ASSESSING THE ROLE OF INDIGENOUS KNOWLEDGE IN WATER RESOURCES MANAGEMENT AND CLIMATE CHANGE ADAPTATION IN THYOLO DISTRICT, MALAWI

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Abstract

This study investigates the intricate relationship between indigenous knowledge systems and the management of water resources in the context of climate change adaptation in Thyolo District of Malawi. Through a comprehensive study conducted in Chimaliro Village under the Traditional Authority Chimaliro, the research employed a combination of survey questionnaires, interviews with key informants, and focus group discussions to gather valuable insights from the local community.

The findings of the study revealed a rich tapestry of indigenous knowledge practices that have been developed and preserved by the indigenous people of the area. These practices play a crucial role in the sustainable management of water resources and in adapting to the impacts of climate change. Examples of such indigenous practices include the construction of dykes and terraces to conserve water and prevent soil erosion, the strategic digging of springs and shallow wells based on observations of vegetation growth and animal behaviour around water sources, and the utilization of traditional methods such as dug latrines, ash treatment, boiling of water, and clay water storage pots to promote water, sanitation, and hygiene.

Moreover, the indigenous community has honed their ability to predict weather patterns through various indicators embedded in their traditional knowledge systems. For instance, the flowering patterns of specific plants like mango trees and wild loquats, the behaviour of certain animals such as turkeys, and the observation of wind patterns serve as early warning signs for impending droughts or floods. In response to the challenges posed by climate change, the community has embraced adaptive strategies such as cultivating drought-resistant crops like sweet potatoes and cassava, digging shallow wells, and practicing irrigation farming to ensure food security and water availability.

The study underscores the importance of integrating indigenous knowledge systems with modern scientific approaches to achieve sustainable water management and effective climate change adaptation. It highlights the need to preserve and transmit these valuable traditional practices across generations, despite the erosion of some knowledge due to social changes,

modernization, and the adoption of new water resource management techniques. This research advocates for a holistic approach that combines traditional wisdom with contemporary scientific methods to foster resilience and sustainability in the face of environmental challenges by recognizing the significance of indigenous knowledge in water resources management and climate change adaptation.

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Acronyms/abbreviations

FAO	Food and Agriculture Organisation
IK	Indigenous knowledge
IKS	Indigenous Knowledge System
MUSTREC	Malawi University of Science and Technology Research Ethics Committee
NGO	Non-Governmental Organisation
PAR	Participatory Approach
T/A	Traditional Authority
UNESCO	United Nation, Education, Social, and Cultural Organisation
WASH	Water, Sanitation and Hygiene
WHO	World Health Organisation

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CHAPTER ONE: INTRODUCTION

1.1. Background

Indigenous knowledge (IK) is the local knowledge that is unique to a given culture or society (Gope, Behera, & Roy, 2017). It is the basis for local-level decision-making in agriculture, health care, food preparation, education, natural resource management and a host of other activities in rural communities (Sharma, 2014). It encompasses traditional knowledge of the natural environment, cultural beliefs and practices and ways of living that have been developed over a long period of time (Kato, 2020). IK plays a vital role to adapt the impact of climate change and ensuring food security in Africa (Mofogoya & Ajayi, 2017). It has also contributed to the development of water management practices that are sustainable and based on the principles of stewardship, conservation and equity (UNESCO, 2023). It plays a role in predicting the weather, understanding climate risks, coping with climate impacts, informing and improving responses to climate change, and variability and identifying adaptation options (Tfwala, et al., 2023). There is a growing body of research on the role of IK in WASH and climate change adaptation (Rarai et al., 2022).

Malawi is a nation in southern Africa that is heavily reliant on its rain-fed agriculture industry (The world Bank in Malawi, 2023). However, changes in rainfall patterns brought on by climate change have reduced agricultural yields and increased food insecurity (FAO, 2018). Additionally, with water shortages and droughts becoming more regular, the nation is having challenges in managing its water resources (World Bank, 2020). Indigenous knowledge has been suggested in this context as a possible resource for overcoming these challenges (Joshua, et al, 2013). Indigenous knowledge is defined as the information, abilities, and customs that local communities have evolved over many generations and have adapted to the local environment (Joshua, et al., 2013). This expertise includes time-tested techniques for managing water, such collecting and storing water, traditional weather fore casting,

agroforestry as well as time-tested crop types that are better suited to the local climatic conditions (Chikowo, et al., 2017). From these situations, it is clear that IK has a significant role to play in water resource manage and climate change adaptation in Malawi. However, this knowledge is often overlooked and undervalued by policy makers and development agencies (Nakashima, et al., 2012; Joshua, et al., 2013 & Boko, et al., 2012). In order to find strategies to incorporate this knowledge into formal water resource management and climate change adaptation policies, this project investigated the role of indigenous knowledge in Malawi's water resource management and adaptation to climate change.

1.2. Problem Statement

The sustainable management of water resources in the context of climate change presents a formidable global challenge (Delgado, et al., 2011). Indigenous communities often living in close connection with their environments have developed and preserved valuable knowledge systems over generations (Ballard, 2012). In Malawi, IK would be acknowledged and included in national policies and initiatives to manage water resources and combat climate change. Local communities would have more authority to take part in decision-making and apply their historical expertise to climate change adaptation. This would result in better water resource management and increased resilience to the effects of climate change. However, there was a gap between the inclusion of indigenous knowledge in national policies and strategies and its acknowledgement (Joshua, et al., 2013). The lack of political will and institutional capacity to incorporate indigenous knowledge into water resource management and climate change adaptation has resulted in limited participation of local communities in decision-making processes. This has caused inefficient methods of managing water resources and increased sensitivity to the effects of climate change, worsening the effects on vulnerable communities. This has resulted into unsustainable water management practices and reduced resilience to climate change in Malawi. Therefore, there was a need to explore the roles of indigenous knowledge in these areas to promote more effective policies and strategies that can ensure sustainable water resources management (WASH) and climate change adaptation.

1.3. Significance of the Study

The integration of IK into water resource management and climate change adaptation policies and programs is crucial for sustainable and resilient water resource management practices in Malawi. IK has been used successfully for generations to manage water resources and adapt to climate change and its integration into formal policies and programs can enhance sustainable and effective water resource management. This research is a baseline to policymakers and water resource management practitioners to understand the value of IK in water resources management and climate change adaptation, to identify opportunities to integrate IK into water resources management and climate change adaptation policies and strategies at the national, sub-national, and local levels, and develop more effective and inclusive water resources management and climate change adaptation programs by taking into account the needs, knowledge, and perspectives of indigenous people.

1.4. Research Objectives

1.4.1. Main research objective

- To assess the role of indigenous knowledge in water resources management and climate change adaptation in Thyolo District, Malawi.

1.4.2. Specific objectives

- To identify IK systems and practices in order to manage water resources and adapt to climate change
- To assess the role of indigenous knowledge in improving water, sanitation, and hygiene (WASH) practices and climate change adaptation.
- To explore barriers that hinder the incorporation of indigenous knowledge into mainstream water resource management and climate change policies.

1.4.3. Research questions

- What are the specific indigenous water management practices and traditions within T/A Chimaliro?

- Are there variations in indigenous knowledge practices across different age groups or genders within T/A Chimaliro?
- How does indigenous knowledge contribute to the improvement of water, sanitation and hygiene (WASH) practices and climate change adaptation practices?
- What are the primary barriers or obstacles that hinder the incorporation of indigenous knowledge into mainstream water resource and climate change policies?
- How do community members perceive the role of external stakeholders, such as government agencies or NGOs, in supporting or inhibiting the incorporation of indigenous knowledge?

CHAPTER 2: LITERATURE REVIEW

2.0. Introduction

This section provides the concepts and theoretical framework that were used to guide the research process and to inform the analysis and interpretation of the data collected. They helped to ensure that the research was grounded in a strong theoretical foundation and that it was focused on addressing real world challenges in a meaningful and impactful way.

2.1. Conceptual and Theoretical Framework of the Study

This section provides the different concepts in indigenous knowledge systems which have been found through research throughout the world.

- IK is defined as the knowledge and know-how accumulated across generations of living in close relationship with nature.
- Water resource management is the process of planning, developing, distributing, and managing water resources to meet the needs of people and the environment.
- Climate change is the long-term alteration of temperature and typical weather patterns in a place.
- Adaptation is the process of adjusting to actual or expected climate change and its effects.
- Climate change adaptation in water resource management is the process of adjusting water resource management practices and policies to address the impacts of climate change.
- Indigenous knowledge systems (IKS) are the complex and dynamic systems of knowledge, practices, and beliefs that have been developed by indigenous people over generations of living in close relationship with nature.

This study used much of the participatory action research, social-ecological system theory and indigenous knowledge system theory. Each theory had its importance based on the specific objectives of this study.

2.1.1. Participatory Action Research (PAR)

This theory emphasizes the importance of involving local communities in research and decision-making processes and recognizes the value of knowledge in addressing complex environmental challenges. It provides a framework for conducting research that is collaborative, participatory and community-driven and that is focused on addressing real world problems. PAR is based on the principle that people are experts in their own lives and that they should have a say in research that affects them.

2.1.2. Social-ecological Theory

This theory emphasizes the interconnectedness of social and ecological systems and how they interact to support human well-being. It provides a useful for understanding the complex relationships between human, communities and their environment, includes water resources and climate change.

2.1.3. Indigenous Knowledge System Theory

This theory recognizes the value and importance of indigenous knowledge in sustaining ecosystem and supporting human well-being. It provides a framework for understanding the unique knowledge and practices of individual communities and how they can be incorporated into broader strategies for sustainable water resources management. It recognizes that indigenous knowledge systems are holistic, dynamic and place based.

2.2. IK systems and practices by indigenous people in water resources management and adapt to climate change

Indigenous people are recognized as stewards of the world's biodiversity as well as cultural diversity and they make up approximately only 5 percent of the world's population and still effectively manage an estimated 20-25 percent of the globe's land surface (United Nations, 2021). Through continuing practice of indigenous knowledge, they have adapted and survived the adverse climate change impacts. For instance, in Kenya, indigenous people have developed strategies that are employed to adapt adverse climate change (Kalele, et al., 2021).

Some being water harvesting techniques, digging of shallow wells, construction of soil and water conservation structures and drought escaping crops. According to the UNESCO (2023), indigenous knowledge has played significant contributions towards development of water resource management practices that are more sustainable and based on the principles of conservation, unity, sustainability and of stewardship. For instance, despite being aware of climate change and having access to radios, communities all over Africa routinely use IK to make important decisions regarding their way of life, such as choosing when to plant their crops (Kangazi, et al., 2021). In Malawi, one study conducted in Chikhwawa, southern part of Malawi, found out that farmers have been utilizing a variety of traditional indicators through perceiving behaviour of the environment such as birds, insect and tree species in making farm level decisions (Mkomwa et al., 2013). Examples of tree species used in the process of weather prediction include baobab (mlambe), Cordyla africana (mtondo), Faidherbia albida (nsangu) and Mangifera indica (mango). Tree leaves shedding and shifting of flower production time indicates drought.

2.3. WASH, climate change and water resources management

WASH is closely linked to water resource management and climate change adaptation (WHO, 2017). The availability and quality of water resources are essential for meeting the needs of WASH, and effective management of these resources is crucial for sustainable WASH interventions. Climate change is also impacting water resources which can affect the provision of WASH services. IK-based WASH practices can help to improve water quality, sanitation, and hygiene behaviours which can lead to reduced risk of waterborne diseases and other health problems (Amoah et al., 2013). For example, in a study of the Maasai people in Kenya, it was found that IK-based water management practices such as sand filtration and rainwater harvesting helped to improve water quality and reduce the risk of waterborne diseases (Amoah et al., 2013). In another study by Ford & Furgal (2009), it was found that the Inuit people in the Arctic were found to be using IK to develop adaptation strategies to climate

change such as building new icehouses to store food and water and using traditional hunting techniques to find food in changing weather conditions.

2.4. Integration of indigenous knowledge systems with modern scientific approach

Integration of IK and scientific knowledge is the process of combining these two various knowledge systems in a way that is mutually advantageous. In recent years, there has been growing recognition of the importance of integrating indigenous knowledge systems with modern scientific approaches in water resource management and climate change adaptation because it offers a holistic approach. Several studies have demonstrated the benefits of integrating indigenous knowledge systems with modern scientific approaches in water resource management. For example, research conducted by Smith et al., (2018) in Australia highlighted how incorporating indigenous fire management practices improved water quality and reduced sedimentation in rivers. Similarly, the study by Johnson et al., (2019) in Canada emphasized the importance of integrating traditional ecological knowledge with hydrological modelling to enhance flood forecasting accuracy. For example, Ford, et al. (2016) conducted a study in the Canadian Arctic where indigenous Inuit communities collaborated with researchers to assess climate change impacts on sea ice. A collaborative project between indigenous communities and scientists in Australia, as described by Finlayson et al., (2015) focused on integrating indigenous knowledge into fire management practices. A study by McGregor et al., (2015) also examined the integration of indigenous knowledge in natural resource management policies in Australia. The research emphasized the need for policy frameworks that recognize and respect indigenous knowledge systems, ensuring their inclusion in decision-making processes.

2.5. Factors that hinder the incorporation of Indigenous Knowledge

IKS have often been marginalized and undervalued in mainstream decision-making processes and policy frameworks. For example, a study by Ens et al. (2015) found that indigenous knowledge was rarely considered in ecosystem management decisions in Australia. Indigenous

knowledge is often transmitted orally and embedded in local languages which makes it challenging to effectively incorporate indigenous knowledge into scientific research or policy development (McGregor et al. 2015). Power imbalances between indigenous communities and external actors such as government agencies or scientific institutions, hinder the meaningful participation of indigenous peoples in decision-making processes. For example, a study by Ford et al. (2016) found that indigenous peoples were often excluded from climate change assessment processes. Institutional constraints including bureaucratic procedures and legal frameworks are not conducive to incorporating indigenous knowledge effectively.

CHAPTER 3: METHODOLOGY

3.1. Description of study area

This research was conducted in Chimaliro village in Traditional Authority (T/A) Chimaliro of Thyolo district located between latitudes 15.9559 and 15.9785 South and longitudes 35.1729 and 35.1957 as shown in the map below:

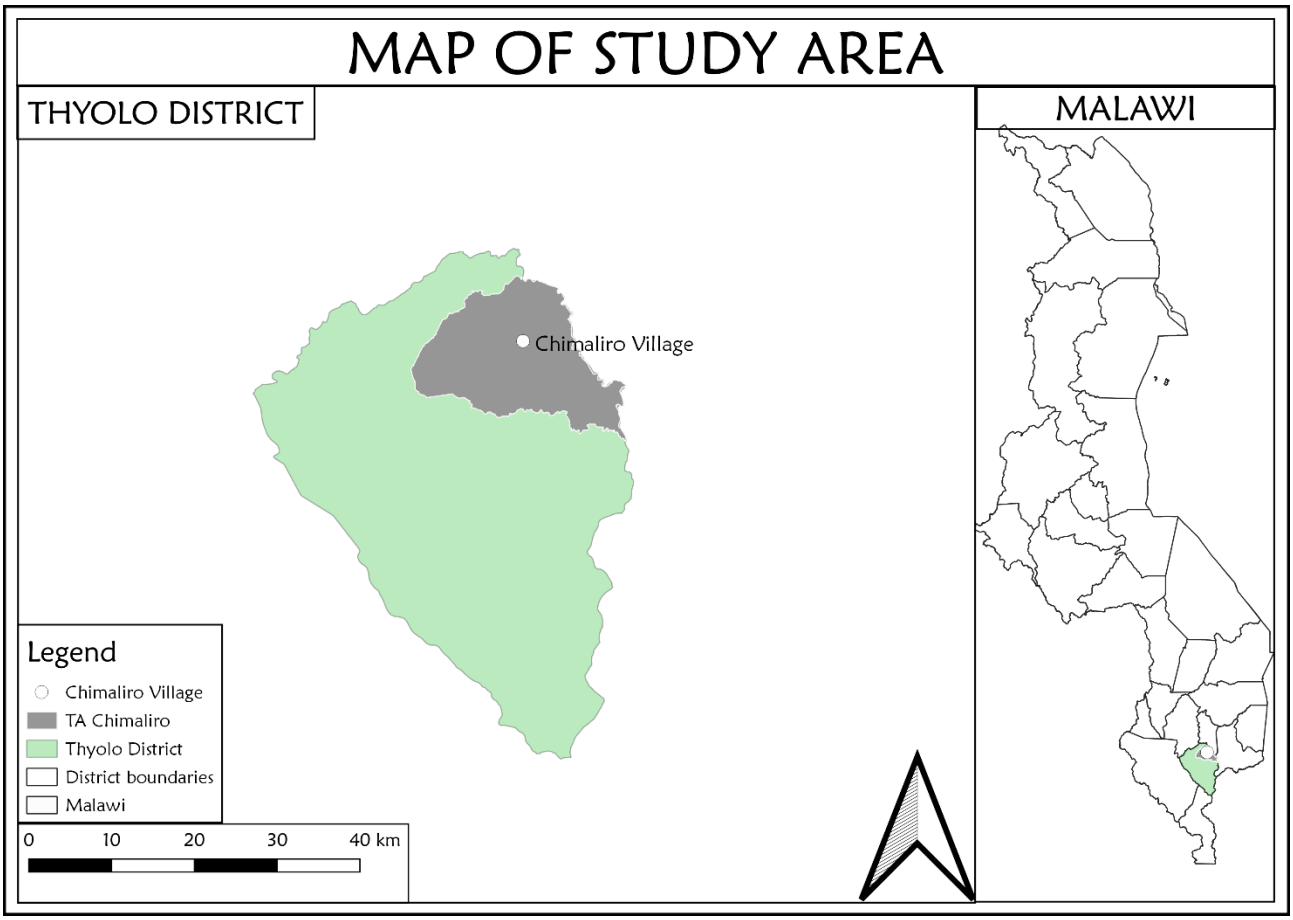


Figure 1: Map of study area

The area was chosen because:

- Thyolo District is one of the most vulnerable districts in Malawi to climate change. The district is located in the southern region of Malawi which is one of the most vulnerable

regions in the country to climate change impacts such as droughts, floods, cyclones, and other extreme weather events.

- T/A Chimaliro has rich indigenous knowledge heritage. This is a home to a number of indigenous people with rich knowledge of water resources management and climate change adaptation. This knowledge is based on centuries of experience living and adapting to the challenges of the region's climate.
- The research has direct benefits for the people of T/A Chimaliro. It has helped to identify the indigenous knowledge and practices that are being used to manage water resources and adapt to climate change which can be used to develop and implement water resources management and climate change adaptation programs that are effective, inclusive and sustainable.

3.2. Research design

The research used an ethnographic research design where mixed research approach, combining quantitative and qualitative methods were used to collect data as shown in the figure 2 below:

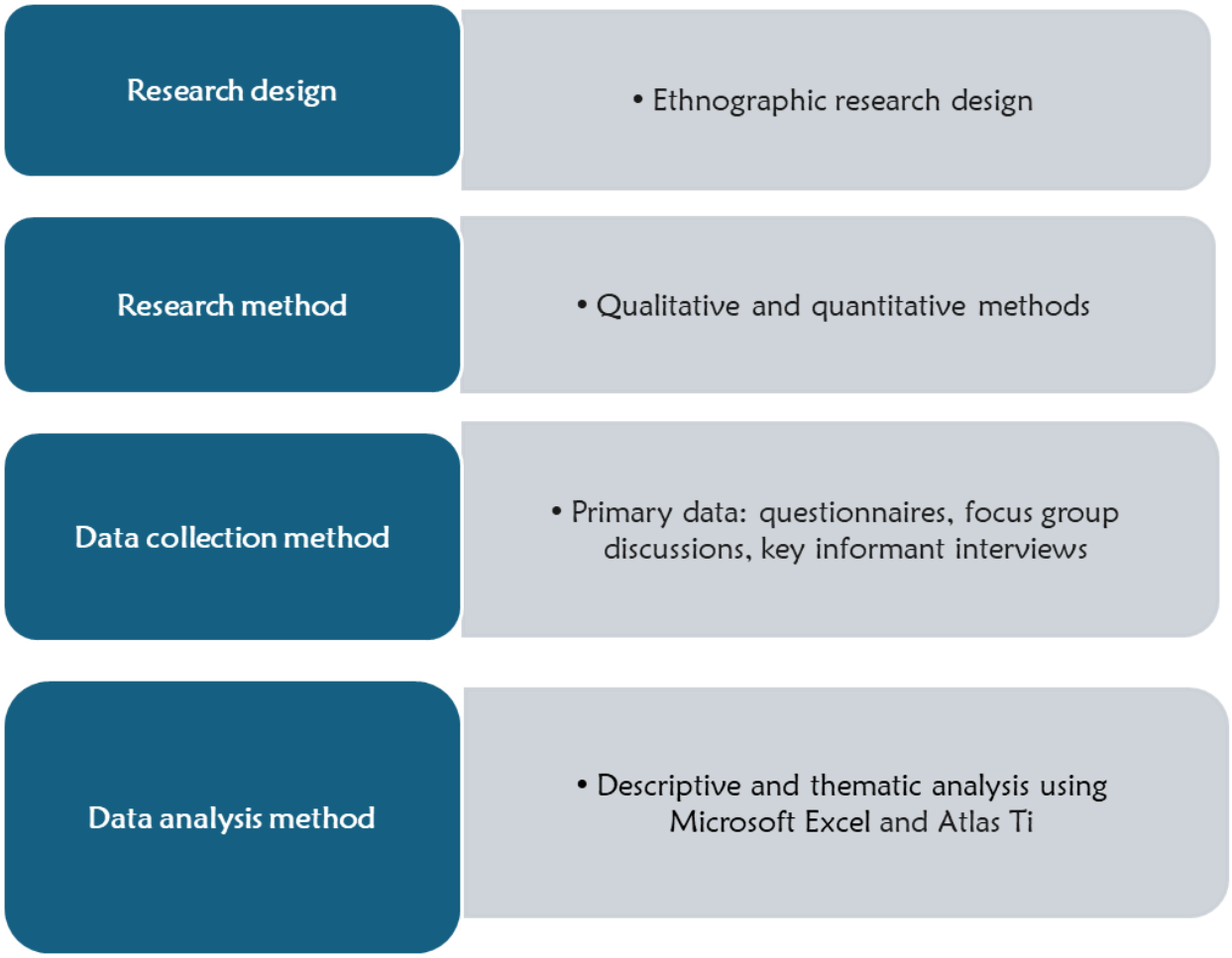


Figure 2: Research design

3.2.1. Data collection method

The data was collected through:

- Focus group discussions which were held with members of indigenous communities and other stakeholders to identify their indigenous systems and practices in order to manage water resources and adapt climate change and explore the barriers they face in incorporating IK into mainstreaming water resource management.
- Key informant interviews which were conducted with experts in indigenous knowledge systems, water resources management and climate change adaptation.

- Participant observation was used to gain a deeper understanding of how indigenous knowledge systems are used in water resources management and climate change adaptation practices in the area.

3.2.2. Target population, sample selection and size

The target population were the community members from Chimaliro village comprising of elderly, representatives from traditional authorities such as community development committees and village heads, women and men representatives, youth representatives and environmental/water practitioners.

The sampling selection was based on stratified sampling techniques where snow-balling method was used. The sample size was determined using the Yamane's Formula below: $n = \frac{N}{(1+Ne2)}$, where n is the sample size, N is the population size = 56,764 people (NSO, 2019) and e is the margin of error = 0.1. Therefore, n = $\frac{56764}{1+56764*(0.1)^2}$ = 100 people. The sample composed of two focus groups discussions, two community development committees and one village head.

3.2.3. Data collection materials and tools

The data was collected by using survey questionnaires, focus group discussions and key informant interview guides which were created in Kobo Collect mobile app in smartphones as well as printed hardcopies, ball pens, flash disks for recording and camera to take pictures.

3.2.4. Data analysis method

The qualitative data was analysed using a thematic analysis using Atlas-Ti app to identify and analyse the main themes emerging from the qualitative data. Quantitative data was analysed using descriptive statistics using software such as Microsoft Excel to create frequency tables and percentages showing the proportions of respondents who have knowledge of adaptive measures to climate change and reliability of indigenous knowledge in traditional water management practices. Regression analysis was used to determine the correlation between

indigenous knowledge and modern knowledge in water resource management and the use of WASH practices and the incorporation of indigenous knowledge into mainstream water resource management and climate change policies.

3.3. Ethical Considerations

The research proposal was submitted to the Malawi University of Science and Technology Research Ethics Committee (MUSTREC) for its review and approval. The participants were informed about the significance of the study and that their participation in the study was voluntary. At the same time, participants were also assured of their confidentiality. The rules guiding the discussions were read to the participants prior to the discussion. The interviewees were assured that respect for their indigenous traditions was a priority and was rigorously followed throughout the research process.

3.4. Limitations of the study

Collection of data in rural area particularly in the context of indigenous communities presented some unique challenges such as language and communication (Lhomwe language) barriers where the researchers were unable understand some of their words, and limited resources. In order to mitigate these challenges, the researcher worked with local translators who were familiar with both Lhomwe and English and carried translated questionnaires (Chichewa). They also carried portable power sources and any necessary field equipment and plan for data storage in offline formats.

CHAPTER 4: RESULTS AND DISCUSSION

This section presents the results from the respondents and discusses them. It will also highlight the solutions to various challenges which indigenous people face in relation to water resource management and climate change adaptation. The findings of this study indicate that indigenous knowledge plays a crucial role in water resource management and climate change adaptation in T/A Chimaliro and therefore, it needs to be preserved and promoted.

4.1. Demographic data of respondents

This study involved collecting data from various community members. These include the key informants, focus groups discussions, community development committees and individual members. It consisted of demographics such as age, gender, education level and their occupation.

4.1.1. Age distributions of the respondents

The following table below shows age of all the respondents

Age range	Frequency	Percentage (%)
18-30	11	11
31-45	33	33
46-64	36	36
65 and above	20	20

Table 1 shows age of the respondents

The age range of the respondents was 28-88 years old, with an average age of 58 as shown in table 1 above. A large number of the respondents were the people between the age of 31 to 64 years which is the productive age. However, the older individuals (20%) had a wealth of indigenous knowledge than the rest of the respondents. They accumulated it over a lifetime through experiences and interactions with their environment.

4.1.2. Gender

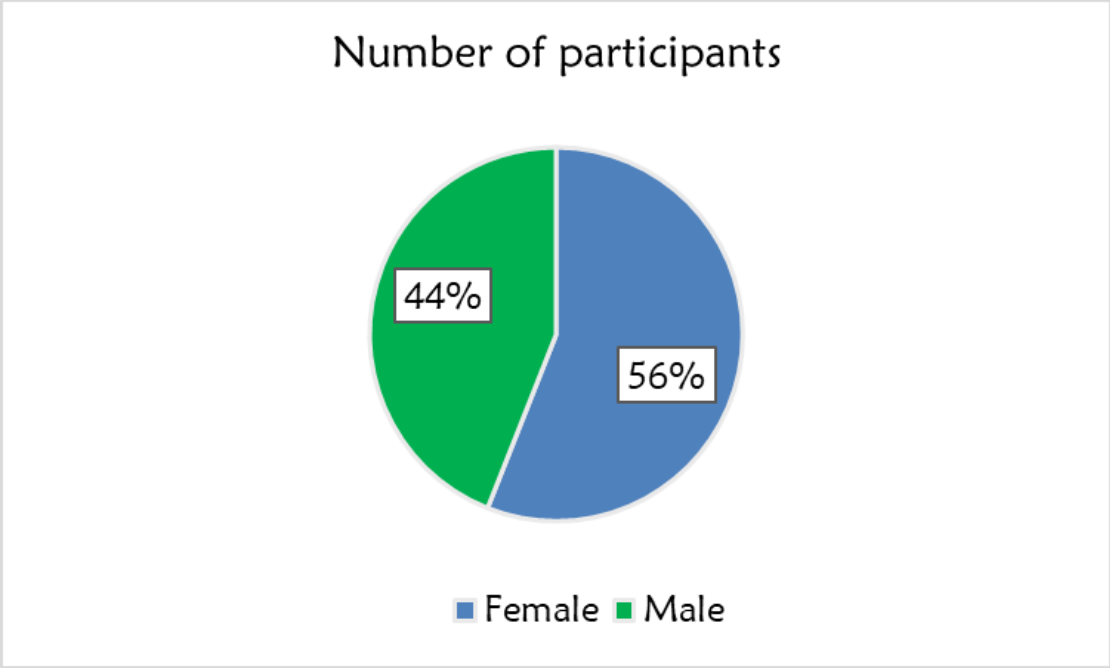


Figure 3 shows the number of respondents by gender

The sample comprised slightly more females (56%) than males (44%) as shown in the figure 3 above. The inclusion of a significant number of female participants allowed for a more nuanced understanding of how women contribute to water management practices within the community.

4.1.3. Education level

The following figure 4 shows the education levels of the respondents.

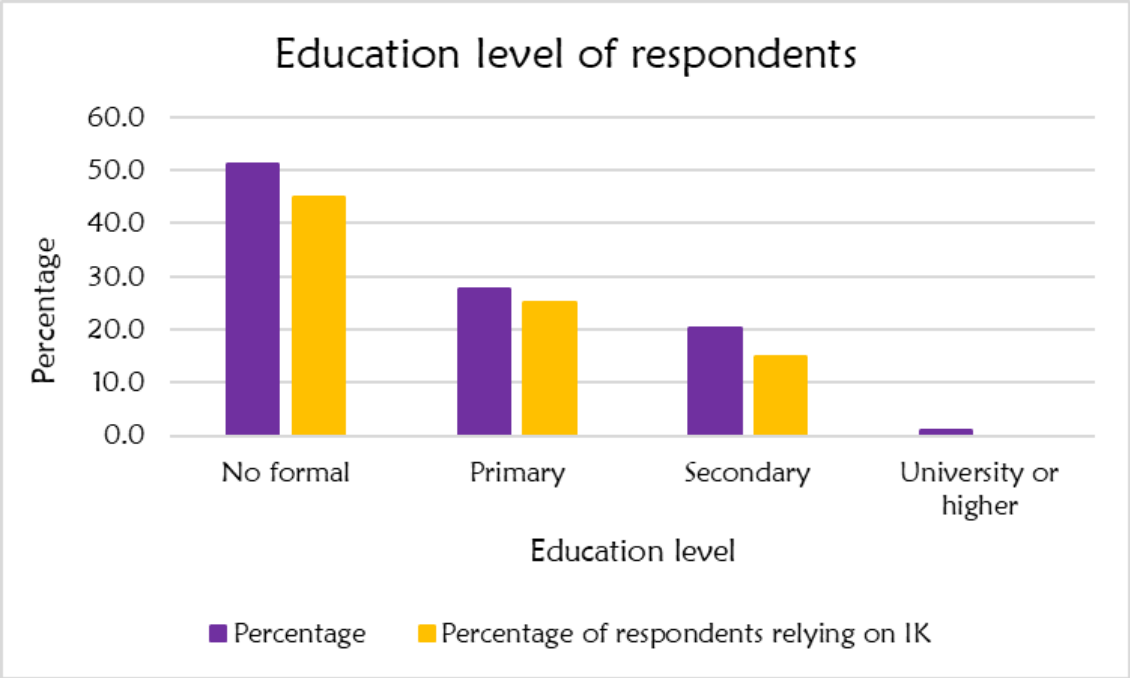


Figure 4 shows the education level of respondents

In terms of education, 27.7% had completed primary school, another 20.2% had secondary school education, another 1.1% higher education while 51.1% had no formal education. The presence of a significant portion of respondents with no formal education (45%) reported means that they rely heavily on traditional weather forecasting methods compared to those with university degrees (0%). This also suggests that indigenous knowledge transmission in the area was stronger among older generations with less formal education. Further research is needed to explore how to bridge this knowledge gap and ensure the continuity of IK practices within the community.

4.1.4. Occupation

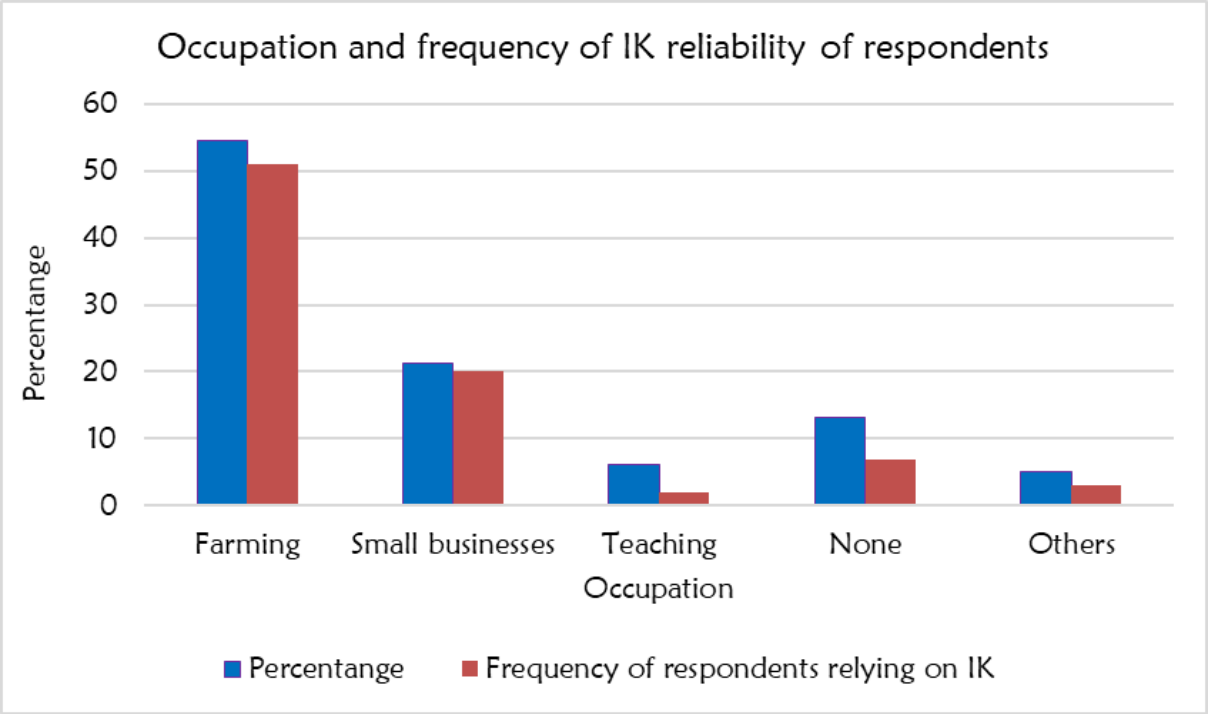


Figure 5 shows occupation of respondents from Chimaliro Village

The majority of respondents (55%) were farmers, followed by small businesses (21%), then followed by teachers (6%), those without occupation such as elderly (13%) and those with other occupations (5%). As shown in the figure above, more farmers (51%) in the sample highlighted the critical role of IK in agricultural practices related to water management and climate change adaptation, followed by small businesspeople and those without occupation. Their experience with traditional irrigation techniques, drought-resistant crops, and weather prediction based on natural signs meant that they provided valuable insights into the use of IK.

4.2. Examples of indigenous knowledge practices in managing water resources and adapting to climate change

The indigenous communities have unique knowledge and experiences which remain largely under-utilized by interventions that aim to reduce vulnerability or increase adaption to new circumstances (Makondo & Thomas, 2018; Whitfield , et al., 2015). The respondents from

Chimaliro Village identified several examples of traditional practices that were used in the management of water resources and adapting to climate change. The use of traditional practices for weather forecasting using natural signs, water collection from rivers, and traditional methods of water conservation and agricultural adaptation demonstrated the resilience and effectiveness of indigenous knowledge systems which agree with the study by Kangazi, et al., (2021) & Mkomwa, et al., (2013).

4.2.1. Weather forecasting using natural signs

The respondents highlighted that they observe the plant phenology. The flowering or fruiting times of specific plants indicated the approaching of a rainy or dry season. For instance, the early flowering of the *Mpatsa* tree (Uapaca kirkiana) and *Nkhokwe* tree (Combretum imberbe) was a sign of impending drought and mark the start of the dry season respectively. Any delays in flowering of these trees suggested a potential drought. Another way is by observing animal behaviours. The respondents said that their community observes the changes in animal behaviour. When there is an increased insect activity such as agitation in bees suggests an approaching rainy season, while early migration of birds, gathering in large flocks and swallows flying low indicates an incoming storm. This is also in agreement with what Mkomwa et al., (2013) in Chikwawa district. Meteorological observations such as wind patterns and direction, cloud formations, and the appearance of rainbows are interpreted by the traditional people to predict short-term weather changes. For example, the respondents reported that high, wispy clouds signified dry weather, while dark, low-lying clouds indicated an approaching storm.

4.2.2. Building dykes and terraces for water conservation and erosion control

According to the respondents, the people from Chimaliro village used dykes called "*mitambo*". Local materials like earth and stones were used to construct small barriers across slopes to slow down water runoff. These dykes allowed infiltration of water into the soil, replenishing groundwater reserves and reducing downstream flooding. This stored water was accessed later during dry seasons through shallow wells dug near the dyke. They also made

terraces locally called "*miunda*" by dividing sloped land into stepped sections with raised edges. The aim was to slow down water flow which prevent soil erosion and allow for better water infiltration into the fields increasing water availability for crops during dry periods.

4.2.3. Locating springs and wells based on observation

Streams and wells are located by observing the vegetation growth. For example, like ferns or mosses, lush green vegetation patches in dry areas indicated the presence of underground water sources for digging wells or springs because they are known for their water-loving nature. The frequent availability of animals with high water requirements like monkeys, elephants or antelopes is commonly in areas with hidden springs or seeps. The community members observe their regular paths which lead to water source discovery. The community members also look for areas with clear, year-round flowing water as potential well locations. They also observe the clarity and colour of water. They expressed that clear, odourless water is typically preferred while murky or discoloured water indicated that it is contaminated and hence avoided.

4.2.4. Predicting weather patterns and climate change in Chimaliro community

Just like most indigenous communities in Malawi, Chimaliro village have developed a sophisticated system for predicting weather patterns and climate change based on close observation of the natural world. According to the respondents, the following are ways in which they use to predict climate change:

4.2.4.1. Predicting weather patterns

In order to predict weather patterns, the study identified various indigenous knowledge. For instance, the flowering of certain plants such as Mangifera indica (mango) and wild loquats (uapaca kirkiana, *natural masuku*) act as natural calendar for Chimaliro community. A delayed flowering of the mango tree indicates a drier than usual rainy season. As such, the community members start to adjust planting times and conserve water resources. Animal behaviour was

another key indicator where unusual activity in birds such as turkey (*nkhukutembo*), and early flocking or changes in their calls enabled the community to predict changes in rainfall patterns. The increase in availability of insects like millipedes climbing trees signifies an impending flood.

4.2.4.2. Predicting climate change

Extreme temperatures, frequent cyclones, heavy rains and frequent occurrence of waterborne diseases such as cholera are considered indicators of climate change. Extreme temperatures are predicted where communities observe a rise in unusually hot or cold spells. This knowledge helped them to prepare for potential heat stress on crops or livestock and adjust housing practices for extreme temperatures. The increased frequency and intensity of cyclones in recent years was also stark indicator of climate change for people in Chimaliro village.

According to (Filho, et al., 2022), the various indicators of climate change have to be observed and promoted to develop senses of ownership and active contribution to sustainability of living which is similar to what the respondents reported. They reported that the knowledge of the prediction of the cyclone prompted them to strengthen their homes for example, covering their house walls with plastic papers to prevent wall erosion as shown in the figure 6 below, identify safe evacuation routes and store enough food in case of disruptions caused by cyclones.



Figure 6 shows a house wall covered with a plastic paper

A rise in occurrence of waterborne diseases like cholera which is associated with heavy rains and flooding was another sign of a changing climate pattern. This knowledge encouraged them to prioritize water, sanitation and hygiene (WASH) practices and store clean water during periods of heavy rainfall.

4.2.5. Traditional management practices of water resources and adapting to climate change

The respondents reported that in the past decades, there were few management practices to manage water resources and reduce the effects of climate change. Conservation of water resources was done through application of some traditional practices and religious taboos, beliefs and myths such as sacrifices to request for rain. The practices were meant to please their spirits or to meet their livelihood using locally found resources such as *thobwa/bota*.

The community has also adapted to climate changes by planting crops that tolerate high temperatures (drought-resistant crops) such as sweet potatoes and cassava, and planting trees.

In times of water scarcity and hunger, the community members reported that they have responded by digging shallow wells to get water and practicing irrigation farming during dry season and in times of erratic rainfall. Other respondents mentioned about migrating of the people to other parts of Malawi as shown in the figure 6. These adaptive measures are also practiced similar to what people in Kenya (Kalele, et al., 2021).

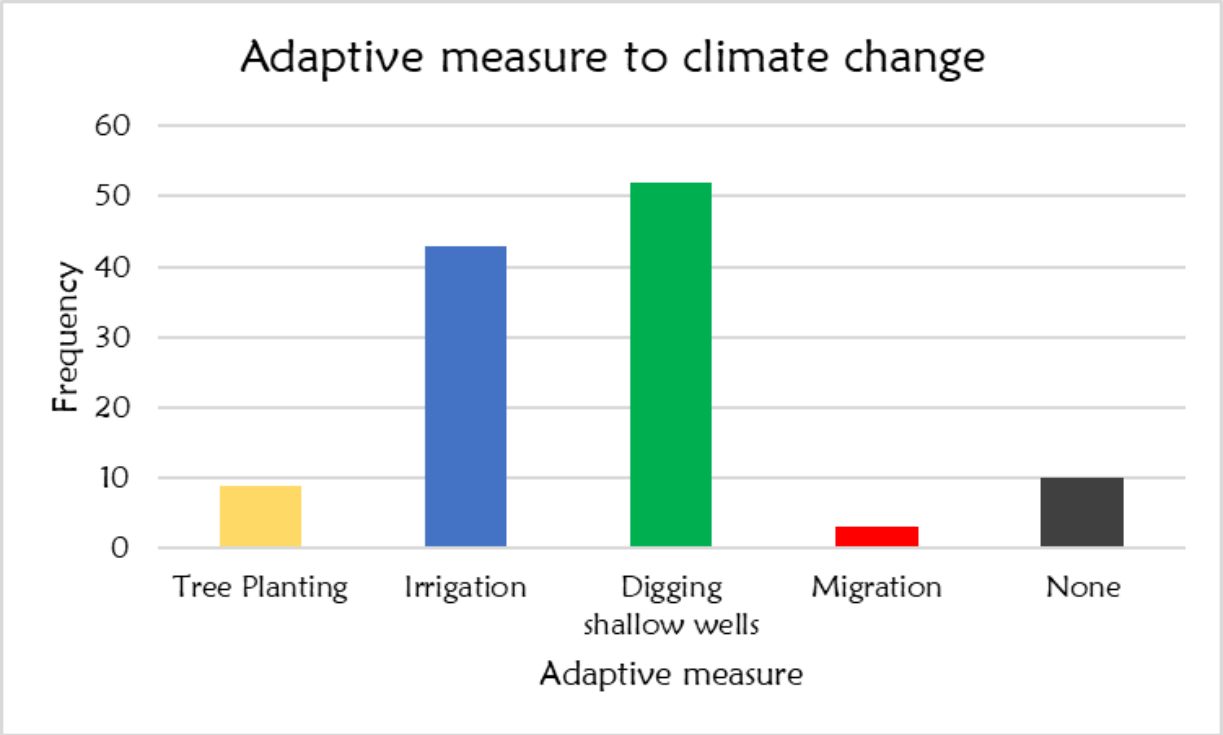


Figure 7: Adaptive measures to climate change

4.3. Contribution of IK to water, sanitation and hygiene (WASH) practices and climate change adaptation

People in Chimaliro village have developed a wide range of practices that contribute to WASH and climate change adaptation. Some specific examples of indigenous knowledge practices related to WASH according to the participants include:

1. Shallow wells

Shallow wells provide a reliable source of clean drinking water in the community since the community does not have access to piped water. This reduces the risk of waterborne diseases and ensures water security for communities. They also help in adapting to climate whereby the participants said that shallow wells enabled the access of groundwater, a critical backup water source when other sources like rivers or streams dry up. The indigenous knowledge of digging the wells in areas with historically high-water tables, communities ensured a reliable source of drinking water even when surface water sources dry up.

2. Efficient and sustainable agricultural practices

Traditional agricultural techniques like intercropping, mulching with organic materials and creating raised planting beds helped in retaining of moisture in the soil. This reduced water needs for crops and allows the people from the Chimaliro area to utilize the limited water resources more efficiently.

3. Shallow dug-out field latrines

These latrines promote sanitation and prevention of diseases. The presence of properly constructed and maintained latrines which are located away from water sources helped them to prevent contamination of water with human waste. This reduced the risk of waterborne diseases especially during floods when latrines can overflow and hence promotes good hygiene practices.

4. Boiling of drinking water

Boiling of water was a simple and effective method for eliminating harmful bacteria and parasites. All the respondents reported that they have once used this and highlighted the practice as very important when water sources were potentially contaminated during floods or droughts.

5. Clay water storing and fetching pots

Clay pots provided ideal transport and storage mechanism of water because they kept it cool and prevented contamination from dust or insects. The respondents argued that the narrow opening of the pot further reduced the risk of contamination during transport.

6. Ash as a water disinfectant

According to the participants, wood ash helps to kill some bacteria in water because contains a mild alkaline property hence water purification. Since using as it is not as effective as modern purification methods, it was only used during emergencies and by community members with limited access to other methods such as chlorine.

4.3.1. Comparison and contrasting indigenous knowledge practices to modern approaches related to WASH

From the study, it can be seen that indigenous practices related to water, sanitation, and hygiene (WASH) have their own strengths and limitations when compared to modern approaches. The following are some of these comparisons:

- Shallow wells versus modern water supply systems

  Under indigenous practice, shallow wells are often self-supply (community-driven and locally managed) providing a direct access to groundwater. They are also relatively inexpensive to construct. On the other hand, modern water supply systems include boreholes, piped water, treated water, and centralized distribution networks which offer consistent and safe water supply but require significant infrastructure investment and maintenance.

- Indigenous agriculture practices versus industrial/modern farming

  Indigenous communities often practice sustainable and efficient agriculture such as crop rotation, intercropping, and organic farming. These methods conserve water and maintain

soil health. On the other hand, industrial/modern agriculture relies on large-scale monoculture, chemical fertilizers and irrigation. While it produces high yields, it can deplete water resources and harm the environment.

- Sanitation practices

Indigenous practice uses shallow dug field latrines which are simple and locally built. They address basic sanitation needs. On the other hand, modern sanitation includes flush toilets, sewage treatment plants, and modern waste disposal for example incinerators. These systems are more efficient but require infrastructure and maintenance.

- Water treatment

Boiling water is an effective indigenous method to kill pathogens. It is low-cost but time-consuming and requires a lot of firewood. On the other hand, modern water treatment plants use filtration, chlorination and UV treatment which ensure safe water supply at scale. The pungent smell and taste of chlorine can be a challenge to some individuals preferences as compared to boiled water especially used for drinking.

- Storage practices

Clay water pots are used for water storage which naturally cool water and improve taste. Modern storage includes plastic tanks, reservoirs, and water towers. These provide larger capacity, but they do not have the same cooling effect.

4.3.2. Reliability of indigenous knowledge

Respondents were asked to rate the reliability of the use of IK practices in managing water resources and adapting to climate change as shown in the figure 8 below.

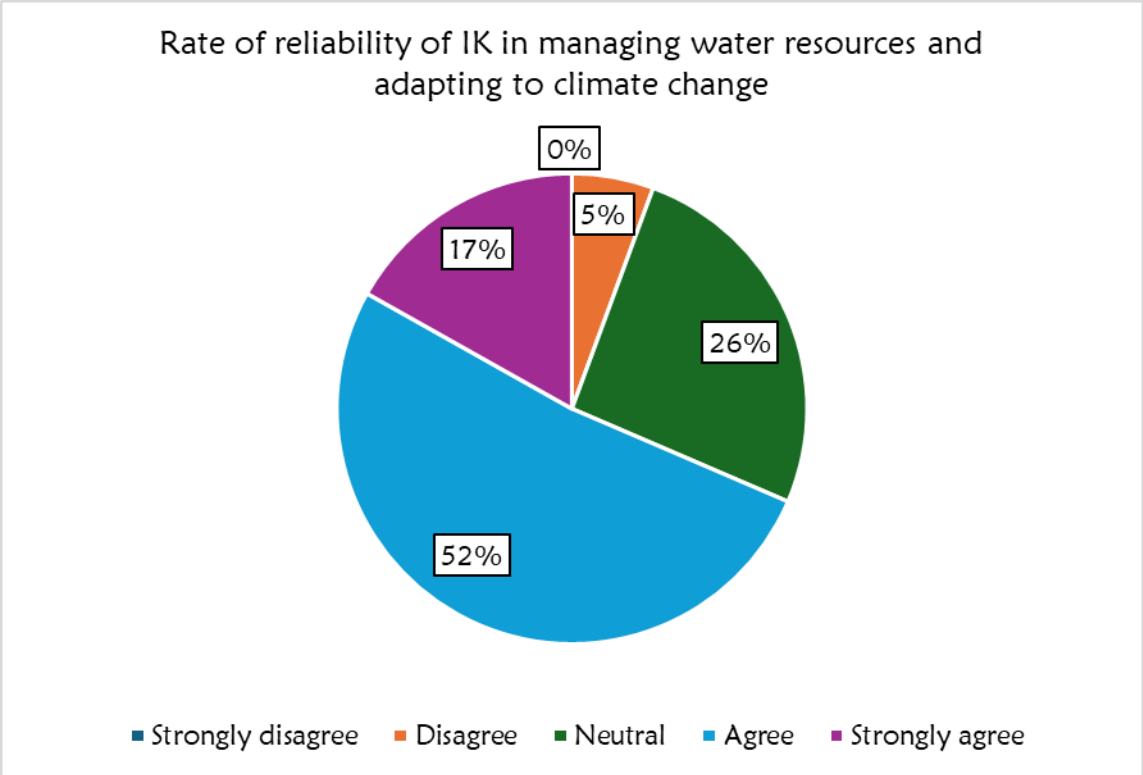


Figure 8 shows the respondents'' rate of reliability of IK

The high percentage of respondents (69%) rating indigenous knowledge as either 'Agree' (52%) or 'Strongly Agree' (17) suggests a strong community belief in its reliability for water resource management and climate change adaptation. While a significant portion of the community (95%) expressed some level of agreement on the reliability of indigenous knowledge, a smaller percentage (5%) disagreed or strongly disagreed. This highlights the need for further education and awareness campaigns to bridge potential knowledge gaps or scepticism.

4.4. Barriers to incorporation of indigenous knowledge with scientific knowledge

While indigenous knowledge (IK) holds immense value for water management and climate change adaptation in Malawi, several factors hinder its full integration according to the respondents. The primary barriers hindering the incorporation of indigenous knowledge into mainstream water resource and climate change policies according to this study include limited

recognition of indigenous knowledge by external stakeholders, lack of documentation and preservation of indigenous practices and the dominance of scientific methods over traditional knowledge.

1. Dominance of scientific methods

Scientific approaches, according to the respondents, are often seen as more objective and reliable in water management and climate change adaptation while IK is viewed as subjective. This has led to a reluctance among some scientists and policymakers to consider alternative knowledge systems like IK. Furthermore, the emphasis on quantifiable data in scientific methods also create another barrier for integrating IK which is often based on qualitative observations and experiential knowledge. Finding ways to bridge this gap and value both forms of knowledge is crucial.

2. Lack of documentation and preservation

The respondents highlighted that IK is primarily passed down orally through generations. This makes it difficult to document and standardize for integration with scientific systems. This lack of formal documentation makes it challenging to present IK as credible evidence to policymakers. Loss of IK is happening due to factors such as rural-urban migration, changing lifestyles, the influence of modern education and the declining influence of traditional elders. Because of lack of proper documentation and transmission efforts, valuable knowledge is being lost. McGregor, et al., (2015) observed the same challenge of oral transmission which prevents the preservation of the IK practices and integrity.

3. Limited recognition by external stakeholders

The current water management policies and decision-making processes often lack mechanisms to consider and integrate IK effectively. They overlooked IK due to a lack of awareness, understanding of its validity and a perception that IK is not rigorous enough compared to scientific methods. This is seen in the limited mention of IK in Malawi's National Water Policy

(2006), which primarily focuses on scientific approaches. This is in agreement with a study by (Ens, et al., 2015).

In addition, the participants reported that development projects related to water and sanitation does not involve indigenous people in the planning or implementation stages. This overlooks the valuable knowledge they possess and hinders the sustainability of such projects. Funding for water management projects often prioritizes scientific solutions which neglects the potential of IK-based approaches. This discourages communities from proposing IK-based solutions even if they are well-suited to local contexts and the development of evidence-based approaches that integrate both systems.

4.4.1. Integration of IK with modern approaches in the management of water resources and adaptation to climate change

From this study, it is seen that indigenous is very important and to sustain it, a more inclusive approach must be adopted. A study by Makondo & Thomas (2018) indicated that there is much to learn from indigenous and community-based approaches to climate change adaptation, resilience and disaster preparedness. It is through this that the indigenous knowledge practices have to be valued so that they contribute fully to the management of water resources and adapt to climate change.

However, this study has revealed the challenges faced in integrating indigenous knowledge into mainstream policies, highlighting the need for greater recognition and preservation of traditional practices. This agrees with the study of Wong & Fernandini (2011). It can also be pointed out that there is low efficiency of regulations put in place to help in water resource management and climate change adaptation, as sometimes modern ways become difficult to adapt easily. This could be a barrier to incorporating indigenous knowledge into mainstream policies. The implementation of climate change response programs for adaptation and resilience is anchored on western scientific knowledge which has led to a tendency to marginalise indigenous knowledge as it is considered unimportant in this process (Whitfield ,

et al., 2015). Yet, these knowledge systems rarely develop in isolation because they normally tend to cross-fertilize and benefit from each other. According to a study by Makondo & Thomas (2018), it recommended that indigenous knowledge is just as important as scientific knowledge and the two must be integrated through multiple evidence base approach for climate change adaptation and mitigation. The findings also emphasize the need for the formulation of policies that value both indigenous and modern ways of water resource management and climate change adaptation strategies.

4.4.2. Measures and Solutions to the challenges faced by the IK people in promoting the use of IK

The research suggests that training and resources should be provided for both scientists and community members to improve understanding and communication across knowledge systems. Overcoming these barriers requires a multi-pronged approach. This includes raising awareness among policymakers, promoting the documentation and preservation of IK, and fostering collaboration between scientists and indigenous communities to develop a more holistic approach to water management and climate change adaptation in Malawi. Based on the results obtained, the following solutions and measures are proposed:

1. Recognition and documentation

   Efforts should be made to recognize and document indigenous knowledge practices to ensure their preservation and integration into mainstream policies. Foster partnerships between indigenous communities, researchers, and policymakers to validate indigenous practices related to water management.

2. Community engagement

   External stakeholders such as government agencies and NGOs, should actively engage with local communities to understand and incorporate indigenous knowledge into water resource management and climate change adaptation programs. This may include

indigenous representatives in local water governance bodies to ensure that their voices are heard during planning and implementation. Decentralize decision-making to allow for community-led initiatives where indigenous elders and practitioners can share their wisdom with scientists and policymakers.

3. Capacity building

Training programs should be developed to build the capacity of community members, researchers and practitioners in utilizing indigenous knowledge for sustainable water resource management and climate change adaptation. Building capacity in both traditional and modern water management techniques.

4. Explore hybrid approaches that blend indigenous and modern knowledge.

For example, combine traditional water harvesting techniques with modern rainwater harvesting systems. Recognize that there is no one-size-fits-all solution, context matters. This is also agreeing with a study by Apraku, et al., (2021) which stated that the local knoeledge has to be merged with modern science to develop syncretic for example, agronomical knowledge among farmers in handling climate change.

CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

5.1. Conclusion

The study highlights the crucial role of indigenous knowledge in water resource management and climate change adaptation in T/A Chimaliro, Thyolo District, Malawi. The findings stress the need to recognize and preserve indigenous knowledge to enhance effective management of water resources and climate change adaptation which agrees with what McGregor et al., (2015) found in their study in Australia. The research underscores the importance of combining existing indigenous knowledge systems with scientific approaches to achieve sustainable water resource management and climate change adaptation. It emphasizes the significance of integrating traditional practices into mainstream policies for sustainable solutions.

5.2. Recommendations

Based on the findings of this study, the following are some of recommendations for further studies:

- Long-term impact studies

These should be conducted to assess the sustained effects of integrating indigenous knowledge into water resource management and climate change adaptation strategies over extended periods. These studies can provide valuable insights into the effectiveness and longevity of traditional practices in addressing environmental challenges.

- Economic valuation

Economic valuations of indigenous knowledge practices should be conducted to determine their monetary worth and contribution to sustainable water resource management. Policymakers and stakeholders can better understand their significance and prioritize investments accordingly by assigning economic value to these practices.

- Documentation of enduring practices

Documenting enduring indigenous practices is important for preserving traditional knowledge systems related to water management and climate change adaptation. Through comprehensive documentation, these practices can be safeguarded for future generations and serve as a valuable resource for ongoing research and policy development.

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