

ASSESSING EFFECTIVENESS OF EARLY WARNINGS AND EARLY WARNING SYSTEMS IN FLOOD RESPONSE IN NSANJE, SOUTHERN MALAWI.

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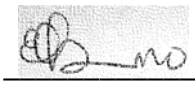
Thyolo, Malawi

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 Bachelor of Science degree in Disaster Risk Management.

JULY 20, 2021

DISSERTATION APPROVED BY:

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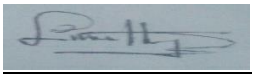
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DECLARATION

I declare that the work in this dissertation titled "Assessing Effectiveness of Early Warnings and Early Warning Systems For Flood Response In Nsanje, T/A Ndamela" has been carried out by me in the Department Of Climate Science. The information obtained from literature has been fully acknowledged in the text and list of references provided. No part of this dissertation was previously presented in another Degree or Diploma in this institution or another institution.



20 JULY, 2021.

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DISCLAIMER

This dissertation explains the work that is part of a program of study for the Ndata School of Climate and Earth Science of the Malawi University of Science and Technology. I declare that this piece of study is an outcome of my independent work. I, therefore, submit it for an award of the degree of Bachelors of Science in Disaster Risk Management.

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ABSTRACT

Floods have caused a lot of destruction to lives and properties in Nsanje, T/A Ndamela, mostly to communities that are close to rivers, this area most times experience floods due to the swelling of rivers for example Nyachilande river, therefore the people living in this area are most vulnerable to floods. Despite the area having a warning system, early warning messages to warning people about the impending floods, a large population of people is being affected by these floods, their properties get destroyed by these floods. This paper has exploited and assessed the effectiveness of early warnings and EWS to flood response in Nsanje, T/A Ndamela.

The main focus of this study revolved around assessing how effective early warnings are to the people in the area by looking and taking into account in most important areas of the early warning system. The study consisted direct involvement of the people in the area in form of key informant interviews and also usage of questionnaire to obtain information about early warnings and EWS to flooding events that have been affecting they livelihoods. The data was analysed using SSPS software to produce trends in form of tables and descriptive analysis was employed, thematic approach was also used to analyse data from key informant interviews. The results of the study indicated that most of the people in this area are affected by floods due to weak early warning system that's doesn't produce warnings in the right time in readiness to floods, lack of communication infrastructure (Radio, TV's) for weather forecasts, lack of good governance that can help to boost community participation and also increase the level of commitment.

It is very important if early warning such areas are strengthened, therefore the study recommended some of the possible solutions to these challenges faced by these people in using early warning for flood response. Some of the suggested solutions are increasing financing in EWS, increased education and training, and also prioritize documentation at a local level as it easier for policy implementation and blending of local knowledge and modern systems.

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ACRONYMS/ABBREVIATIONS

ACPC: Area Civil Protection Committee

CPC: Civil Protection Committee

DCCMS: Department Of Climate Change And Meterological Services

DHM: Department Of Hydrology And Meteorology

DoDMA: Department Od Disaster Management Affairs

DWS: Department Of Water Services

EWS: Early Warning System

HSA: Healthy Surveillance Assistance

NGO: Non Governmental Organisation

SDG: Sustainable Development Goals

UNDP: United Nations Development Program

VCPC: Village Civil Protection Committee

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Chapter 1: Introduction

Early warning system provides timely information before catastrophic events to those exposed to hazard to reduce the amount of property loss and also loss of life by taking preventive measures and precautions to aid effective response to hazards. The effects of a flood can be local affecting only a local community and also at the same time these flood effects can be huge affecting an entire country (Kwak et al., 2011). Kwak (2011) described that " A 100% safety to flood risk prevention is impossible" a large population of people is exposed to many different types of risk every day, climate nowadays poses many risks to the people, properties, and also the environment some of the risks posed by climate scenarios include flood risk, landslide risks, etc. Floods are the overflow of water towards the land which is normally dry, examples of floods are riverine floods, coastal floods, flash floods.

Floods are a common hazard in lower shire affecting districts like Chikwawa and Nsanje frequently, leaving multiple casualties and damages to the societies. Therefore, to reduce the losses and other impacts of flood there is a need to employ some mitigation measures which include early warning systems. Early warning systems are a major component in mitigation strategies in the preparedness phase, to achieve primary goals early warnings have to be effective so that the response to flood scenarios has to be effective also, for example, the warnings should be timely, accurate, and credible which are incorporated with climatic data.

Early warning systems are considered as an essential component providing timely and effective information to individuals and communities so that immediate, appropriate, and effective responses can be taken into account to reduce potential injury and deaths, and damage to property and livelihoods (Sufri et al., 2020). Thereafter, the generated early warning information based on close monitoring of the system, climatic and weather data will help in increasing the efficiency of the system.

Nsanje district has been known for using traditional practices in predicting weather patterns, traditional knowledge has been used also to foretell adverse weather conditions, forecasts from the department of meteorology has been used to issue

warnings to people that are most vulnerable to floods in Nsanje and also the swelling of upstream tributaries is used also to warn the people in the lower valley on possible flood situations. For example, in Nsanje, the Nyachilande river is one of the sources of major floods in the Nsanje area of chief Ndamela, river gauges were installed to monitor changes in water levels in 2018 (Malawi Red Cross Society, 2018).

1.1 Background

Early warning systems are the major processes aimed at disseminating timely information in a systematic way for the impending hazard that can affect the community, which helps to reduce hazard impact and increase response by taking preventive measures. Early warning systems are used in detecting various impending hazards for example floods, volcanic eruptions, earth crust movements for possible earthquakes, droughts if it is incorporated with drought indexes.

In pursuit to achieve sustainable development goals, goal 13 on climate speaks of the importance of mitigating climate change and also reducing its impacts. Specifically, Goal 13 encourages and emphasizes the spreading of Early Warnings to reduce climatic associated hazards through the following targets, Strengthen resilience and adaptive capacity to climate-related hazards and disasters in all countries, Improve education, awareness-raising, and human-institutional capacity on climate change mitigation, adaptation, impact reduction and early warning (SDG,s 2015-2030) (Johnston, 2016).

In Malawi, disaster response has been ad hoc, less concentration was put in dealing with the causal factors of disasters and put preparedness measures in place. Early warning systems are not utilized effectively hence most people in different areas are affected by floods and huge losses due to these disasters, for example, example floods of Mtandire in Lilongwe and lower shire (Nsanje) in 2019 and 2015 respectively.

Malawi adopted a community-based early warning system (people-centered early warning system) whereby the early warning system is operated by the community and owned by the community. The early warning system can be designed and installed by an external organization but it will be operated and owned by the community, which

means every activity has to involve the community. All the community members especially the most vulnerable should be involved in all stages of the community-based early warning system from designing the operating systems, monitoring the system, receiving warning information, and responding to the warnings (Mercy corps and Practical Action, 2010).

1.2 Problem Statement

Nsanje is frequently hit by floods that bring huge losses to a large population that are in contact with the hazard whereby some of the effects are loss of life, loss of properties, disruption of the environment, and destruction of infrastructure thereby follows the displacement of people. Floods also contribute to other secondary effects such as disease outbreaks, conflicts, loss of cultural beliefs and values in the process. Response to floods by the community, disaster practitioners, and other external organizations (e.g Dodma) has helped in lessening the sufferings of people due to floods by the provision of shelter, water, food, health care, and other basic needs to those affected by floods. Climatic and weather data paucity escalates low response to warnings by typical communities which is highly populated by elderly and children's who have less knowledge and rely upon others to direct them in making decisions. In addition, most people in local communities, in the most vulnerable areas lack basic amenities which some of them is lack early warning communication infrastructure to receive warnings that are ciphered understandably such as radios, television, advanced mobile phones. Most researchers put much concentration in investigating and assessing vulnerabilities of communities in the lower shire and less concentration is put on assessing the effectiveness of early warnings and systems as a component in disaster preparedness. Hence, to reduce damage, costs, and casualties associated with flood hazards there is a need for assessment of early warning systems in Nsanje to maximize efficiency and effectiveness rendered to the most vulnerable groups in typical hazardous locations in Nsanje.

1.3 Main Objective

The main objective of this study is to assess the effectiveness of the early warnings and early warning system that is used in Nsanje for flood response.

1.4 Specific Objective

- Investigating the current state of the early warning system and ways of issuing early warnings in Nsanje
- Investigating the effectiveness of early warnings based on key elements of early warning system in Nsanje
- Determine ways to address research gaps and challenges in strengthening the early warning system in Nsanje.

1.5 Research Question

The study answers the following question:

- What is the current state of the early warning system and the ways early warnings are issued in Nsanje?
- How effective early warnings are based on early warning system key elements?
- How the early warning system can be improved to increases its efficiency?

1.6 Significance Of The Study

This study is very important in the field of disaster risk management since it provides a test and also weighs the credibility and efficiency of early warnings and systems. The institutional framework in early warning systems will also be recognized and assessed by viewing the roles and responsibilities at different levels in the framework that will help in pointing out levels and individual groups that are underperforming in increasing inefficiency of the system and provide ways to address the challenges. Therefore this study has to assess the system used to detect flood hazards in the lower shire and also find the challenges faced by the existing early warning system and institutional frameworks at the district level, Area, and Village level to find the gaps so that it should create room for improvements and modifications.

Chapter 2: Literature Review

Many researchers have published great works on research topics concerning early warning systems and flood responses. In Nsanje people-centered early warning system was adopted by the government of Malawi in connection with United Nation Development Programme (UNDP) so that to achieve sustainable development goals in particular to goal number 13 that strengthen in reducing the impact of different types of hazards. Early warning systems (EWS) are recognized in both the Hyogo Framework for Disaster Reduction (2005-2015) and the Sendai Framework for Disaster Risk Reduction (2015-2030) as an important element of disaster risk reduction and hence to the achievement of sustainable development goals.

The early warning system is an integrated type of system for monitoring, collecting data, analyzing, interpreting, and communicating monitored data, which can then be used to make decisions at proper times to protect the public from different types of hazards (Essamuah-quansah, 2017). The early warning system was implemented as a tool and structure that will help people to react fast to an impending hazard so that to achieve an effective response, this can be accomplished as long as the system works hand in hand with every element in the system. In Nepal, gauge readers carefully monitor when water levels approach warning and danger levels, ready to disseminate warnings. "District-level government maintains electronic flood monitoring display boards, with sirens that sound automatically when water reaches warning levels. The web-based telemetry system also triggers an SMS, text message, warning that is sent to Chief District Officers"(Kafle, 2017). Failure in any one of the communication channels implies that the information will not cover the reality of the scenario. When looking at building resilience at the community level through early warning systems, all four elements must be considered (Cowan et al., n.d.).

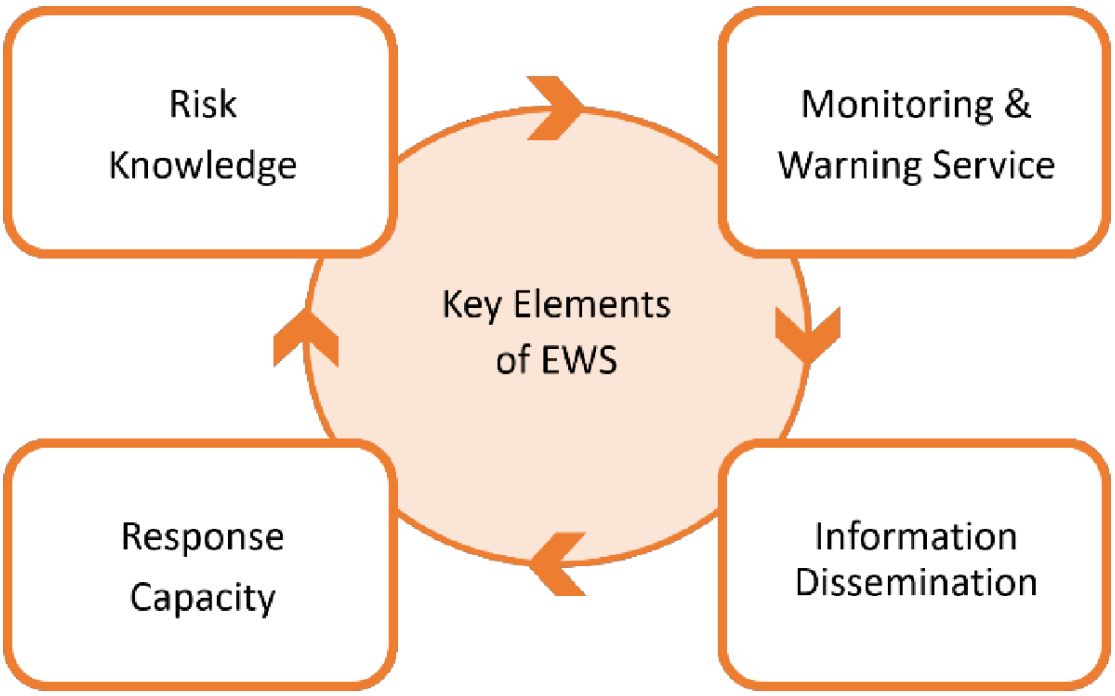


Figure 1: shows elements of an effective early warning system

Source: *The role of early warning systems in natural disasters: A consideration of contextual factor*

Every warning system has its checklist for each element operations separately helps also to increases the effectiveness of the system. However, some other cross-cutting issues need to be put into consideration and these are cultural diversity, gender, and disability, if not taken into the close look they can cause also an early warning system to be ineffective in terms of response to the hazards.

An early warning system to be trusted and to be more effective has to deviate from errors that lead to false alarms and missed alarms, by making sure that the system is accurate and credible. Mostly ground measurements from ground stations usually have a short coverage and only and usually measure the variables of interest at that particular point only, for example in Malawi there are few ground stations, which are of short coverage that makes data not be truly represented by other areas that do not have ground stations to collect data.

Findings identified numerous challenges to engaging the community in an early warning system. They included inadequate sustainability of engaging the community in early warning system design and operation due to the insufficiency of funds, technical assistance, and human resources (experts) when supported agencies terminate their projects (Tarchiani et al., n.d.)(Sufri et al., 2020). The absence of policy and legal frameworks has weakened the efforts of the establishment and strengthening of effective and functional early warning systems in Nepal (Kafle, 2017). Kaffle also stressed that "Some of the key challenges for effective early warning systems in Nepal include inadequate investment, lack of effective monitoring and evaluation, lack of responsible national early warning center, inadequate publicity at the community level, inability to develop appropriate mechanisms for communications, weak capacity for response, lack of coordination among various bodies, lack of legal, policy and institutional provisions and inability to conduct adequate training courses, research and study activities on regular basis".

It is argued that participatory approaches are great opportunities for knowledge exchange between vulnerable groups and the scientific community (Kelman and Glantz 2014), Community engagement is often interchangeably used with community participation or involvement to describe actions taken to engage with communities and interest groups in dealing with issues that affect them within five main types of engagement processes: informing, consulting, involving, collaborating and empowerment (Sufri et al., 2020). Sufri, further stress that 'involving of the community in the design and operation of an early warning system that utilizes a multi-hazard approach is important since it enhances system efficiency when human and financial resources are limited and also said communities should be engaged in numerous disaster response events with either slow or rapid onsets such as floods or flash floods, landslides, cyclones, and epidemics.

2.1 Nepal Community Based Early Warning System

Nepal is a country that is mostly at risk from climate change and also it is mostly affected by floods that reached millions of people affected (Brown, 2013), for example in 2007 Nepal recorded 2,933 deaths and nearly 3.5 million people affected. Just like in Malawi, Nepal uses also a community-based early warning system, whereby the community at risk is fully involved in the process of the system. In Nepal's existing early warning flood information is generated at hydrological stations managed by the department of hydrology and meteorology (DHM), in total Nepal has 400 thousand meteorological stations and 200 hydrological stations, 70 out of them are real-time stations. Real-time stations are very efficient since they give real-time information which is accurately measured this helps the people at risk to get real-time information about weather conditions and take proper measures to respond to it, assuming the information sharing channel is effective from top to bottom.

Nepal's early warning system to efficiency and sustainability experienced many challenges, Brown states that " Nepal early warning system faces technical challenges, institutionalization and capacity building, institutional collaboration, equipment and communication problems, financial barriers, and also lack of system monitoring and evaluation".

2.2 Bangladesh's Flood Early Warning System

In Bangladesh accurate and effective flood forecasting is becoming an ever-increasing concern, lead time continues to be an issue. Dissemination of warnings and forecasts and interpretation at the sub-national or community level remains a major challenge, at district level relief and rehabilitation officers are responsible for collecting data on changes in river systems from various national and local sources, including flood information centers (Brown, 2013). Therefore, district relief and rehabilitation officers communicate early warnings to local disaster committees along with other risk reduction and emergency activities. In Malawi, mostly in Nsanje early warning accuracy is a major concern and the people also suffer from lead times of the system due to lack of real-time

data of early warning monitoring systems. Bangladesh was choosen as a benchmark in this study since EWS in bangaldesh has similar challenges, problems to Malawi EWS.

2.3 Case Study From East And West Africa

Country Sudan has suffered from persistent droughts and also a scarcity of water in the country, this accelerates conflict in the country due to political instability. Sudan experienced long trends of declining rainfall amounts in many parts of the country this increases recurring droughts which increase the number of people dying (Brown, 2013). Most countries in Africa suffer from meteorological and hydrological hazards which hampers the country's growth in both economies of the country and also the livelihoods of the population. Disasters nowadays put pressure on most of the countries on the economy in terms of recovery and reconstruction projects, floods, earthquakes, cyclones, and tsunamis are the most devastating disasters in most countries. In true sense disasters cannot be eliminated, only their impact can be reduced by following disaster reduction measures, the different organization has linked science and disasters in formulating ways to address disaster impacts and also finding ways to minimize the magnitude of disaster by employing different approaches in structural and also nonstructural measures. An early warning system is an example of a structural measure in disaster reduction strategy that has been employed in most African countries. In 2020 floods affected over 2.7 million people in countries like Nigeria, DRC Congo, Senegal, Cameroon, Guinea just to mention a few, affected a total of 18 countries in West Africa (Reliefweb 18 Dec 2020). These countries receive the highest amounts of rainfall due to the equatorial climate, floods frequently occur in these areas and the majority of the population is affected in most events.

2.4 Flood Early Warning System In Malawi

Malawi is heavily affected by floods in most parts especially the lower shire, frequently the lower shire is affected by floods which cause massive damages, loss of life, the environment, and many others. This has led to the development of many frameworks in the field of disaster management in Malawi for example annual national contingency plans, recovery plans, and reconstruction plans. Early warning information in Malawi

mostly is provided by the Department of Climate Change and Meteorological Services (DCCMS) in form of forecasts, and the department of water services (DWS). The DCCMS has 21 surface observing stations, 27 automatic weather stations, 64 rainfall loggers, satellite receiving stations, and over 100 rainfall stations across the country to produce early warning information (Brown, 2013).

The early warning information is disseminated and utilized by the community members guided by the civil protection committee (CPC). The civil protection committee acts as a bridge of information of early warning information, that includes translating information to vulnerable groups which mostly consist of less educated, elderly, disabled people that are physically impaired. These groups need special treatment and assistance in terms of early warning messages that include translation of information, and also guidelines to undertake in response to warnings.

2.5 Sustainability And Effectiveness Of Early Warning Systems

In most countries there is a lack of connection between community and national systems, that lack of connection possess so many challenges and setbacks to effective community-based early warning systems (Brown, 2013). In most countries project funding is difficult, for a country like Malawi in most cases is unable to fund its projects, it relies on donor aids to get funds and others include human capital. Brown states that " the absence of funding to be used in funding early warning system costs of a local government and community level remains a major constraint to enhance risk and early warning programs", for example, telecommunication networks and mobile phones to be used in early warning communication these approaches can be used to overcome some challenges and increase efficiency.

In research conducted by Brown, it was discovered that there is a big gap to be filled, where there is a need to increases the number of people within communities reached in different ways in various communication channels. This implies that different groups in different locations have different risk levels and all groups will benefit from different dissemination approaches, a single communication approach/channel is different among various groups in a community since people receive and understand the information in

different ways. The research examines private sector engagement in monitoring and dissemination of risk information this gives a huge opportunity for mobile service operators within community-based early warning systems.

Chapter 3: Methodology

3.1 Study Area

The study area of this research is Nsanje in T/A Ndamela, which is found in the Lower shire section that covers a large section in the southern region of Malawi with other districts like Chikwawa, Blantyre, Zomba, Thyolo, Mulanje, Balaka, Mwanza. Much concentration of this research was put on the Nsanje district that recorded the most flood events, the high frequency of flooding events was an ideal factor to be chosen as a study area. Nsanje registered more flood events in Malawi's history which lies along the flat basin of the Shire Valley with a measured altitude of around 780 to 800 meters above sea level. Nsanje covers an area of 1940 km^2 (Map Action, 2015), which is about 15% (Government of Malawi, 2017).

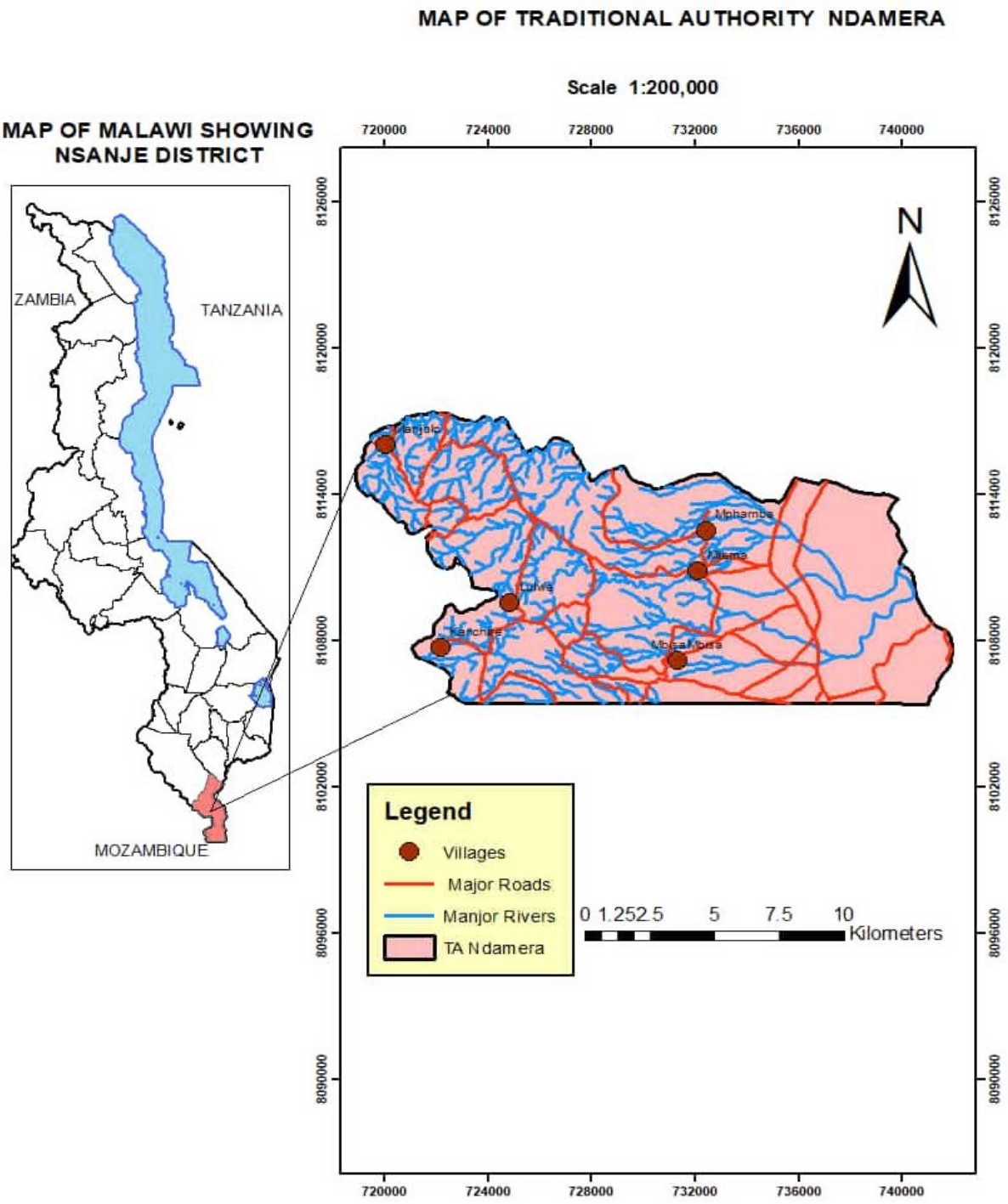


Figure 2: Map showing study area for Nsanje, T/A Ndamela

3.1.1 Climate

Nsanje experiences a tropical type of climate that comprises wet and dry seasons over the year, whereby the wet season mainly starts in late November progresses up to April

and May while the dry season progresses from August to November with the highest temperatures in the lower shire perhaps the country Malawi. Having looked at the climate of lower shire including Nsanje receives an average amount of rains of about 1651.5mm to 414.7 maximum and minimum respectively.

3.1.2 Topography

Nsanje lies on a flat topography along the shire basin situated along the great African rift valley. The district is surrounded by escarpments that lie between Thyolo towards the far ends of Chikwawa and Nsanje where most of the rivers are originated (Thuchila, maperera, livunzu, likhubula, mwamphanzi, and nkudzi) and connects to the main shire river. The lower shire has abundant water sources from rivers and marshes.

3.2 Research Design

The study used two methods which are a quantitative and qualitative method whereby the general quantitative approach involved numerical values with less mathematical calculations that are used to describe the relationships among variables and also data tables. Secondary data that has been already collected by other researchers and departments eligible to correct and store this type of data was also used for example data from the department of disaster management affairs (Dodma) and district council data.

3.3 Materials And Methods

The study used different materials to source information. A questionnaire was used as a research tool to source some primary data that helped to find current information about the topic of study. The data obtained from the questionnaire was put in statistical software, SPSS for analysis.

3.3.1 Desktop Analysis

Desk review involved detailed analysis of fundamental data which include published and unpublished reports from organizations and government materials, articles, academic books, graphics, journals that describe and explain disaster risk reduction measures that include analysis of early warning systems.

3.3.2 Questionnaire

In this research, a questionnaire was constructed to collect more primary data, it involved structured questions which were given to respondents. The purposive sampling method was used in this study where heterogeneous samples were selected to represent the population, this method was used due to the small target population, limited time, and also limited resources (money) to cover a large population. This method targeted people that are in contact with flood hazards, disaster risk management experts, this method was used to achieve maximum variation in the sample population, there were 36 participants. The questionnaire was constructed in English form, and translation was also made available when the respondents have difficulty in English language. A questionnaire was used due to secondary data paucity, there was a need to have primary data that supplement secondary data on the desk review process, and also data from the questionnaire is easy to analyze and visualize which offers actionable data, questionnaire gives room to collect data that is in qualitative and also quantitative.

3.3.3 Key Informant Interviews

This method involved interviewing people who know disaster risk reduction strategies that include early warning systems in Nsanje and also other particular places in Malawi, those that experienced floods, that have worked in different organizations, both government and non-governmental organizations in different programs that include humanitarian programs. Informants were selected based on the knowledge they have on an early warning system, the informants included community members, government officials, and also non-governmental officials since they have good sources of information and also they take a huge part in implementing some of the projects in the communities. The interview also allowed wider ranges of information from experiences, stories, myths, and also it gave them a chance to express challenges faced and ways in which they can be addressed.

3.4 Data analysis

To achieve the objectives and answer research questions the data was processed in different ways, data from the questionnaire was collected using kobo toolbox software

which is then exported into an excel sheet. Then the data was later imported into statistical software (SPSS) for analysis to produce tables in form of frequencies and percentages, this data gave the results on EWS key elements to find out how effective early warnings are.

Data from key informant interviews was put into themes that are consist of points or areas that respondents emphasized, repeated, this data was later coded and ciphered into main points of focus in the study, this data consists of information on the current state of early warning system in the area (T/A Ndamera) and also the challenges faced of using the system in issuing early warnings. Key informant was a goal for this information since there is no documentation of such.

3.5 Limitations Of The Study

Through qualitative approach is cheap and an easy way to gather data there were constraints in using this type of method, some of the challenges that were encountered were data paucity on early warning systems in Malawi whereby currently they are few records of early warning systems that are used in Malawi, so it was difficult to achieve some objectives about early warning operations in Malawi especially in Nsanje, lack of documentation on early warning operation activities at local levels. The quantitative approach also had challenges in using questionnaire smallest sample size was chosen to reduce the cost that is incurred in using large sample sizes that increases time hence increases cost too, some areas were not visited due to funding issues that limit the information required to achieve some of the research objectives.

Chapter 4: Results and Discussion

4.1 Current State of Early Warning system and way of issuing warnings In Nsanje

Nsanje district partly uses indigenous early warning systems, in some areas of the Nsanje river gauges were installed to monitor water levels in major rivers. Malawi Red Cross Society in 2018 installed a river gauge to one of the major rivers (Nyachilande river) that has been causing a lot of floods in the area (T/A Ndamela).

Currently, Nsanje depends on community early warning systems (river gauge), whereby representatives are selected to monitor the water levels in the rivers, this signifies full ownership and operation of the system by the community.

Early warnings in Nsanje are mostly issued by the community through community leaders, rise in water levels in rivers prompts community members to conduct local meetings, it is through these meetings decisions are made to issue a warning to people in the communities for an impending flood hazard.

The community mostly rely on water levels in the river to issue warnings for flood, since most of the people in the areas (Ndamela Traditional Authority) they do not have access to meteorological data, community leaders bears a huge responsibility to the people for warnings for floods. Flood response in this area, therefore, has been weak since most people they don't react so fast to flood hazard, sometimes floods occur without any warning issued to them, for example at night whereby there is no one to monitor change in water level. Key informant interviews was used to find out this piece of information in this section due to lack of documentation, this approach was viable.

4.2 Effectiveness of early warnings based on key elements of early warning system in Nsanje

4.2.1 Risk Knowledge

Most people in Nsanje know that they are subjected to the risk of flooding, since flooding in Nsanje is a frequent event, the level of vulnerabilities in the area varies across the population and they are well known. Risk knowledge, therefore, has to make

vulnerabilities well known to the people through vulnerability maps, as well as hazard maps.

The findings show that 41.7% of people said there are no hazard maps, while 5.6% claimed that hazard maps are available, the rest 52.8% don't know if there is a hazard map or not.

On hazard map distribution to the community, it was found that no one has ever received hazard maps of their areas, which splits findings to be 61.1% of people who said there is no distribution of hazard maps and the rest they don't know about hazard map distribution.

On updating hazard maps, findings also showed that the people in the area don't know if the maps are updated assuming they are available, since it shows that there are no hazard maps to their knowledge. These maps help residents know areas that are safe from hazards (floods), in times of disaster maps will help residents to take safe routes towards assembly points and evacuation centers. Therefore, these maps have to be made in a form that residents can easily read and interpret. Since there are no such maps to the people in the community, in times of flood for example, majority will still find it difficult to take safe routes towards safe evacuation areas, some will take routes that will read them to inundated areas.

4.2.2 Monitoring and warning services

In this section, monitoring and warning services of early warning systems covered the lead time of the system, forecasting frequency, data recorded on early warning systems, and early warning information output. The results show that majority of the population are not aware of the lead time of the system representing 63.9% while some respondents said that the lead time of the system is from hours to daily and daily to monthly represent 13.9% and 22.2% respectively. Forecasting frequency of the system based on the data 52.8% is of event-based and 38.9% feedback said is of the seasonal forecast. Most of the data recorded from the system (river gauges) are water levels in

rivers, which constitute 61.1% of the population's feedback. As for the output data of the early warning system is found that mainly is data for the water level in rivers.

The following tables show further information on EWS monitoring and warning services.

Table 1: Data on forecast frequency

Feedback	Frequency	Percent	Valid %	Cumulative %
Event based	19	52.8	52.8	52.8
continuous	2	5.6	5.6	58.3
Seasonal	14	38.9	38.9	97.2
Don't know	1	2.8	2.8	100.0
Total	36	100.0	100.0	

Table 2: The table shows the type of data recorded on EWS

Feedback	Frequency	Percent %	Valid %	Cumulative %
Water level	22	61.1	61.1	61.1
No data recorded	3	8.3	8.3	69.4
Don't know	11	30.6	30.6	100.0
Total	36	100.0	100.0	

Table 3: Data on EWS information output

Feedback	Frequency	Percent	Valid %	Cumulative %
Water level	23	63.9	63.9	63.9
Stream flow	1	2.8	2.8	66.7
Inundation	1	2.8	2.8	69.4
Don't know	11	30.6	30.6	100.0
Total	36	100.0	100.0	

4.2.3 Information dissemination

Information dissemination of early warnings in Nsanje, it was found that chiefs play major roles in disseminating information about impending flood hazards that constitute 38.9% of warning information being disseminated by local chiefs. Communication infrastructure in Nsanje typical communities, only 16.7% of people have access to this infrastructure, but the majority of people (58.3%) in this area always find early warning information reliable.

The tables below show the data on information dissemination:

Table 4: ways of warning dissemination

Feedback	Frequency	Percent (%)	Valid %	Cumulative %
Chiefs	14	38,9	38.9	38.9
Siren	1	2.8	2.8	41.7
Volunteers	6	16.7	16.7	58.3
Speakers	5	13.9	13.9	72.2
Radio	10	27.8	27.8	100.0
Total	36	100.0	100.0	

Furthermore, most people in the community lack communication infrastructure such as TVs and Radios, It was found that 16.7% have access to communication infrastructure and 63.9% of people do not have full access to a communication infrastructure or some don't use them due to telecommunication problems. The community finds communication infrastructure reliable in terms of forecasting and warnings, by then most communication messages reach them late for example weather forecasts. This makes the people only to rely on community local methods of warning dissemination which has a short lead time in most cases, increasing chances of being affected by floods when they occur.

4.2.4 Response capability

In response to warnings for floods, it was found that 47.2% of people do not respond to warnings as they are issued, while 30.7% of people respond to these warnings for the impending floods in Nsanje. Though the majority respond to these warnings, most people do not take proper actions to these warnings such as evacuating. Some residents said that " if they evacuate their properties will not be looked after (security), and also due to short lead times they don't have adequate time move out of those danger areas and also some cultural and ancestral beliefs make them stay in those areas even if danger from floods is pronounced.

In order flood response to be effective, EWS has to be effective in all four major key elements, for example response capability in Nsanje is not effective as it shows many people refuse to move out from danger zone, lack of communication infrastructure to receive warnings(weather data) puts more pressure to rely on river gauge readings which have also implications to the people receiving in flood areas. Therefore, the system is not fully effective since some areas in these elements are not achieved.

4.3 Addressing research gaps and challenges in strengthening the early warning system in Nsanje

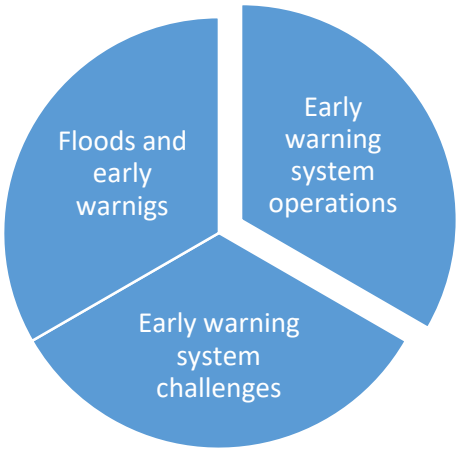


Figure 3: themes and categories of information obtained from key informant interviews.

4.3.1 Floods and early warnings

In lower shire, the flatness of the area makes it susceptible to floods, this is a triggering factor that makes it easier for rivers to discharge excess water to residential areas, markets, schools, and hospitals. In Nsanje few early warning instruments were installed in river systems (river gauges) to monitor water levels. Most times floods occur due to heavy and prolonged rainfall, this hinders water level monitoring and local meetings that are usually held to issue warnings.

4.3.2 Practicability and operation of early warning system in Nsanje

A community-based early warning system in Nsanje is mostly operated by volunteers that are selected among the community members, the member is either in VCPC or

ACPC in that particular community or just an ordinary community member. The work mostly is unpaid which makes some operations to be difficult for example water level recording and also the process itself of communication and information dissemination. Most of the members are heads of families, farmers, and other small scale businesses, and this makes it hard sometimes to give much more time in monitoring some of the systems for example the river gauges, and also data from the MET department that is shared in different platforms (radio, television, etc.)

4.3.3 Key gaps and challenges

Speaking to different people that know the field of disaster risk management particularly on mitigation measures of flood impacts, they said that " most of these mitigation measures, implementation and documentation of core responsibilities and policies that strengthen projects like early warning systems is rare. Lack of enough funds to employ people from the villages to work hand in hand with government and organizations in issues to do with early warning systems that include, monitoring systems, communication, and dissemination of information, for example in the ministry of health HSA's are employed to monitor health programs of people in local communities on behalf of district health officers, the same approach in disaster management could have been employed. Lack of skilled personnel is a challenge, lack of materials and resources also makes it difficult to have an effective early warning system in Malawi.

4.3.4 Ways to increase system efficiency

The following can help to increase the system efficiency:

- Making climatic and weather data widely available to the people
- Putting effective decision-making policies in place can also help to increase warning efficiency.
- Increasing community understanding and perception towards flood hazards.
- Timely dissemination of warning messages and also timely response to floods help to make the system efficient.

- End to end framework should also be employed (a framework whereby end users which are local people in a community an involved in formulating implementing and also adopting policies that govern them)

Chapter 5: Conclusion And Recommendation

5.1 Conclusion

Flood disasters in Malawi are among the most devastating events, and their cost to the country's economy is significant and continuously increasing. To reduce impacts from floods early warning systems in many parts of the world have been implemented to lessen the damages and the impacts of floods. In Malawi, disaster management has been ad hoc in the past years, where more concentration was put on response and recovery. The paradigm shift in disaster risk management has made it possible to change in dimensions as far as disaster management is concerned.

Early warning system in Malawi is partly used as a tool in disaster risk preparedness, in most areas in Malawi they use partly indigenous early warning system and river gauge system that monitor water levels in rivers. In Nsanje, most people have encounter floods and are aware of the hazard they are exposed to, but the knowledge of ways to anticipate the hazards is low. The research targeted the local communities in Nsanje that are mostly affected by floods.

This dissertation has attempted to address some of the gaps that exist in the early warning system used in flood response in Nsanje and also provided ways to address them. Some of the problems include inadequacy use of climatic and meteorological data, lack of scientific early warning systems (relying on manual methods), lack of full community participation in the system, lack of good governance. Inadequacy of meteorological and climatic data can be addressed by making climatic data widely available in understanding form through increasing communication infrastructure (TV's, Radios) in the local communities so that this can be fully utilized to increase efficiency, there is a need for a paradigm shift in an early warning system to a more scientific system, community sensitization and enhancing good governance from village level to local levels, these will help to address the challenges faced.

The study indicates that the overall aim of early warning system in flood management in Nsanje is still uncertain due to many issues include social challenges, financial challenges, communication challenges, technical challenges, and overall due to poor governance in

early warning in Malawi. To overcome these challenges and achieve global development agendas to increase the effectiveness of the system, therefore, international agencies, central government, NGO's, policymakers, disaster risk managers, and the community needs to put extra mile in using early warning systems as a major component in risk preparedness, more resources including financial resources need to be put in place, and guiding policies need to be enforced, documentation needs to be prioritized.

5.2 Recommendation

Based on findings discussed in previous sections, as well as to reduce the losses due to disasters there is a need for improvement and shift in the current early warning system management, the following are suggested recommendations:

- Financing in early warning systems in Malawi is lacking, which increases the reliance on the use of indigenous systems and other simple systems like river gauges. Lack of adequate financing also undermines the early warning systems due to over-reliance on volunteer approaches, most voluntary works are done in personal free time, therefore, there is less commitment since is nonpaid work. Therefore, there is a need to put more funds into early warning systems to adopt modern scientific systems that are timely and more efficient. An increase in funding should also consider to top individuals that are selected in the community to monitor systems and other crucial responsibilities to be paid for the work to increase the commitment of such individuals.
- Documentation in Malawi is also a challenging part, mostly at local levels, it is found that early warning system activities are not documented at local levels, which makes it difficult to track progress and identify underperforming areas. This poses a challenge to researchers, policymakers to integrate indigenous knowledge practices with modern knowledge, and also it difficult to determine its effectiveness.
- Education and training in early warning systems and other disaster risk management preparedness activities are limited. Since the communities are the first responders to floods, most people gain their knowledge through meetings and seminars with the different organizations but further knowledge and training in disaster preparedness and response, and early warning system needs to be given to the local community

representative. Disasters are dynamic they affect a community in different ways so further knowledge is needed to anticipate disasters in different ways.

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APPENDICES

Appendix 1: Risk knowledge

Are hazard maps for floods available in the community?

Feedback	Frequency	Percent (%)	Valid percent	Cumulative %
Yes	2	5.6	5.6	5.6
No	15	41.7	41.7	47.2
Don't know	19	52.8	52.8	100.0
Total	36	100.0	100.0	

Are hazard maps distributed in the community?

Feedback	Frequency	Percent (%)	Valid percent	Cumulative %
Yes	0	0	0	0
No	22	61.1	61.1	61.1
Don't know	14	38.9	38.9	100.0
Total	36	100.0	100.0	

Are hazard maps updated?

Feedback	Frequency	Percent	Valid percent	Cumulative %
N/A	5	13.9	13.9	13.9
No	1	2.8	2.8	16.7
Don't know	30	83.3	83.3	100.0
Total	36	100.0	100.0	

Appendix 2: monitoring and warning services

Early warning system lead times

Feedback	Frequency	Percent %	Valid %	Cumulative %
Hours to daily	5	13.9	13.9	13.9
Daily to monthly	8	22.2	22.2	36.1
Don't know	23	63.9	63.9	100.0
Total	36	100.0	100.0	

Appendix 3: information dissemination

Are communication infrastructures are available?

Feedback	Frequency	Percent	Valid %	Cumulative %
Yes	6	16.7	16.7	16.7
No	23	63.9	63.9	80.6
Null	7	19.4	19.4	100.0
Total	**36**	**100.0**	**100.0**	

Is the communication system reliable?

Feedback	Frequency	Percent	Valid %	Cumulative %
Yes	21	58.3	58.3	58.3
No	7	19.4	19.4	77.8
Null	8	22.2	22.2	100.0
Total	**36**	**100.0**	**100.0**	

Appendix 4: response capability

Do people respond to these warnings?

Feedback	Frequency	Percent	Valid %	Cumulative %
Yes	11	30.6	30.6	30.6
No	17	47.2	47.2	77.8
Null	8	22.2	22.2	100.0
Total	**36**	**100.0**	**100.0**	