ASSESSING THE EFFECTIVENESS OF MALAWI NATIONAL FLOOD EARLY WARNING SYSTEM IN MITIGATING FLOOD RISK IN VULNERABLE COMMUNITIES. A CASE STUDY OF CHIKWAWA, T/A MASEYA

MERVIS LAMECK

(DRM/004/19)

THYOLO, MALAWI

DISSERTATION SUBMITTED TO NDATA SCHOOL OF CLIMATE AND EARTH SCIENCES OF THE MALAWI UNIVERSITY OF SCIENCE AND TECHNOLOGY IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE BACHELORS OF SCIENCE DEGREE IN DISASTER RISK MANAGEMENT.

June, 2024

DISSERTATION APPROVED BY:

SUPERVISOR:

MRS T. NTHARA SIGNATURE: 

ASSESSOR:

SIGNATURE:

DISCLAIMER

This document describes work undertaken as part of a program of study at Ndata School of Climate and Earth Sciences of Malawi University of Science and Technology. All views and opinions expressed therein remain the sole responsibility of Mervis Lameck, do not necessarily represent those of the school.

COPYRIGHT STATEMENT

This copy of dissertation has been supplied on condition that anyone who consults it is understood to recognize that its copyright rests with its author and that no quotation from the proposal and no information derived from it may be published without acknowledgement.

ABSTRACT

Floods have major devastating impacts on lives, livelihoods and properties of people worldwide. Malawi, one of the countries in the Sub Saharan Africa experiences huge losses due to flood disasters almost annually. However, in attempt to alleviate the adverse impacts of flood disasters in vulnerable communities, Malawi government established a National Flood Early Warning System (MN-FEWS) in 2015. But only few comprehensive papers on the performance of flood EWS in areas where floods occur frequently in Africa existed. This study assessed the effectiveness of MN-FEWS in mitigating flood risk in vulnerable communities specifically T/A Maseya. The study employed a mixed research method where data was collected qualitatively using a questionnaire and it was analyzed quantitatively using SPSS and excel. The MN-FEWS was assessed based on awareness of people, dissemination channels, reliability of the system and the responses of people. The study revealed strengths and weaknesses of the N-FEWS in mitigating flood risk in vulnerable communities which includes gaps in system awareness, issues of reliability including issues of false and missed alarms, short lead time, and varying response rates and actions among the population. The study included recommendations for improving the systems effectiveness which are enhancing public awareness, strengthening communication and dissemination channels and promoting innovative early warning methods.

Key words: Floods, Mitigation, Early Warning System, Flood early warning system, Vulnerable communities.

ACKNOWLEDGEMENT

My sincerely gratefulness should first be to God for giving me knowledge and good health that I manage to write this thesis throughout the way. Then I humbly appreciate my supervisor, Mrs. T. Nthara, for her tirelessly effort, support, inspiration and expertise on this work to be achieved, she really made a great impact on me through this dissertation, may the almighty God bless you always. Nether the less, am also thankful to Mr. Chauluka, the research coordinator, he has played a great work on teaching us about the proposal from scratch, you have really imparted us with knowledge about proposal may you be blessed. Another appreciation should go to my examiners for my proposal presentation, they guided me on points of weaknesses the proposal had to update and this was considered, God bless you also. Finally, I appreciate my family and friends for the support and motivation they always give to me, may you all be blessed also.

Table of Contents

CHAPTER 1: INTRODUCTION 1

1.1 BACKGROUND 1

1.2 PROBLEM STATEMENT 2

1.3 OBJECTIVES 3

1.3.1 MAIN OBJECTIVE 3

1.3.2 SPECIFIC OBJECTIVES 3

1.4 RESEARCH QUESTIONS 3

1.5 SIGNIFICANCE OF THE STUDY 4

CHAPTER 2: LITERATURE REVIEW 5

2.1 INTRODUCTION. 5

2.2 Establishment of Flood early warning system in Malawi 5

2.3 EWS'S PART IN REDUCING DISASTER RISK 6

2.4 FACTORS INFLUENCING HOW PEOPLE REACT TO WEATHER ALERTS 6

2.5 Flood early warning systems in Malawi 7

2.5.1 HOW THE NATIONAL FLOOD EARLY WARNING SYSTEM IS OPERATED 8

2.6 FLOODS IN MALAWI 9

CHAPTER 3: METHODOLOGY 11

3.1 STUDY DESIGN 11

3.2 STUDY AREA 11

3.3 SITE SELECTION 12

3.4 SAMPLE SIZE 13

3.5 TARGET POPULATION 13

3.6 DATA COLLECTION 14
3.7 DATA ANALYSIS 14
3.8 DATA PRESENTATION 14
3.9 ETHICAL CONSIDERATION 14
CHAPTER 4: RESULTS AND DISCUSSION 15
4.1 INTRODUCTION 15
4.2 RESULTS OF THE STUDY 15
4.2.1 SOCIAL ECONOMIC AND DEMOGRAPHIC DATA 15
4.2.2 AWARENESS AND EFFECTIVENESS OF DISSEMINATION CHANNELS 17
4.2.3 RELIABILITY OF MALAWI NATIONAL FLOOD EARLY WARNING SYSTEM.. 18
4.2.4 THE RESPONSE OF PEOPLE TOWARDS THE NATIONAL FLOOD EARLY WARNING MESSAGES 20
4.3 DISCUSSION OF THE RESULTS 22
4.3.1 DEMOGRAPHIC DATA AND THE EFFECTIVENESS OF THE EARLY WARNING SYSTEMS 22
4.3.2 AWARENESS AND EFFECTIVENESS OF DISSEMINATION CHANNELS 23
4.3.3 RELIABILITY OF THE WARNING SYSTEM 24
4.3.4 RESPONSES OF PEOPLE TOWARDS THE N-FEWS 25
CHAPTER 5: CONCLUSION AND RECOMMENDATIONS 26
5.1 INTRODUCTION 26
5.2 CONCLUSION 26
5.3 RECOMMENDATIONS 27
5.4 STUDY LIMITATIONS 28
7.APPENDICES 34
7.1 Research questionnaire form 34

7.3 Community Based Early Warning System In T/A Maseya..... 41

ACRONYMS/ABBREVIATIONS

%	Percentage
>	Greater than
<	Less than
ACPC	Area Civil Protection Committee
ANOVA	Analysis of Variance
CBEWS	Community Based Early Warning Systems
DCCMS	Department of Climate Change and Meteorological Services
DoDMA	Department of Disaster Management Affairs
DWRs	Department of Water Resource Management
EWS	Early Warning Systems
FEWS	Flood Early Warning System
GCF	Green Climate Fund
GWP	Global Water Partnership
M-CLIMES	Modernized Climate Information and Early Warning System
MN-FEWS	Malawi National Flood Early Warning System
NDRMP	National Disaster Risk Management Policy
NFEWS	National Flood Early Warning System
NSO	National Statistical Officer
RCMDR	Regional Centre For Mapping of Resources for Development
SDGs	Sustainable Development Goals
SPSS	Statistical Package for the Social Sciences

T/A Traditional Authority

UNDP United Nation Development Programme

UNDRR United Nations for Disaster Risk Reduction

VCPC Village Civil Protection Committee

WMO World Meteorological Organization

LIST OF FIGURES

Figure 1: Malawi National flood early warning system 8
Figure 2: Study area map of TA Maseya in Chikwawa District 12
Figure 3: Awareness Level 17
Figure 4: warning communication and dissemination channels 18
Figure 5 : shows different categories of warning lead time and timeliness 19
Figure 6: warning reliability indicators 20
figure 7: shows responses of people 21
Figure 8: asset protection and response action 21

LIST OF TABLES

Table 1: Displays ANOVA Analysis 16
Table 2: T-Test for Socioeconomic Status and Response Rate To MN-FEWS 16

CHAPTER 1: INTRODUCTION

1.1 BACKGROUND

Flooding is a type of disaster that occurs globally on diversity scales and in numerous locations each year, claiming many lives, destroys property, and devastates the ecosystem (Glago, 2020). For instance, in 2022, floods caused the deaths of roughly 7,400 people across the globe (Salas, 2023). Nevertheless, floods frequently result in severe harm and suffering, particularly in lower-income nations where infrastructural systems, such as drainage and flood protection, are often poorly developed (World Bank, 2023). For example, Africa is one of the two continents in the world where floods occur most frequently. Floods in Africa have afflicted a significant number of people over the last three to five years. In 2020, the number of affected individuals peaked at seven million (Tomala, 2021).

Floods in African countries are becoming more frequent and severe. For instance, in Sub-Saharan Africa, floods have affected over 2.8 billion people and claimed over 200,000 lives in the last few decades (Odizua, Eyo, & Jackrich, 2024) . Additionally, Malawi, one of the African countries, is frequently hit by catastrophic floods, which have resulted in varied degrees of destruction. For example, between 1942 and 2019, the nation faced huge flooding as a result of rain brought on by Cyclones which devastated hundreds of thousands of people's homes, animals, and crops (Hussein, Tole, & Mwakumanya, 2023). Shire River Basin (SRB) in Malawi is prone to severe flooding. Chikwawa is one of the ten districts in the Shire River Basin of Malawi that is severely hit by floods annually (Hussein, Mwakumanya, & Tole, 2023) . To overcome this, flood Early Warning Systems (EWS) were established as a preparedness measures to mitigate flood impacts.

Flood early warning systems (FEWS) are systems that provide timely and effective information to people who are at risk of flooding, so that they can take actions to reduce the potential impacts of floods (UNEP, 2017). The Sendai Framework for Disaster Risk

Reduction and the Sustainable Development Goals (SDGs) have established targets for their availability, and the UN Office for Disaster Risk Reduction acknowledges their significance and vigorously works for their increased availability (UNDRR, 2006). But even though FEWS are widely acknowledged as being important for disaster risk reduction (DRR), little is known about their availability and status globally, their advantages and disadvantages, the difficulties they face, and the patterns that are connected to their development (Perera, et al., 2019). This study aimed to assess the effectiveness of the Malawi National Flood Early Warning System (NFEWS) in mitigating flood risk in vulnerable communities such as T/A Maseya in Chikwawa, Malawi. The goal was to evaluate its performance in mitigating flood risk at community level.

Malawi established a National Flood early warning system in response to Hyogo framework for action of disaster risk reduction and following its National Disaster Risk Management Policy (NDRMP) of 2015 (GoMa, 2015), hence Flood early warning systems (EWS) are needed to lessen the danger of flooding and its consequences. However, there are few comprehensive papers on the performance of flood EWS in areas where floods occur frequently in Africa (Ringo, Sabai, & Mahenge, 2024).Therefore, this study documented the performance of the NFEWS by specifically focusing on T/A Maseya, which is among the most flood frequent affected areas in Africa, within Malawi. The study was based on 2019 and 2022 floods.

1.2 PROBLEM STATEMENT

Despite the establishment of N-FEWS in Malawi in 2015, significant losses, injuries and mortalities continued to occur. For instance, in 2019, Severe flooding negatively affected people's lives, livelihoods and socio-economic infrastructure, leading to an estimated US$220.2 million losses. Approximately 975,000 individuals were affected, with 86,976 displaced, 60 killed and 672 injured in 17 districts (Malawi Government, 2019). Similarly, in January 2022, flash floods hit the Chikwawa district after heavy rains, affecting thousands of people in different villages, destroyed homes, livestock were washed away, and crops were submerged (Chikwawa Diocese, 2022). Previous studies have indicated

that ever since the installation of F-EWS in Malawi, no study has been conducted to evaluate their effectiveness (Chinguwo & Deus, 2022). So, there was a need for conducting a comprehensive study to assess the effectiveness of the MN-FEWS in mitigating flood risk in vulnerable communities like T/A Maseya. The study was important because it provided deep insights on why people were affected even though warnings were in place.

1.3 OBJECTIVES

1.3.1 MAIN OBJECTIVE

To assess the effectiveness of national flood early warning system in mitigating flood hazard to vulnerable communities specifically Maseya villages.

1.3.2 SPECIFIC OBJECTIVES

i. To identify the effectiveness of dissemination channels people in Maseya village use for receiving flood warnings.
ii. To investigate the reliability of national flood early warning system at community level.
iii. To assess the response of people in Maseya villages toward a flood warning.

1.4 RESEARCH QUESTIONS

i. What channels of warning dissemination do the people in Maseya uses in receiving the early warning messages?
ii. What are the bottlenecks of warning channels in disseminating warning messages?
iii. Are the warnings issued on time?
iv. How accurate are the issued warnings i.e cases of false or missed alarms?
v. What is the response rate of people in various dissemination channels?

1.5 SIGNIFICANCE OF THE STUDY

A flood early warning system is an important component of flood risk reduction (FRR). Communities at risk must actively participate in an EWS, and public awareness of risk and education are also necessary components (Teule, 2019). Effective dissemination of EWS messages is necessary, as is a constant level of readiness. Early warning systems that are local and "bottom-up" allow for a complex response to problems and demands (UNDRR, 2006). Assessing the effectiveness of FEWS established the weaknesses, strengths and areas of improvement in the system that would enable officials to create effective strategies that will align with the community's needs and expectations thereby fostering community's participation and awareness in responding to warnings hence reducing the flood risk in T/A Maseya. In addition, the study added up to existing literature and will be used by future scholars as a reference material.

CHAPTER 2: LITERATURE REVIEW

2.1 INTRODUCTION.

An EWS is described by the United Nations Office for Disaster Risk Reduction (UNDRR) as an integrated system of hazard monitoring, forecasting and prediction, disaster risk assessment, communication and preparedness activities systems and processes that enables individuals, communities, governments, businesses, and others to take timely action to reduce disaster risks before hazardous events (UNDRR, 2006).The framework of an early warning system was designed based on the following four elements; Risk knowledge, hazard monitoring and forecasting, dissemination and communication as well as response capability. However, the current EWSs in poor nations are frequently weak and ineffective (Teule, 2019). Early warning system is an important component of disaster risk management strategies. Based on this, the research intends to find out if these flood warnings are effective in averting damage in flood disaster prone areas of TA Maseya.

2.2 ESTABLISHMENT OF FLOOD EARLY WARNING SYSTEM IN MALAWI

The largest threat to Malawi's population, infrastructure, and economy is natural disasters. Over the past 50 years, Malawi has had more than 19 major floods, and over time, the frequency, size, and scope of these events have all grown (Kapatuka, 2021) . Due to a highly changeable environment that includes periodic floods that, in many locations, occur virtually annually, as well as droughts that leave them impoverished and food insecure, the Lower Shire Valley people of Malawi suffer extreme development challenges (GWP, 2018).

After realizing the devastating impact of floods on the economy and humanitarian fronts, the government of Malawi initiated the development and implementation of National Guidelines for Community-Based Flood Risk Management (FRM). These include measuring the danger of flooding, as well as the planning, designing, and building of FRM measures like public awareness campaigns and the installation of a suitable flood early warning system in the Lower Shire Valley (GWP, 2018).

In order to alleviate the Lower Shire Valley's flooding issues and break the cycle of poverty and vulnerability in the most affected villages, the project's main objective was to provide FRM infrastructure and public education (GWP, 2018). Guidelines for FRM planning, design, and execution at the district, traditional authority (TA), and group village head (GVH) levels did not exist prior to this initiative.

2.3 THE ROLE OF EARLY WARNING SYSTEMS IN REDUCING DISASTER RISK

FEWS are crucial to the global DRR effort, an initiative being implemented known as Early Warning for All is with the aim of minimizing the adverse impacts of disasters on global (UNDRR, 2023). An effective early warning system can reduce damage by 30% and save many lives (UNDRR, 2022). By enabling workers', employers', and national or local authorities' prompt response and preparation, they can contribute to the prevention of losses in terms of lives and property through the spread of accurate and timely information about the threat of catastrophes. Implementing such protocols can also contribute to greater resilience, since enhanced preparedness enhances recovery capacity and reduces susceptibility (UNDRR, 2022).

2.4 FACTORS INFLUENCING HOW PEOPLE REACT TO EARLY WARNING SYSTEMS

Even with significant improvements in the ability of meteorological forecasts to predict the future, severe weather still causes property damage, human casualties, and injuries (Weyrich, Scolobig, Bresch, & Patt, 2018). The consequences of natural hazards on people, economies, and the environment cannot entirely be avoided, although they can be greatly reduced. One of our "best bets" is to use early warning systems (EWS), as they help people understand natural hazards, provide warning information, and give us time to act quickly to avoid unnecessary repercussions (Golding, 2022) As a result, the ability of the national meteorological agencies to accurately forecast high-impact weather events has increased, both in terms of risk and impact. Consequently, forecasts are generated with greater geographic specificity, accuracy, and lead time, allowing the vulnerable to take the appropriate safety measures. However, there are a growing number of documented cases when people ignore these warnings. For example, in 2013 Tropical Cyclone Haiyan, a

category 5 storm, killed many people and left behind significant damage to infrastructure and crops in the Philippines. The government acted and the meteorological agency swiftly issued appropriate warnings for strong winds and heavy rain, according to the World Meteorological Organization's (WMO) post-typhoon expert mission review (WMO, 2021).

Nonetheless, in the vulnerable populations, a lack of awareness, particularly regarding storm surge, impeded or postponed the evacuation of cyclone-affected areas. The World Meteorological Organization (WMO) has hypothesized that part of the human casualties is caused by people's insufficient comprehension of the warnings, based on the expanding list of documented incidents where people do not respond to the usual phenomenon-based warnings (Golding, 2022).

2.5 FLOOD EARLY WARNING SYSTEMS IN MALAWI

Flood early warning systems in Malawi were implemented in different phases and locations. For instance, the first project about flood early warning systems dates back to 2015, for example the Malawi National Flood Early Warning System (F-EWS) was established. The Green Climate fund (GCF) in collaboration with UNDP approved the use of modernized climate information and early warning systems in Malawi (Gerdvila, 2021). Implemented by Malawi's department of disaster management affairs (DODMA), in partnership with Department of Climate change and Meteorological services (DCCMS), the project involved installation of automatic weather stations, hydrological monitoring stations, and lake-based weather buoys.

In 2017, Regional Centre for Mapping of Resources for Development (RCMRD) was contracted by UNDP to support the Government of Malawi in Establishing Community-Based Flood Early Warning System (CBFEWS) in the flood prone districts in Malawi (Kapatuka, 2021).

The project aimed at supporting the government efforts on Scaling up the Use of Modernized Climate Information and Early Warning systems (M-CLIMES).

In 2022, community-based flood early warning systems (CBFEWS) was operationalized and integrated with earth observation and satellite technologies providing forecast for flood prone communities (Kriner & Nesoba, 2023).

MALAWI NATIONAL FLOOD EARLY WARNING SYSTEM SET-UP

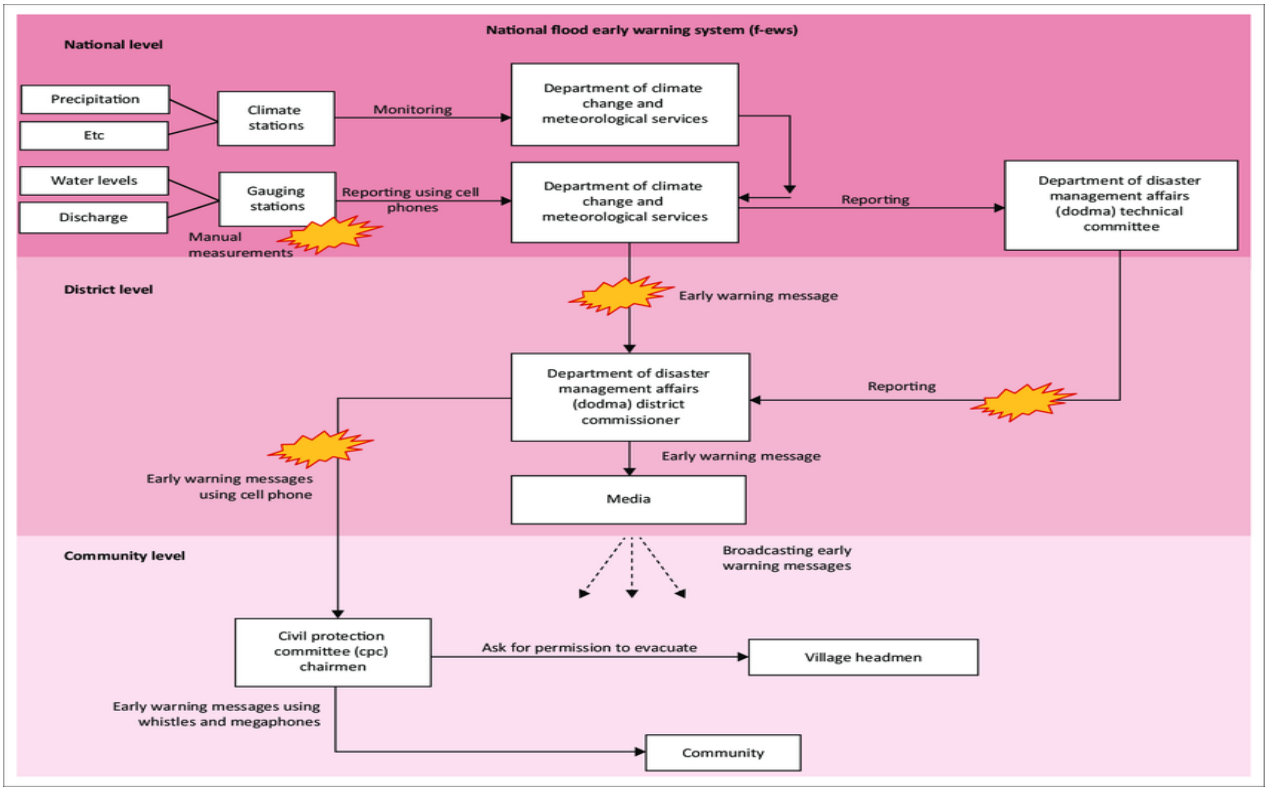


Figure 1: Malawi National flood early warning system

Source: Adapted from Hagenlocher, M., Zeil, P., Füreder, P. & Hölbling, D., 2012, Linthipe and Lingadzi River System Study Central Region River Basin, Malawi, COOPI, viewed 29 July 2019, from https://europa.eu/capacity4dev/file/70352/download?token=KU-tsbYQ

2.5.1 HOW THE NATIONAL FLOOD EARLY WARNING SYSTEM IS OPERATED

It operates at three different levels: the national, district, and community levels. According to reports, the Department of Climate Change and Metrological Services (DCCMS), the Department of Water Resources (DWRs), and the Department of Disaster Management Affairs (DoDMA) are principally responsible for the operation and management of F-EWS

(GoMa, 2015). A number of gauging stations on significant rivers are maintained by the Department of Climate Change and Metrological Services and DWR to monitor water levels and discharge.

An administrative merger of two separate EWS has been attempted to create a national F-EWS. The departments of the government that oversee this at the national level are DoDMA, DWR, and DCCMS. Locally, CPC is in charge of managing them inside flood-prone communities. Certain committee members are elected by community members or serve as volunteers. The integration between the CBEWS and the F-EWS is summarized in Figure 1.

In theory, weather monitoring stations are part of government departments' systems, and their data and information are transmitted to the offices for additional processing. Warning communications happen only when an official process has been completed. However, at the local level, the committee's designated representatives are in charge (Chinguwo & Deus, 2022).

2.6 FLOODS IN MALAWI

Malawi is one of the developing countries in the world which is dependent on its agricultural sector (Gerdvilla, 2021). Consequently, People who mostly live in rural areas and engage in smallholder agriculture, are now poor due to the devastating impacts of disasters like floods. Mzuza, et al., revealed that Malawi is the most flood-prone country in the Sub-Saharan area because it has experienced flood disasters for decades (Mzuza, Zhang, Kapute, & Wei, 2019). For instance, in 2015, Malawi experienced a once-in-500-year flood, which impacted the country socially and economically. During this time Malawi suffered a property loss of about US$335m with recovery and reconstruction cost of about US494m, about 1.1 million people were affected by the floods with 230 000 people displaced, 173 missing and 106 killed (GoMb, 2015). Due to the combined effects of droughts and floods, Malawi loses an average of 1.7 percent of its gross domestic product annually (Pauw, Thurlow, & Van Seventer, 2010). For example, the housing subsector suffered the most harm in the social sector, with 288,371 homes being destroyed

entirely or in part (DODMA, 2019). These flood disasters have had a significant impact on the lives and livelihoods of the people in Malawi, particularly Chikwawa district, as well as the development and resilience of the district. Therefore, there is a need for effective flood early warning systems, disaster preparedness, and recovery efforts to reduce the potential impacts of future floods.

CHAPTER 3: METHODOLOGY

3.1 STUDY DESIGN

This research used a mixed research method (both qualitative and quantitative). The qualitative technique was used to gather primary data through the physical interaction with individuals in the study area using a questionnaire. The questionnaire was designed in a simple and clear manner corresponding to the research objectives and a mixture of questions such as open ended, close ended, Likert scales as well as yes or no in order to gather both qualitative and quantitative data for comprehensive understanding of the research. The questions were inputted in KOBO software to reduce errors during data collection.

3.2 STUDY AREA

The main area of the study was T/A Maseya, found in Chikwawa district which is located in the southern regional of Malawi along the lower shire valley. The district covers an area of 4,755 km^2 with a projected population of 628,282 where 306,517 are males and 321,765 are female (NSO, 2023).The total population of people in T/A Maseya based on the findings from the chair of area civil protection committee (ACPC) was 58 764 in 4691 households. T/A Maseya has 24 group village heads and villages approximate to 119 but 4 group villages (Kalima, DalakaPhiri, Chambuluka and Mtondedza) are the ones which faces the risk of flood hazards due to the presents of Shire, Mwanza and Unthumba rivers, so the study focused on those group villages.

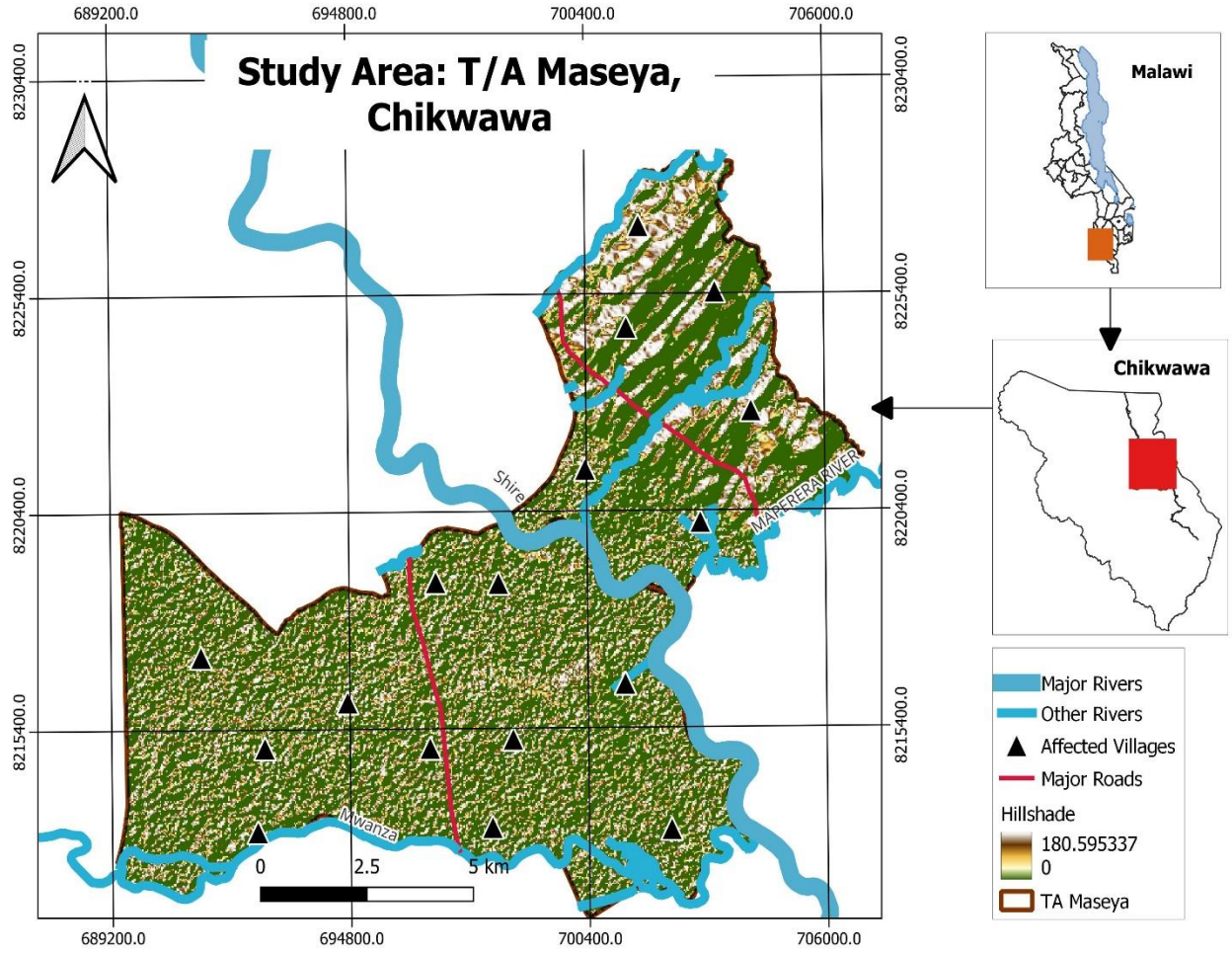


Figure 2: Study area map of TA Maseya in Chikwawa District

3.3 SITE SELECTION

Traditional Authority Maseya was chosen as a study area because it is one of the areas located adjacent to large rivers like Shire, Mwanza and others that make it prone to flood hazard hence floods happen each and every year and there are river gauge and color-coding flood early warning systems which were installed in the area in rivers like Shire and Mwanza which makes a complete set up of the National flood EWS. So, the study carried in this area helped in the gaining of the deep insights on the performance of the flood early warning systems in the area since it revealed its strength, weaknesses as well as areas that needs improvement for positive outcomes in reducing the impacts of flood risk.

3.4 SAMPLE SIZE

The study involved a purposive sampling technique where information was obtained from only those people who have flood experience in the area. To select the appropriate sample size for a known population, the Slovin's formula was used ($n=N/ 1+Ne^2$).

Where n= the sample size

N=Population

1= constant

e =5% margin of error at 95% confidence level

Therefore, N = 58,764; $58,764/1+58,764(0.05)^2$

$=58, 764/1+58, 764(0.0225)$

$58,764/1+146.91$

$58,764/147.91$

397.17 (to 2 decimal place)

=397 people (rounded up)

3.5 TARGET POPULATION

The study targeted all heads of the families aging from 18-65 years, in both genders who had the flood experience and are responsible for decision making especially on when and where to evacuate. And could provide deep insights on the practicability and usefulness of the system for better evaluation. Vulnerable people like those who are physically challenged, elders as well as women were also included in the target population. And officials like the leaders of the area civil protection committee as well as the village protection committee. The total population was attained from the findings in Slovin's calculation which was 397 people. So, in 4GVHs, 12 people were questioned in each village such that 32 villages were approached.

3.6 DATA COLLECTION

The data for this study was primarily collected using questionnaires, observation and key informant interviews with various stakeholders like area civil protection committee chair and village civil protection committee chair and secretary. While secondary data was obtained from desktop reviews of available literatures. The questionnaire was well designed with both closed and open-ended questions to provide data which correspond with the research topic and answers for the objectives. A Likert 5point and frequency scales was used in designing some questions. For better communication with the local people, the questionnaire was translated in Chichewa language. Data for flood damage was obtained from the office of the area civil protection committee.

3.7 DATA ANALYSIS

The data which was collected was firstly translated in English. The statistical packages for social sciences (SPSS) was used to generate descriptive statistics like generating frequencies, inferential statics e.g. correlation analysis, t-test and ANOVA analysis. For open ended questions, relational content analysis was used to generate themes and sub themes in order to get general meaning of the responses of the respondents.

3.8 DATA PRESENTATION

The analyzed data was presented in form of graphs, pie charts and tables.

3.9 ETHICAL CONSIDERATION

The Malawi University of Science and Technology Research Ethics Committee granted approval for the project. Before any data was collected, participants gave their informed agreement and the Chikwawa District Council as well as the Group Village Head were requested for a permission to conduct the research in their areas. In order to maintain participant anonymity, a code number was used in place of the individual's name during the study.

CHAPTER 4: RESULTS AND DISCUSSION

4.1 INTRODUCTION

This chapter presents the analyzed data and interpreted findings inform of graphs, charts, correlations analysis, some ANOVA tests and tables. The study assessed the effectiveness of national flood early warning system in mitigating flood risk in vulnerable communities in this case TA Maseya (group villages: Kalima, Mtondedza, Chambuluka, and DalakaPhiri). This main objective of the study was achieved by focusing on the following specific objectives; identifying the effectiveness of dissemination channels people in Maseya village used for receiving flood warnings as well as their awareness upon the N-FEWS, investigating the reliability of national flood early warning system at community level and assessing the response of people in Maseya villages toward a flood warning system. Data was collected from the targeted population in T/A Maseya using questionnaire and below were the results of the study.

4.2 RESULTS OF THE STUDY

4.2.1 SOCIAL ECONOMIC AND DEMOGRAPHIC DATA

The results of the study revealed that 60% of the respondents were females while 40% were males. Based on the age, 43% of the respondents were youths whilst 67% were adults. This is demonstrated by the results on the number of people with the age range of 18-34(43%), 36-50 (33%) and 50-65(24%). On academic qualification, the results showed that almost 76% of the population is illiterate as compared to 24% which is not. This is evidenced by the number of people that have not attained any education (26%), primary school (50%), secondary school (20%) and tertiary (4%). On socioeconomic status, the study showed that 56% of the population had no assert as related to 44% who had assets. Likewise, on income, the study indicated that 94% of the population is poor whereas 6% only is of middle income. Thus, confirmed by 56% of the population obtaining monthly income of less than 10,000, 23% (10,000-20,000), 15% (20,000-50,00) and 6% (more than 50,000). This data was necessary for the study hence it has revealed the reason why there was differences in responses of people and the use of

dissemination channels. Table 1 and 2 summarised the means of men and women based on their response rate from ANOVA and the mean difference of people with and without assets obtained from t-test.

Table 1: Displays ANOVA Analysis

Response Rate	Gender	Mean
Very quickly	Male	1.645
	Female	1.794
Quickly	Male	1.639
	Female	1.633
Partially	Male	1.344
	Female	1.154
Slowly	Male	1.754
	Female	1.798
Very slowly	Male	2.333
	Female	2.056

Table 1. illustrates a notable disparity in response rate between men and women as indicated by ANOVA analysis.

Table 2: T-Test for Socioeconomic Status and Response Rate To MN-FEWS

Test Variable	Grouping Variable	Mean difference
Response Rates	Socioeconomical status (people with assets and without assets)	-.528

Table 2 shows the negative mean difference of people with assets and others without assets based on their response rate obtained in t-test.

4.2.2 AWARENESS AND EFFECTIVENESS OF DISSEMINATION CHANNELS

(A) AWARENESS OF PEOPLE ABOUT THE MALAWI NATIONAL-FLOOD EARLY WARNING SYSTEM

As analyzed from SPSS, the study found that 36% of the sample size were not aware at all about the N-FEWS, 33% were slightly aware, 12% were moderately aware,11% were very aware and only 8% were extremely aware. The difference can be attributed to lack of public awareness about the integration of community-based flood early warning systems and national flood early warning system. Figure 3 displayed the findings.

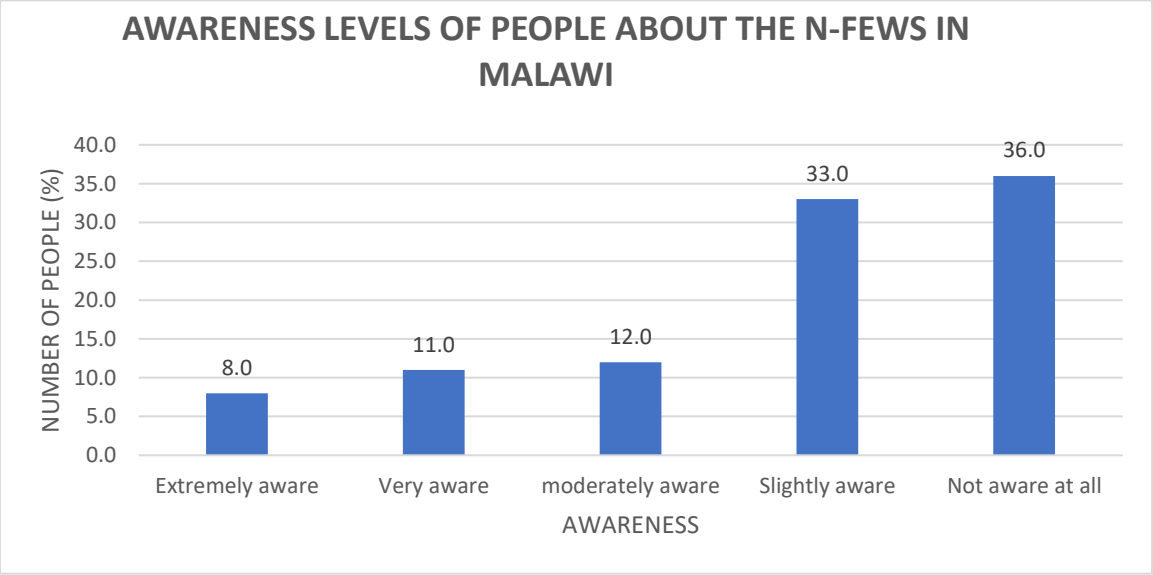


Figure 3: Awareness Levels

(B) WARNING COMMUNICATION AND EFFECTIVENESS OF DISSEMINATION CHANNELS

The results show that 79% of people were receiving the early warning messages from the system while 21% were not receiving messages from the system. On the other hand, dissemination channels indicated that 47% of people received messages using Megaphones, 16% received from radios, 16% received from social media ,12% received from friends or churches and 9% received from other channels like televisions and newspapers. On clarity of the messages, 25% of population indicated that they could not

clearly understand the messages, while 24% partially understand the warnings, 21% were on average whilst 16% clearly understood the messages and 14% extremely understood the messages. The results have been summarized on figure 4.

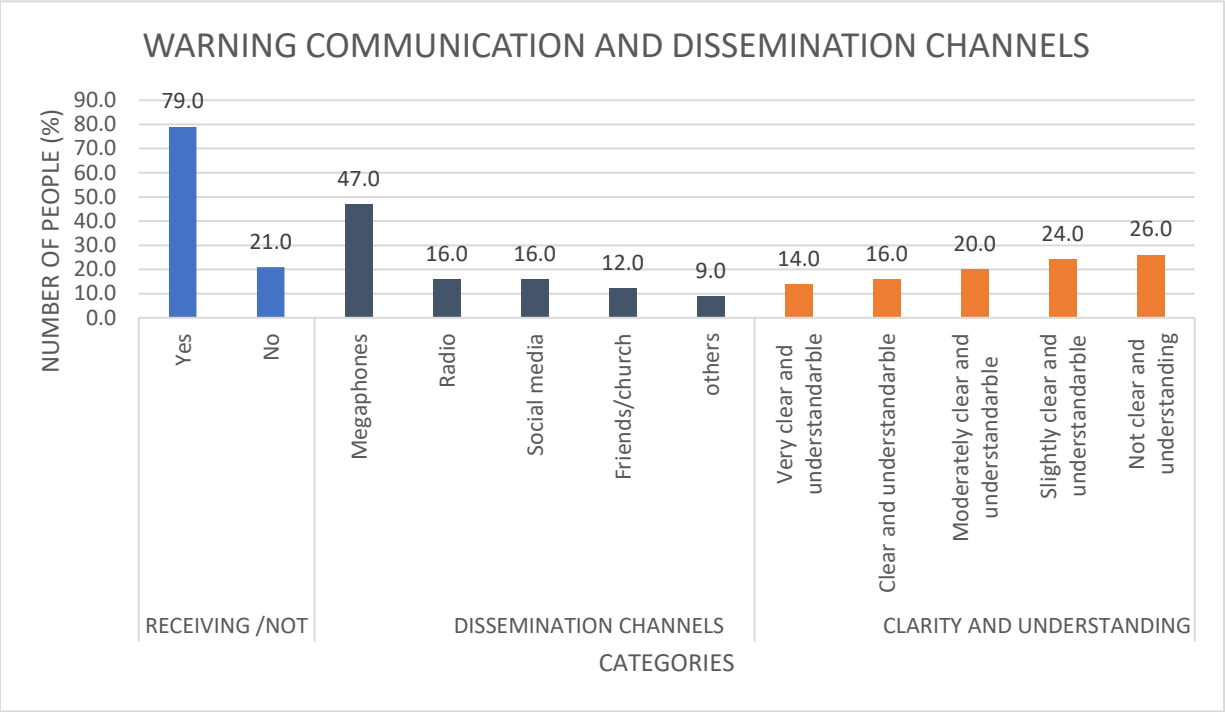


Figure 4: warning communication and dissemination channels

4.2.3 RELIABILITY OF MALAWI NATIONAL FLOOD EARLY WARN ING SYSTEM

The study evaluated the National Flood Early Warning System's reliability by examining lead time, warning accuracy, and timing of warnings. Findings revealed that 30% of the sample received warnings before the floods, 49% as the floods started, 11% during the flood, and 10% after the flood. Regarding lead time, 45% received warnings < 24 hours, 30% at exactly 24 hours (a day), 12% > day < week, 10% took a week, and 3% took a month prior to the expected floods. Table 3 summarized the correlation relationship between warning lead time and the ability of people to protect their assets.

In terms of the regularity of warnings, the study found that 47% of the sample always received flood warnings when floods occurred, while 24% frequently received them, 14% received warnings occasionally, 10% rarely received them, and 5% never received warnings. However, 72% of respondents experienced issues with false and missed alarms, while 28% reported no such issues. Regarding satisfaction with the system's performance, 11% rated it as excellent, 24% as good, 27% as average, 31% as slightly good, and 7% as bad. The results have been summarized graphically in figure 5 and 6.

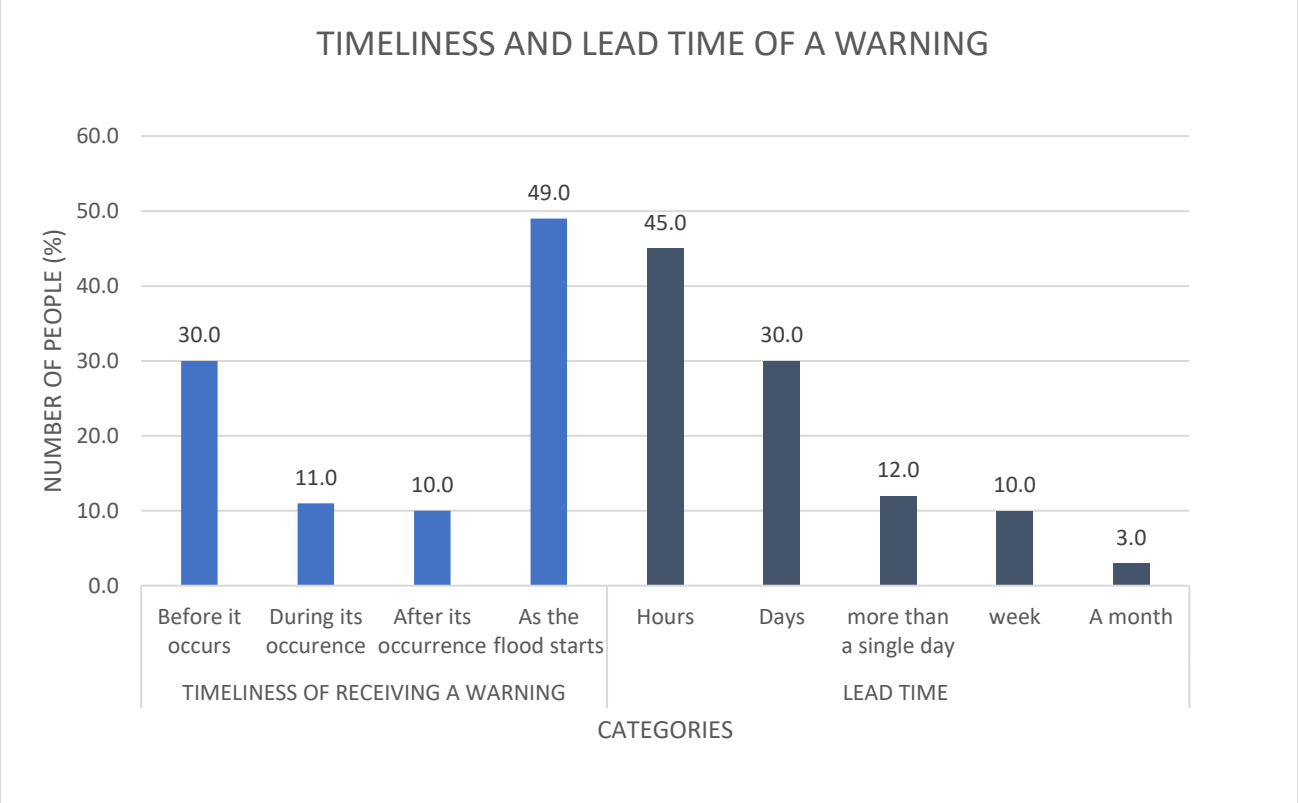


Figure 5 : shows different categories of warning lead time and timeliness

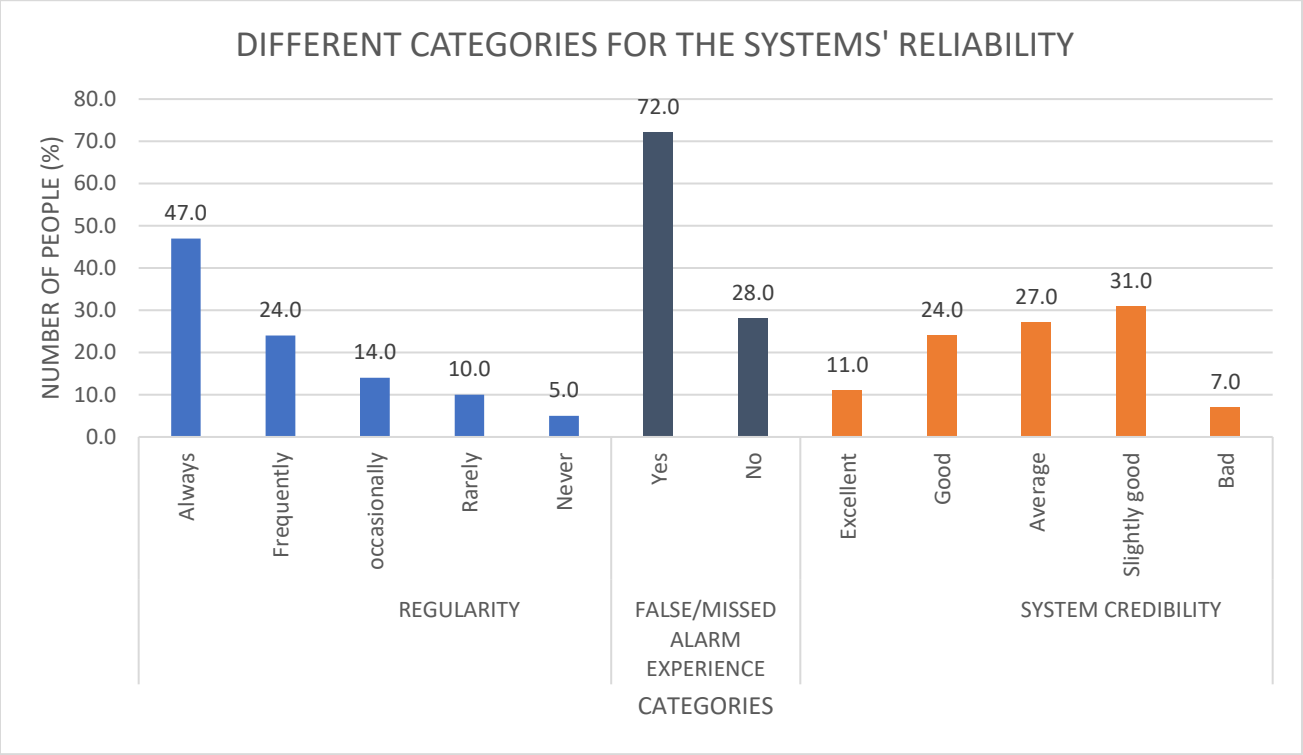


Figure 6: warning reliability indicators

4.2.4 THE RESPONSE OF PEOPLE TO EARLY WARNINGS

This study section evaluated people's responses to early warning messages, where it revealed that 43% of the population responded very quickly, 23% responded quickly, 8% responded partially quickly, 19% responded slowly, and 7% responded very slowly. These response times were influenced by various factors, including past experiences (35% of the sample population), fear (32%), concerns about asset protection (15%), distrust in dissemination channels like social media and friends (11%), uncertainty about evacuation routes (7%). And on response actions 57% evacuate, 25% wait for floods, 10% protect assets and 8% do nothing upon the warnings. On asset protection, 51% just ignore the assets, 28% move them, 14% keep them in safer areas and 7% sell the assets. Figure 7 and 8 displayed these findings in graphical form.

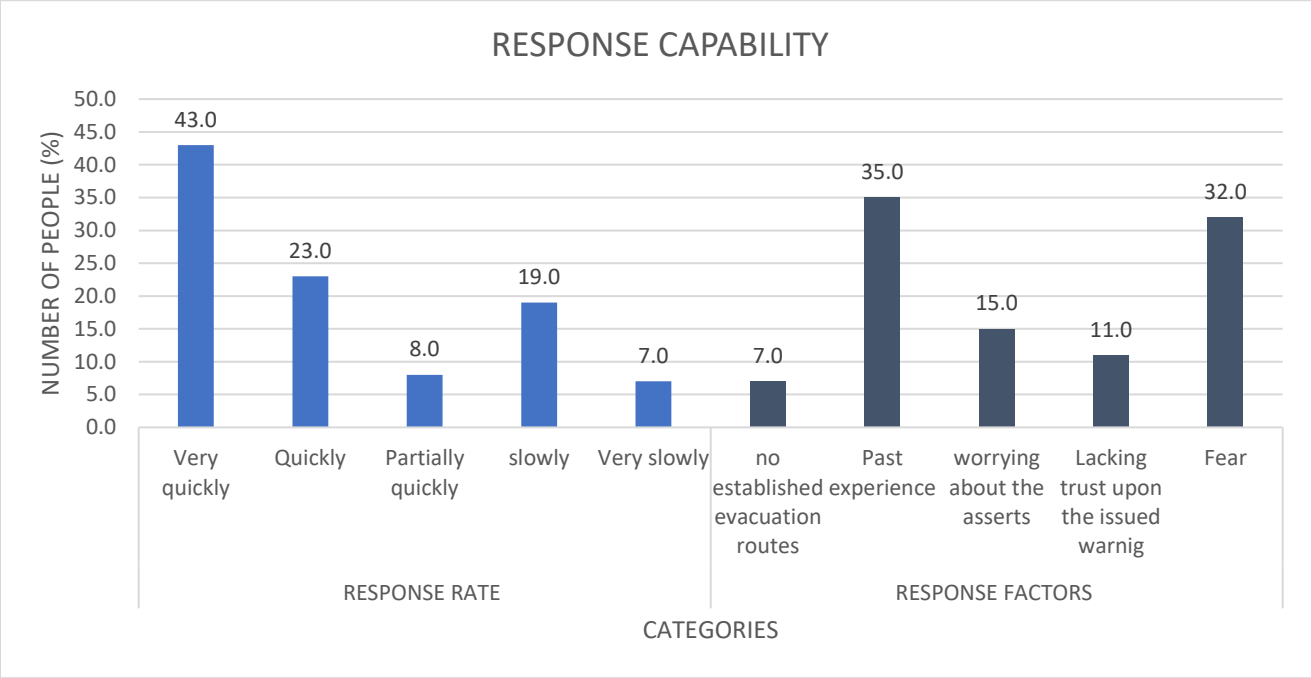


Figure 7: Shows Responses of People

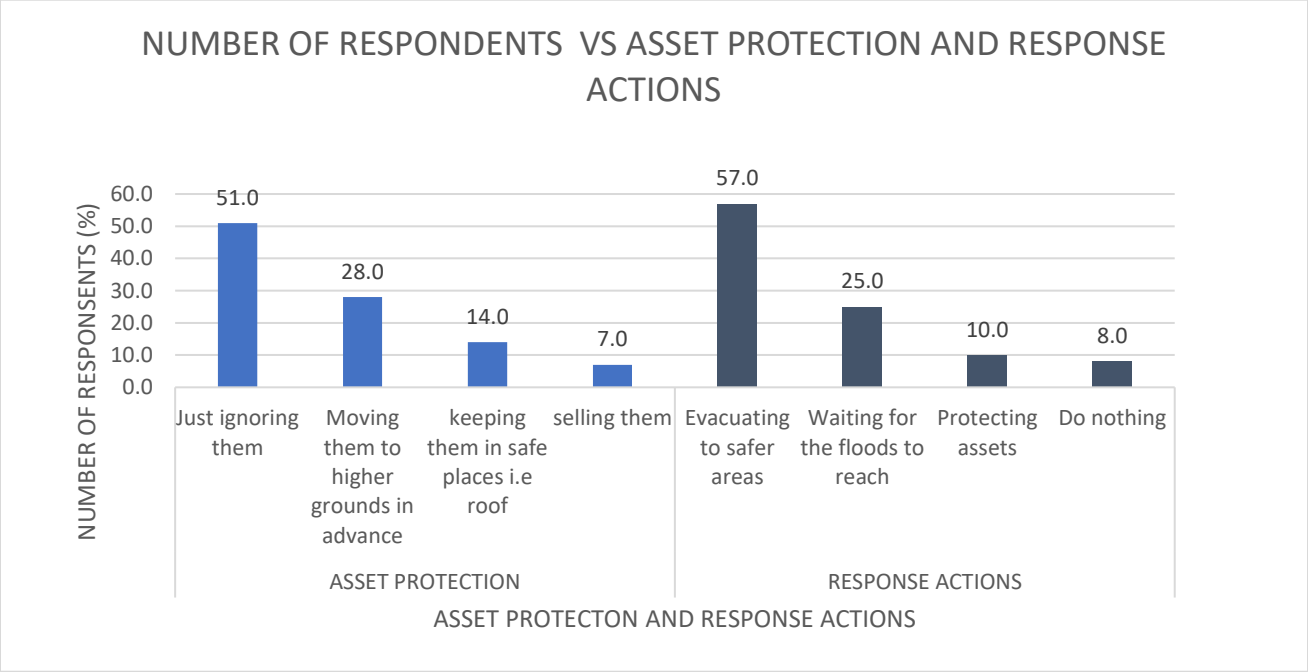


Figure 8 Asset Protection and Response Action

4.3 DISCUSSION OF THE RESULTS

The study assessed the effectiveness of the N-FEWS based on the following indicators as included in the specific objectives; warning lead time, accuracy of the warning, effectiveness of dissemination channels and response rate of people towards the warning.

4.3.1 DEMOGRAPHIC DATA AND THE EFFECTIVENESS OF THE EARLY WARNING SYSTEMS

Demographic information had an impact on the effectiveness of the N-FEWS for instance on socioeconomic status t-test displayed in table 2, was done to find if there was a significant difference in responses between the two groups of people, those with assets and others without assets and the results were -0.528 which indicated that people without assets tend to respond quicker to warnings compared to those with assets. This is in contrast with Enarsons' study, (1999), which found that low income women were less able to respond to warnings than more affluent women in evacuating to alternative shelters hence low-income women lacked means of transport (Enarson, 1999) .

Additionally, the results demonstrated that the ability of people to read, understand and interpret the warnings was affected by the level of education since an estimate of 26% of population were completely illiterate and almost 70% could moderately, partially or not clearly understood the warnings. This agrees with the study done by Mack and Backer (1961), where they found that low-education respondents were less likely to interpret a warning signal as valid than individuals of higher education (Mack & Backer , 1961). Further on Gender, the study revealed that, women were responding very quickly than men as a result of fear or past experience. Argumentatively Enarson and Chakrabarti (2009) revealed that women respond slower than men due to the reasons like Women's constrictive attire makes it difficult for them to move quickly, and when a tragedy strikes, they typically take greater risks to safeguard their families and personal things (Earnson & Chakrabarti, 2009).Table 1 summarized ANOVA analysis which the study attempts to identify significant differences between in response and gender.

4.3.2 AWARENESS AND EFFECTIVENESS OF DISSEMINATION CHANNELS

(A) AWARENESS OF PEOPLE ABOUT NATIONAL-FLOOD EARLY WARNING SYSTEM

The study revealed that 69% of population in Maseya were not aware of the N-FEWS even though they were receiving messages but they had little or no knowledge about the existence of the combined two distinct systems which is managed by the DCCMS and the DWR and DoDMA at National level and ACPC and the VCPC manage it at a community level. This had an impact on the effectiveness of the N-FEWS at community level hence it leads to the reduction of the trust of people on warnings sent from the system hence making them to be more vulnerable. This agrees with Salah and Sasaki (2021), who revealed that communities lack of trust in governments' alerts lead to greater vulnerability. For instance, hundreds of people died as a result of cyclone Sidr in 2007 off the coast of Bangladesh, as a result of people not believing the early warnings issued by the local government and the media (Salah & Sasaki, 2021), so this happens most times due to the lack of awareness about the system leading to the failure of the system to mitigate flood risk in vulnerable communities.

(B) EFFECTIVENESS OF THE DISSEMINATION CHANNELS

The study revealed that 64% of people used dissemination channels like radios, social media, word of mouth (friends or church) that were not effective at community level because most people could not access them nor trust them as a result of lack of resources and geographical location. Thus agreeing with Perera et, al. (2020) who found that warnings, even when issued and disseminated with sufficient lead time, do not essentially reach all the people at risk because warnings are generally broadcasted on national or local medias like radios, televisions or websites and such vulnerable groups lack access to basic facilities required to receive these warnings (Perera, Seidou, Agnihotri, Mehmood, & Rasmy, 2020). For instance, in T/A Maseya only 16% had radios which sometimes could not operate due to power or signal problems, smart phones to be on social media and the majority of the population were not well educated which made them difficult to have an access to the warnings through some channels. And megaphones on the other hand was the most commonly used and reliable channel with 46% of population relying on it, but

could not deriver messages to the people who were deaf and others living in hard to reach places. Though they were good in the sense that they do not depend on electrical or solar power or network to function but still it's not a fully reliable channel. Early warning dissemination is the availability of media that can be used to deliver early warning and relevant information. The efficacy of warning delivery is determined by how these mediums are used during an emergency (Setiadi, 2014). As such the dissemination channels currently being used in N-FEWS are not effective at a community level.

Besides the accessibility of the various channels, the study also revealed that 50% of the population could not understand the messages which was also a weakness of N-FEWS. This is because the NF-EWS in Malawi provide information which does not meet the need of the vulnerable groups for instance, the DWR in collaboration with DCCMS releases warning reports inform of pdfs that cannot be read or accessed by the vulnerable people hence the messages are sometimes incomplete, in a different language or too technical. DoDMA (2010) justified this matter that when the early warning requirements of particular vulnerable groups are not well understood, the information being provided to the people is not clear and understood (DoDMA, 2010).

4.3.3 RELIABILITY OF THE WARNING SYSTEM

Reliability is defined as the trustworthy and dependability of the system in providing timely and accurate warnings to mitigate the impacts of a flood hazard (Alhloul, 2023). Therefore, the reliability of the MN-FEWS was explored based on timeliness of early warning, lead time, its regularity in issuing warnings, issues of false or missed alarms, its credibility on performance provided by the respondents as well as the accuracy of the warnings. The study found revealed a gap in the systems reliability hence 45% of people were provided with a short lead time which was hours less than a day. This lead time could not have been more useful to the people in taking actions to reduce damages or loss. This is justified by Cheng, Wang, Qin, Li and Chiao, (2017) study which emphasized that Flood

forecasting with long lead time of 1-15 days are useful as they could provide enough time for flood warnings and effective responses (Cheng, Wang, Qin, Li, & Chiao, 2017).

And another aspect of reliability was built on the accuracy of the system in disseminating messages and based on the findings, the study showed that most people experienced issues of false or missed alarms from the system which reduces their dependability on the system. For instance, T/A Maseya experienced missed alarms more frequently in terms of floods that was caused by rains happened in Mwanza district. Hence Mwanza river make a tributary with shire river in Maseya and its location in low lands. And besides the missed alarms the study also found that people in Maseya receives false alarms from the system. In this case, governments institutions like DCCMS sometimes disseminate warnings about flooding but floods could not occur. Thus, lessen the dependability of people towards the system made it ineffective even though the regularity of receiving the messages was effective in the sense that majority of the people received messages always or frequently in times of floods.

4.3.4 PEOPLES RESPONSE TO EARLY WARNING IN TA MASEYA

Response component is crucial to be deployed in flood early warning system to increase the performance of the system (Hammood, et al., 2021). In response to flood early warning systems, communities build flood-resistant homes, organise disaster committees, advise residents about flood risks, evacuate from flood-prone locations, and preserve food (Ringo, Sabai, & Mahenge, 2024). This is in line with the results of the study where in T/A Maseya, people evacuate to safer areas when flood occurred, some are constructing flood resistance houses and the disaster committees were formulated. This active participation of the community also brought into a highly positive response rate regarding the assessment of N-FEWS. In this case, the study assessed the responses of people based on time of their responding, factors influencing them and actions taken as indicators. And it was found that 66% were responding quickly while 44% were slow and 57% evacuating to safer areas before the floods reach their place. This increases the efficacy of the F-EWS in reducing mortalities.

CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

5.1 INTRODUCTION

Assessing the effectiveness of MN-FEWS at community level in mitigating flood risk in vulnerable communities using both qualitative and quantitative data is very significant. The study has revealed weakness and areas of improvement of the system in translating messages into actionable measures to mitigate flood risk even though it was able to predict and disseminate warnings. The study has found that 69% of the sample population were slightly aware or not aware at all about the NFEWS even though they were able to receive warnings. Pertaining warning communication, 76% were able to receive the warnings whilst 24% could not receive warnings as a result of location as well as knowledge. On dissemination channels, the study found out that 46% of the population were using megaphones which turns to be the dissemination channel with the highest number of people. Response rate has indicated a positive outcome where 66% of the sample were able to respond quickly but on asset protection 51% could just ignore their assets.

5.2 CONCLUSION

The study found differences in performance statuses of different elements. In this case, some elements in the system are effective whereas others are not effective. For instance, on the systems awareness, the study found out that 45% of people were not aware about the system which drops the systems performance, most people in T/A Maseya were not able to receive early warning messages through various dissemination channels following different reasons revealed in the study and this reduced the effectiveness of dissemination channels making the system ineffective.

Apart from that, on the reliability of the system, the study found out that the system experienced issues of false and missed alarms, the lead time of the warnings were short that could not enable people to protect their assets hence on assert protection, most people just ignore the assets, this makes the system ineffective hence it was not able to enable people protect their assets as a result, people lost their assets and finally on the response, the system indicated some positivity where most people were able to respond quickly in

taking safety measures even though no standard practical action were set in place for the people to follow during response time, instead people just evacuate without knowing the safety of their evacuation routes which also risk their lives. Therefore, the study has revealed some of the strengths of the system as well as gaps that need to be filled for enhancing the effectiveness of the MN-FEWS in mitigating flood risk in vulnerable communities.

Further, more researches are needed to be conducted pertaining the N-FEWS which includes quantifying the effectiveness of the system to ensure the systems ongoing effectiveness at a larger scale, Spatial analysis of warning Dissemination for better utilization of dissemination channels that will reach all vulnerable people and economic cost benefit analysis, under disaster financing-people should conduct economic cost benefit analysis of the N-FEWS in order to analyze the benefits of early warning systems in preventing economic losses over the cost of its implementation.

5.3 RECOMMENDATIONS

(i) Public education and sensitization campaign should be strengthened to enhance public awareness and trust on people towards the N-FEWS by providing inclusive education public campaigns.

(ii) The coordination and communication channels between government stakeholders and the local people should be improved to ensure effective flow of information related to flood warnings and response actions.

(iii) There should be an establishment of inter-district and inter-river alliances to facilitate timely communication and sharing of flood related information to reduce chances of missed alarms and improving community preparedness.

(iv)The automated early warning systems like sirens and alarms should be promoted. Malawian nation should adopt and promote the use of automated EWS to replace the manual data collection methods.

(v) More innovation should be explored i.e. the use of SMS and audio messages in mobile phones to disseminate warnings.

(Vi) There should be regular inspections and maintenance of the river gauges to improve accuracy of the warnings.

5.4 STUDY LIMITATIONS

The study had encountered various challenges in the process which includes;

(i) Limited sample size and area coverage. The study covered one T/A in Chikwawa district and 397 individuals which could not provide deep insights on the systems performance.

(ii) Limited time and funding-limit the study from exploring more.

(iii) Existence of limited literatures caused difficulties on the study to draw upon established knowledge and frameworks.

REFERENCES

Alhloul, A. (2023). Early crisis warning system using community engagement through social network sites in times of disaster. *Scientific Journal*, 1-14.

Cheng, Y., Wang, H., Qin, J., Li, J., & Chiao, S. (2017). Etending Flood Forecasting lead time in large watershed by couplin WRF QPF with a distributed hydrological odel. *Journal for Hydrology and Earths system Sciences*, 1-16.

Chikwawa Diocese. (2022, January 15). *Floods leave thousands desparate in Chikwawa*. Retrieved from Chikwawa diocese: https://chikwawadiocese.org

Chinguwo, D. D., & Deus, D. (2022). Assessment of community-based flood early warning system in Malawi. *Jamba: Journal of Disaster Risk Studies 14(1),a1166.*, 1-40.

DoDMA. (2010). *National Disaster Risk Reduction Policy.* Lilongwe: Government of Malawi.

DODMA. (2019). *Malawi 2019 floods post Disaster Needs Assessment Report.* Lilongwe: Depatment Of Disaster Risk Affairs.

DODMA. (2023). *Cyclone Freddy Situation Report.* Lilongwe: Department of Disaster Risk Management.

Duque, L. F., O'Connell, E., & O'Donnell, G. (2023). demonstrating the probabilistic forecasting over deterministic forecasting in terms of flood warning reliability. *Journal of hydrology*, 129340-129340.

Earnson, E., & Chakrabarti, D. (2009). In women,gender, and disaster. *Sage journals*, 1-380.

Enarson, E. (1999). *Red River Valley: Ten lessons learned .* Westport: Praeger Publishers .

Gerdvila, S. (2021). *Protecting Malawi with Climate Information and Early Warning Systems.* Incheon: Green Climate Fund.

Gerdvilla, S. (2021). *Innovative Humanitarian Solution.* News and press Release.

Glago, F. J. (2020). Flood Disaster Hazard: Causes Impacts and Management : A State -of-the-Art-Review. *Interch open Journal*, 1-19.

Golding, B. (2022). *Towards the "Perfect" Weather Warning .* Cham: Springer.

GoMa. (2015). *Disaster Risk Management operational guidline policy.* Zomba,Malawi: Malawi Government.

GoMb. (2015). *Malawi 2015 Floods Post Disaster Needs Assessment Report.* Lilongwe: Malawi Government.

GWP. (2018, August 12). *Changing course before Flood: Lower Shire river basin flood risk management*. Retrieved from GWP: https://www.gwp.org

Hammood, W. A., Arshah, R. A., Asmara, S. M., Halbusi, H. A., Hammood, O. A., & Abri, S. (2021). Early Warning and Response System (FEWS): A Deep Review and Analysis. *Sustainability Assessment: Theory and Practice* , 1-10.

Hussein, D. N., Mwakumanya, M. A., & Tole, M. (2023). Flood Forecasting in Malawi's Shire River basin. *American Journal of Envirinmental Sciences*, 1-11.

Hussein, D. N., Tole, P. M., & Mwakumanya, M. (2023). The Trends and Effects of Flood Occurences in the Shire River Basin in Chikwawa District of Malawi: A Historical Perspective (1980-2019). *American Journal of environment studies*, 1-17.

Kapatuka, N. K. (2021, December 7). *Malawi: New early warning system to reduce mortalities and loss*. Retrieved from Prevention Web: https://www.preventionweb.net/

Kapatuka, N. K. (2021, December 7). *Malawi: New Early Warning System to reduce mortalities and loss*. Retrieved from Diraj: https://diraj.org

Kapatuka, N. K. (2021, December 7). *Malawi: New Early Warning System to reduce mortalities and loss*. Retrieved from Diraj: https://diraj.org

Kriner, E., & Nesoba, D. (2023, February 2). *Early warning Systems*. Retrieved from Climate links: https://www.climatelinks.org

Mack, R., & Backer , G. (1961). *The occasional Instant.* Wahington,DC: National Academy of Sciences.

Malawi Government. (2019). *Malawi 2019 Floods Post Disaster Needs Assessment Report.* Lilongwe: Malawi Government.

Malawi Government. (2019). *Malawi 2019 Post Disaster Needs Assessment Report.* Lillongwe: Government of Malawi.

Maureen Mzuza, ,. W. (2019). The impacts of landuse and landcover changes on the Nkula Dam in the middle Shire river catchment. *Earth observation and Geospartial Analysis*.

Mwale, F. D., Adeloye, A. J., & Beevers, L. (2015). Quantifying vulnerability of rural communities to flooding in SSA: A contemporary disaster management perspective applied to the Lower Shire Valley, Malawi. *International Journal of Disaster Risk Reduction*, 172-187.

Mwale, F., Adeloye, A., & Beevers, L. (2015). Quantifying Vulnerability of Rural Communities to Flooding in Sub Saharan Africa: A Contemporaly Disaster Management Perspective Applied to Lowe Shire Valley, Malawi. *International Journal of Disaster Risk Reduction*, 172-187.

Mzuza, M., Zhang, W., Kapute, `., & Wei, X. (2019). The Impacts of Land Use and Land cover changes on the Nkula Dam in the middle Shire River catchment, Malawi. *Earth Observation and Geospartial analysis*, 1-21.

Mzuzu, M. K., Zhang, W., Kapute, F., & wei, X. (2019). The Impacts of Land Use and Cover Changes on the Nkula Dam in the Middle Shire River Catchment, Malawi. *Earth Observation and Geospatial Analyses.* doi:DOI: 10:5772/intechOpen.86452

NSO. (2023). *Malawi Population and Housing Census.* Lillongwe: National Statistical Office.

Odizua, F. O., Eyo, J. O., & Jackrich, I. S. (2024). Analysis of Flood disasters in sub saharan Africa Using Python visualisation tools . *International Journal of Engineering applied sciences and technology*, 1-11.

Pauw, K., Thurlow, J., & Van Seventer, D. (2010). *Droughts and Floods in Malawi.* International Food Policy Research Institute.

Perera, D., Seidou, O., Agnihotri, J., Mehmood, H., & Rasmy, M. (2020, June 6). Challenges and Technical advances in Flood Early Warning Systems (FEWSs). *Journal of early warning systems* , 1-18. Retrieved from Researchgate: https//www.researchgate.net

Perera, D., Seidou, O., Agnihotri, J., Mehmood, H., & Rasmy, M. (2020). Challenges and Technical Advances in Flood Early Warning Systems (FEWSs). *Flood Impact Mitigation and Resilience Enhancement*, 1-16.

Perera, D., Seidou, O., Agnihotri, J., Viadimir, R., Smakhtin, V., Coulibaly, P., & Mehmood, H. (2019). Flood Early Warning Systems: A Reviews of Benefits, Challenges and Prospects . *Journal of water,Environment and Health*, 1-31.

Ringo, J., Sabai, S., & Mahenge, A. (2023). Performance of early warning systems in mitigating flood effects. . *Journal of African Earth Sciences*, 1-4.

Ringo, J., Sabai, S., & Mahenge, A. (2024). Perfomance of Early Warning System in Mitigating Flood Effects. A review. *Journal of African Earth Science*, 1-7.

Salah, P., & Sasaki, J. (2021). knowledge,Awareness,and Altitudes toward Tsunamis. *Hazard and sustainability*, 1-20.

Salas, E. B. (2023, september 22). *Global number of deaths caused by floods 1960-2022*. Retrieved from Statista : www.statista.com

Sattele, M., Brundl, M., & Daniel, S. (2015). *Reliability and effectiveness of early warning system for natural hazrds:conept application to debris flow warning.* Swirtzerland: Davos Dorf.

Setiadi, N. J. (2014). Assesing People's Early Warning Response Capability to Inform Urban Planning Interventions to Reduce Vulnerability to Tsunamis. *Journal of disasters* , 1-10.

Teule, T. (2019). *Assessing Two Methods To potentially Improve the flood early warning system in the lower Shire Valley in Malawi.* Amsterdam: Vrije Universiteit.

Tomala, w. (2021). Increasing Droughts and Floods on the African Continent in Global and Development . *Journal of Geoscience and Geomatrics* , 1-16.

Trogrlic, R. S., Golding , B., Sneddon, A., Mcquistan, C., Budimir, M., & Homberg, M. V. (2022). Early warning system and how it can reduce the risk of a disaster. *The daily star*, 1-10.

Trogrlić, R., Adeloye, A. J., Wright, G. B., Duncan, M. J., & Mwale, F. (2017). Community based-flood risk management: experiences and challenges in Malawi. *XVI World*

Water Congress (pp. 1-13). Cancun, Mexico: International Water Resources Association (IWRA).

UNDRR. (2006). *Developing Early Warning Systems.* Washington Dc: United Nations.

UNDRR. (2022, October 13). *The importance of early warning systems in disaster risk reduction.* Retrieved from UNDRR: https://iddrr.undrr.org

UNDRR. (2023). *Creating Effective Warnings For All Conference.* London, UK.

UNEP. (2017). *Climate change adaptation technologies for water.* Geneva: United Nations Environment Program.

UNESCO. (2021, June 21). *Early Warning Systems.* Retrieved from UNESCO: https://en.unesco.org

UNICEF Malawi. (2022, March 17). *Malawi Floods: Situation Report*. Retrieved from Unicef: http://www.unicef.org

UNISDR. (2015). *Sendai Framework for Disaster Risk Reduction.* Geneva: United Nations Office for Disaster Risk Reduction.

Weyrich, P., Scolobig, A., Bresch, D., & Patt, A. (2018). Effects of Impact-Based Warnings and Behavioral Recommendations for Extreme Weather Events . *Weather, Climate and Society*, 781-796.

WMO. (2000). *Standardised Verification System (SVS) For Long Range Forecast (LRF).* Geneva: World Meteorological Organisation.

WMO. (2021). *Review for the forty years of WMO Tropical Cyclone Progamme.* Geneva: World Meteorological Organisation.

World Bank. (2023). *Annual Report: A new Era in Development.* Washington DC: United Nations.

7.APPENDICES

7.1 Research questionnaire form

questionnaire: Assessing the effectiveness of National flood Early Warning System in communities of T/A Maseya

INTRODUCTION

Hallo, my name is Mervis Lameck, a fourth-year student at Malawi University of Science and Technology studying Science in Disaster risk management. I conduct this survey to collect data on the performance of Malawi National Flood Early Warning System in reducing the impacts of flood hazards at a community level which will be used on my research as a primary data. So, your participation in this survey is strictly confidential.

BACKGROUND

i. Questionnaire number…….
ii. Date/ Month/ Year ……../……/……
iii. Name of Village…….
iv. Traditional Authority (T/A) ……
v. Gender: Male/ Female
vi. Age: ……

SECTION A: SOCIAL ECONOMIC AND DEMOGRAPHIC DATA

1. What is your household size? …….

2.What is your academic qualification? Tick any

Primary ☐ Secondary ☐ Tertiary ☐

3.What do you do in order to earn a living?

1. Farming
2.Business
3. Employed

4.others (specify)

4.What is the monthly income range you obtain?

1. Less than 10,000

2.10 000-20 000

3.20 000-50 000

4. more than 50 000

5.Do you have any asserts (Do you own any one of the listed items own your own)?

1. bicycle/motor bike

2.Shop/maize mill

3.Domestic animals

4.Farms/estate

5. Others (Specify)

6. What is the structure of your house?

1. Cement
2. Mud
3. Baked brick
4. Unbaked brick
5. Other(specify)

SECTION B: AWARENESS AND EFFECTIVENESS OF DISSEMINATION CHANNELS

1. How aware are you about National Flood Early Warning System in Malawi?

1.Extremely aware
2.Very aware
3.Moderately aware
4.slightly aware
5. Not aware at all

2. Do you receive flood warning messages?

1. Yes

2.No

3. What channel(s) do you use to receive Flood Warning Messages?

1. Mega phones
2. Radio
3. social media
4. friends/ church
5. others (Specify)

4. How clear and understandable are messages presented from the mentioned channel?

1.very clear and understandable
2.clear and understandable

3. moderately clear and understandable
4. slightly clear and understandable
5. Not clear and understandable at all

5. what challenges do you face pertaining the dissemination channels?

SECTION C: RELIABILITY OF NATIONAL FLOOD EARLY WARNING SYSTEM

1. At what time are the flood warning messages delivered from the system?
   1.Before it occurs
   2. During its occurrence
   3. After its occurrence
   4.As the flood starts

2. How regularly do you receive the early warning messages?
   1. Always
   2. Frequently
   3. Occasionally
   4. Rarely
   5. Never

3. How satisfied are you with the accuracy of flood warnings provided by the system?
   1. Extremely satisfied
   2. Satisfied
   3.Moderately satisfied
   4. Slightly satisfied
   5.Not satisfied

4. Have you ever experienced issues of false or missed alarms?

1. Yes

2.No

5. What did you do? _____

6. What was false in the message?

1.the warning was delivered but the event did not happen

2. what happened was not what was issued

3. the event happened, but no warning was issued

4.the events' date did not meet the issued date

7. How long does the lead time takes for an issued flood warning?

1. Hours

2.A day

3. A week

4. Month

8. Have you ever experienced any technical challenge with the system that affected its performance?

1. Yes

2.N

9. Are there regular inspections or assessments conducted on the system to identify potential vulnerabilities?

1. Yes

2. No

10. How do you credit the system based on its performance?

A. Excellent

B. Good

c. Average

D. Slightly good

E. Bad

SECTION D: THE RESPONSE OF PEOPLE TOWARDS THE NATIONAL FLOOD WARNING MESSAGES

1. How quickly do you respond to the warning messages?
   1.very quickly
   2.quickly
   3.partially quickly
   4.slowly
   5.very slowly

2.What factors affect your response rate?.....

3. Are there any challenges that hinders your ability to respond promptly to flood warnings?

1. yes

2. No

4. If yes, what are the challenges?.....

5. Have you ever ignored a flood warning?

1. Yes

2. No

6. If yes, explain what influenced your decision?.....

7. How do you protect your asserts (if you have) when warnings are issued?

8.On vulnerable people, how are they assisted in moving to safer areas?

9. When a flood warning is issued what actions do you take to ensure your safety?

10. Any suggestion or comment pertaining the improvement of the National Flood Early Warning System: _____

The end!!!

Thank you for your participation.

7.3 Community Based Flood Early Warning System In T/A Maseya

River-gauges and color-coding system





