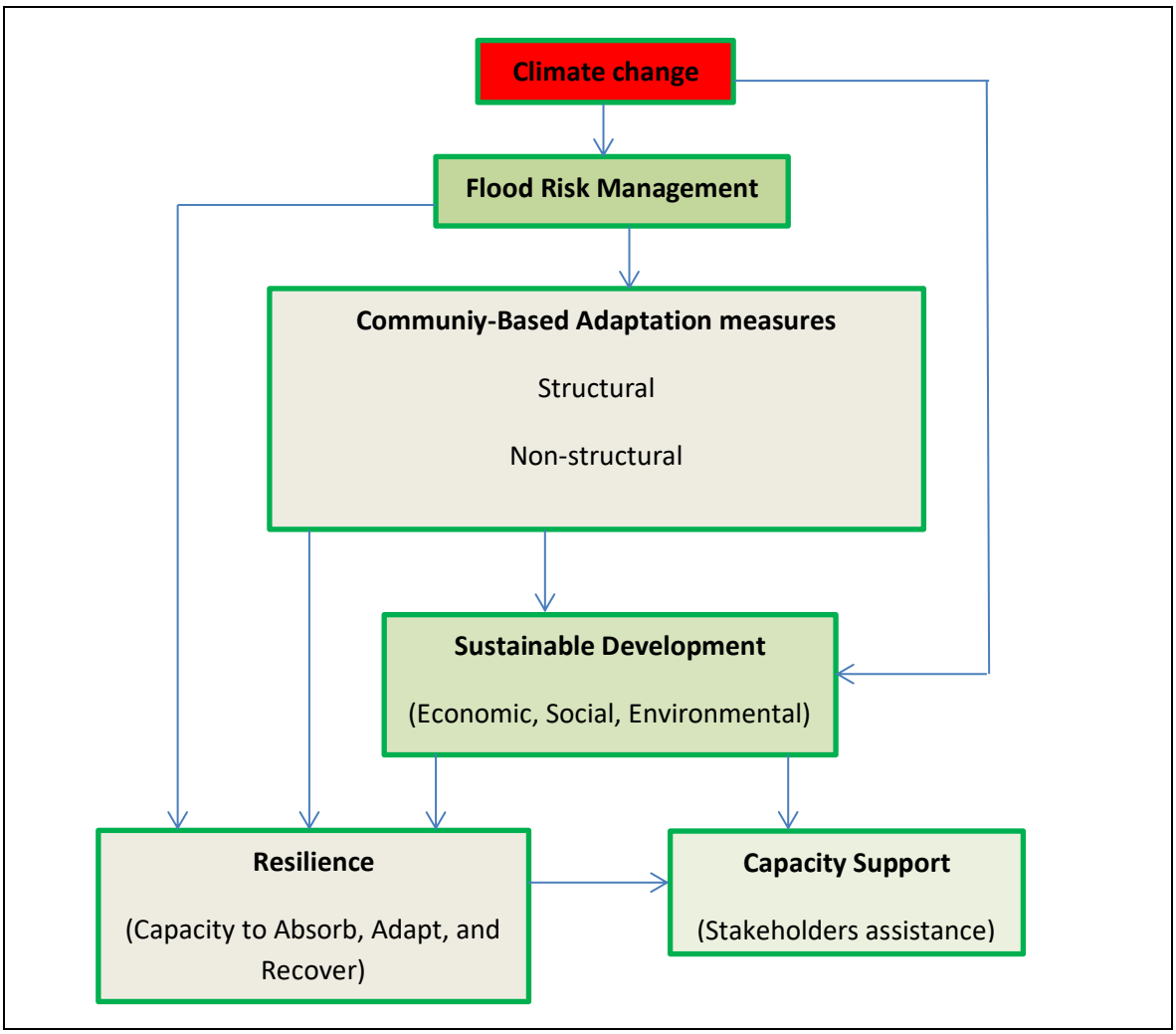


Figure 2. 2: Intregrating flood risk management, community-based adaptation strategies, and sustainable development to inform flood adaptation measures. (Adapted from: United Nations Office of Disaster Risk Reduction (UNDRR) (2015).

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A conceptual framework is a visual representation that illustrates the relationships between essential concepts, theoretical foundations, and variables guiding research investigations (Ravitch & Riggan, 2016). The conceptual framework for this study presents the complex relationship between climate change, flood risk management, community-based adaptation strategies, sustainable development, resilience, and capacity support. Climate change, characterised by rising temperatures and increased frequency and severity of flooding, exacerbates flood risk (IPCC, 2014), emphasising the need for robust flood risk management strategies (Davies, 2016). Effective flood risk management involves a multi-faceted approach, incorporating community-based adaptation strategies that encompass both structural and non-structural measures to mitigate flood impacts (IPCC, 2014).

Structural measures comprise infrastructure development, flood control barriers, and upgraded drainage systems, while non-structural measures focus on planning, community engagement, land use planning, and early warning systems. These community-based adaptation strategies are guided by sustainable development principles, ensuring balanced economic, social, and environmental considerations (IPCC, 2014). The framework posits that these strategies can enhance resilience, which is the capacity to absorb, adapt, and recover from flood impacts (UNISDR, 2015). Furthermore, capacity support from stakeholders, including governments, funders, NGOs, and international organisations, plays a crucial role in strengthening community adaptation capacity and facilitating context-specific solutions (Badriya, 2017).

The framework also acknowledges the role of social and economic factors, such as poverty, inequality, and social vulnerability, in influencing flood risk and adaptation (Mabasa et al., 2019; UNDP, 2019). By integrating sustainable development principles and considering economic, social, and environmental factors, effective flood risk management can be achieved (IPCC, 2014). The framework suggests that comprehensive community-based adaptation strategies, including structural and non-structural measures, are essential for reducing flood impacts and promoting sustainable development.

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2.8 Insights into the literature

This literature review provides a comprehensive examination of the complexities surrounding flood adaptation actions and plans, highlighting the need for integrated approaches that consider social, economic, environmental, and institutional factors. The review underscores the exacerbating effects of climate change on flood risks in vulnerable areas, such as Vhembe District Municipality, where historical floods have caused significant damage.

The review reveals that Vhembe District employs a multifaceted approach to flood risk management, integrating structural and non-structural measures, policy frameworks, and community-based initiatives. Local governments play a crucial role in enabling flood adaptation through the development and implementation of local plans, risk assessments, and early warning systems. Effective adaptation strategies, including technological, behavioral, and institutional measures, are vital for building resilience. Despite the existence of policies and frameworks for flood adaptation and disaster management, several factors hinder these efforts in Vhembe District, including institutional capacity constraints, decisional conflicts, inadequate funding, limited community engagement, and insufficient infrastructure maintenance.

This chapter highlights significant research gaps in flood adaptation within Vhembe District, specicifically regarding localised strategies, institutional capacity, community engagement, and adaptation effectiveness. Unlike national and internation studies, localised research is scarce, despite the district's unique socio-economic and environmental characteristics. Addressing these gaps is crucial to develop effective flood adaptation measures tailored to Vhembe district challenges, including its geography, climate change impacts, and infrastructure limitations.

This study aims to bridge these gaps by investigating adaptation actions, plans, and perceived effectiveness in Vhembe District, aligning with Sustainable Development Goals (SDGs) 11 and 13. By addressing these gaps, this research contributes to context-specific solutions, highlighting the importance of localised research in providing actionable insights that support data-driven decision-making and inform the development of impactful policies.

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CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

This chapter delineates the methodological framework employed in this study to evaluate the effectiveness of flood adaptation actions and plans within the Vhembe District Municipality. It provided a comprehensive description of the research design, sampling methods, data collection methods, data analysis procedures, and ethical considerations that grounded this study.

3.2 Research design

This study employed a mixed methods research design, combining qualitative and quantitative methodologies to gather and analyse data, thereby enhancing the rigor and trustworthiness of the findings (Leedy & Ormrod, 2016). The mixed methods approach was essential in achieving the study's objectives, as it facilitated an in-depth investigation of the flood adaptation actions and plans implemented in the Vhembe District Municipality.

The qualitative component of the study provided rich, contextual insights into participants' experiences, behaviors, and perspectives related to flood adaptation, allowing for a detailed and comprehensive investigation of complex factors such as social norms, socioeconomic status, and cultural influences (Leedy & Ormrod, 2016). The qualitative data facilitated a detailed and contextualised understanding of stakeholders' experiences, perceptions, and challenges of flood adaptation, revealing the intricate factors influencing adaptation planning and decision-making processes. Conversely, the quantitative approach employed structured methods to collect numerical data, enabling the identification of patterns, trends, and correlations between variables, as well as describing demographic characteristics (Cresswell, 2014). The quantitative method provided a statistical analysis of flood occurrence, frequency, impacts, and severity, and helped identify existing adaptation measures used at community and household levels, offering a broad overview of flood vulnerability in the district. By combining qualitative and quantitative data, this study gained significant contextual insights (Munzhedzi, 2024).

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3.3 Sampling

This study employed a multi-stage sampling strategy, integrating purposive sampling with simple random sampling to ensure a representative sample. According to Levay et al. (2022), sampling involves selecting units from a population to study a subset and generalise conclusions to the entire population. Purposive sampling was used to deliberately select individuals or groups possessing specialised knowledge or expertise in flood adaptation, thereby providing valuable insights into the phenomenon (Palinkas et al., 2020). This approach was employed to select communities previously affected by flood disasters and key informants linked to specific flood adaptation initiatives.

Two communities, Tshakhuma and Tshenzhelani, were purposively selected for their susceptibility to flooding. Key informants included two municipal officials from the Vhembe Disaster Risk Reduction Centre and four community leaders, two from each of the selected communities. Simple random sampling was then used to identify households that had experienced flooding, resulting in a sample of 93 households (60 in Tshakhuma and 33 in Tshenzhelani). The sample size was considered adequate to provide valuable insights and address the research questions. Notably, the 33 households selected in Tshenzhelani represented approximately 40% of the community's population. The sampling approach deliberately targeted adult household members as primary respondents during the questionnaire administration phase.

3.4 Data collection

This study utilised a mixed-methods approach, incorporating primary and secondary data sources to accomplish its research objectives. Combining these data sources increased the study's validity and reliability, yielding more accurate and trustworthy results. Primary data were gathered through in-depth interviews with key stakeholders and household surveys. In contrast, secondary data, including demographic information and municipal records, were obtained from credible sources, such as census reports and municipal development plans.

3.4.1 Key informant interviews

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Key informant interviews were conducted as in-depth, qualitative discussions with specifically chosen individuals possessing first-hand knowledge and expertise on flood adaptation and experiences (Kumar, 2014). Purposive sampling was employed to select these key informants, ensuring they could provide rich, detailed, and relevant insights into flood adaptation strategies and personal experiences with flooding.

A total of six (6) key informant interviews were carried out to acquire expert insights at both district and community levels. The interviews involved authorities from the Vhembe Disaster Risk Management Centre and community leaders from Tshakhuma and Tshenzhelani communities. The interviews covered various aspects, including existing adaptation actions and plans, objectives, strategies, and measures of adaptation plans, flood experiences, challenges, planning, and community involvement in flood adaptation. Additionally, the key informants provided insights into the perceived effectiveness of the flood adaptation actions and plans employed, as detailed in Appendix B and C.

3.4.2 Household Questionnaire

A questionnaire survey was employed as a data collection instrument, comprising a structured set of open-ended and closed-ended questions (Krosnick & Presser, 2020). This design enabled the collection of both qualitative and quantitative data, allowing respondents to provide detailed and specific information in response to the survey questions. The survey instrument was designed to gather data on the perceived effectiveness of flood adaptation actions and plans implemented in response to flood disasters. It provided an in-depth understanding of the flood-affected communities' perspectives, experiences, and viewpoints.

The questionnaire was designed to ensure its validity and reliability, following the guidelines outlined by Brace (2018). Specifically, it included items relevant to the research topic, employed appropriate question formats, and minimised response bias and errors. The questionnaire comprised several themes, including demographic information and socioeconomic characteristics, flood occurrence and impact, early warning systems, flood adaptation actions and plans, and community involvement and recommendations for improvement. Prior to distributing the

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questionnaire, participants provided written informed consent. Data was collected through direct interactions with household members, ensuring a personal and interactive approach to gathering information.

The questionnaire survey yielded valuable data, gathering information related to experiences and perceptions of flood disasters and flood adaptation actions and plans. The survey instrument provided a detailed understanding of participants' views, uncovering key insights that can inform the development of evidence-based flood adaptation policies and interventions tailored to vulnerable communities' requirements.

3.4.3 Document reviews

In addition to primary data, this study also used secondary data collection methods. A comprehensive document review was conducted to gather relevant information on existing flood adaptation actions, plans, and policies. Various documents, reports, and publications from government agencies, internarional organisations, and academic institutions were reviewed to provide context and background information of the study area. The document review helped to identify gaps in current adaptation effots and informed the development of interview guide for primary data collection (Ziervogel et al., 2022).

3.5 Data analysis

3.5.1 Quantitative data analysis

Quantitative data analysis was conducted using various statistical techniques, including descriptive statistics, multiple response analysis, and cross-tabulation (Chi-square test). Descriptive statistics, comprising frequencies and percentages, were employed to summarise and describe the questionnaire data, providing an overview of key characteristics and patterns. This approach enabled a detailed understanding of the data, with frequencies revealing the number of events and percentages expressing these frequencies as a proportion of the total representation.

Multiple response analysis was employed to accommodate the multiple responses from participants. Cross-tabulation analysis using the Chi-square test was used to

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examine relationships between categorical variables, including demographic characteristics and perceptions of flood adaptation measures and plans. Data analysis was facilitated using Statistical Package for Social Sciences (SPSS) version 29 and Microsoft Excel 2010. Microsoft Excel served as a data management tool, enabling data storage, organisation, and handling, which were subsequently imported into SPSS for statistical analysis.

The study findings were presented using various visual aids, including tables, graphs, and pie charts. Tables provided a clear visual presentation of the data, making it easy to identify relationships, deficiencies, and potential avenues for enhancement. Graphs enabled easy comparison of trends, patterns, and relationships between variables. These presentations enhanced clarity and comprehension, facilitating clear understanding and easier communication of the research findings, and reducing uncertainty.

3.5.2 Qualitative data analysis

A thematic analysis approach was employed to examine the qualitative data derived from the key informants' responses and the open-ended questions from the questionnaire survey. The thematic analysis was conducted manually, involving thorough reading, coding, and theme identification from qualitative data. The thematic analysis idenfified key themes that aligned with the study objective's, including: flood adaptation actions and plans, which explored the existing measures and strategies implemented in response to flood disasters, including structural and non-structural measures; community involvement in flood adaptation, which assessed the level of community participation in the design and implementation of adaptation actions and plans in response to flood disasters; and effectiveness of flood adaptation measure, which examined the perceived effectiveness of institutional, structural, and non-structural measures in response to floods. A theme description technique was subsequently utilised to provide a detailed and nuanced account of the findings from the key informant interviews, facilitating a rich and contextualised understanding of the data. This analytical technique is particularly effective in exploratory studies examining complex social phenomena (Ngima, 2015).

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3.6 Ethical considerations

This study adhered to rigorous ethical standards, ensuring that the research was conducted in an ethical and responsible manner. Ethical clearance was obtained from the University of Venda's ethics committee prior to commencing data collection, in accordance with established research protocols (Kumar, 2019). Additionally, permissions were secured from district municipal and community authorities to conduct the study. Informed consent was obtained from participants through a written consent form, which they signed, and their identities were kept confidential in the final report. The researcher ensured that participants' responses were voluntary, without coercion or pressure, and adhered to standards of objectivity and accuracy in presenting the study's findings, thereby maintaining the integrity and credibility of the research outcomes.

3.7 Chapter summary

This chapter presented a comprehensive overview of the research methodology employed in the study, which adopted a mixed-methods approach integrating qualitative and quantitative techniques to evaluate the efficacy of flood adaptation measures and plans in mitigating flood disasters in the Vhembe District Municipality. The chapter elaborated on the data collection methods used, including key informants' interviews and questionnaires, sampling process, data analysis methods, and ethics followed when conducting the study. The following chapters will present the research findings, providing a comprehensive discussion and analysis of the results.

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CHAPTER 4: ADAPTATION ACTIONS AND PLANS TO FLOOD DISASTER IN VHEMBE DISTRICT MUNICIPALITY

4.1 Introduction

This chapter presents and discusses the study's findings related to adaptation actions and plans for flood disasters, based on the perceptions of key informants and community members. The primary aim of this chapter is to identify the adaptation actions and plans employed in the Vhembe District Municipality to address flood disasters, including measures taken before, during, and after flooding. To provide context for the discussion of the study's findings, an overview of demographic characteristics and socioeconomic backgrounds of the respondents is first presented. Understanding these characteristics is important, as it enables a nuanced analysis of the adaptation actions and plans employed in the municipality. Furthermore, examining these adaptation actions and plans is crucial, as it enables an analysis of the perceived effectiveness of existing measures used within the municipality and communities.

4.2 Results

4.2.1 Demographic information and socioeconomic characteristics

The study was conducted in two villages, Tshakhuma and Tshenzhelani, with a total of 93 respondents, comprising 60 respondents (64.5%) from Tshakhuma and 33 respondents (35.5%) from Tshenzhelani.

This section presents and discusses the demographic and socio-economic characteristics of the respondents. The analysis encompasses various variables, including gender, age, marital status, household size, years of residency, educational level, main occupation, main source of income, and range of monthly income. Table 4.1 depicts the demographic and socio-economic data of the respondents. The findings reveal that the majority of respondents were female (55.9%), while 44.1% were male. The age distribution shows that 22.6% of respondents belonged to the 50 – 59 age group. In terms of marital status, 44.1% of respondents were single. The household size distribution indicates that 52.7% of households had 4 – 6 members. The length of residency in the community varied,

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with 28% of respondents having lived in their community for 40 – 49 years. The educational level of respondents shows that 47.3% had secondary education. The occupation and income data reveal that 45.2% of respondents were unemployed, 41.9% received a salary as their main source of income, and 60.2% earned between R1001 – R5000 per month.

Table 4.1: Demographic and Socio-economic characteristics of the respondents

Demographic Socioeconomic characteristics	**Description**	**N = 93**	**% of household**	x^2	***p*-value**
Gender	Male	41	44.1	0.057	0.811
	Female	52	55.9		
Age	Below 20	8	8.6	6.609	0.251
	20 - 29	12	12.9		
	30 - 39	16	17.2		
	40 - 49	20	21.5		
	50 - 59	21	22.6		
	60 and above	16	17.2		
Marital Status	Married	25	26.9	3.014	0.390
	Single	41	44.1		
	Divorced	10	10.8		
	Widowed	17	18.3		
Household size	1 – 3	26	28	2.780	0.249
	4 – 6	49	52.7		
	7 and above	18	19.4		
Years of residency	10 - 19	8	8.6	5.756	0.218
	20 - 29	14	15.1		
	30 - 39	21	22.6		
	40 - 49	26	28		
	50 and above	24	25.8		
Educational level	No formal education	12	12.9	0.663	0.882
	Primary level	23	24.7		
	Secondary level	44	47.3		
	Tertiary level	14	15.1		

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Main Occupation	Employed	33	35.5	2.166	0.539
	Unemployed	42	45.2		
	Student	11	11.8		
	Retired	7	7.5		
Main source of income	Child/elderly grant	34	36,6	0.987	0.804
	Salary	39	41		
	Wage	11	11.8		
	Pension	9	9.7		
Range of monthly income	R500 and Below	4	4.3	7.090	0.131
	R501 – R1000	8	8.6		
	R1001 – R5000	56	60.2		
	R5001 – R10 000	22	23.7		
	R10 001 – R15 000	3	3.2		

Significance level; $p < 0.05$ (Source research survey, 2023)

4.2.2 Flood risk context

4.2.2.1. Primary causes of floods in the community's

Figure 4.1 identifies the main causes of floods in Tshakhuma and Tshenzhelani. According to the respondents, the primary causes of floods were poor land development (18.4%) and heavy rainfall (18.1%), which were closely linked. Other significant contributing factors included deforestation (16.5%), land use changes (14.9%), climate change (10.4%), overflowing rivers and streams (7.7%), poor drainage maintenance (7.2%), and location in floodplains (6.7%).

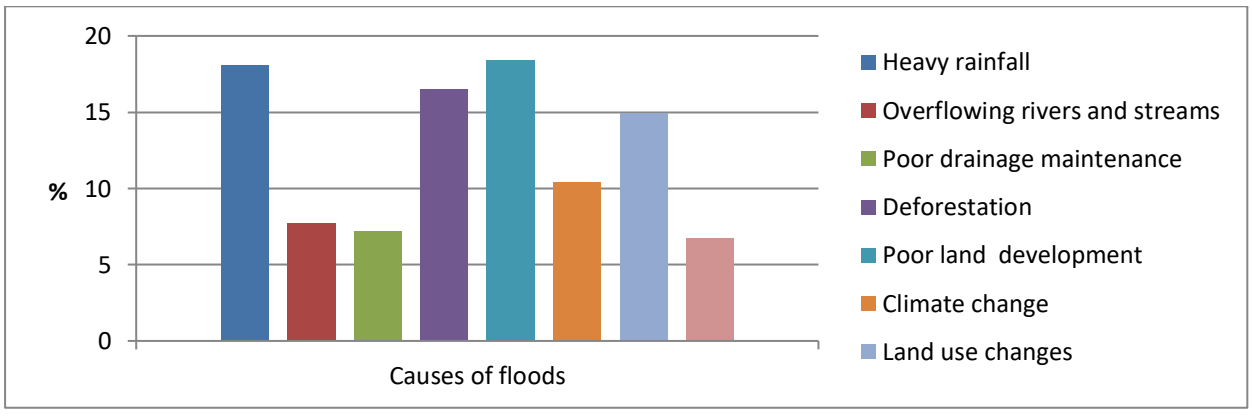


Figure 4. 1: Primary causes of flood in Tshakhuma and Tshenzhelani

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4.2.2.2. History of flood risks within the communities in the past five years in Tshakhuma and Tshenzhelani

Table 4.2 presents the study findings on the history of flood risk in Tshakhuma and Tshenzhelani over the past five years. The results show that the majority of households (78.5%) were aware of past flood risks in their communities, with 49.5% reporting being severely affected by floods. The frequency of flooding was reported as once a year by 52.7% of households, twice a year by 38.7%, and more than twice a year (8.6%). Furthermore, 48.4% of households indicated that floodwater typically lasts for a day, while 58.1% reported no changes in flood frequency.

Table 4.2: History of flood risks in the community for the past five years in Tshakhuma and Tshenzhelani

History of flood risk	Description	N = 93	% of households
Past flood experience	Yes	73	78.5
	No	20	21.5
Households severely affected	Yes	46	49.5
	No	47	50.5
Frequency of flood occurrence	Once	49	52.7
	Twice	36	38.7
	More than two times	8	8.6
Duration of floods (floodwaters)	Few hours	29	31.2
	A day	45	48.4
	2 – 3 days	19	20.4
Changes in flood frequency	Yes	39	41.9
	No	54	58.1

To explore potential variations in vulnerability and adaptability, the study examined the relationship between gender and flood experiences through cross-tabulation (Table 4.3). The findings reveal that a significant proportion (78.5%; n = 73) of respondents have experienced floods. Notably, both males (43.8%; n = 32) and

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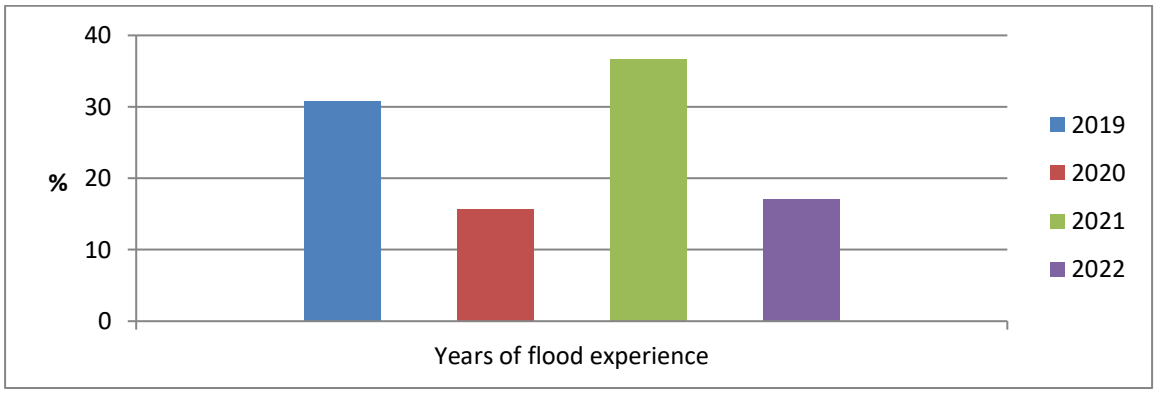
females (56.2%; n = 41) reported similar frequencies of flood experiences, indicating a relatively even distribution of flood experiences across genders.

Table 4.3: Cross tabulation of gender and flood experience in Tshakhuma and Tshenzhelani

			Floods experience		Total
			Yes	No	
Gender of the Respondents	Male	Count (n)	32	9	41
		% within Flood experience	43.8%	45.0%	44.1%
		% of Total	34.4%	9.7%	44.1%
	Female	Count (n)	41	11	52
		% within Flood experience	56.2%	55.0%	55.9%
		% of Total	44.1%	11.8%	55.9%
Total		Count (n)	73	20	93
		% of Total	100.0%	100.0%	100.0%
			78.5%	21.5%	100.0%

4.2.2.3. Years floods were mostly experienced in the past four years in Tshakhuma and Tshenzhelani

Figure 4.2 illustrates the years in which households experienced floods over the past four years. The findings show that the majority of households (36.6%) reported experiencing floods in 2021, followed by 2019 (30.7%), 2022 (17%), and 2020 (15.7%).



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Figure 4. 2: Years of floods experience in the past four years in Tshakhuma and Tshenzhelani

4.2.2.4. Household-level effects of flood in Tshakhuma and Tshenzhelani communities

Figure 4.3 illustrates the various effects of floods at the household level in Tshakhuma and Tshenzhelani communities. The findings reveal that the most common effects of floods were equally distributed among structural damage (13.6%), loss of personal belongings (13.6%), and food and water shortages (13.6%). Other significant effects include property damage (13%), increased vulnerability (8.1%), financial losses (7.8%), loss of home (7.6%), education disruption (7.2%), health and safety risks (6.9%), displacement (5.8%), and emotional distress (2.7%).

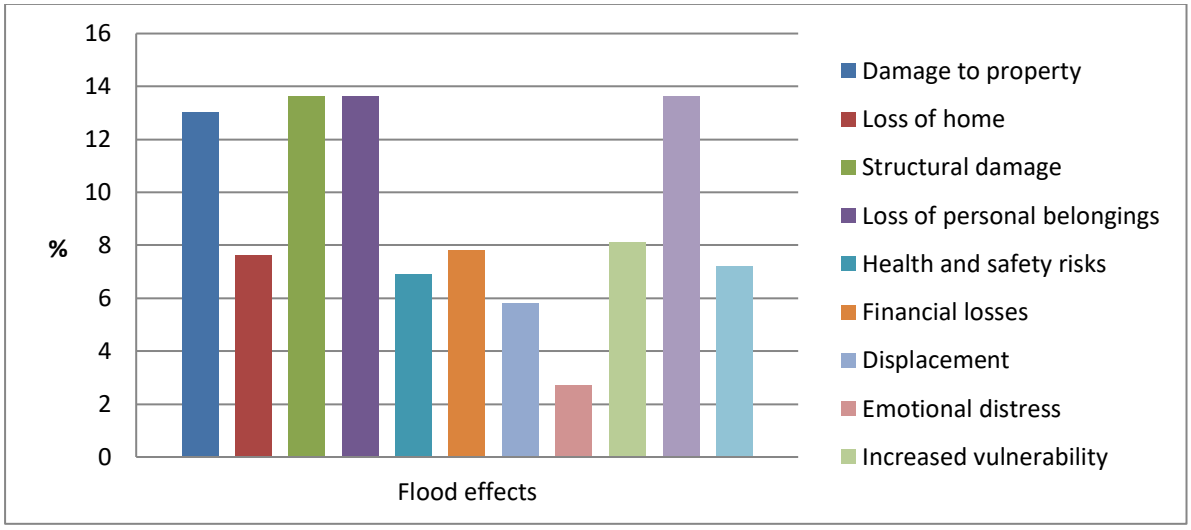


Figure 4. 3: Household-level floods effects in Tshakhuma and Tshenzhelani

4.2.2.5. Main impacts of floods at community level in Tshakhuma and Tshenzhelani

Figure 4.4 illustrates the main flood impacts observed and experienced in the communities. The findings show that the most common impacts were disruption of transportation (13.6%), disruption of schooling (13.6%), disruption of essential services (13.6%), and damaged infrastructure (13%). Additionally, households reported experiencing strain on public services (8.1%), environmental damage (7.8%), damage to crops and food supplies (7.6%), emergency response challenges (7.2%), contamination of water sources and supplies (6.9%), economic loss (5.8%), and agricultural losses (2.7%).

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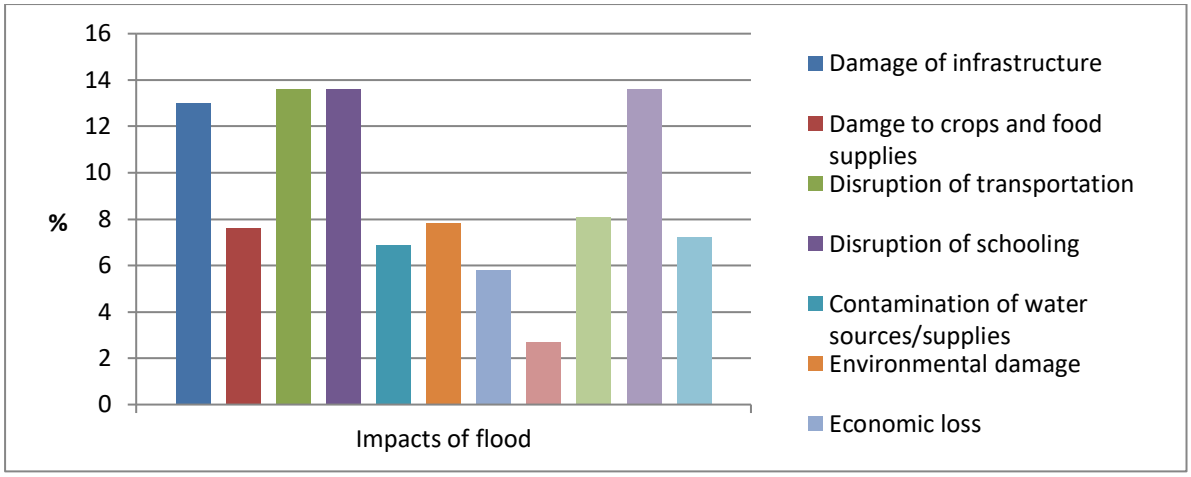
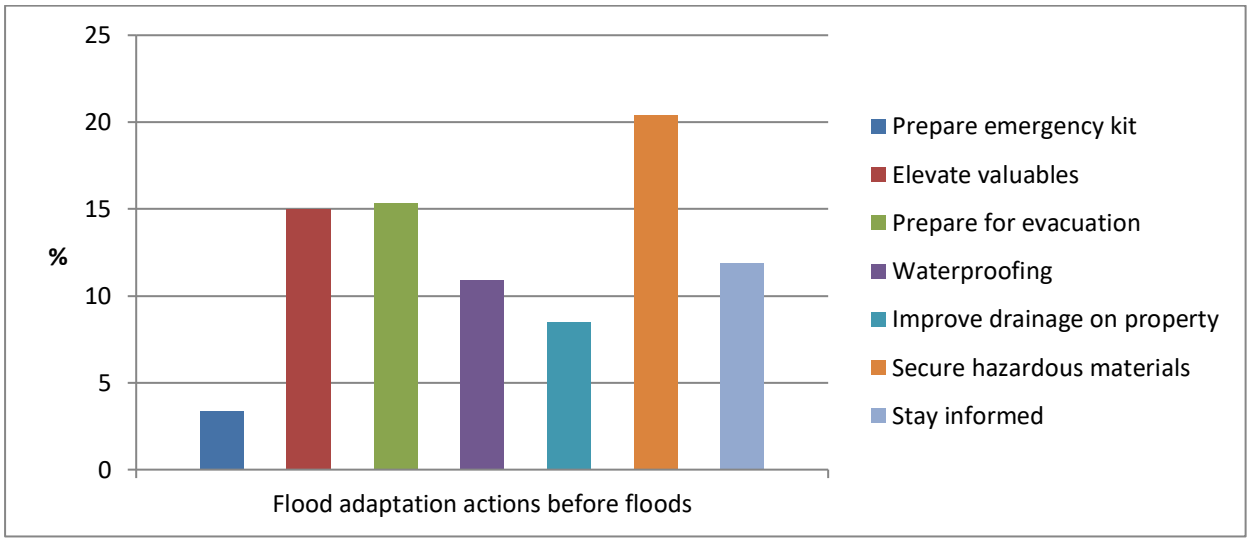


Figure 4. 4: Impacts of floods at community-level in Tshakhuma and Tshenzhelani

4.2.3 Flood adaptation actions

4.2.3.1 Flood adaptation actions taken before floods occur at household level in Tshakhuma and Tshenzhelani.

Figure 4.5 illustrates the various adaptation actions taken at the household level prior to flood occurrence (n = 93). The most common actions included securing hazardous materials (20.4%), preparing for evacuations (15.3%), and elevating valuables (15%). Additionally, the findings highlighted the importance of community-level initiatives, 11.9% staying informed about flood warnings, 10.9% implementing waterproofing measures, and 8.5% improving drainage on their properties. Notably, only 3% of households reported preparing emergency kits.



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Figure 4. 5: Adaptation actions taken before floods at household level in Tshakhuma and Tshenzhelani

4.2.3.2 Flood adaptation actions taken during floods at household-level in Tshakhuma and Tshenzhelani

Figure 4.6 illustrates the various actions taken by households during floods. Given the relatively small sample size in each study site, the results are presented in a combined manner to provide more robust and generalisable understanding of flood adaptation actions across the two study sites. This allows for a more comprehensive analysis of the overall trends and patterns in household-level adaptation actions.

The findings reveal that households employ multiple strategies to respond to flood risk during flood occurrence. The most common actions include avoiding driving and walking through floodwaters (13%), exercising caution with animals (12.1%), and evacuating if necessary (11.2%). Other notable actions include checking on neighbours (10.4%), monitoring flood levels (10.1%), and turning off utilities (7.5%). However, a smaller proportion of households take proactive measures, such as moving valuables to higher grounds (5.9%), calling for help (3.7%), listening to updates (3.1%), using emergency supplies (3.1%), and moving to higher grounds (2.2%), or following emergency alerts (2%).

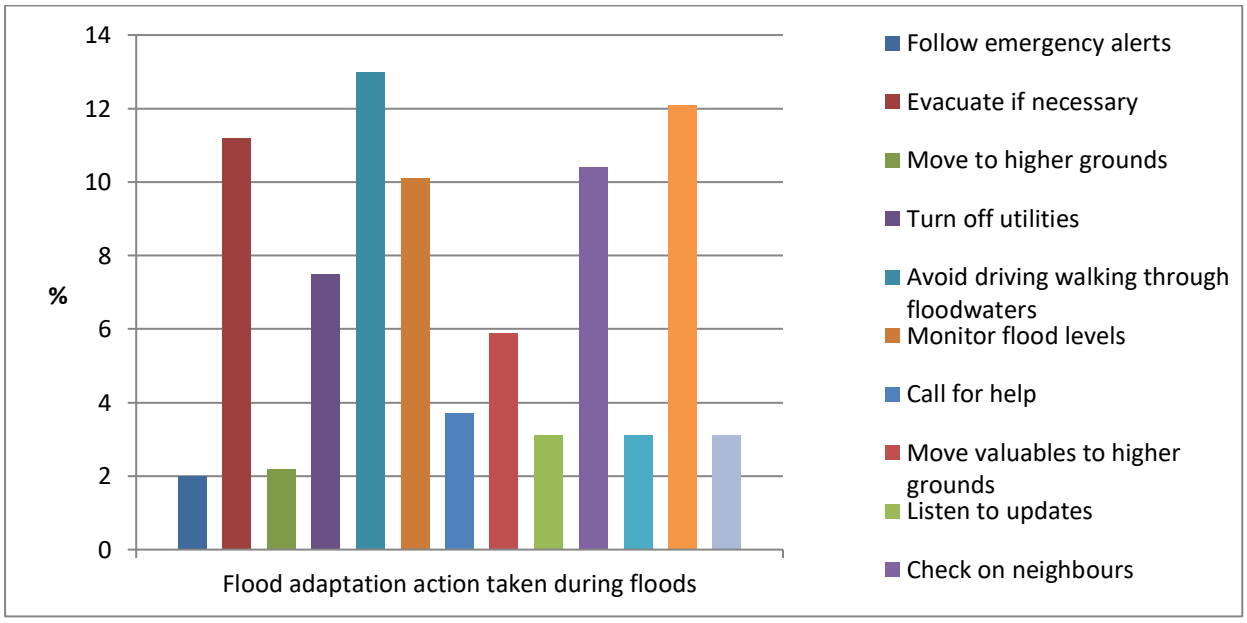


Figure 4. 6: Adaptation actions taken during flood at household-level in Tshakhuma and Tshenzhelani

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4.2.3.3 Flood adaptation actions taken after floods at household level in Tshakhuma and Tshenzhelani

Figure 4.7 illustrates the various household actions taken after floods occurs, highlighting the focus on recovery and restoration (n = 93). The most common actions include removing water from the premises (18.6%), preventing further damage (10.8%), assessing safety (10.3%), disposing of contaminated items (7.3%), and exercising caution with appliances (6.4%). Other notable actions include cleaning and disinfecting (5.75%), addressing structural damage (5%), waiting for clearance (4.4%), and reconnecting utility safety (4.1%). Additionally, some households stayed informed (3.2%), replenished emergency supplies (3.2%), wore protective gear (1.6%), and checked for mould growth (0.2%).

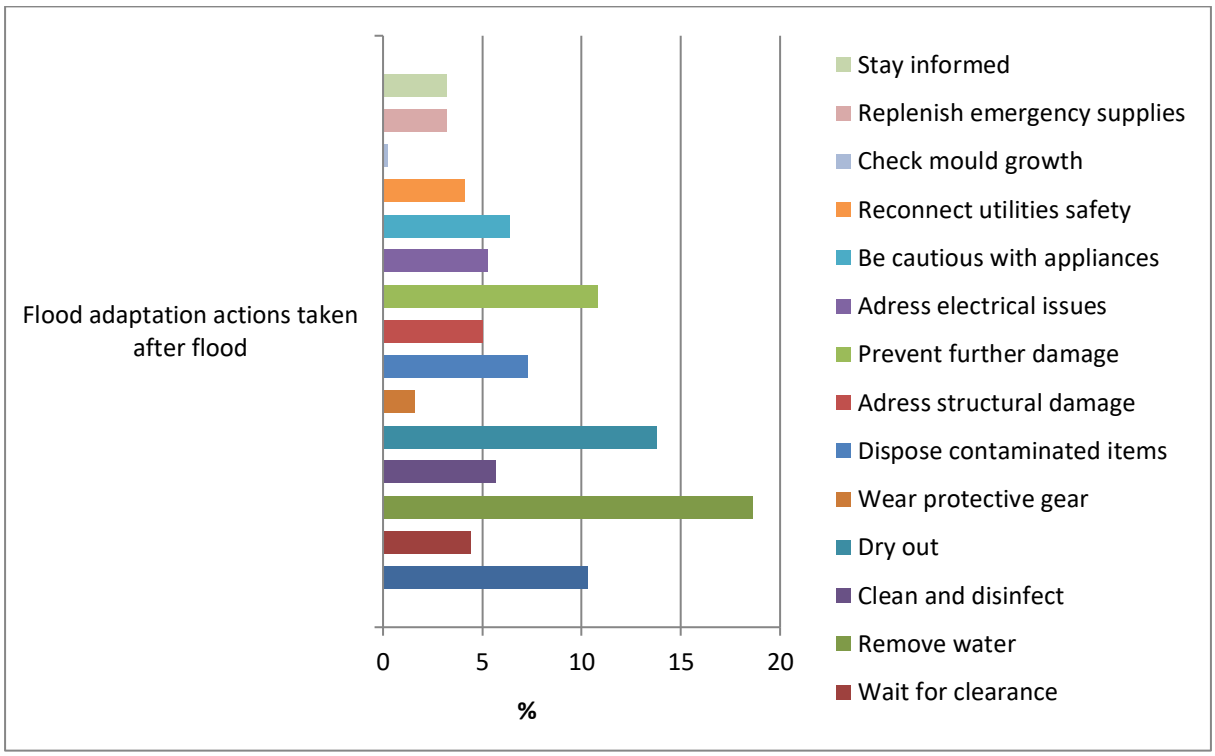


Figure 4. 7: Flood adaptation actions taken after floods at household level in Tshakhuma and Tshenzhelani

4.2.3.4 Actions taken by the municipality to provide assistance to community members

The municipal officials were asked about the role of the Vhembe Disaster Management Centre in assisting communities and households affected by floods.

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The study findings indicate that the municipal government provides assistance to affected communities and households through local municipalities. Specifically, the officials stated that they provide rescue services to households and communities severely at risk, distribute relief materials, offer social and psychological support, and relocate community members to safer areas when necessary. According to the municipal officials:

Municipal official 1: *"The district municipality provides relief materials to the affected communities. This is done through the local municipality channels as they often communicate directly with community members and are responsible for the distribution of relief materials at community level. They are the ones who make sure that the affected communities receive all the materials."*

Municipal official 2: *"The municipality offered support from social development in the form of giving out food parcels in areas where community members were affected; they also provided counselling services to the affected families and business owners."*

4.2.4 Flood adaptation plans

4.2.4.1. Legal frameworks and acts guiding the Vhembe Disaster Management Centre mandate to reduce flood impacts

The literature highlights the critical role of national legislative frameworks and acts guiding disaster management and flood risk reduction efforts in South Africa (Mehryar & Surminski, 2021; Mukwada et al., 2016). As discussed in Chapter 2, the country's disaster management legislation and framewoks, such as Disaster Management Act (2002), the National Disaster Management Framework (2005), the National Disaster Risk Reduction Framework (2019 – 2024), and the National Adaptation Strategy (2019), provide a foundation for reducing flood risk and promoting resilience (South Africa, 2002; RSA, 2005; Department of Cooperative Governance and Traditional Affairs; DEFF, 2019). In line with this, the study's findings indicate that the Vhembe Disaster Management Centre's flood risk reduction and mitigation initiatives are guided by these legislative frameworks and acts, specifically the Disaster Management Act (2002), the Constitution of South Africa (Act 108 of 1996), the Sendai Framework for Disaster Risk Reduction (2015-2030),

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and the Vhembe Disaster Management Plan (2023). These frameworks provide a critical foundation for the municipality's disaster management efforts, emphasising the importance of a structured approach to reduce flood impacts.

4.2.4.2. Key objectives, strategies, and measures of flood adaptation plans

The study revealed that the municipal flood risk management approach is comprehensive, with clear objectives outlined in the adaptation plan. The primary focus of these objectives is on flood prevention and mitigating flood impacts. To achieve these objectives, the municipality employs several strategies, including stakeholder meetings, emergency response plans, and community support. Various measures are implemented to mitigate flood risks, such as awareness campaigns, workshops, promoting afforestation, developing resilient infrastructure, and capacity building. Additionally, municipal officials reported that they provide support to affected communities through counselling services, damage-level assessments, and risk impact assessments.

4.2 Discussion

Flooding is a destructive and economically devastating natural hazard that results in significant human mortality and extensive property and infrastructure damage (Merz et al., 2021). The study finding's reveal that communities and households within the Vhembe District Municipality experience a wide range of flood-related impacts emphasising the necessity for tailore and effective flood risk management strategies (Mtapuri et al., 2018).

Studies have shown that floods can severely affect communites, damaging houses, properties, and infrastructure, harming crops, livestock, and disrupting essential services (Shah et al., 2021). Floods can have profound impacts on the well-being of individuals affected and their families, including increased vulnerability, emotional distress, and health and safety risks (Kreibich & Thieken, 2018). Educational institutions have also been unevenly severely affected by floods (Behera et al., 2020). The findings underscore the significance of considering the comprehensive impacts of floods on households when developing adaptation plans.

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The study's findings indicate that the leading causes of floods in the Vhembe District are primarily attributed to human activities, including poor land development, deforestation, and land use changes (Birkmann et al., 2019). These activities exacerbate the severity of flood events, underscoring the importance of adopting sustainable land use practices and implementing effective flood risk management strategies. Heavy rainfall is also cited as a primary cause of floods, with the severity and duration of rainfall being considered key factors contributing to flood risks (Couasnon et al., 2020). These findings are consistent with existing literature, highlighting the complex interplay between human and natural factors in flood risk.

The study's findings indicate that households in the Vhembe District have taken proactive steps to reduce and adapt to flood risks and impacts, similar to findings by Twigg (2015) on community-based adaptation measures. Approximately 81.7% of households reported using adaptation actions in response to flood disasters, demonstrating a high level of awareness and resilience, comparable to studies by Wang et al. (2022) that highlight the importance of household-level adaptation measures.

The adaptation actions employed by households and communities are a combination of structural, non-structural, and institutional measures, including improving waterproofing, community engagement, and preparing for evacuation (Twigg, 2015), aligning with global best practices. Notably, households can proactively enhance their flood resilience by undertaking preparatory measures, such as assembling emergency supply kits and safeguarding critical documents in easily retrievable locations (Wang et al., 2022). However, a notable 18.3% of households reported a lack of adaptation measures, highlighting a substantial shortfall in flood risk management (Kelman, 2015). This underscores the need for targeted interventions to support and enhance the resilience of vulnerable communities (Birkmann et al., 2019).

The study's findings reveal a mixed picture of preparedness and resilience among households. While many demonstrate a proactive approach to safeguarding their properties and possessions, notable gaps persist in their preparedness and response measures (Birkmann et al., 2019). The low uptake of critical measures like

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evacuations, utility shutdown, and using emergency supplies suggests a need for more preparedness and awareness (UNISDR, 2015).

Effective flood adaptation actions that support household-level undertakings are essential to enhance resilience to flood events (Kelman, 2015). The study's findings underscore the crucial role of adaptation measures in augmenting flood resilience, emphasising the need for effective implementation and reinforcement of these actions to reduce the consequences of floods (Kelman, 2015).

To achieve this, effective flood adaptation actions and plans must prioritise post-flood recovery support, including resources for water removal, drying out, and damage assessment (Mabasa et al., 2019). Furthermore, households require guidance on safe post-flood practices, including electrical and structural safety, mold remediation, and disposal of contaminated items. Policymakers and practitioners must prioritise flood risk communication and community needs and priorities to improve the effectiveness of flood adaptation actions and plans (UNISDR, 2015). This includes promoting good practice and providing resources for flood risk mitigation.

The study highlights the importance of various frameworks and acts that inform the municipality's response to flood disasters, including the Disaster Management Act of 2002, the Constitution of South Africa (Act 108 of 1996), the Sendai Framework for Disaster Risk Reduction (2015-2030), and the Vhembe District Municipality Plan (2023) (Mehryar & Surminski, 2021). These frameworks provide the legal foundation for the municipality's adaptation plans, promoting proactive strategies to mitigate flood risks and impacts. The municipality’s response to flood disasters is also guided by the principle of disaster risk and impacts of disasters (UNISDR, 2015). The study findings highlight the need for effective implementation of these frameworks and plans to support household-level adaptation actions and enhance flood resilience.

The study offers valuable insights into flood adaptation in the Vhembe District Municipality. The study's findings have significant implications for flood adaptation actions and plans, emphasising the importance of integrated approaches that address the multifaceted aspects of flood risk management (Twigg, 2015; UNISDR, 2015). Effective flood adaptation actions and plans require community involvement,

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perception, and trust to be successful (Parker et al., 2020) and underscores the need for sustained actions to enhance community resilience and mitigate flood risk and impact in the Vhembe District Municipality.

4.3 Chapter summary

This chapter identified and examined flood adaptation actions and plans in Vhembe District, emphasising the importance of effective adaptation measures. The study found that households take proactive steps before, during, and after floods, including securing hazardous materials, monitoring floodwater levels, and removing water to prevent further damage.

The district's approach to flood risk management is preventive, emphasising adaptation, mitigation, and prevention through stakeholder engagement, awareness-building, and education. The municipality provides assistance to affected communities, including relief materials, relocation, and emotional support.

The study highlights the importance of integrated planning, stakeholder engagement, and community participation in reducing flood risk. Established legal frameworks, such as the Disaster Management Act of 2002 and the Sendai Framework for Disaster Risk Reduction, guide municipal initiatives to mitigate flood impacts.

Community members exhibit a high level of awareness regarding flood risk, with most households having experienced severe flood impacts in recent years. Poor land development and heavy rainfall are identified as primary causes of flooding, underscoring the need for improved adaptation actions and plans to reduce flood risk in vulnerable communities.

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CHAPTER 5: COMMUNITY INVOLVEMENT IN FLOOD ADAPTATION PLANNING AND IMPLEMENTATION

5.1 Introduction

Chapter 4 identified and examined the flood adaptation actions and plans in response to flood disasters in Vhembe District Municipality. This chapter expands on the previous analysis, presenting and discussing the study's findings on planning processes and community engagement in designing adaptation actions and plans. The importance of community involvement in adaptation plans is crucial, as the lack of meaningful engagement may increase the vulnerability of households and communities to flood risks, particularly given projected climate change impacts and increased human activities contributing to flooding.

5.2 Results

5.2.1 Nature of planning and community involvement in flood adaptation in Tshakhuma and Tshenzhelani

The study's findings reveal a significant lack of community engagement in flood adaptation planning in the Vhembe District Municipality, with 89.2% (n = 83) of households reported no active engagement or participation in meetings and workshops related to flood adaptation (Table 5.1). All households (100%; n = 93) stated that their inputs were not considered in adaptation plans, and 68.8% (n = 64) reported no flood adaptation engagements in their communities. Most households (86%; n = 80) were uninvolved in the development of flood adaptation plans, with only 14% (n = 13) having minimal involvement. Community members engagement in decision-making was also reported as poor (47.3%; n = 42), very poor (45.2%; n = 44), or fair (7.5%; n = 7). Alarmingly, all households (100%; n = 93) reported a complete lack of communication and collaboration between community members and the municipality regarding flood adaptation planning.

Table 5. 1: Community involvement and engagement in flood adaptation planning in Tshakhuma and Tshenzhelani

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Community involvement & engagement	Description	Tshakhuma		Tshenzhelani		Overall		x^2	p-value
		N = 60	%	N = 33	%	N = 93	%		
Members of the household active	Yes	8	13.3	2	6.1	10	10.8	1.173	0.279
	No	52	86.7	31	93.9	83	89.2		
Inputs considered	No	60	100	33	100	93	100		
Community engagements	Yes	26	43.3	3	9.1	29	31.2	11.633	0.001
	No	34	56.7	30	90.9	64	68.8		
Members involved in planning	No	60	100	33	100	93	100		
Members involved in development	Not involved	47	78.3	33	100	80	86	8.312	0.004
	Minimal involvement	13	21.7	0	0	13	14		
Members engaged in decision-making	Poor	26	43.3	18	54.5	44	45.2	4.417	0.110
	Very poor	27	43	15	45.5	42	47.3		
	Fair	7	11.7	0	0	7	7.5		
Communication and Collaboration with authorities	No	60	0	33	0	93	0		

5.2.2 Challenges faced by Vhembe Disaster Risk Reduction Centre in community engagement and participation

The study's findings reveal that the district municipality faces significant challenges in engaging and involving communities in flood adaptation initiatives. These challenges include communities not taking flood issues seriously, failing to attend stakeholder meetings and workshops, blaming the municipality when they are negatively affected by floods, and community members prioritising service delivery over flood adaptation, while some community leaders neglect to engage in adaptation efforts. Additionally, some community members attend meetings and workshops solely for personal gain, rather than to contribute to flood adaptation initiatives.

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5.2.3 Challenges preventing community members from engaging in flood adaptation planning in Tshakhuma and Tshenzhelani

Figure 5.1 highlights the significant challenges that hinder community members' engagement in flood adaptation planning. The most common challenges include financial constraints (20.5%), limited resources (19.4%), limited access to information (19.2%), and lack of trust (15.7%). Other notable challenges include lack of awareness (11.4%), limited capacity and skills (9.3%), and power dynamics (4.5%).

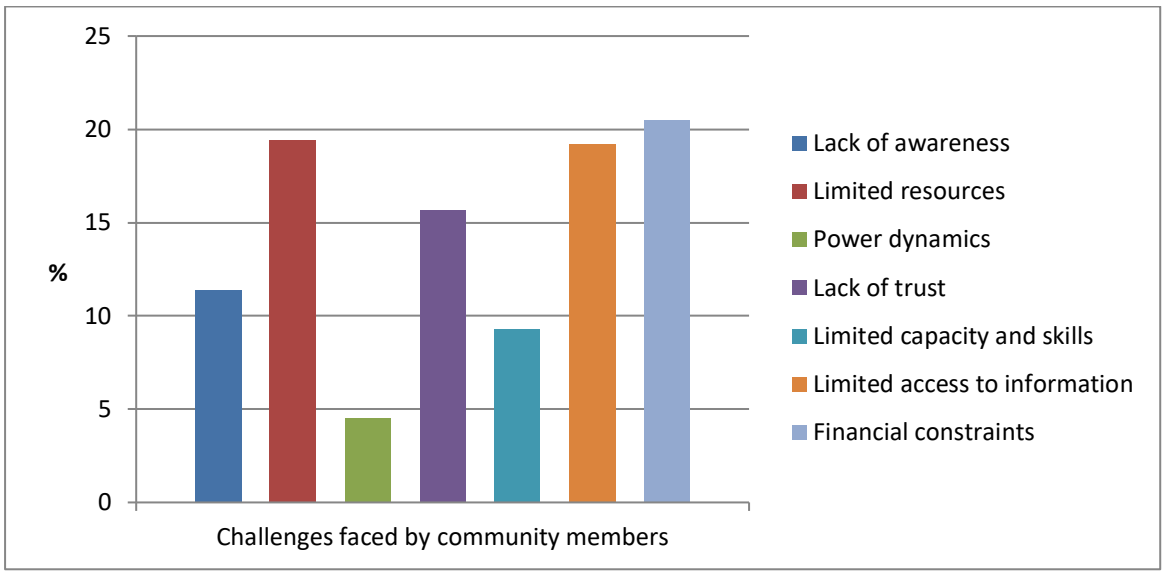


Figure 5. 1: Challenges faced by community members from engaging in flood adaptation planning in Tshakhuma and Tshenzhelani community

5.3 Discussion

The study's finding reveals a significant lack of community engagement in flood adaptation planning in the Vhembe District Municipality, which highlights the importance of community involvement in planning, designing, and decision-making processes related to flood adaptation (Defra, 2012). Effective flood adaptation relies on active community involvement and participation (Twigg, 2015). Community-led initiative can enhance resilience and reduce flood risk by leveraging local knowledge and experience to inform adaptation strategies (Kelman, 2015).

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The lack of community engagement and participation in flood adaptation planning is a significant concern, similar findings have been reported in other studies, which emphasise the need for more inclusive and participatory approaches to flood risk management (Parker et al., 2020). The study's findings underscore the importance of addressing economic, social, and informational challenges faced by communities to enhance their engagement and participation in flood adaptation planning.

The study revealed several challenges that the municipality face in engaging with community member on flood adaptation planning. These challenges include communities not taking flood issues seriously, failing to attend stakeholder's meetings and workshops, and blaming the municipality when they are faced with flood-related issues. Furthermore, community members often prioritise service delivery over flood adaptation, while some community leaders neglect to engage in adaptation efforts. Additionally, some community members attend workshops and meetings solely for personal gains, rather than to contribute to flood adaptation initiatives, highlighting a great need for improvement.

The study highlights the significant challenges that hinder community member's engagement in flood adaptation planning. These challenges include financial constraints, limited resources, limited access to information, lack of trust, lack of awareness, limited capacity and skills, and power dynamics. These findings are consistent with existing literature which highlights the importance of addressing these challenges to enhance community engagement and participation in flood adaptation planning (Twigg, 2015; Adger et al., 2013).

The study's findings have significant implications for flood adaptation planning. They highlight the need for more inclusive and participatory approaches that address the economic, social, and informational challenges faced by communities. By acknowledging the importance of community involvement, perception, and trust, flood adaptation initiatives can be designed to be more effective, sustainable, and equitable (Parker et al., 2020). The lack of community engagement and participation in flood adaptation planning can lead to adaptation actions and plans that fail to address local needs and concerns, ultimately undermining their effectiveness (Parker et al., 2020). Therefore, there is a need for more inclusive and participatory

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strategies for flood risk management, which involve community members in planning and decision-making processes (Chandra & Sinha, 2020).

5.4 Chapter summary

This chapter provides an in-depth examination of the research question, highlighting the need for comprehensive and participatory approaches to flood adaptation planning. The study's findings reveal that the absence of community involvement in planning, designing, and decision-making processes, combined with inadequate communication and collaboration among stakeholders, hinders effective adaptation and exacerbates flood risks.

The municipality faces challenges in engaging with community members, including non-participation in adaptation initiatives and the raising of unrelated issues. Communities also encounter challenges, such as financial constraints, limited resources, and limited access to information, which prevent them from engaging in flood adaptation planning.

To address these challenges, a transformational change is needed, focusing on community-based adaptation planning that prioritises engagement, empowerment, and consideration of community members' inputs. The study emphasises the vital importance of collaboration among municipal authorities, policymakers, stakeholders, and communities in co-developing flood adaptation plans that are locally relevant, inclusive, and sustainable.

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CHAPTER 6: PERCEIVED EFFECTIVENESS OF INSTITUTIONAL, STRUCTURAL, NON-STRUCTURAL FLOOD RESPONSE MEASURES

6.1 Introduction

This chapter discusses the study's findings on the perceived effectiveness of various adaptation measures employed to respond to floods at the household and community levels. These measures include institutional, structural, and non-structural initiatives such as relocation, flood warning systems, household flood protection, community emergency response, and flood evacuation shelters (Jamshed et al., 2020). The chapter provides valuable insights into community perceptions of the efficacy of existing measures in managing flood risks and impacts. The findings are crucial for assessing the strengths and weaknesses of current flood response measures, identifying areas for improvement, and ultimately enhancing community resilience to flood risks.

6.2 Results

6.2.1 Institutional measures, structural, and non-structural measures used within the communities

Table 6.1 presents the flood adaptation measures employed by communities in response to flood disasters. These measures include institutional, structural, and non-structural initiatives. Institutionally, 69% of respondents reported having community flood response teams, while 31% indicated collaboration with local authorities. Structurally, communities employed various measures, such as constructing flood control structures (49.5%), using flood barriers and levees (32.2%), elevating critical structures (10.5%), maintaining drainage systems (9.9%), and building retention ponds (7.9%). Additionally, non-structural measures were utilised, including early warning systems (50%), emergency response planning (42%), and floodplain zoning (8%).

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Table 6.1: Flood adaptation measures used within the communities

Flood adaptation measures	**Descriptions**	**N = 93**	**% of households**
Institutional measures	Community flood response team	31	69
	Collaboration with local authorities	14	31
Structural measures	Flood barriers & levees	49	32.2
	Drainage maintenance	15	9.9
	Building retention ponds	12	7.9
	Constructing flood control structures	60	39.5
	Elevation of critical infrastructure	16	10.5
Non-structural measures	Early-warning systems	25	50
	Floodplain zoning	4	8
	Emergency response planning	21	42

6.2.2 Perceived effectiveness of flood adaptation actions and measures in Tshakhuma and Tshenzhelani

Figure 6.1 reveals that a significant majority of respondents perceive the adaptation actions and measures taken at both household and community levels in response to floods as ineffective. Specifically, 73.1% of respondents felt that pre-flood actions were ineffective, while 82.8% and 71% reported that actions taken during and after floods, respectively, were also ineffective. Moreover, a substantial 78.5% of respondents perceived community-level measures as ineffective, highlighting a widespread dissatisfaction with current flood adaptation strategies.

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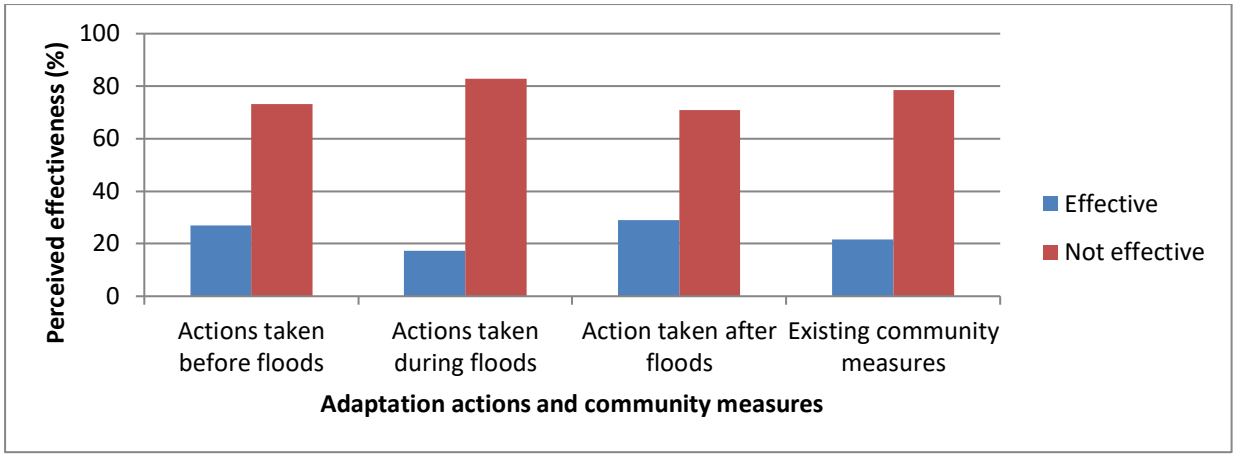


Figure 6. 1: perceived effectiveness of the adaptation actions and measures in Tshakhuma and Tshenzhelani

6.2.3 Perceived effectiveness of structural measures at community level

Figure 6.2 shows that certain community-level structural flood adaptation measures are perceived as effective in reducing flood impacts. These structural adaptations appear to provide a level of protection against flood risks, suggesting that targeted investments in infrastructure can be a valuable component of community-level flood adaptation strategies. Existing flood walls are perceived as effective in reducing flood impacts by acting as a physical barrier to prevent or reduce the flow of floodwaters into the community. Wetlands are viewed as effective measures in reducing flood impacts by absorbing excess water and slowing down floodwaters, thereby reducing the peak flow of floodwaters and giving communities more time to prepare and respond to flood events. Protective walls surrounding households are perceived as effective in reducing flood impacts by providing an additional layer of protection for individual households, preventing floodwaters from entering homes and reducing the risk of damage to property and belongings.

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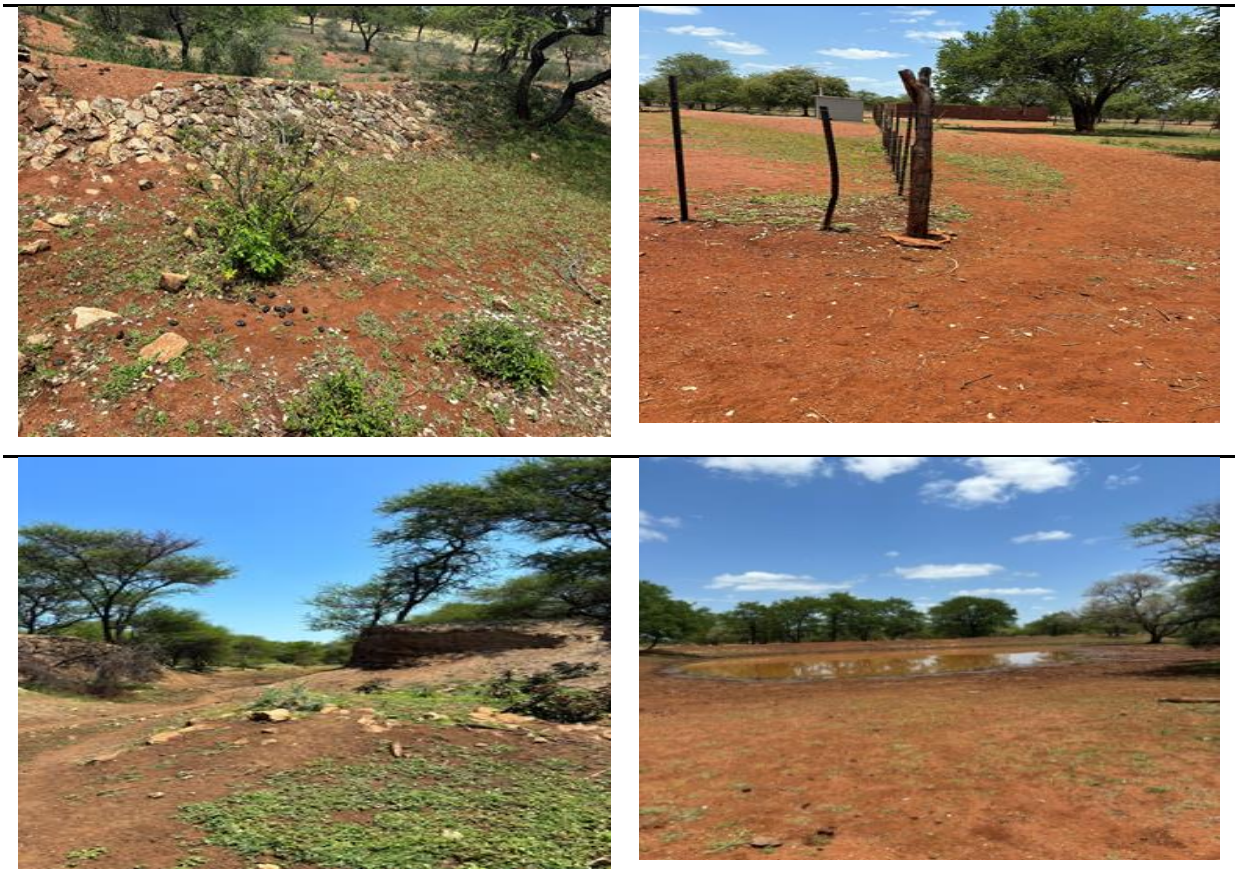


Figure 6. 2: Community-level structural flood adaptation measures that are perceived as effective in reducing flood impacts, including existing flood walls, wetlands, and protective walls rurrounding households.

6.2.4 Early warning systems and perceived effectiveness of early warning methods in Tshakhuma and Tshenzhelani

6.2.4.1 Existing early warning systems in Tshakhuma and Tshenzhelani communities

The study's findings (Table 6.1) indicate that a notable proportion of households (51.6%) possess early warning systems within their communities, with a slightly higher percentage (59.1%) reporting receipt of early warning messages and information. An examination of the timing of these warnings reveals a varied distribution, with 30.1% of households receiving warnings 2 hours prior to the flood, an identical percentage (30.1%) receiving warnings between 3 – 4 hours in advance, 21.5% receiving warnings 2 – 3 days prior, and 18.3% receiving warnings merely 1 hour before the flood event. Furthermore, the frequency of warning information received by households was also investigated, with the majority (55.9%) reporting receipt of warning information on a single occasion, while 24.7% received warnings

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twice, 10.8% received warnings three times, and 8.8% received warnings on more than three occasions.

Table 6.2: Early warning systems in Tshakhuma and Tshenzhelani communities

Early warning systems	**Descriptions**	**N = 93**	**% of households**
Community Early warning systems	Yes	38	51.6
	No	55	48.4
Household access to early warning information	Yes	55	59.1
	No	38	40,9
Duration warning messages are received before flood occurs.	1 hour	17	18.3
	2 hours	28	30.1
	3- 4 hours	28	30.1
	2 – 3 days	20	21.5
Frequency of the warning message	Once	52	55.9
	Two times	23	24.7
	Three times	10	10.8
	More than three times	8	8.6

6.2.4.2 Channels used to distribute early warnings in Tshakhuma and Tshenzhelani community

Figure 6.3 illustrates the various channels through which households receive early warning information. The findings indicate that mobile phones are the most commonly used channel, with 26.9% of households relying on this method. Neighbours (21.2%) and radio/FM (20.2%) are also prominent channels, followed by television (18.3%) and other community members (13.5%).

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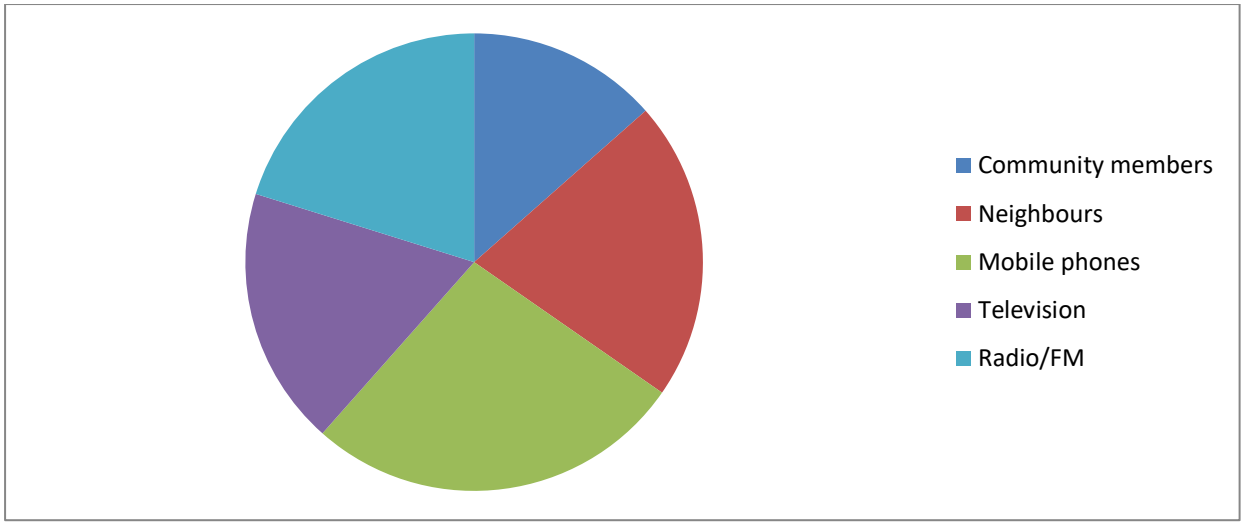


Figure 6. 3: Channels of information in Tshakhuma and Tshenzhelani

6.2.4.3 Perceived effectiveness of the early warning methods in Tshakhuma and Tshenzhelani

The findings indicate a significant disparity in perceptions, with a substantial majority (74%) of respondents viewing the existing flood early warning methods as ineffective, while a minority (26%) perceived them as effective.

A gender-based analysis of the perceived effectiveness of the existing early warning methods revealed notable differences between male and female respondents. The findings indicate that a significantly higher proportion of male respondents (62.5%) perceived the early warning methods as effective, compared to female respondents (37.5%). Conversely, a larger proportion of female respondents (62.3%) perceived the early warning methods as ineffective, compared to male respondents (37.7%).

Furthermore, a chi-square test revealed a significant association between gender and perceived effectiveness of early warning systems (EWS) ($X^2 = 4.83$, df = 1, p = 0.028), suggesting that males are more likely to perceive early warning systens as effective compared to females.

Table 6.3: Crosstabulation of gender and perceived effectiveness of early warning systems (EWS)

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			Early warning effectiveness		
			Yes	No	Total
Gender	Male	Count (n)	15	26	41
		% within early warning effectiveness	62,5%	37,7%	44,1%
		% of Total	16,1%	28,0%	44,1%
	Female	Count (n)	9	43	52
		% within early warning effectiveness	37,5%	62,3%	55,9%
		% of Total	9,7%	46,2%	55,9%
Total		Count (n)	24	69	93
		% within early warning effectiveness	100,0%	100,0 %	100,0%
		% of Total	25,8%	74,2%	100,0%

6.2.5 Perceived effectiveness of community flood response team in Tshakhuma and Tshenzhelani

Table 6.4 reveals the perceived effectiveness of community flood response teams, with majority of respondents (78.5%) expressing the view that these teams were not effective in responding to flood disasters. In contrast, a relatively small proportion of respondents (21.5%) perceived the community flood response teams as effective.

Table 6.4: Perceived effectiveness of community response teams

Community perceived effectiveness	**Description**	**N = 93**	**% of households**
Perceived effectiveness of community response teams	Effective	20	21.5
	Not effective	73	78.5
Total		93	100

6.2.6 Overall effectiveness of the flood adaptation actions and plans employed

Households were asked to categorise the effectiveness of the flood adaptation actions and plans as either ‘Effective’or ‘Not effective’. Table 6.5 presents the overall results on the perceived effectiveness of the adaptation actions and plans used in

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response to flood disasters. Notably, 100% of households perceived the existing adaptation actions and plans as not effective in responding to flood disasters.

Table 6.5: Perceived effectiveness of the flood adaptation actions and plans used in response to flood disasters

Community perceived effectiveness	**Description**	**N = 93**	**% of households**
Effectiveness of plans and actions employed	Effective	0	0
	Not effective	93	100

6.3. Assessment of perceived effectiveness of flood adaptation measures using quantitative and qualitative criteria

This section assesses the effectiveness of the flood adaptation measures in Tshakhuma and Tshenzhelani using quantitative and qualitative criteria. The study's findings suggest that the existing flood adaptation measures in Tshakhuma and Tshenzhelani are ineffective in reducing flood risks and impacts. The assessment of effectiveness using both quantitative and qualitative criteria highlights the need for more effective and sustainable flood adaptation strategies that take into account the unique socio-economic and environmental characteristics of the communities.

6.3.1 Cost-effectiveness criterion

The study found that the existing flood adaptation measures in Tshakhuma and Tshenzhelani are perceived as ineffective, indicating a potential need for more cost-effective solutions. The cost of constructing flood control structures (49.5%) and flood barriers and levees (32.2%) could be evaluated in relation to their perceived effectiveness. However, the study did not provide explicit cost-benefit analysis or return on investment (ROI) for the flood adaptation measures.

6.3.2 Environmental effectiveness criterion

The study found that certain community-level structural flood adaptation measures, such as flood walls, wetlands, and protective walls, are perceived as effective in reducing flood impacts (Figure 6.2). However, the study did not provide quantitative

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data on the environmental effectiveness of these measures, such as the reduction in greenhouse gas emissions or improvement in water quality.

6.3.3 Institutional capacity criterion

The study found that 69% of respondents reported having community flood response teams, while 31% indicated collaboration with local authorities (Table 6.1). However, the study also found that 78.5% of respondents perceived community flood response teams as ineffective (Table 6.4), indicating a need to strengthen institutional capacity.

6.3.4 Resilience building criterion

The study found that a significant majority of respondents (73.1%) perceived the adaptation actions and measures taken at both household and community levels in response to floods as ineffective (Figure 6.1). This suggests that the existing measures may not be enhancing the resilience of communities or systems.

6.3.5 Social equity criterion

The study found notable differences in perceptions between male and female respondents regarding the effectiveness of early warning methods (Table 6.3). Specifically, a significantly higher proportion of male respondents (62.5%) perceived the early warning methods as effective, compared to female respondents (37.5%). This suggests that there may be social equity issues related to access to information and resources.

6.3.6 Sustainability criterion

The study found that 100% of households perceived the existing adaptation actions and plans as ineffective in responding to flood disasters (Table 6.5). This suggests that the existing measures may not be sustainable in the long term. Furthermore, the study found that the existing early warning methods were perceived as ineffective by 74% of respondents (Table 6.3), which may indicate a need for more sustainable early warning systems.'

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6.4. Discussion

Effective flood adaptation necessitates a multifaceted approach, combining public measures with household-level actions to foster robust resilience against flood events (Berrang-Ford et al., 2021). Flood management involves a combination of structural and non-structural measures to minimise the adverse impacts of flood disasters (Sayers et al., 2013; IPCC, 2014). This study's findings emphasise a proactive approach to flood risk management, with structural measures being the most prevalent. These measures include constructing flood-resistant buildings and installing flood control structures to prevent water intrusion (Carter et al., 2015).

The results of this study highlight the importance of structural flood adaptation measures at the community level. The perceived effectiveness of existing flood walls, wetlands, and protective walls surrounding households suggests that these measures can play a crucial role in reducing flood risks and impacts. These findings are consistent with previous studies that have shown the effectiveness of structural measures in flood risk management.

The findings revealed that there are structural measures available are old in age and condition raised concern, emphasising that there is a great need to develop new structures that are resistant and improve the structures that are already available (Kelman, 2015). Notably, some community members had built on top of the flood structures, potentially compromising their effectiveness.

Findings reveal that the broken wall as shown in Figure (6.2) is perceived as an effective measure that allows water to flow in the opposite direction from households. However, while communities recognise the importance of structural and institutional measures in reducing flood risk, adopting non-structural measures, such as floodplain zoning and emergency response planning, was limited (Parker et al., 2020). Research suggests that non-structural measures are more cost-effective and implementable (Dawson et al., 2011).

Globally, implementing flood early warning systems has become widespread and crucial in disaster risk reduction and management efforts (Acosta-Coll et al., 2018). The study findings show that communities have existing early warning methods that

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they utilise to indicate moderate preparedness. However, many households lack the early warning system, which highlights a significant flood risk management gap (Twigg, 2015). Although some communities possess early warning systems, their effectiveness is restricted.

Adequate flood warnings that are timely and reliable can significantly alleviate the physical and emotional impacts of flooding (Murno et al., 2017). However, the effectiveness of flood warnings is often compromised when they fail to reach the intended recipients, are not adequately understood, or do not prompt appropriate responses, thereby undermining their potential benefits (Sukhwani et al., 2019).

The effectiveness of flood early warning systems relies heavily on the quality of communication that disseminates critical information to communities at risk. Adequate warnings inform communities of impending floods and prompt them to take necessary precautions, thereby mitigating potential harm (Morss et al., 2016). The findings of this study reveal a multifaceted approach to disseminating early warning information, with mobile phones serving as the primary channel. Furthermore, the findings also support the need for inclusive planning that includes communities in designing and implementing the early warning systems to improve their effectiveness (Parker et al., 2020).

The perceived effectiveness of community response flood teams in the communities raises concerns. Most (78.5%) of the respondents showed that they were not satisfied with the effectiveness of the response teams, while only 21.5% perceived that these teams were effective. This significantly suggests that the community response teams are not well equipped, trained, or supported to effectively respond to flood disasters (Birkmann et al., 2019).

The overall effectiveness of flood adaptation actions and plans in Vhembe District is promising but yet to be universal. Most communities have taken steps to adapt or cope with flood risks; a significant majority need resources and support to improve their resilience (Moyo et al., 2020). These findings highlight the need for capacity building to make sure that households and communities are equipped to face the challenges of flooding (Kelman, 2015).

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6.5. Chapter summary

This chapter addressed the research question on the perceived effectiveness of institutional, structural, and non-structural measures in responding to flood disasters in Vhembe District Municipality. The findings indicate that communities and households employ various measures to respond to floods, with structural measures being the most prevalent, particularly flood barriers, levees, and flood control structures. Institutional measures, such as community-based flood response teams, are also heavily relied upon, although most respondents perceived these teams as ineffective. This underscores the need for proactive planning and community engagement in flood adaptation efforts prior to flood events.

Regarding non-structural measures, the study revealed that early warning systems and emergency response planning are widely used by communities and households. However, the effectiveness of these early warning systems was perceived as limited. The study also identified various channels used to disseminate flood information, with mobile phones being the most utilised and reliable channel. The perceived effectiveness of the adaptation measures used in response to flood disasters in Vhembe District Municipality was found to be inadequate. This highlights the need for developing proactive adaptation measures that prioritise community needs and concerns, ultimately enhancing the resilience of communities to flood risks.

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CHAPTER 7: CONCLUSIONS AND RECOMMENDATIONS

7.1 Introduction

This study aimed to analyse the perceived effectiveness of existing flood adaptation actions and plans in response to flood disasters in Vhembe District Municipality and provide recommendations for enhancing these measures. Flood adaptation actions and plans are crucial in mitigating the impacts of floods, especially in vulnerable communities. The study objectives were: (1) Examine the existing adaptation actions and plans implemented in response to flood disasters in Vhembe District Municipality, with a focus on their design and functionality, (2) Assess the level of community involvement in the design and implementation of adaptation actions and plans in response to flood disasters in Vhembe District Municipality; (3) Establish the perceived effectiveness of institutional, structural, and non-structural measures in responding to floods. The preceding chapters presented a detailed analysis of the study's findings, and this final chapter synthesises key conclusions and recommendations, providing a foundation for future research and practice in enhancing flood resilience in the region.

7.2 Conclusions

The study's findings underscore the urgent need for practical and effective adaptation actions and plans to mitigate the impacts of flood disasters in Tshakhuma and Tshenzhelani communities. The communities' vulnerability to flood risks and impacts is exacerbated by their awareness of the risks, with 78.5% of households having experienced flooding in the past five years. The severity and duration of flood events emphasise the need for inclusive and resourceful flood risk adaptation actions. Communities identified heavy rainfall and human activities such as poor land development and deforestation as the primary causes of floods.

Households and communities employ various measures to respond to floods, including actions taken before, during, and after flood occurrences. However, the current flood adaptation actions adopted by households could be more effective, and communities' adaptation abilities should be considered when designing plans and frameworks. The focus should be on improving communities' adaptation and

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livelihood conditions and reducing flood vulnerability. This can be achieved by encouraging communities to build houses and properties using durable materials that withstand floods and to relocate away from flood-prone environments.

The study highlights the need for effective early warning systems to distribute flood information, as some households lack access to timely warning messages, putting their lives and properties at risk. The absence of early warning systems and poor distribution of flood information weaken communities' capacity to prepare and respond to flood occurrences, increasing their vulnerability.

Furthermore, the study reveals that communities are not actively participating in planning, developing, and decision-making on flood adaptation, highlighting the need for community engagement and involvement in flood adaptation initiatives. The lack of community involvement in flood adaptation plans increases their vulnerability, emphasising the importance of adopting community-based approaches to flood adaptation, prioritising inclusive planning, capacity building, and cooperative management.

To improve communities' resilience, it is essential to develop and integrate effective channels of information, commit to monitoring flood risk, prediction, communication, and actions, and ensure that flood warning information reaches all vulnerable communities on time. This requires collaboration among policymakers, practitioners, researchers, municipal officials, local authorities, and community members to develop and implement effective flood adaptation actions that address communities' unique needs and concerns. Ultimately, the study emphasises the need to develop better, more effective, and appropriate actions to prepare for and adapt to floods' effects, reducing communities' vulnerability to flood risk and improving their resilience in the face of climate change.

7.3 Recommendations

Based on the general findings of this study, the following key recommendations for enhancing flood adaptation planning and early warning systems in the Vhembe District Municipality were proposed.

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- The municipality should engage and involve community members when planning and designing flood adaptation plans, incorporating their valuable insights to ensure that plans address community needs, concerns, and priorities.
- Effective community-based early warning systems must be established to provide accurate and timely flood information, enabling communities to take necessary precautions and prevent exposure to floods.
- A community-centred approach to flood adaptation planning is essential, prioritising community needs and addressing their concerns through inclusive planning and decision-making processes.
- Policymakers should consider implementing policies to restrict the use of non-resilient building materials in flood-prone areas, particularly in rural settings, to reduce the vulnerability of communities to flood impacts.

7.3.1 Recommendations for further research

- This study analysed the perceived effectiveness of the existing flood adaptation actions and plans used in response to flood disasters in Vhembe District Municipality. A similar study can be conducted that examines community engagement, participation and collaboration in flood adaptation planning. This will help policymakers develop solutions that are sustainable to solve issues of floods in the community. This inclusive approach will ultimately empower community members to contribute to policy development and decision-making, fostering a more collaborative and effective flood risk management strategy

- A comprehensive gap analysis may be required to identify areas of improvement in the existing adaptation actions and plans. This will help improve existing adaptation action plans and develop new frameworks/plans that include and prioritise community needs and concerns, particularly vulnerable communities.

7.4 Limitations of the study

The study's findings and conclusions are specific to the Vhembe District and may not be generalisable to other municipalities.

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The analysis presented in this study are mostly based on descriptive statistics, providing a snapshot of the current situation. Future research could benefit from more advanced statistical analysis to further explore the relationships betweem variables and provide more robust conclusions.

The unavailability of recent statistics posed a challenge, as the data available was mostly from 2011 and 2016, which may have impacted the study's findings on existing flood adaptation actions and plans.

The study's recommendations for improving flood adaptation planning and early warning systems may require further testing and validation in different contexts to ensure their applicability and effectiveness.

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APPENDICIES

Appendix A: Households Questionnaire

My name is Nwanamidwa Pfarelo, a postgraduate student at the University of Venda, under the Department of Geography and Environmental Sciences. I am conducting a research study on **Effectiveness of Institutional Flood Adaptation Actions and Plans in the Vhembe District Municipality, South Africa.** This study seeks to analyse the current adaptation actions and plans used in response to flood disasters in the Vhembe District Municipality, as well as to provide recommendations for enhancing the effectiveness of the adaptation actions and plans. Your responses are important in enabling the researcher to obtain valuable information and gain an understanding of the impacts of floods and the flood adaptation actions and plans within the communities. The decision of participating in this study is entirely voluntary. Your information and responses will be treated with the utmost confidentiality.

Name of respondent: ……..…..

Date: ……

No: ……

Community/Location: ……

Section 1: Demographic Information and Socio-economic Characteristics

1.1 Gender:

Male ☐ Female ☐

1.2 Age:

Below 20 ☐ 20-29 ☐ 30-39 ☐ 40-49 ☐ 50-59 ☐ 60 and above (60+) ☐

1.3 Marital Status:

Married ☐ Single ☐ Divorced ☐ Widowed ☐

1.4 How many people live in your household?.....

1.5 How long have you been living in this community? ____ years

1.6 Educational level

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No formal education ☐ Primary level ☐ Secondary level ☐ Tertiary level ☐

1.7 Main occupation

Employed ☐ Unemployed ☐ Student ☐ Retired ☐ Other (Specify)……

1.8 What is the main source of income in your household.

Child/elderly support grant ☐ Salary ☐ Wage (contract) ☐ Pension ☐

Other (specify)……

1.9 Range of monthly income in your household.

R500 and below ☐ R501-R1000 ☐ R1001-R5000 ☐ R5001-R10 000 ☐

R10 001-R15 000 ☐ R15 001+ ☐

Section 2: Flood Occurrence, Frequency, Causes, and Impacts

2.1 Are you aware of any past flood risk in your community? Yes ☐ No ☐

2.2 Have you, your household or community experience any flooding in the past 5 years? Yes ☐ No ☐

if yes state the years. ……..

2.3 Have you or any member of your household been severely affected by flood in the past? Yes ☐ No ☐

2.4 How frequent did floods occur in a year in the past 5 years? Once a year ☐ Twice a year ☐ More than two times ☐

2.5 How long does a flood event usually last at each occurrence in your community? Few Hours ☐ A Day ☐ 2- 3 days ☐ 4-6 days ☐ 7 days (a week) ☐

2.6 Have you noticed any changes in the frequency of flood in your community over the past years? Yes ☐ No ☐ if yes, please specify.

……..

2.7 What are the primary causes of floods in your community? **Tick all that apply.**

Heavy rainfall ☐ Overflowing rivers or streams ☐ Poor drainage infrastructure ☐

Deforestation ☐ Urbanisation ☐ Paving ☐ Poor Land Development ☐

Climate Change ☐ Land use changes ☐ Location in floodplain ☐ Other (please specify

…… ……..

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2.8 Are there any other human factors/activities contributing to floods in your community? Yes ☐ No ☐

if yes, please specify. ……..…….

2.9 How have floods affected your household? **Tick all that apply.**

Damage to property ☐ Loss of home ☐ Structural damage ☐ Loss of personal belongings ☐ Loss of livelihoods ☐ Health and safety risks ☐ financial losses ☐ Displacement ☐ Emotional distress ☐ Increased vulnerability ☐ Food and water shortages ☐ Educational disruption ☐

2.10 What are the main impacts of floods that you have observed in your community? **Tick all that apply.**

Damage of infrastructure ☐ Damage to crops and food supplies ☐ Disruption of transportation ☐ Disruption of schooling ☐ Contamination of water sources/supplies ☐ Environmental damage ☐ Economic loss ☐ Agricultural loss ☐ Strain on public services ☐ Disruption of essential services ☐ Emergency-response-challenges ☐ Other (specify)…….

2.11 On a scale of 1 to 5, how would you rate the overall impact of floods in your community? Very severe ☐ Severe ☐ Moderate ☐ Mild ☐ Negligible ☐

Section 3: Early warning systems

3.1 Do you receive any warning messages about heavy rainfall or potential flooding in your community? Yes ☐ No ☐

3.2 Have you or any household member ever received early warning information about floods? Yes ☐ No ☐ If yes, does the warning messages includes information about the severity of the flood?.

……

3.3 Which channels of information do you use to receive early warning messages about floods?

Radio/FM ☐ Television ☐ Mobile-phones ☐ Local-newspaper ☐ Alarms/Sirens ☐

Other (specify)……

3.4 How early do you receive warning messages before flood happen?

1 hour ☐ 2 hours ☐ 3 to 4 hours ☐ 2 to 3 days ☐ 3 to 4 days ☐ 4 to 5 ☐ 5 to 7 days ☐

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3.5 How many times do you receive the warning messages? Once ☐ Two times ☐ Three times ☐ More than three times ☐

3.6 Do you think the current flood early warning methods used in your community are effective? Yes ☐ No ☐ if yes or no, please explain why?

.....

.....

Section 4: Flood Adaptation Actions and Plans

4.1 Considering the impacts reported earlier, does your household have any flood adaptation actions in place? Yes ☐ No ☐

4.2 What actions do you take before severe flood occurrence? **Tick all that apply**.

Prepare emergency kit ☐ Elevate valuables ☐ Prepare for evacuation ☐ Waterproofing ☐ Improve drainage on property ☐ Secure hazardous materials ☐ Engage in community initiatives ☐ Stay informed ☐

Other (Specify) .....

4.3 What actions do you take during floods? **Tick all that apply.**

Follow emergency alerts ☐ Evacuate if necessary ☐ Move to higher floors ☐ Turn off utilities ☐ Avoid walking and driving through floodwaters ☐ Use sandbags ☐ Monitor flood levels ☐ Call for help ☐ Move valuables to higher ground ☐ Listen to updates ☐ Seek shelter ☐ Check on neighbours ☐ Use emergency supplies ☐ Avoid contact with electricity ☐ Be cautious of animals ☐ Listen to authorities ☐ Other (Specify)

.....

.....

4.4 What actions do you take after floods? **Tick all that apply.**

Assess safety ☐ Wait for clearance ☐ Remove water ☐ Clean and disinfect ☐ Dry out ☐ Wear protective gear Dispose contaminated items ☐ Adress structural ☐ damage ☐ Prevent further damage ☐ Adress electrical issues ☐ Be cautious with appliances Reconnect utilities safety ☐ Seek professional help ☐ Check mold growth ☐ Replenish emergency supplies ☐ Stay informed ☐ Other (specify).....

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4.5 What measures exist or are used to prevent flood damage your community? **Tick all that apply.**

Floodplain zoning ☐ Land-use planning ☐ Construction regulations ☐ Flood barriers and levees ☐ Early warning systems ☐ Emergency response planning Community flood response team ☐ Education and awareness ☐ Drainage maintenance ☐ Building retention ponds ☐ Construct flood control structures ☐ Elevation of critical infrastructure ☐ Community awareness and education ☐ Wetland preservation ☐ Collaborations with local authorities ☐ Promote afforestation ☐ Other (specify) ……

4.6 What guides the community on these flood adaptation actions?.....

……

4.7 Do you receive any assistance before, during, and after floods occurs? Yes ☐ No ☐ If yes pleasespecify the assistance given and when you receive the assistance

……

4.8 Are there any groups/organisations in your community which come together to help during flood events? Yes ☐ No ☐ if yes, please name the groups/organisations.

……

4.9 Do you get any assistance from the local/district municipality during flood events? Yes ☐ No ☐

If yes, please specify……

4.10 In your own opinion, do you think the flood adaptation actions used and plans implemented in your community are effective in adapting and reducing floods impacts at both household and community level? Yes ☐ lo ☐

if yes or no, please explain your answer.

……

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Section 5: Community involvement and engagement

5.1 Are there any meetings or workshops to plan and prepare for flood risk in your community? Yes ☐ No ☐ If yes, how frequent do the meetings or workshops occur?

.....

5.2 Have you or any member of your household actively participated in any flood adaptation initiatives or community planning meetings? Yes ☐ No ☐ if yes, please describe your involvement

. .....

5.3 Have any of your inputs been considered or included in some of the decisions, plans, and actions? Yes ☐ No ☐

If yes or no why.....

5.4 How else does your community plan for flood adaptation?

.....

.....

5.5 Are you or any member of your household involved in planning with government (local municipality) on flood disaster preparedness? Yes ☐ No ☐

5.6 To what extent are community members involved in the development of the flood adaptation plans? Not involved ☐ Minimal involvement ☐ Moderate ☐ involvement ☐ Significant involvement ☐ Extensive involvement ☐

5.7 On a scale of 1 to 5, how well do you think community members are engaged in the decision-making process of flood adaptation actions and plans? Very poor ☐ Poor ☐ Fair ☐ Good ☐ Very good

5.8 Do you think there is enough communication and collaboration among community members regarding flood adaptation actions and plans? Yes ☐ No ☐

If yes or no, why?

.....

5.9 Are there any challenges that stop community members from engaging in flood adaptation planning? **Tick all that apply.**

Lack of awareness ☐ Limited resources ☐ Power dynamics ☐ Lack of trust ☐ Limited capacity and skills ☐ Limited access to information ☐ Financial constraints ☐ Other (Specify)

.....

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Section 6: Recommendations for improvement

6.1 In your own opinion, what changes can be done to limit the loss and damage that may be caused by floods in the future.

……

……

6.2 Based on your own experience and observations, what recommendations and suggestion can you make to improve the effectiveness of the flood adaptation actions and plans in your community?

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Appendix B: Key Informant Interview Guide (Municipal Officials)

Full name: ……

Tittle: ……

Position: ……

Location: ……

Date of interview: ……

1. What is your role and responsibility in relation to flood adaptation?
2. Can you recall any recent flood event (provide year and month)
3. Can you identify communities that were affected by the floods, and how badly these communities got affected? How did your organisation assist the community?
4. What guides your organisation in the mandate to reduce flood impacts?
5. What are the challenges that you face when implementing the flood adaptation actions and plans?
6. Can you describe the key objectives, strategies, and measures that are included in the flood adaptation plans?
7. How do you monitor and evaluate the effectiveness of flood adaptation actions and plans
8. What is your perception of the effectiveness of the flood adaptation actions and plans that are implemented?
9. Are the any areas that require improvement in flood adaptation actions and plans?
10. What is the level of community engagement and participation in the development and implementation of flood adaptation actions and plans?
11. What challenges do you face in engaging and participation of the communities in flood adaptation?
12. Do you have any recommendations for improving flood adaptation efforts in future?

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Appendix C: Key Informant Interview guide (Community/Traditional leader)

Full name: ……

Title: ……

Position: ……

Location: ……

Date of interview: ……

1. What is your role and responsibility as a community/traditional leader in relation to flood related issues?
2. What stakeholders are involved in flood adaptation in your community?
3. What are the flood adaptation actions and plans that have been implemented in your community?
4. Have you noticed any changes in flood pattern in the recent years? Explain the change.
5. In your own opinion, how effective are the current adaptation actions and plans in reducing the impacts of floods in your community?
6. Are there any challenges or limitations with the current flood adaptation actions and plans.
7. Are there any community-based practices that have proven to be effective in dealing with floods in this community?
8. Are there any community-based practices that have proven to be effective in dealing with floods in this community?
9. What role do you think traditional/community leaders can play in improving the effectiveness of flood adaptation actions and plans?
10. Based on your own experience, do you have any recommendations or suggestions that you would propose to improve flood adaptation in this community?

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Appendix D: Letter of permission

VHEMBE DISTRICT MUNICIPALITY
PRIVATE BAG X5006, THOHOYANDOU, 0950
TEL: 015 960 2000, FAX: 015 962 1017
Website: www.vhembe.gov.za

Enq: Nethanani N.
Municipal Manager's Office

Dear Nwanamidwa P

RE: REQUEST FOR PERMISSION TO CONDUCT A RESEARCH AT VHEMBE DISTRICT MUNICIPALITY: NWANAMIDWA P

1. The above matter bears reference
2. This writing serves to confirm that Vhembe District Municipality grants you permission to conduct research on: *"Effectiveness of Flood Adaptation Action and Plans in Response to floods Disasters in Vhembe District Municipality*, The case of Vhembe District Municipality, Limpopo, South Africa"
3. **Ms' Nthambeleni T.G**, who is a **Manager: Institutional Capacity** has been assigned to you for engagements with the municipality regarding your research. She is contactable on 067 861 2453
4. It is further emphasised that your data collections should be done in accordance with ethical requirements of the research failure which would jeopardise your opportunity.
5. Your findings should be shared with Vhembe District Municipality as they would uplift knowledge base within the district.
6. Vhembe District Municipality wishes you the best in your endeavour.
7. It is hoped that this will meet your expectations.

Kindly regards

MUNICIPAL MANAGER
KUTAMA Z.N

05/09/2023
DATE

"A developmental municipality focusing on sustainable service delivery and socio-economic development towards an equal society"

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Appendix E: English proof reading and editing report

Language Certificate

kufazano@gmail.com
+27631434276
10 January 2025

To whom it may concern,

RE: CONFIRMATION OF LANGUAGE EDITING

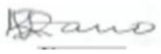
This serves to confirm that I have copy-edited a dissertation written by Nwanamidwa Pfarelo (Student number 18006801) titled ***Effectiveness of Flood Adaptation Actions and Plans in Vhembe District Municipality, South Africa***
.

The scope of my editing comprised:

- Spelling
- Tense
- Vocabulary
- Punctuation
- Word usage
- Language and sentence structure

If you need any further details, kindly contact me on the details provided above.

Yours faithfully



Kufakunesu Zano

Dr Kufakunesu Zano, PhD (English). A member of the South African Translators' Institute, **Ref no 1000686**

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Appendix F: Ethical Clearance

ETHICS APPROVAL CERTIFICATE

FACULTY OF SCIENCE, ENGINEERING AND AGRICULTURE
RESEARCH ETHICS COMMITTEE

NAME OF RESEARCHER/INVESTIGATOR: PFARELO NWANAMIDWA

Student No. 18006801

PROJECT TITLE: EFFECTIVENESS OF FLOODS ADAPTATION ACTIONS AND PLANS IN VHEMBE DISTRICT MUNICIPALITY, SOUTH AFRICA

ETHICAL CLEARENCE NO: FSEA/23/GES/14

SUPERVISORS/ CO-RESEARCHERS/ CO-INVESTIGATORS

NAME	INSTITUTION & DEPARTMENT	ROLE
Prof N.S Nethengwe	University of Venda, Geography and Environmental Sciences	Supervisor
Dr E. Mugari	University of Venda, Geography and Environmental Sciences	Co-Supervisor

Type: STAFF RESEARCH

Risk: **Minimal risk to humans, animals, or environment (Category 1)**

Approval Period: **August 2023 – July 2024**

The Faculty Research Ethics Committee (FREC) of the Faculty of Science, Engineering and Agriculture hereby approves your project as indicated above.

University of Venda
PRIVATE BAG X5050, THOHOYANDOU, 0950 LIMPOPO PROVINCE SOUTH AFRICA
TELEPHONE (015) 962 8504/8313 FAX (015) 962 9060
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Appendix G: Turnitin Report



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