DISSEMINATION OF DISASTER EARLY WARNING MESSAGES FOR FLOODS IN VOSLOORUS TOWNSHIP

By

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DECLARATION

I Nompumelelo Sibongile Ekeke declare that the Master's research dissertation that I herewith submit at the University of the Free State, is my independent work and I have not previously submitted it for a qualification at another institution of higher education.

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ABSTRACT

The implementation of early warning systems by municipalities affects how communities cope with disasters such as floods. Although the technical aspects of the collection of weather and climate data have improved over the years, the dissemination of effective early warning messages to semi-urban communities remains a challenge. The main aim of this study was to investigate how the City of Ekurhuleni disseminated early warning messages to the community of Vosloorus Township during the 2019 floods from the perspective of the community. Most of the respondents stated that they did not receive early warning alerts from the municipality pertaining to these floods. Furthermore, the community's perception is that the mechanisms used by the City of Ekurhuleni to dissemine early warning messages are not effective enough to enable community members to save lives and their properties from impending disasters.

The objective of this study also included investigation of the methods and procedures used by the city to communicate early warning messages to the community of Vosloorus Township. An investigation was undertaken of disaster management policies and strategies that underpin the communication of disaster information to communities in informal settlements within Vosloorus Township. In addition, coping mechanisms implemented by the affected communities to lessen the impacts of floods were also assessed in this study. Begg, De Ramon & Lese (2021) argue that government entities must pay attention to both climatic and non-climatic information when building resilience against disaster impacts within communities.

This study was conducted using mixed methods. Mixed method is defined as the implementation of two methods used to investigate a singular phenomena in a study.(Abro et al., 2015). This study used both qualitative and quantitative research methods to analyse data but also deal with the social components of early warning systems in the City of Ekurhuleni. The results of the study showed that the community of Vosloorus Township preferred the formation of community flood management committees as a measure to mitigate challenges relating to the dissemination of effective early warning messages to the community. The City of Ekurhuleni should consider implementing some improvements in the existing early warning systems to bridge the gap between the collection of weather data and ensuring that the disseminated disaster alerts reach the targeted communities.

Keywords for this study

Disaster; disaster risk management; vulnerability; resilience; early warning systems; dissemination.

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ACRONYMS

CoE	City of Ekurhuleni
CBDRM	Community Based Disaster Risk Management
CBEWS	Community Based Early Warning Systems
CBSO	Community-Based Society Organisations
CDCRF	Climate-Related Disaster Community Resilience Forum
DM	Disaster Management
DMA	Disaster Management Act
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
EEA	Equatorial East Africa
EO	Earth Observation
EWS	Early Warning Systems
GIS	Geographic Information System
GNSS	Global Navigation Satellite System
IDNDR	International Decade for Natural Disaster Reduction
IDP	Integrated Development Plan
IDL	International Disaster Law
IFRC	International Federation of Red Cross and Red Cross Crescent Societies
IVR	Interactive Voice Response
IT	Information Technology

KPAs	Key Performance Areas
MHEWS	Multi Hazard Early Warning Systems
NDMC	National Disaster Management Centre
NDMF	National Disaster Management Framework
OSM	Open Street Map
SAFFG	South Africa Flash Flood Guidance
SCF	Seasonal Climate Forecasts
SMS	Short Message Service
SADC	Southern African Development Community
SALGA	South African Local Government Association
SAWS	South Africa Weather Services
SDGs	Sustainable Development Goals
SPSS	Statistical Package for Social Sciences
UN	United Nations
VDMC	Village Disaster Management Committee
WUI	Wild Urban Interface

CHAPTER 1: INTRODUCTION AND BACKGROUND TO THE STUDY

1.1 Introduction

Disaster early warning is defined as a system that has the capability to generate weather or climate data and disseminate the data to affected communities (UNISDR, 2009). This definition of early warning by the UNISDR is adopted by this study as it emphasises the importance of establishing people-centred early warning systems.

Communication and disaster information form a huge part of disaster risk management (Bjerge, Clark, Fisker & Raju, 2016). Furthermore, disaster risk reduction planning cannot take place without receiving relevant data on the eminent disasters and therefore mitigation planning becomes difficult (Bjerge et al., 2016). It is important that disaster early warning systems are not only regarded as a measure to collect weather data but, should also incorporate communication processes to the end-user (Oktaria, Munadi & Ridha, 2014). Moreover, early warning systems alerts, should be on time (Oktaria et al., 2014). It is also important to involve the affected communities as the end-user in the process of dissemination of early warning messages (Oktaria et al., 2014). Bangladesh managed to adapt the existing early warning systems to be more people-centred, saving lives (Haque et al., 2017).

Nugrahenia and De Vries (2015) reported that involving affected communities in the dissemination of early warning systems was critical for triggering a response measure from the community. In Malaysia and Sri Lanka, the government introduced the use of cell phones as a medium to disseminate early warning messages to ensure that the affected communities receive disaster alerts on time (Nugrahenia & De Vries, 2015).

Linguistic issues can be the reason for the failure in the communication of disaster information (Perera et al., 2020). Furthermore, it was reported that different languages and cultures should be considered when disseminating early warning messages to accommodate migration to cities (Ogie, Rho, Clarke & Moore, 2018).

People migrate from different areas looking for work, making the city community multi-lingual and multi-cultural (Ogie et al., 2018). The challenge in such communities is that using one language in communicating disaster alerts may exclude other community members who speak a different language from understanding the early warning messages (Ogie et al., 2018).

Furthermore, effective dissemination of disaster early warning messages can assist in a timely evacuation of affected communities (Dutta, Basnayake & Ahmed, 2015). In Cambodia after the 2013 floods, the disaster alerts communicated were not clear in terms of the location of imminent floods and this resulted in more than 168 fatalities (Dutta et al., 2015).

It is therefore, important to note that early warning messages aim to improve specific intervention measures from communities (WMO, 2017). The purpose of disseminating disaster early warning messages for natural hazards is different from the purpose of disseminating disaster alerts for pandemics (Fearnley & Dixon, 2020). For example, disseminating early warning messages for COVID-19 was aimed at the community staying in their own areas or isolating to designated areas when there is a need, whereas the aim of disseminating early warning messages for floods for example, in most severe cases requires affected communities to evacuate the disaster struck areas (Fearnley & Dixon, 2020).

At the second international early warning conference, it was highlighted that early warning systems should be supported by relevant regulations and policies (ISDR, 2003). The technical aspect of early warning systems was considered important but so was the legislation and policy framework that guides the development and implementation of early warning systems (ISDR, 2003). In Indonesia, the government had a policy framework that underpinned the development of customised early warning systems in the country (UNDP, 2009). In addition, the Indonesian policy framework highlighted the importance of community participation regarding the dissemination process of early warning messages (UNDP, 2009).

Similarly, EWSs in South Africa are regulated through the Disaster Management Act (Act 57 of 2002 as amended) and the South African Weather Services Act (Act 8 of 2001 as amended). Municipalities must comply with regulations to save lives from disaster events within their communities. Municipalities have the responsibility to ensure that local communities are protected from the impacts of dangerous disaster events (Act 57 of 2002 as amended).

According to the South African Weather Services (SAWS) act (Act 8 of 2001 as amended); institutions such as SAWS focus on the ever-changing weather patterns in South Africa, and advise all government spheres on weather predictions. The weather predictions from SAWS are communicated as disaster alerts that comprise of eminent daily or weekly extreme weather conditions (Act 8 of 2001 as amended). Each municipality needs to link early warning dissemination processes to the municipality's Integrated Developmental Programme (IDP) (Buccus, Hemson, Hicks & Piper, 2008).

This study set out to review and assess the dissemination of disaster early warning messages in Vosloorus Township within the City of Ekurhuleni (CoE) in Gauteng Province of South Africa. Therefore, this chapter provides a detailed discussion of backround to the study, the study area, followed by significance of the study, as well as the problem statement. Also, research, questions, aims and objectives are outlined. Furthermore, deliberations on the research method and design

are outlined. This chapter also outlines how data was colled and analysed for this study and how the researcher dealt with issues relating to ethical considerations.

1.2 Background and context of the study

The earthquake in 1755 resulted in the loss of life and property in Lisbon and created a need for scientists to find means to notify communities of imminent disasters (Zschau & Küppers, 2003). At this stage, it was important for scientists to find out where and when disaster events would take place (Zschau & Küppers, 2003). Furthermore, it was after the Lisbon earthquake that Thomas Malthus designed an early warning system in 1798 (Zschau & Küppers, 2003).

In the past fifteen years, effective disaster early warning systems have been discussed as a critical aspect for disaster risk reduction measures (DRR) (UNDP, 2018). Furthermore, the need to improve on existing early warning systems increased in recent years as disaster events increased (UNDP, 2018). This led to different countries exploring the need to design customised early warning systems related to the nature of disasters in each area (Al-dalahmeh, Aloudat, Al-hujran & Migdadi, 2014). The realisation by most countries that lack of effective communication of disaster early warning messages intensified fatalities due to disaster impacts propelled the discussion on the improvement of existing early warning systems (Al-dalahmeh et al., 2014). The loss of more than 10 000 lives in the 1999 cyclone in India was attributed to failure to generate and disseminate early warning messages on time (Ray-Bennett, 2016). During the period 1999 to 2013, the Government of Odisha in India, worked on improving the dissemination of early warning messages and this resulted in fewer fatalities during cyclone Phailin in 2013 (Ray-Bennett, 2016).

The first recognised international conference on disaster early warning systems was held by the United Nations (UN) in 1989 (UNDP, 2018). The conference was held in Potsdam (UNDP, 2018). At the third international early warning conference that was held in Bonn, Germany in 2006, the emphasis was on the establishment of effective people-centred early warning systems (ISDR, 2006).

As part of deliberations at the international early warning conference, the UN outlined the following categories for the establishment of effective early warning systems (Lendholt & Hammitzsch, 2012):

- Identification of risk knowledge,
- Monitoring and warning service,

- Dissemination and communication of early warning messages, and
- Response capability.

Consequently, the early warning checklist developed by the UN during the international conference on early warning systems, emphasised that the above steps of early warning systems should incorporate the involvement of the affected communities (UNDP, 2018).

Disaster early warning systems are a critical component of disaster risk reduction (Wächter & Usländer, 2014). Furthermore, in disseminating early warning messages, government authorities should ensure that the targeted communities have the required capabilities to respond once they receive disaster alerts (Horita, Albuquerque, Marchezini & Mendiondo, 2016), this aspect talks about mitigation capabilities which formed part of this study.

In certain instances, disaster early warning messages do not always translate into an effective disaster response that can assist the affected communities to save their lives and property (Perera et al., 2020). The reason behind this might be attributed to disaster early warning messages not being understood by the affected communities (Perera et al., 2020). A gap still exists between the disseminated disaster alert messages communicated by government officials and the level of understanding of such messages by the targeted communities (Perera et al., 2020).

The implementation of disaster early warning systems impacts different countries differently (Mayhorn & McLaughlin, 2012). In South Africa for example, failure to disseminate early warning messages on time to vulnerable communities worsens the socio-economic status of the affected communities (DEFF, 2014).

The deliberations above led to the identification of a gap that exists between the collection of weather data and ensuring that the disaster alerts are communicated to the end-user effectively and efficiently. This study was limited to the community of Vosloorus township in CoE. Furthermore, this study was necessary as it resulted in findings that highlighted the areas of improvement of existing disaster early warning strategies within the CoE.

South Africa is comprised of urban, semi-urban, and rural areas. Semi-urban areas are referred to as townships (COGTA, 2009). Township communities comprise of vulnerable groups that are frequently affected by the effects of natural disasters like flash floods (CSIR, 2018). The majority of the communities that are affected by natural disasters live below the poverty threshold (CSIR, 2018). Furthermore, there are various reasons attributed to township communities being affected more by the impacts of disasters; poor spatial land planning is one of the reasons (Busayo & Kalumba, 2020). Hlahla & Hill (2018) argue that poor spatial land planning inherited from the

apartheid era increases the vulnerability of poor urban communities to the impacts of natural disasters in South Africa. Furthermore, the poor urban communities are not in a position to pay insurance to cover their assets in case they are destroyed by the impacts of disasters (Hlahla & Hill, 2018).

Every year, various communities in South Africa suffer due to the impacts of disaster events that could have been mitigated through the implementation of effective early warning systems (Van Niekerk & Shoroma, 2018). Moreover, disaster early warning messages have not always reached the targeted vulnerable communities of South Africa, resulting in loss of lives and economy (Khavhagali et al., 2016). In 2014, 570 000 people were displaced in South Africa due to floods (Khavhagali et al., 2016). Dissemination of disaster early warning messages on time is important to enable the affected communities to make informed decisions to save their lives and assets (Macherera & Chimbari, 2016).

Communities in South African townships experience disaster events that result in fatalities or loss of property due to various disaster events (CSIR 2018). Therefore, early warning systems should be developed and implemented by all municipalities as part of disaster risk management initiatives as prescribed by the act (Act 57 of 2002 as amended). Furthermore, each municipality should have an early warning strategy that comprise of the following, among others (Brown, 2008):

- Observation, forecasts and quantitative description of the collected data and its consequences;
- Warnings and dissemination thereof; and
- Response once the early warning messages have been received by the affected
- communities.

This research investigated the effectiveness of the dissemination of existing disaster early warning measures within CoE, as outlined above (Brown, 2008). Moreover, early warning systems should be developed in a holistic manner and form part of a comprehensive people centred disaster communication flow strategy that includes language and medium used to disseminate early warning systems (Basher, 2006). It is important to accommodate different languages and be medium-specific to the affected communities given the immigration of different people to the cities in search of work.

Even though there are international institutions such as United Nations (UN) committee for resilience-focused DRM programmes (UN, 2012), natural disasters are still a major challenge for various less developed countries. This might be attributed to challenges relating to poor communication flow of disaster risks messages coupled with lack of appropriate response

measures in developing countries (Cools, Innocenti & O'Brien, 2016). Furthermore, the poor response to disaster alerts may also be attributed to disaster messages that are not understood by the communities (Kunguma & Tereblanche, 2013). The argument is that disaster communication plans should be developed based on municipal policies (Kunguma & Tereblanche, 2013).

The arguments above outlined the benefits of implementing effective early warning systems as this will prevent loss of lives and assets and assist in the development of preparedness strategies in developing countries (Hallegatte, 2012). Countries like India, despite having a meteorological department with a cumulative experience of 100 years, could not disseminate early warning messages on time to save lives during the 2002 cyclone Orissa (Ray-Bennett, 2016). More than 10 000 people were killed and some were left destitute because the affected community did not receive early warning messages on time (Ray-Bennett, 2016). Moreover, community members who stay along the coast where this cyclone happened in India were left with concerns as to whether the Indian meteorological department (IMD) had measures and capacity in place that would assist the community to receive early warning messages on time should a similar disaster occur in the future (Ray-Bennett, 2016). Although early warning systems have improved in the past years, there is still a gap between the collection of weather data and the dissemination of disaster alerts to communities in danger (Guru & Santha, 2013).

The above deliberations created a need for this study to investigate the effectiveness of the measures put in place to disseminate early warning messages to poor urban communities in South Africa. The above challenges relating to ineffective communication flow measures led to the need to analyse the disaster early warning systems within CoE.

1.3 The study area

Vosloorus Township is situated in the south of Boksburg within the CoE, which is regarded as the fourth-largest metro in South Africa (CoE, 2018). According to CoE integrated development plan (IDP), CoE has a population of approximately 3.5 million people (CoE, 2018). Vosloorus is part of the townships within CoE, with 68% of the City's total population collectively (CoE, 2018).

After gold and coal were discovered around Boksburg, it was evident that more workers were required to work in the mines (Seyfeddinipur & Gullberg, 2014). The growth of the mining sector

caused a land challenge, as it was inadequate to accommodate the mineworkers from various areas who came to work in the mines (Seyfeddinipur & Gullberg, 2014).

The mine owners then requested the government to provide land on which black and coloured mineworkers would build their houses. A place called Stirtonville was then established where mineworkers from Boksburg resided (Seyfeddinipur & Gullberg, 2014). These mineworkers were later removed from Stirtonville once the government realised that this black residential settlement was too close to the white community of Boksburg (Seyfeddinipur & Gullberg, 2014).

Even though this is how Vosloorus was established in 1964, it is a common belief that all townships in South Africa followed a similar establishment process (COGTA, 2009). Vosloorus township has a population of 163 216 with 46 095 households (Stats SA, 2013). Vosloorus Township is divided into 22 subsections that comprise of urban and informal settlements (Stats SA, 2013).

Due to the nature of their structure, townships within CoE, like in many areas of South Africa, lack proper infrastructure like proper roads and drainage systems. The townships end up being flooded on a regular basis (COGTA, 2009).

This research study was based on the theory that the early warning systems put in place by CoE could not effectively disseminate early warning disaster messages within the Vosloorus area.

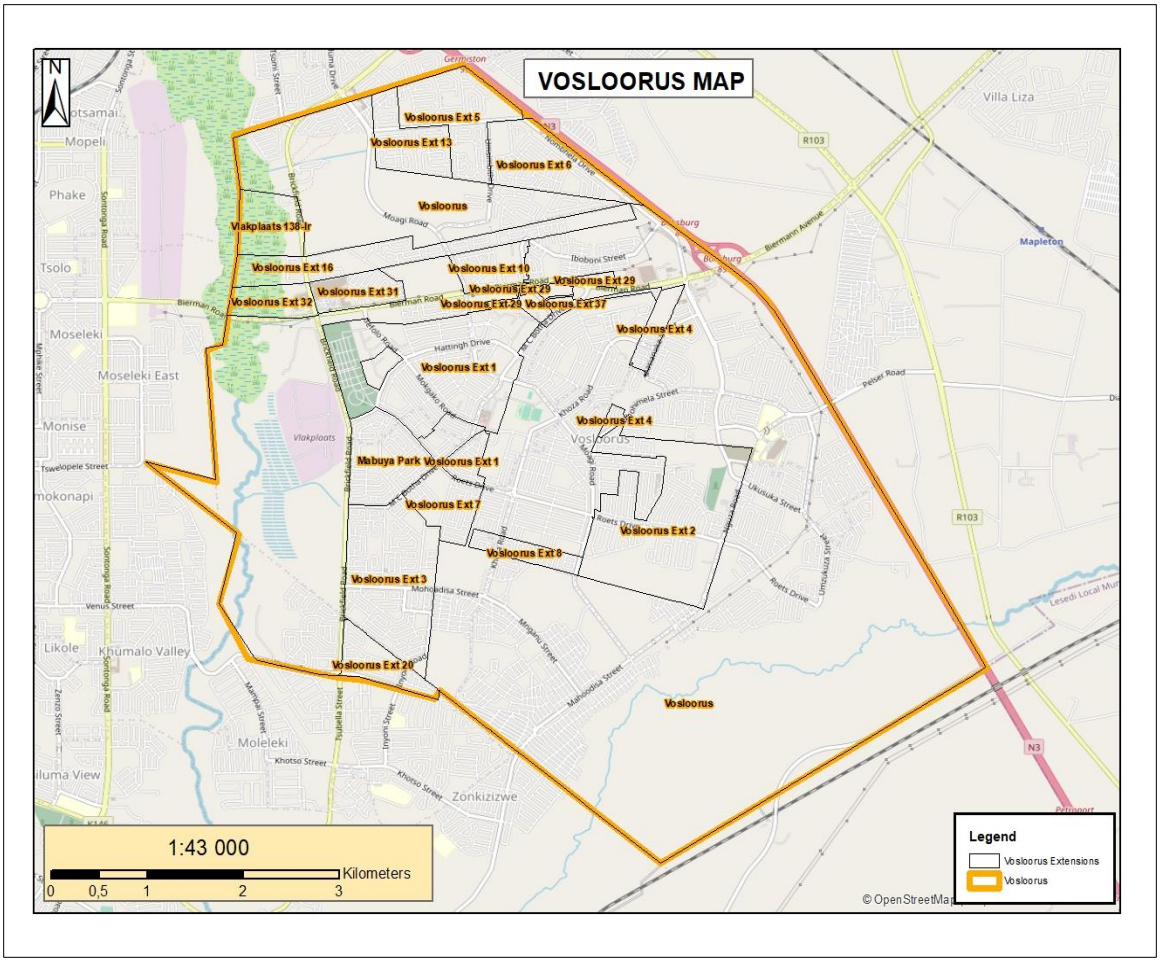

Figure 1.1: Map of Vosloorus Township in the City of Ekurhuleni Metropolitan Municipality

Source : Earth on demand.

1.4 Significance of the study

Disaster early warning systems are regarded as a complex component of disaster risk reduction (UNDP, 2018). The international decade for disaster reduction (IDDR) highlighted early warning systems as critical for disaster risk reduction (UN, 1999). IDDR shifted the world focus to two aspects, namely: disaster prevention and response measures (Lechat, 2007). Moreover, disaster early warning systems become one of the key activities in the implementation of both disaster prevention and response measures (Alcántara-Ayala & Oliver-Smith, 2019).

Noyes and Yarwood (2013) stated that disaster early warning systems are placed at the centre of disaster risk management (DRM) initiatives that are meant to save the lives and properties of vulnerable communities during disaster events by various countries. In addition, Gough and

Gough (2003) reported that for disaster management practitioners to manage the negative impacts of disaster events they had to focus on two aspects, these are to provide the early warning measures, and the measures used to communicate the risk to the affected communities.

The need to implement effective disaster early warning systems in Africa, in particular, dates back to the early nineties (Alcántara-Ayala & Oliver-Smith, 2019). Even before the UN Sendai conference, initiatives to improve on existing early warning systems had already been identified (Alcántara-Ayala & Oliver-Smith, 2019). In addition, disaster events such as the 2001 floods in Mozambique left the continent seeking for better measures to alert communities on imminent disasters (Lumbroso, Ramsbottom & Spaliveiro, 2008).

A study to explore the dissemination of disaster early warning messages was therefore critical, as it would assist in aligning disaster risk reduction measures implemented with the Sendai Framework for DRR (Zia & Wagner, 2015). The above deliberations also highlighted the significance of undertaking a study on the dissemination of disaster early warning messages within the urban poor communities in South Africa. Furthermore, the significance of the study was to provide insight and contribute to the effectiveness of disaster early warning dissemination methods use by the City of Ekurhuleni. Furthermore, this study provided understanding on the flood mitigation measures that the community consider effective.

1.5 Problem statement

Early warning systems have improved in the past years, but there is still a gap between the collection of weather data and the dissemination of disaster alerts to communities in danger (Guru & Santha, 2013). Furthermore, the poor response to disaster alerts may also be attributed to disaster messages that are not understood by the communities (Kunguma & Tereblanche, 2013). The argument is that disaster communication plans should be developed based on municipal policies (Kunguma & Tereblanche, 2013).

Moreover, early warning systems should be developed holistically to form part of a comprehensive people-centered disaster communication flow strategy that includes language and methods used to disseminate early warning systems (Basher, 2006). It is important to accommodate different languages and be medium-specific to the affected communities given the immigration of different people to the cities in search of work. This research investigated the effectiveness of existing disaster early warning dissemination measures within CoE.

1.6 Research questions

The main question for this research was:

What are the existing early warning measures that have been put in place by CoE to disseminate early warning messages to the community of Vosloorus Township?

S*ub-questions:*

- What are type of dissemination measures are used to communicate disaster alerts successfully within the community of Vosloorus?
- What aspects of the existing disaster policies hinder current communication processes to be implemented effectively?
- Are there areas of improvement that CoE can improve on within the early warning dissemination strategies that are used to provide disaster information to the community of Vosloorus?

1.7 Research aims and objectives

The main objective of this study was to critically analyse the strategy used to disseminate early warning messages to the community of Vosloorus township by the CoE.

Sub-objectives – the sub-objectives that were used to facilitate the main objectives have been identified as follows:

- To review strategies that inform the choice of methods used for dissemination of disaster early warning messages by the City of Ekurhuleni;
- To identify methods previously used to disseminate early warning messages within the townships in the City of Ekurhuleni;
- To evaluate issues that hinder early warning messages to be received by the community of Vosloorus;
- To evaluate aspects of existing disaster policies that hinder the communication flow processes; and
- To identify areas of improvement by CoE in the dissemination of early warning messages.

1.8 Research design and methodology

1.8.3 Research design

A case study strategy was utilised in this study to gather information (Abdulai & Owusu-Ansah, 2014). The case study used was bound by time and location (Abdulai & Owusu-Ansah, 2014).

This study dealt with EWS as a phenomenon that includes various processes, providers, and receivers and the methods used to disseminate the identified early warning messages. Furthermore, the data required an in-depth analysis (Yaya, 2014).

Vogt, Gardner & Haeffele (2012) defined research design as a practical plan of how data is generated, and how it assists the researcher in ensuring that the evidence obtained to effectively address the research problem as unambiguously as possible (Vogt et al., 2012). Furthermore, a case study design was adopted for this study as it provided the researcher with an opportunity to go beyond the quantitative statistical results to understand the behavioural conditions through the subject's perspective (Zainal, 2007). This case study included both quantitative and qualitative data, and thus it helped to explain both the process and outcome of EWS as a phenomenon through complete reconstruction, and analysis of the case under investigation (Zainal, 2007).

1.8.1 Method

This study was based on mixed research methods (qualitative and quantitative), as this study required an understanding of both social aspect and statistics (Mohajan, 2018). Furthermore, the purpose of this study was to accumulate more knowledge on the dissemination of early warnings as a phenomenon to the community of Vosloorus. This enabled the researcher to understand the variables of early warning from a social perspective (Astalin, 2013). In addition, the qualitative research method also known as the interpretation method, was considered suitable for this study (Leedy & Ormrod, 2016). Also, the qualitative research design was suitable for this research study because of its flexibility during the implementation process. Moreover, the qualitative research method enabled the process of data collection not just to be a collection of statistics (Leedy & Ormrod, 2001), but also to be a process where data is critically analysed to reach the intended conclusion. Furthermore, the quantitative method enabled the researcher to draw correlation among variables using statistical package for social sciences (SPSS) as a tool for analysis (Ong, and Puteh 2017). Moreover, quantitative method was used as this method provided findings from the sample that could be generalized to the broader population (Rahman, 2020).

1.8.2 Population sampling

Due to time and financial constraints, it was not possible to collect data from all the residents in Vosloorus Township. Therefore, sampling was used to collect data for this research. Sampling refers to the process of identifying a group of people that will participate in the collection of data (Terrell, 2016). For this study, purposive sampling was the preferred choice of sampling method (Terrell, 2016). This type of sampling was suitable for this study as it accorded the researcher the opportunity to select a small group of participants (Terrell, 2016), ten community members from Vosloorus township were then provided with a questionnaire as a measure to sample the data collection tool. In addition, the sample was selected from the informal settlements within Vosloorus Township. The sample number comprised of 1% of the total study participants within the two informal settlements where data was collected.

The advantage of using purposive sampling was that it ensured strategic choices about who or how the data was collected (Palys, 2007).

1.8.4 Data collection

Questionnaires were used as a tool to collect data for this study (Yaya, 2014). Questionnaires allowed for the provision of individual opinions from the respondents (Yaya, 2014). The data was collected from both primary and secondary data sources (Kivunja, 2016). In addition, secondary data was gathered through desktop studies, by reviewing literature related to the objectives of this study (Kivunja, 2016).

1.8.5 Data analysis

Statistical Package for Social Sciences (SPSS) was used to analyse data for this study, and all tables and figures were produced using this program. This study used coding as a measure to capture data on excel before migrating it to SPSS (Kivunja, 2016). Coding was used to classify the different themes, variables, and the relationship between all these aspects (Kivunja, 2016). The collected data was converted into frequencies and correlations among certain variables were calculated using SPSS (Jahan et al., 2021).

The use of themes for this study assisted in the interpretation of feedback from the respondents. Furthermore, themes assisted the researcher to capture both positive and negative inputs of the collected data (Jones & Hidiroglou, 2013).

1.8.6 Data validity and reliability

Validity is considered as process to ensure that the concept of the study is measured effectively (Heale & Twycross, 2015). Furthermore, reliability relates to measures put in place to ensure consistency in feedback from all administered questionnaires. This research ensured that the measurement process used to collected data yielded consistent feedback across all the participants (Taherdoost, 2016).

This study also ensured that the findings were based on the trustworthiness of the information provided by the participants (Noble and Smith, 2015). To ensure rigor, this study incorporated the following aspects (Noble and Smith, 2015):

- In ensuring validity, the research findings were based on collating the exact feedback the participants provided through the questionnaires and interviews.
- To ensure reliability, this study acknowledged different participants opinions within the findings.
- To ensure data validity and reliability, the questionnaire was designed to answer the study research questions.

1.9 Ethical considerations

This study was conducted during a pandemic, COVID -19 that resulted in a lot of devastation within the community of South Africa and the world. In engaging with participants for this study, it was critical to ensure that the safety of all those who participated in the study was prioritised. Furthermore, the collection of data from participants was done without putting any of the participants in danger. Due to COVID -19 regulations (Regulations and guidelines, 2020), the following safety measures were observed when engaging with the participants:

- Everyone involved during data collection for this study was asked to wear masks at all times;
- Participants were engaged in their homes to avoid gathering of crowds ;
- Social distancing of one and half meters was adhered to, when administering the questionnaires; and
- The researcher and research assistants used hand sanitiser during data collection with participants to curb infections.

The following research ethical issues were adhered to as well (Orb et al., 2000):

- Consent forms were given to the participants to complete and sign once the purpose of the research was explained (Miller et al., 2012):
- Literature by other professionals was reviewed with the necessary respect accorded for intellectual property (Orb et al., 2000):
- Details of all participants was handled with confidentiality;
- Publication was done in a responsible manner (Orb et al., 2000): and
- This study sought human ethics clearance from the University of the Free State and adhered to the University's ethics principles at all times.

1.10 Study limitations and delimitations

Since this was the first study for the researcher, it would have been naïve for the researcher to think that once the research method was selected, the implementation would continue without any challenges, limitations for this study may be summarised as follows:

- Choosing a sample size was a challenge, as it might be argued that for studies that include qualitative research method, if the sample size is not properly selected, it might not provide a true reflection of the views of the whole community. Moreover, given the vast community, it was important and necessary to select a sample size that was representative of the community within the study area (Leedy & Ormrod, 2001).

Furthermore, this study was supposed to cover more townships within CoE as it is believed that the challenges faced by the communities within the townships because of the impacts of disaster events were widespread (COGTA, 2009). However, due to financial and other capacity issues, this study was limited to Vosloorus Township in the CoE.

1.10.1 Delimitations

Sampling is regarded as a limitation in social science studies (Lopez and Whitehead, 2013). Therefore, this study used purposive sampling that ensured that the feedback from questionnaires was consistent across all the participants. Also, the sampling was done with focus of those mostly affected by the impacts of floods within the study area.

This study acknowledged that if the study was conducted in all the townships of CoE, the findings might be different from findings relating to Vosloorus Township only.

To address the above issues, the findings for this research could be generalised to:

- All communities that reside within the townships in CoE; and
- Predominantly black communities within CoE that live below the poverty line.

1.11 Research outline

The outline of this research was as follows:

Chapter 1 – This chapter provided a brief background on how disaster events affect urban poor communities within the world and in South Africa. Furthermore, this chapter outlined how EWS has been implemented in the world, the shortfall, and gaps. In addition, the importance of the implementation of effective dissemination of disaster early warning messages in South Africa was highlighted in this chapter as well.

Chapter 2 – This chapter explored how disaster early warning systems can be incorporated into the disaster risk management framework as a measure to mitigate the impacts of floods. It also analysed the policy framework that guides the implementation of effective EWS in the world and in South Africa. In addition, Chapter 2 also highlighted how EWS should be aligned to international standards as prescribed by the UN. The chapter also highlighted the importance of implementing people centered EWS within the urban poor communities.

Chapter 3 –In this chapter, perspectives on the dissemination of early warning messages by other scholars was outlined.

Chapter 4 – This chapter outlined why the mixed method approach was chosen as the preferred method for this study. Chapter 4 also explained the reasons for the selection of questionnaires and case study as data collection measures.

Chapter 5 –This chapter provided the analysis of the data collected; this analysis was done through SPSS.

Chapter 6 – Research findings were tabled in this chapter. The findings included recommendations and challenges experienced during the implementation process.

1.12 Summary

The devastating disaster incidents can be mitigated through the implementation of effective disaster early warning systems (UNDP, 2018). This study did not seek to invent a new aspect of early warning systems, but the study investigated the effectiveness of the current disaster early warning dissemination measures used to communicate disaster alerts to the communities within the Townships in CoE.

CHAPTER 2: LEGISLATIVE AND THEORETICAL FRAMEWORK

2.1 Introduction

In the past few years' disaster incidents have increased in magnitude and frequency (Aronsson-Storrier & da Costa, 2017). Similarly, for better management of the impacts, disaster management should be regulated to ensure that DRR and DRM measures are guided and effective (Aronsson-Storrier & da Costa, K, 2017). The increase in fatalities caused by disaster events has led countries like Japan and the Netherlands to review disaster risk reduction and management laws (Vink & Takeuchi, 2013). Aronsson-Storrier & da Costa (2017) argue that the international disaster law (IDL) should be linked to international human rights.

Disaster risk management (DRM) and disaster risk reduction (DRR) are amongst the theoretical frameworks that the United Nations (UN) introduced to address the impacts of disasters in a systematic manner (Eltinay & Charles, 2017). For several years, research has focused on how to mitigate flood impacts, for this study, DRM is preferred as a holistic measure to deal with floods (Kellens, Terpstra & De Maeyer, 2013). DRM is the preferred theoretical framework for this study as it addresses information relating to the frequency and magnitude of disasters (Eidsvig et al., 2014). This study focuses on the understanding of the dissemination of early warning messages to the community of Vosloorus, to understand further how the community prepares themselves once disaster early warning messages are received. Furthermore, vulnerable communities across the world have been seeking measures to protect themselves from disasters for years (Cannon, 2014). A solid legislative framework should support the implementation of DRM measures (Scolobig et al., 2015). In Asia for example, the implementation of DRM measures is entrenched in the millennium development goals and the Hyogo framework for action (Davis, 2014).

2.2 Legislative framework

2.2.1 International legislation

The measures put in place to deal with the increase in fatal disaster incidents should be preceded by disaster management policies that are aligned to International Disaster Law (IDL) (Mashi, Oghenejabor & Inkani, 2019). Bilateral agreements to implement DRR measures entered by different countries should be informed by international disaster response law, among others (De Guttry et al., 2012). In addition, De Guttry et al. (2012) contend that it is important to align international treaties within countries with the IDL so that there are no discrepancies in terminology and policies. In Nepal, for example, the institutional and legislative approach that the country is currently implementing is developed in line with the IDL (Nepal et al., 2018). DRM

legislation should outline disaster management institutional and governance policies. Moreover, in the past few years, there has been a shift in international disaster law from being an instrument for response measures to being used for designing of relief policies (Aronsson-Storrier & da Costa, K, 2017). China, for example, implemented a DRM method that is community-based; improved disaster policy and laws guide this DRM method (Aronsson-Storrier & da Costa, K, 2017).

In countries that have a high incidence of disasters, effective DRM implementation should be done through the development of a response regulatory framework (Picard, 2017). DRM laws assist the affected countries to better prepare for disaster incidents that are beyond the country's capability (Picard, 2017). For example, countries like Japan and USA have developed DRM laws that are customised for vulnerable communities (Vink & Takeuchi, 2013). Furthermore, after the 2011 Queensland floods, disaster policies and laws that promote resilience were developed (Aldunce et al., 2015), local municipalities should learn from areas such as Queensland..

IDL has been reviewed to enable the international community to focus on aligning this law to all DRR and DRM measures (Breau & Samuel, 2016). A philosophical worldview aligns IDL to constructivism since IDL supports the protection of people in the event of disaster policies (Breau & Samuel, 2016). Sommario and Venier (2018) argue that if disasters are not predicted, these disasters will catch the communities unaware and the impacts will be far more devastating, hence this study is focussed on the effectiveness of EWS in CoE and the policy framework that guides the EWS. Therefore this study is aligned to constructivism phiplosophical worldview. Alcántara-Ayala & Oliver-Smith (2019) argue that the acknowledgment that EWS are critical for DRM will facilitate the development of social and institutional policy frameworks. In addition, African countries are among the countries that are hard hit by the impacts of natural disasters even though disaster management frameworks have been developed in most of these countries (Bang et al., 2019). In Cameroon, for example, there are several challenges relating to DRM measures despite the implementation of the international disaster management framework (Bang et al., 2019). This may be because of misalignment between DRM policies and IDL.

The evolution and increase of disasters and disaster management as a knowledge area, makes it imperative for disaster managers to follow and apply recent international and local legislation, concepts and related frameworks. Mainstreaming DRR and climate change adaptation is very important in managing disasters. This chapter starts first by putting sustainable development goals into perspective relative to this study as an international framework. The chapter also explores the international frameworks based on the conferences that these frameworks (the

Hyogo and the Sendai frameworks) emanated from. Early Warning Systems in South Africa are linked to local legislations and frameworks that govern early warning systems in the country.

2.2.2 Sustainable development goals

Sustainable development goals (SDGs) also known as the Global Goals, as a successor for Millennium Development Goals (MDGs) were established in March 2015 as a policy framework to guide development and to end all forms of poverty, especially in vulnerable communities (Hák, Janouskova & Moldan, 2016). Furthermore, the SDGs targets to fight inequalities and tackle climate change, while ensuring that no one is left behind by 2030 (Pradhan et al., 2017. The most prominent climate-related hazard in recent years in South Africa has been floods caused by cyclones from neighbouring countries.

The goals represent a framework that is scientifically robust and widely intuitive intended to build upon the progress established by Millennium Development Goals (MDGs). Furthermore, the goals provide a well-consulted framework that is sufficiently scientifically robust in dealing with disaster impacts, politically acceptable, and publicly intuitive (Morton, Pencheon & Squires, 2017).

Although all the goals are relevant in DRR, goals under people and goal 13 under planet resonates most with this study in that ineffective early warning message dissemination can lead to people experiencing disasters like floods that will flood their houses and shift them more to poverty. Also, floods bring about waterborne diseases against (Goal 3-Health), floods destroy school buildings especially in poor countries where building codes are not used, affecting the quality of education when students are learning under trees during rebuilding processes against (Goal 1-No Poverty). Indeed, floods like any other disaster leave vulnerable groups outside, for instance, women and children who might not be able to swim (Goal 5-Gender Equality). Severe floods destroy water and sanitation infrastructures and water is contaminated in the process against (Goal 6- Water and Sanitation).

Goal 13 (Climate Action) aims to promote urgent action to combat climate change and its impacts. The goal resonates with our study; early warning message dissemination requires urgent action to reduce meteorological disasters. Climate action goal refers to the development of policies and frameworks that address DRM issues in a manner that builds resilience (Thomalla et al., 2018). Furthermore, SDGs represent a shift from the idea of managing disasters as was initially outlined by the Millennium Development Goals to managing risk (Etinay et al., 2018).

Disaster risk communication has been identified as a link between SDGs and promoting change action that will support sustainable use of the environment (Volenzo & Odiyo, 2019). Moreover,

the environment is degrading due to the impacts of disaster events such as floods (McBean, 2012). It is important to ensure that disaster risk communication and EWS are linked to sustainable development as a measure for DRR (McBean, 2012). In addition, challenges that impede the effective implementation of SDGs agenda are linked to a lack of relevant policy relating to DRM (Collins, 2013). For example, the establishment of policies that guide remotely sensed earth observation (EO) for agriculture has been identified as one of the indicators of streamlining SDGs with early warning measures (Whitcraft et al., 2019). Furthermore, Whitcraft et al. (2019) argue that EO provides disaster early warning information that goes beyond statistics and data collection.

Implementation of sustainable development that is in line with SDGs relies on the availability of capacity in each country (Aitsi-Selmi, Blanchard & Murray, 2016). The 13th goal states that resilience and capacity-building capability of affected communities is based on availability and access to critical information (Haigh et al., 2018). Alcántara-Ayala & Oliver-Smith (2017) argue that EWS are a critical component of capacity building process. Scientific and technological information, which is a huge component of EWS, should be linked to goal 11 of building sustainable cities and communities (Alcántara-Ayala & Oliver-Smith, 2017). Etinay et al. (2018) support this statement, building infrastructure after damages caused by disaster events should be preceded by identification of gaps and prediction of future disasters, this will be in line with goal 11 as well. In Asia, for example, damages caused by the 2019 floods were not just infrastructure, but hundreds of people lost their lives as well (Parajuli, 2020); such flood events can be dealt with through the implementation of goal 11, building sustainable cities and communities, among others.

2.2.3 Early warning systems conferences

The international decade of natural disaster reduction (IDNDR) report emphasized the importance of using alternative measures that will integrate scientific knowledge of early warning systems (EWS) with the involvement of the people that are affected by the impacts of disaster events (UNIDNDR, 1989). Furthermore, the involvement of the local communities in the DRM measures later formed the basis of discussions in the UN Yokohama conference; the Yokohama conference was based on the theme of building a safer world for all (De la Poterie & Baudoin, 2015).

In addition to the IDNDR, the Yokohama strategy and plan for safer world conference took place in 1994 (UNDRR, 1994). The purpose of this conference was to discuss disaster risk reduction (DRR) strategies that would promote a safer world (UNDRR, 1994). Moreover, this conference

was able to review the success of EWS and provide guidance on future improvements as it took place halfway through the IDNDR. Furthermore, the conference agreed on ten principles that were to be implemented by participating countries as mechanisms to manage risks (UNDRR. 1994). In addition, these DRM systems had to be implemented for the remainder of the decade and beyond (UNDRR, 1994).

Furthermore, the Yokohama conference was the first conference to analyse the role played by EWS in managing disaster risks; that is the integration of knowledge and innovation to deal with disaster risks (Aitsi-Selmi et al., 2015).

Moreover, the Hyogo framework of action was developed at a conference in Kobe, Japan, which continued with the agenda of reducing disaster risks and promoting strategies that would save lives and properties from the impacts of extreme disaster events (UNISDR, 2005). The conference identified two fundamental aspects of managing disaster risks (UNISDR, 2005) that include a need to build resilience within vulnerable communities as a mechanism to implement a holistic DRM measure. The conference analysed the role of EWS and the importance of focusing disaster risk reduction (DRR) initiatives on vulnerable communities (Maskrey, 2011). Moreover, the Yokohama conference highlighted that increasing coping capabilities play a pivotal role in the implementation of effective EWS (Djalante et al., 2012). Later the Hyogo framework of action was developed in a conference that took place in Kobe, Japan. The conference in Kobe continued with the agenda of reducing disaster risks and promoting strategies that would save lives and properties as deliberated on, in the Yokohama conference (UNISDR, 2005). Most recently, the predecessor of the Hyogo framework, the Sendai framework for disaster risk reduction ensured that the agenda for implementing disaster risk reduction measures continues (Saja, Sahid & Suthaeshanan, 2020). This framework emphasized the importance of establishing holistic DRM strategies (UNISDR, 2015), by identifying the following key priorities for action:

- Priority 1 – Understanding disaster risk.
- Priority 2 – Strengthening disaster risk governance to manage disaster risk.
- Priority 3 – Investing in disaster risk reduction for resilience.
- Priority 4 – Enhancing disaster preparedness for effective response and to “Build Back Better” in recovery, rehabilitation and reconstruction.

Amongst the aforementioned priorities, priority 2 and 3 are the most relevant to this study. Priority 2 on strengthening disaster risk governance and management, highlights the implementation of DRM policies that take into consideration the financial and physical resources that ensure the effective implementation of DRM strategies. The implementation of these policies in disaster

management should include policies that are relevant and guide EWS policies such as social media policies used for both communities and disaster management practitioners (Lovari & Bowen, 2020) and disaster risk and communication policies (Abunyewah et al., 2018). Communication is important for EWS to work effectively and efficiently (Garcia & Fearnley, 2012).

Priority 3 focuses on investing in DRM measures to build resilience within the communities. By virtue of their nature to reduce risks, EWS are regarded as an effective DRR measure that is mostly structural. However, non-structural EWS such as short message service (SMS) alerts also exist in this age of technology as we move to the 4th Industrial Revolution era (4IR). Scholars worldwide have reported EWS as effective DRR measures; for example, Lassa et al. (2019) advocate for investments in effective EWS as a DRR measure, and Baudoin et al. (2016) highlights the importance of linking effective disaster communication to sustainability and effectiveness of DRR activities. Whereas, Balay-As, Marlowe & Gaillard (2018) argue that there should be a link between indigenous knowledge and EWS as a measure for DRR.

Both developed and developing countries have shared success stories of how EWS have been used in DRR measures (Cools et al., 2016). Ward et al. (2017) argues that floods result in millions of damages each year, hence individual countries should invest in effective EWS. Furthermore, India invested in cellphones to communicate cyclone early warning alerts within the community of Andhra Pradesh (Shamano, 2010). In Southern Africa, a project to reduce the impacts of disaster risks through EWS was implemented (Jubach & Tokar, 2016). Effective communication measures to provide communities at risk within the Southern Africa region with flash floods early warning alerts was implemented (Jubach & Tokar, 2016).

The overall aim of the Sendai framework, with regards to the EWS, is to encourage participating countries to establish a multi hazard early warning system (MHEWS) that will be able to monitor all types of disasters effectively (Zia & Wagner, 2015). The Sendai framework promotes risk reduction measures that consider the community's vulnerabilities in the design of DRR strategies (Zia & Wagner, 2015).

As the DRR and DRM conferences were taking place, the UN established a parallel process that would focus on the improvement of early warning systems. This resulted in three global early warning conferences being held, including the global early warning conferences held during the international decade of natural disaster reduction period. Resolutions taken at the global early warning conferences resulted in the development of early warning systems that involved the affected communities (Marchezini et al., 2018).

The first global early warning conference was held in Potsdam (Germany) in 1998, the purpose of this conference was to assess the good practice issues identified in the existing early warning systems, but some shortfalls were identified from the existing early warning systems as well, these shortfalls related to disaster alerts notification and effective communication flow to the affected communities (UNISDR, 2005).

The second global early warning conference was held in 2003 in Bonn (Germany), the purpose of this conference was to integrate early warning systems into the existing disaster risk management policies (UNISDR,2005). Furthermore, the second early warning conference focused on using disaster policies in the establishment of effective early warning dissemination measures (UNISDR, 2005).

The third global early warning conference took place in 2006, this conference focused on the assessment of early warning systems that was used during the Indian Ocean tsunami (UNISDR, 2005). This conference identified the need to develop EWS that are linked to disaster response and preventative measures (UNISDR, 2005). In addition, every conference that took place tried to improve on the previous one by identifying the gaps. Global early warning conferences provided guidelines that should be customised for individual participating countries since the underlying socio-economic issues of each country are different.

The establishment of multi-hazard and people centred EWS were advocated for by all the global early warning conferences (UNDP, 2018). The third conference resulted in the establishment of early warning systems checklist (UNISDR, 2006). In addition, it was agreed at the third global early warning conference (UNISDR, 2006), that the establishment of disaster EWS should be based on the following aspects.

2.2.3.1 Risk knowledge

EWS as an important part of all prevention and response measures should provide accurate weather and climate data (Singh et al., 2018). Furthermore, UNISDR (2006) states that EWS should be able to provide accurate and consistent data that is embedded on the following:

- Organisational arrangements that are established among all spheres and sectors of government;
- Knowledge of imminent disasters that is based on scientific disaster risk assessments; and
- The risk assessment should outline current and future disasters.

Risk knowledge collected should display the community vulnerabilities. The identified vulnerabilities should be taken into consideration when early warning systems are developed; and the collected risk knowledge should be kept in a safe and secure system (UNISDR, 2006).

2.2.3.2 Monitoring and warning

Institutional arrangements between the organs of state that are responsible for monitoring and collecting early warning data should be in place (UNISDR, 2006). The institutions that are tasked with the responsibility of monitoring weather and climate data should have programs to interpret the collected weather data in place. Furthermore, the interpretation of the collected weather data should be based on effective communication systems. In Northeast Louisiana, for example, teachers and students have been trained and provided with technology that assists in interpreting disaster early warning messages communicated to the community (Clark et al., 2015).

2.2.3.3 Dissemination and communication

The dissemination of early warning messages should be based on a systematic process of communication (Oktari et al., 2014). Furthermore, communication systems that have been established to disseminate early warning messages should involve affected communities. According to the UN checklist on early warning, the disseminated early warning messages need to trigger disaster response measures from the affected communities. In Bangladesh, for example, a flood forecasting method has been developed to assist farmers in the affected areas to respond appropriately and protect themselves and their assets (Fakhruddin & Chivakidakarn, 2015).

2.2.3.4 Response capability

There should be a link between the EWS and the required response as per disaster (Sutton et al., 2020). Furthermore, information gaps should be addressed through disaster awareness and community capacity-building programmes. For example, in the villages across the Karnali river's vast floodplain areas (in Nepal), hand-operated sirens have been introduced to notify communities of pending floods (Gladfelter, 2018), this assists in bridging the gaps in communication of early warning alerts.

2.3 Early warning systems and disaster risk management framework

This study acknowledges DRM as the preferred theoretical framework, with a particular focus on people-centred EWS and DRM measures for floods. A people-centred DRM framework should incorporate sharing of disaster warning information to be considered effective (Ranke, 2016). Furthermore, an effective people-centred DRM should be based on risk assessment, risk management and risk communication (Ranke, 2016). Tiwari (2015) argues that a people centred DRM should be developed with lessons learnt from previous disaster incidents in mind. This will assist each government to allocate the necessary resources for programmes that reduce disaster risks (Tiwari. 2015). For example, the 2010 earthquake in Haiti could have had fewer fatalities if the government in this country allocated resources to enhance DRM and early warning strategies as per lessons learnt from previous disaster incidents (Tiwari, 2015).

South African Development Community (SADC) reported an increase in the frequency of natural disaster incidents in Africa (Brown et al., 2012). The reasons for this increase in natural disaster events is attributed to the challenges relating to lack of provision of resources to DRM strategies (Brown et al., 2012). Furthermore, some of the challenges relate to incapacitation of effective DRM strategies in SADC, lack of funding to support institutional plans that are meant to support disaster risk reduction measures; and lack of effective disaster collection and dissemination of information systems (Brown et al., 2012).

Thi, Nguyen, Shaw & Tran (2015) highlighted the concept of Community based Disaster Risk Management (CBDRM) to complement risk management and communication in DRM. The CBDRM has been practiced since the mid-1990s (Thi et al., 2015) and is designed around people as a way of involving the affected communities in activities that are meant to reduce risks (Nguyen et al., 2011). Moreover, involving communities at risk in DRM is considered critical in promoting bottom-up information sharing (Nguyen et al., 2011). CBDRM includes sharing information relating to disaster early warning alerts as well. To demonstrate this, the city of Dagupan in the Philippines, trained the community members on evacuation measures, once disaster early warning messages were received (Nguyen et al., 2011).

The South African Local Government Association (SALGA), to deal with issues that relate to DRM and EWS, commissioned research to assess the state of DRM within municipalities in South Africa (Ranke, 2016). This study highlighted challenges relating to lack of financial resources, political buy-in and personnel that hindered the implementation of a consolidated DRM. Furthermore, the challenges relating to lack of implementation of effective DRM strategies are associated with poor sharing of disaster early warning information within municipalities (Ranke,

2016). In addition, municipalities in South Africa do not implement DRM strategies that include a clear process of risk communication (Ranke, 2016).

The development of effective EWS as part of DRM is regarded as one of the critical aspects for the implementation of all DRM strategies (Khankeh et al., 2019). Chang Seng (2012) argues that effective EWS are critical as they assist in protecting economic assets from the impacts of natural disasters and promote sustainable development as well. Furthermore, in the midst of the evolving EWS, Chang Seng (2012) reported that traditional EWS comprised of three phases depicted below:

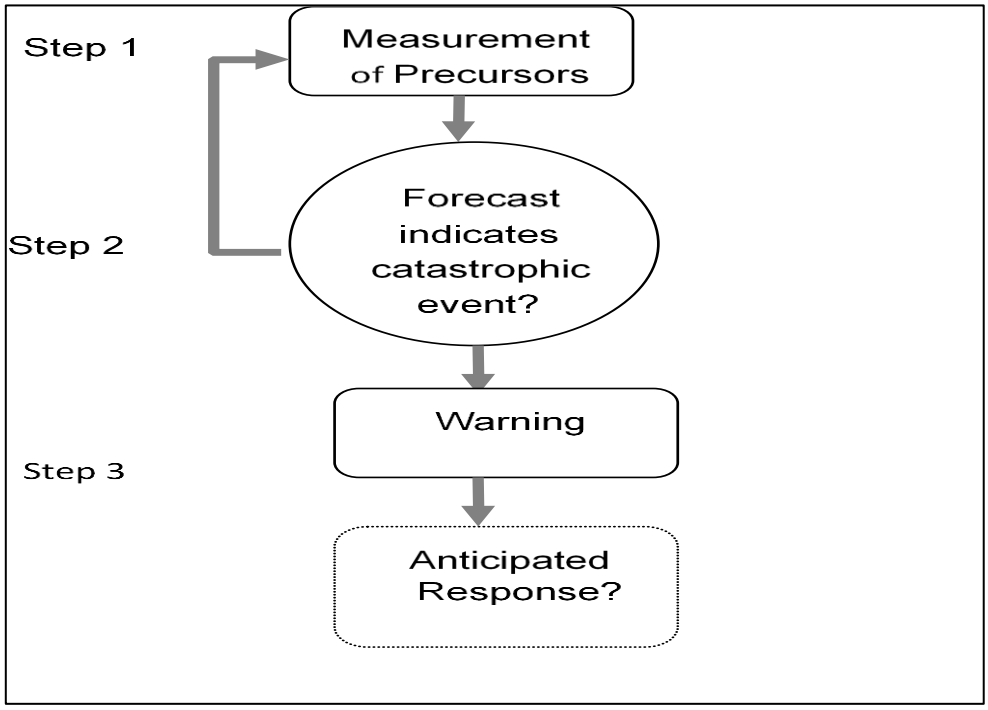

Figure 2.1: Traditional three-phase early warning system

Source: (Chang Seng ,2012)

The UNDP (2018) reported that EWS due to their complex nature, if not properly implemented may result in inefficiency of dissemination of disaster risk alerts. Moreover, Khankeh et al. (2019) contend that all disaster EWS developed in earlier years had problems that made them not to be integrated fully into the DRM framework. In addition, Garcia & Fearnley (2012) added that failure in the link of any of the components of the disaster EWS will fail in the entire functioning of that EWS. Furthermore, UNDP (2018) identified challenges that are linked to ineffective implementation of disaster EWS as follows:

- Legal and institutional arrangements that are not developed;

- Lack of development of integrated technology and forecasting systems in developing countries;
- Lack of sharing of human professional resources and expertise ; and
- Lack of involvement of public engagement, empowerment and community.

Early warning data according to the UNDP (2018) should be used for response co-ordination and disaster preparedness. However, if this data is not accurate, response and preparedness plans cannot be implemented (UNDP, 2018). Moreover, for EWS to be effective and factor in all anticipated challenges, the community should be involved (Macherera & Chimbari, 2016). This study is based on the concept of implementation of effective dissemination of disaster early warning messages as a component of a holistic DRM framework.

2.3.1 People-centered early warning systems

The role of the community within the EWS has been debated upon through the various UN conferences (UNISDR, 2005). People-centred EWS that involves the participation of the local affected communities is recommended as effective by UNISDR (Marchezini et al., 2017). Furthermore, the participation of the community in EWS will assist disaster management practitioners to deal with the impacts of extreme disaster events in line with the CBDRM model (Machera & Chimbari, 2016). Similarly, the involvement of the community in the collection and dissemination of early warning data will encourage communities to implement response measures that enhance the service provided by the first responders (Tarchiani et al., 2020),

People-centred EWS has been implemented successfully in various countries, for example, Nepal (Kafle, 2017). Two fundamental aspects that enabled Nepal to implement a successful people-centred EWS are reported to be legal and policy instruments, which enabled the different sectors of government to implement DRM strategies in an integrated manner (Kafle, 2017). China also implemented a people-centred EWS as they are considered to be less costly and effective in their country (Zhang et al., 2020).

Effective people-centred EWS involves risk knowledge, monitoring, and warning, dissemination, communication, and response capabilities (Garcia & Fearnley, 2012). In addition, people-centred disaster EWS provides an opportunity for the government to reduce the impacts of natural disasters (Baudoin et al., 2016). Various mechanisms can be used to involve affected communities in people-centred EWS (Baudoin et al., 2016). Even though the UNISDR supports the involvement of affected communities in EWS, the UN does not clearly outline how

communities should be involved in disaster early warning processes (Marchezini, 2020). Zia & Wagner (2015) argue that both Hyogo and Sendai frameworks omitted to state critical information on how to implement people-centered EWS effectively (Zia & Wagner, 2015) leaving member states to implement as they see fit. In Pakistan for example, the implementation of people-centred EWS is not gender-sensitive (Mustafa et al., 2015). People-centred EWS are commended for creating resilience within the affected communities despite the lack of clear implementation guidelines from the UN (Ewbank et al., 2019). In Nicaragua, vulnerable communities that were involved in the people based early warning processes were reported to have increased resilience towards drought (Ewbank et al., 2019).

Involving the communities in EWS for recurring disasters like floods assists to build resilience within the affected communities and increase response measures (Tarchiani et al., 2020). Wisner et al. (2012) state that involving communities in effective disaster EWS should be based on success stories from other countries. For example, in Thailand, the resilience of the communities along the coastline was established through the involvement of the people within the EWS implementation processes (Wisner et al., 2012). However, some challenges are linked to people centred EWS (Marchezini, 2020). Moreover, the role of effective technology for the dissemination of disaster alerts in people centred EWS is still a challenge as well (Mow et al., 2017).

There are different preferential mediums of dissemination of early warning messages (Velasquez et al., 2015). In Samoa, for example, affected communities prefer the dissemination of early warning messages through radio and television (Mow et al., 2017). However, other countries have adopted the SMS early warning messaging approach, even in South Africa. Effective people-centred disaster early warning should ensure that different measures are used to disseminate messages to trigger response measures (Marchezini et al., 2018). Bee et al. (2019) argue that people-centred EWS should be based on the dissemination of communication messages that can be understood by affected communities. Furthermore, some government sectors have factored in the use of social media into DRM policies (Bee et al., 2019). Social media is considered the preferred medium of disseminating disaster alerts to communities because it provides real-time, critical disaster data that may have been omitted (Bee et al., 2019).

2.4 Early warning systems in South Africa

In South Africa (SA), the National Disaster Management Centre (NDMC) has put in place measures to notify all organs of state about early warning disaster information (COGTA, 2018). In compliance with the national disaster management framework (NDMF), the NDMC developed a system of monitoring, collecting and disseminating early warning messages (COGTA, 2018).

Furthermore, NDMC operational plan for early warning outlined weather intelligence and disaster information management as critical (COGTA, 2018). The purpose of the NDMC plan is to generate a tool to be used as a guide by all spheres of government when drafting and implementing EWS for respective areas (COGTA, 2018).

In addition, South African Weather Services (SAWS) is also responsible for monitoring and disseminating weather and climate data (Act 48 of 2001 as amended). Legislation that is relevant to EWS in South Africa includes the white paper on disaster management, the Disaster Management Act (DMA) and the National Disaster Management Framework (NDMF) among others.

2.4.1 National legislation framework on early warning systems

2.4.1.1 The white paper on disaster management

The white paper on disaster management identified two key principles that the disaster management regulation in the country should be based on (Zuma et al., 2012). However, of relevance to this study is the development and the establishment of stronger mechanisms that enhance the collection and dissemination of disaster information to the communities at risk on time (SA. 1999). Furthermore, based on the deliberations on the white paper on disaster management, the importance of effective EWS has always been a priority in SA (SA. 1999).

2.4.1.2 South African disaster management act

Since the promulgation of the Disaster Management Act, South Africa is considered as one of the leading countries in DRM measures (Van Niekerk, 2014). The challenge with this lies in the implementation of the Act by municipality officials at local level (Van Niekerk, 2014). Furthermore, this Act provides a guide on the involvement of the community in disaster response activities. This means that the involvement of the community in disaster capacity building and early warning measures should be viewed as compliance to the act (Act 57 of 2002 as amended). Furthermore, the Act also highlights the importance of the establishment of the NDMC as the national entity that will establish disaster information management systems in the country. The Act further states that disaster information systems should consider the underlying factors that exacerbate the impacts of disaster events within vulnerable communities in the country. Moreover, the Act outlines the process of managing disaster early warning data. Collection of weather and climate

data is based on disaster management policies of the country and establishment of dissemination of disaster early warning data that reach affected communities.

2.4.1.3 South African national disaster management framework

The NDMF was published in 2005 from the Disaster Management Act (Act 57 of 2002 as amended). This framework identified four key performance areas (KPAs) and three enablers that are regarded as the basis of all DRM and reduction measures **(**NDMF, 2005). The NDMF KPAs are outlined as follows:

- KPA 1 – Integrated institutional capacity for disaster risk management
  The purpose of this KPA is to ensure that all institutional arrangements that promote effective disaster risk management policies are established at all spheres of government.
- KPA 2 – Disaster risk assessment
  This KPA must be implemented with the guidelines on disaster risk and vulnerability assessment process.
- KPA 3 – Disaster risk reduction (DRR)
  Disaster risk reduction measures should be linked with the community's coping capabilities.
- KPA 4 – Response and recovery
  It is within this KPA that the dissemination of early warning messages is highlighted. According to the NDMF, the dissemination of early warning messages should reach both the first responders and the affected communities in a manner that is easily understood to trigger response measures.

The NDMF identifies the NDMC as the custodians of weather and climate information (NDMF, 2005). According to the NDMF, the NDMC should put in place strategies and processes that will ensure that climate and weather data is accurate and reaches the affected communities. This highlights KPA 3 as it provides for DRR. EWS are one of the many mechanisms used for DRR, making KPA 3 important this study (Jibiki et al., 2016, Nahayo et al., 2017 and Mukhtar, 2018). For example, most governments have improved their DRR measures by improving the collection and dissemination of disaster related information (Kitazawa & Hale, 2021). Furthermore, the financial benefits of improving EWS as a measure for DRR have been highlighted by countries like Samoa (Fakhruddin & Schick, 2019). In addition, EWS have evolved from being a scientific collection of weather data to being a critical aspect of DRR processes (Cowan et al., 2014).

2.4.1.4 South Africa weather services act

The South Africa Weather Services (SAWS) act (Act 8 of 2001 as amended), outlines the services that have to be provided by the SAWS and their partners in schedule 1.This act states that the weather and climate data collected should include surrounding areas (Act 8 of 2001 as amended). It will assist in developing regional consolidated disaster risk management strategies that ensure that resilience is built within the SADC region; and provides disaster alerts that inform the steps that have to be taken to save lives from imminent disaster events.

2.4.1.5 Spatial data infrastructure act

The Spatial Data Infrastructure Act (Act 54 of 2003) was developed to govern entities that are regarded as the custodians of weather and climate information. This Act also provides guidance in terms of institutional collaborations that should exist for the purposes of collection, monitoring and dissemination of weather and climate data. Furthermore, the Act also states measures to be taken to ensure that the collected data is kept in a safe and secure system. Moreover, both the NDMC and the SAWS have established EWS that are accurate and are monitored regularly.

2.4.1.6 Early warning systems within the City of Ekurhuleni

The CoE has developed a corporate disaster management strategy that is meant to guide all disaster management activities within this metropolitan municipality. One of the key performance areas stated in the CoE disaster management plan emphasizes the importance of enhancing disaster information sharing measures (CoE IDP, 2018). The CoE corporate disaster management plan highlights the implementation of EWS as one of the key activities to be undertaken as measures to reduce disaster risks (CoE IDP, 2018). In addition, the measures mentioned to disseminate disaster early warning messages are stated in the CoE within the corporate disaster management strategy. According to this strategy, the measures taken to disseminate early warning messages include the use of loud hailers, local community radio stations and SMS messaging system sent to the ward councilors to alert their communities (CoE, 2018).

According to the interviews held in 2012 with the members of Atlasville in CoE, the community members stated that disaster early warning dissemination is poor within the municipality (Fatti, 2012). Also, the community of Atlasville believed that early warning systems within CoE can be regarded as non-existent (Fatti, 2012).

2.5 Summary

Lack of development and implementation of relevant disaster management theoretical frameworks and policies have been identified as one of the reasons for ineffective disaster EWS (Lumbroso, 2018). This study is based on understanding the effectiveness of early warning message dissemination measures in Vosloorus Township, including the policies that underpin the implementation of EWS in CoE. Fearnley & Dixon (2020) contend that for EWS to be effective, they should be embedded in the disaster management policies and frameworks that relate to target communities. It is for this reason that the community of Vosloorus Township was identified for this study, to understand the effectiveness of EWS in CoE from the perspective of the community that was impacted by the 2019 floods. Furthermore, COVID 19 pandemic highlighted the importance of linking EWS measures to national and international disaster management laws.

CHAPTER 3: LITERATURE REVIEW

3.1 Introduction

Literature on early warning systems (EWS) reported that different strategies have been used to disseminate early warning messages (Marchezini et al., 2018; Ogie et al., 2018 and Bradley et al., 2014). Furthermore, these strategies highlighted the importance of dissemination of community-based early warning systems (CBEWS) alerts as a critical part of Disaster Risk Management (DRM) (Macherera & Chimbari, 2016). Zhou et al. (2019) argue that the strategy used to disseminate early warning messages should be timely and accurate. In addition, early warning communication has been identified as a necessary aspect of disaster preparedness process as well. Mwinami (2017) argues that effective early warning communication should be based on the knowledge of an impending disaster, the method of dissemination, and the ability of the affected community to respond accordingly. In Japan, community disaster preparedness was identified as an important process for the community to prepare themselves accordingly for recurring earthquake disasters in the country (Tomio et al., 2014).

Moreover, the dissemination of early warning messages should be investigated, especially in developing countries such as South Africa where disasters such as floods are recurring (NDMC Report, 2020). It was under this premise that this study was undertaken to assess the effectiveness of early warning message dissemination measures put in place by the City of Ekurhuleni (CoE). Tarchiani et al. (2020) argue that the process of collection and analysis of disaster early warning information should involve the participation of the affected community as well. Participation will ensure that the disseminated CBEWS messages will assist the affected communities to understand the disaster alerts, the nature of the imminent disaster, and what prevention measures need to be taken (Gautam & Phaiju, 2013).

Since CoE is comprised of 23 cities and towns (CoE, 2018), this study identified the need to critically evaluate the strategies used to disseminate disaster early warning messages especially to semi-urban communities such as Vosloorus Township. Liu et al. (2016) argue that the active participation of government or municipalities in community-based structures that are used in EWS as dissemination measures are critical for the identification of underlying factors, this also prevents unintended negative actions. Therefore, this chapter provides a detailed discussion on global EWS, EWS in Africa, EWS and response measures, effective dissemination early warning messages including strategy and methods.issues hindering effective dissemination of early warning messages are also deliberated on.

3.2 Global early warning systems

Worldwide multiple strategies have been used to disseminate early warning messages for different disasters (Haigh et al., 2018). Different countries use different strategies to disseminate messages from EWS (Macherera & Chimbari, 2016). For example, in the Yaan, Sichuan Province, in China, a rain-induced landslide EWS was constructed. Hou, Han & Zhou. (2013) states that the advantage of implementing the rain-induced landslide EWS is to disseminate early warning messages in real-time and provide targeted information that is incident-based (Hou et al., 2013). Although there is limited information on dissemination of disasterearly warning messages in Vosloorus, dissemination of early warning messages with CoE has been perceived as ineffective (Fatti, 2012).

Furthermore, disseminating warning messages that notify communities of heavy rainstorms, for example, the incident chain model disseminates targeted messages to areas where such storms might result in flooding (Zhou et al., 2019). The Wanzhou District in China implemented a community based, government led disaster risk reduction (DRR) strategy that incorporated education and training and the interpretation of disaster early warning alerts (Liu et al., 2016).

Furthermore, in Karnali, it was discovered that the affected communities could not disseminate disaster early warning messages due to underlying factors such as poverty and politics that were not considered by the EWS strategies in this country (Gladfelter, 2018). Gladfelter (2018) argues that the dissemination of disaster early warning messages should always be the responsibility of the government. Consequently, countries such as China that deal with recurring unexpected disaster events, established a meteorological disaster plan system that is run and managed by local municipalities (Wang, 2017). In addition, in cases where the meteorological disaster plan system detects multiple imminent disaster events for different areas, this system disseminates early warning alerts according to colour codes for easier understanding by the communities (Wang, 2017).

In a study review on the evolution of EWS, Sufri et al. (2020) emphasized the point that dissemination of disaster early warning strategies should be based on the involvement of affected communities. Moreover, a lack of community involvement in the dissemination of early warning strategies results in ineffective response measures from the affected communities (Sufri et al., 2020). For example, in a study to review the provision of improved EWS within the coastal areas of Bangladesh, Ahsan et al. (2020) reviewed the extent to which community members were willing to go to receive effective early warning messages. The findings of the EWS review conducted in Bangladesh revealed that the affected communities were willing to pay for strategies that would

enable them to receive early warning messages that are disseminated in local languages through voice messages and radio (Ahsan et al., 2020). Currently, disaster early warning messages in Bangladesh are still disseminated through the establishment of a disaster management committee's strategy that is based at sub-district level (Ahsan et al., 2020). This is relevant to this study as mitigation measures for floods also featured in the community questionnaire.

In Thailand, a study showed that the affected community members were willing to disseminate disaster early warning messages among themselves using social media as a dissemination strategy (Kaewkitipong et al., 2016). Furthermore, social media is regarded as the most effective strategy of disaster early warning message dissemination in Thailand (Kaewkitipong, Chen & Ractham, 2016). In Nijhum dwipin Bangladesh, women could not reach the shelters assigned for protection against the imminent cyclone because they could not access disaster alerts on time (Hossain et al., 2013). It is therefore critical that dissemination of disaster early warning messages take into consideration gender, language and other related cultural aspects to be considered effective.

3.2.1 Early warning systems in Africa

In Africa, various strategies have been implemented to disseminate disaster early warning messages for different disaster events in vulnerable communities (Sufri et al., 2020). Gaps highlighted from the review of previous studies lead to the undertaking of this research to investigate the dissemination of early warning systems in CoE. In the city of Mbeya in Kenya, the strategy to shorten the time of dissemination of early warning messages was achieved through the construction of an earthquake seismic network that is hosted by the community (Manyele & Mwambela, 2014). In areas such as Limbe municipality in Cameroon that experience recurring urban floods, community structures known as local flood management committees have been established (Tangan et al., 2018). These committees were established as a strategy to disseminate flood early warning messages to the community on time (Tangan et al., 2018). The above case studies emphasised the importance of the implementation of effective dissemination measures for early warning messages for recurring disasters such as floods (Tangan et al., 2018).

It is critical to highlight that for communities to take measures to protect lives and property, dissemination of early warning alerts should be based on people-centred strategies (Calvel et al., 2020). In Mangochi and Salima districts of Malawi, the dissemination strategy implemented provided customised and timely drought early warning messages that enabled small-scale farmers to prepare for the planting season and mitigate drought impacts in an effective manner

(Ayuma et al., 2018). Similarly, in Karamoja sub-region in Uganda, the dissemination of early warning messages was communicated through the local parish chiefs (Akwango et al., 2017).

Lessons learnt from the dissemination of early warning messages from previous disaster events indicated that there is still a gap between dissemination of early warning messages and the understanding of the messages by the affected communities (Alhmoudi & Aziz, 2016).

Even though the methods and technology to disseminate early warning messages have improved in recent years, the existing strategies still lack dissemination of disaster alerts that are effective and can be understood and acted upon (Alhmoudi & Aziz, 2016). Furthermore, the lack of effective dissemination of disaster early warning messages might be attributed to a lack of efficient governance, guidance, and leadership in EWS processes especially in African countries (Sakalasuriya et al., 2020).

EWS in South Africa are based on the Geographic Information System (GIS) that is used for the collection and dissemination of early warning data. The national disaster management centre (NDMC) manages the GIS (Ngcamu & Dorasamy, 2011). Furthermore, in the Western Cape, a need was identified to establish an estuary EWS that would be used for the collection and dissemination of early warning information for floods within coastal areas (Stander, 2020). In addition, at a conference held in Hennops River in Gauteng, EWS were described as a very critical aspect of managing disasters as they enable all role players to plan for short and long- term disasters (CSIR, 2015).

This study aimed to review how effective the dissemination of early warning strategies implemented in South Africa were, in particular in the CoE. In South Africa, EWS are deliberated on in multiple legal, policy and guideline documents available at national, provincial and local spheres. These include the Spatial Data Infrastructure Act and South Africa's National Climate Change Adaptation Strategy and several other policies, with the intention to improve the dissemination of early warning alerts in South Africa (Storiea, 2017).

Consequently, a system called South Africa flash flood guidance (SAFFG) was established to monitor and provide flood early warning alerts in the country (Poolman, 2015). The challenge with this system was that it could only provide flood early warning alerts that were diagnostic and could not be understood by the end-users (Poolman, 2015). Furthermore, areas such as Cape Town, even though they are capacitated with professional and experienced disaster management practitioners still face challenges relating to the dissemination of early warning disaster alerts (Pharoah et al., 2016). The devastation caused by flash floods in Western Cape in 2013, where

12 people lost their lives and 23 000 people were displaced was attributed to the gap that exists between forecasting and communication of flood early warning alerts (Pharoah et al., 2016). However, De Coning et al. (2015) argue that the advantage of the new forecasting system used by the South Africa weather service (SAWS) is that it can provide location specific early warning alerts. In addition, dissemination of early warning information by government in South Africa should always include proactive ways of alerting the affected communities (Busayo & Kalumba, 2021).

South Africa is among the most vulnerable countries in terms of disasters, in particular, flood disasters (Jubach & Tokar, 2016); with an estimated 83.3% annual flood risk (Zuma et al., 2012). Olorunfemi (2011) argues that poor housing structures within informal settlements in South Africa exacerbate communities' vulnerabilities to the impacts of flood disasters. Solomon (2011) contends that people centred flood EWS should be recommended as mitigation measures for informal settlements in South Africa. Furthermore, people centred flood measures in South Africa should address communities' perceptions on flood risks (Macherera & Chimbari, 2016).

Musyoki et al. (2016) state that floods have devastated communities in South Africa, for example, during the December 2010 and January 2011 floods, Limpopo province was one of the hardest-hit provinces (Musyoki et al., 2016). Vhembe district municipality, for example, reported that 632 houses were damaged, and in the Thulamela local municipality, 246 houses were damaged (Musyoki et al., 2016). Moreover, socio economic issues that hindered communities to receive flood early warning communication left the community in Hamutsha-Muungamunwe village, in Makhado local municipality vulnerable to floods (Munyai et al., 2019). Lack of effective EWS for floods within the Limpopo river basin leaves the communities within Mapumalanga, Limpopo, North West, KwaZulu Natal and Gauteng provinces not only vulnerable to frequent floods but prone to water-borne diseases such as malaria as well (Kundu et al., 2015).

3.3 Focusing early warning systems on disaster response measures

Substantial progress has been made on the establishment and implementation of EWS for natural disasters (Cools et al., 2016). However, for EWS to be considered effective they should address all aspects of disaster risk management, including providing response measures to affected communities (Cools et al., 2016), this is one of the objectives that this study sought to understand. Kelman & Glantz (2014) argue that it is critical to keep the communities at risk informed on imminent disasters, but also provide measures to save lives. Furthermore, Geographic

Information System (GIS) should be incorporated in the mapping of areas where early warning information has been disseminated and areas that require response measures as well (Tomaszewski et al., 2015). Moreover, early warning disaster alerts should be linked to measures that provide communities at risk with clear response information, this opinion has been adopted internationally (Rohwerder, 2015) This study supports the concept of linking EWS with disaster response. Abdel-Basset et al. (2020) contend that the link between early warning messages and the associated response measures should be done through information and communication technology (ICT). In addition, linking EWS to response measures for disasters such as floods and tsunamis to ICT enable local governments to run smart cities with effective EWS (Ramesh et al., 2019). Zia & Wagner (2015) state that the link between EWS and response measures should be streamlined in government entities development programmes.

Different methods of information dissemination can be customised and used to trigger response measures at the local level, for example, social media can provide data of where response measures should be channelled (Ragini, Anand & Bhaskar, 2018). In China, for example, during the 2019 rock landslide disaster, a global navigation satellite system (GNSS) was used to notify communities of the imminent rockslide for communities to take response measures that would save their lives and properties (Fan et al., 2019). Coughlan de Perez et al. (2016) argue that disseminated early warning information should trigger response measures from humanitarian organisations as well. Furthermore, it is important for cities to strive for action-based flood warnings that trigger's response measures from both the affected communities and humanitarian support (Coughlan de Perez et al., 2016). In West Africa, the International Federation of Red Cross and Red Cross Crescent Societies (IFRC) used seasonal climate forecasting as a EWS instrument to highlight which areas require humanitarian response measures (Tall et al., 2012).

During hurricane Katrina in New Orleans, for example, the community at risk failed to take responsive measures even though disaster alerts were disseminated days before (López-Carresi et al., 2013). Furthermore, failure to respond to hurricane Katrina early warning alerts was attributed to the failure of the disseminated early warning messages to reach the poor and elderly within the affected communities (López-Carresi et al., 2013). Mulyasari & Shaw (2014) argue that it is critical to disseminate early warning risk information through community-based society organisations (CBSO) that take into consideration vulnerable groups such as women, youth and elderly within the affected communities.

The economic development of each country determines the nature of EWS to be established and the associated response measures (Das, 2019). Furthermore, if the EWS fails to include end-user

strategies for receiving disseminated disaster alerts, it results in the community at risk's failing to take response measures (Das, 2019). De Silva, Amaratunga & Haigh., (2015) argue that the third industrial revolution placed emphasis on digital technology for effective collection and dissemination of disaster early warning messages that included communities. Hence, the EWS during this era were able to trigger response measures as dissemination of disaster alerts incorporated community networks and key social structures (De Silva et al., 2015). Moreover, as disasters continue to ravish communities at risk, the development of effective emergency communications and early warning measures that provide critical information on time for communities to take response activities have become critical (Martin & Rice, 2012).

3.4 Effective dissemination of disaster early warning messages

Dissemination of disaster early warning messages is a critical step in determining the effectiveness of disaster EWS in each area (Nugraheni & De Vries, 2016). Goniewicz & Burkle (2019) state that the dissemination of effective disaster early warning messages depends on the calibre of technology that each country can afford to use to provide such messages. Developed countries, for example, may have the technological capacity to disseminate disaster early warning messages better than less developed countries (Goniewicz & Burkle, 2019). However, in Malaysia, disaster alerts are disseminated through short message service (SMS) mostly as they cover a wide range of the affected communities (Ayobami & Rabi'u, 2012). Nugraheni & De Vries (2015) argue that a mobile phone message confirmation tool, to ensure that the end-user has received the disaster early warning alert, should accompany disaster early warning messages that are disseminated through text messages. This is an area that can be improved on in most developing countries, including South Africa.

Other countries prefer to use multiple methods of disseminating disaster early warning messages (Tagami, et al., 2016). In the December 2014 Kelanda floods in Pakistan, various measures of disseminating disaster alerts for the anticipated flood disaster were used (Alias et al., 2020). Alias et al. (2019) state that more than 50% of the affected communities were reported to have received flood disaster alerts before the actual disaster incident. In addition, among all the dissemination measures used, the community in the Kelantan area were reported to prefer dissemination of the flood disaster alerts through television (Alias et al., 2019).

In circumstances where there is an imminent earthquake, dissemination of disaster early warning alerts to the communities at risk might be a challenge as telecommunications infrastructure may

be affected during earthquakes (Parajuli & Haynes, 2016). In Nepal, Parajuli & Haynes (2016) suggest that the government should build a telecommunications infrastructure that can withstand the impacts of earthquakes. In such circumstances where telecommunications infrastructure has been affected by disaster incidents, alternative additional dissemination channels should be built into the existing EWS as a mechanism to update affected communities (Mambu & Gutierrez, 2016). Velasquez et al. (2015) state that for disaster early warning messages to be considered effective, the disseminated disaster early warning information should be easy to understand to trigger mitigation measures (Kelman & Glantz, 2014). Dissemination of messages that can be understood by the community formed one of the critical aspects of this study. In Bangladesh, communities strongly felt that flood disaster alert disseminated through mobile phones using interactive voice response (IVR) tools were the best as the messages were easy to understand (Velasquez et al., 2015). Other communities at risk of imminent disasters preferred dissemination of disaster early warning methods through social media (Wu & Cui, 2018). Simon, Goldberg & Adini (2015) outlines the following advantages of using social media as a mechanism to disseminate disaster early warning messages:

- Social media enables disaster management practitioners to provide disaster alerts that are relevant and on time.
- As disaster incidents unfold, social media enables government officials to track disaster incident developments.
- The use of social media to disseminate disaster early warning messages provides room for self-regulation.
- Dissemination of disaster early warning messages through social media allows for open online conversations.

Another advantage of disseminating disaster early warning messages through social media is that social media gives real-time information (Alexander, 2014). Ma & Yates (2014) argue that online social media networks such as Facebook and Twitter have been used to communicate disaster alerts to numerous communities at risk. In the 2015 Chennai floods in China, Facebook was regarded as one of the popular methods used to disseminate flood disaster alerts (Bhuvana & Aram, 2019). However, Rahman, Alam & Chowdhury (2012) argue that location-based dissemination of disaster early warning messages can be done through a mobile phone tool called open street map (OSM) system rather than social media to avoid fake news dissemination. The OSM method of disseminating disaster early warning messages is focused on specific streets that might be affected by the anticipated disaster event. In Haiti, OSM is one of the successful

methods that has been implemented to disseminate disaster early warning alerts (Rahman et al., 2012). However, in the Teesta riverine area of Bangladesh, the Village Disaster Management Committee (VDMC) assisted local communities to develop relevant technologies related to the adaptation to disasters such as floods (Karim & Thiel, 2017), flood mitigation measures implemented by the community of Vosloorus was taken into consideration by this study.

Effective EWS can be used to prevent loss of lives and protect property from imminent disasters (Arru et al., 2016); however, it is still a challenge to quantify existing challenges affecting EWS (Sättele et al., 2016). Hemachandra et al. (2020) argue that it is important to identify socio-economic changes as one of the challenges affecting the effective implementation of EWS.

3.4.1 Effective dissemination of disaster early warning messages in Africa

There is an increase in hydro-meteorological disasters such as floods across the world (Zia & Wagner, 2015). Around 20% of hydro-meteorological-related disasters occur in Africa (Hohmann, 2021). Within the past few years in Africa, notification of disaster alerts has been done largely through social media methods (Simon et al., 2015). However, in Nigeria, the government resorted to disseminating disaster early warning messages through newspapers and tweets (Hohmann, 2021). In contrast, other African countries such as Ivory Coast and Burkina Faso do not have an existing official method to disseminate disaster early warning messages (Hohmann, 2021). Braman et al. (2013) argue that international humanitarian agencies such as IFRC raised concerns that the implementation of dissemination of early warning strategies should be linked to early action in Africa.

Furthermore, for African countries, the establishment of the National Meteorological and Hydrologic Services (NMHSs) assists in the dissemination of early warning messages that covers a wide range of hazards (Jubach & Tokar, 2016). In Karamoja a sub-region of Uganda, for example, the existing dissemination of early warning measures did not take into consideration the size of the area to be covered and the level of education of the affected communities (Akwango et al., 2017); understanding of the disseminated early warning messages formed the basis of the investigations conducted by this study. Mutasa (2013) argues that for the dissemination of early warning messages to be effective, there should be an integration of disaster early warning information with DRM curriculum.

Calvel et al. (2020) contend that the provision of timely notifications should be linked to seasonal forecasts that include multiple measures of dissemination of disaster alerts. In the Equatorial East Africa (EEA) a two-weekly lead-time was initiated as a measure to disseminate early warning

messages (MacLeod et al., 2021). Furthermore, in Kenya, an initiative to align existing EWS with international standards was done by increasing investments for EWS in this country (Braimoh et al., 2018). Hoedjes et al. (2014) argue that effective EWS for disasters such as floods should be based on public-private partnerships as well. In Kenya, a partnership was established between the government and the local mobile telephone operator as a measure to provide timely alerts that could be disseminated to large groups within the affected communities (Hoedjes et al., 2014).

For communities to take measures to protect lives and property, the dissemination of early warning alerts should be based on people-centred strategies (Calvel et al., 2020). In Mangochi and Salima Districts of Malawi, the dissemination strategy implemented provided customised and timely drought early warning messages that enabled small-scale farmers to prepare for the planting season and mitigate drought impacts in an effective manner (Ayuma et al., 2018). Similarly, in Karamoja sub-region in Uganda, the dissemination of early warning strategy that was considered effective in this area was done through disaster alerts communicated through the local parish chiefs (Akwango et al., 2017).

In South Africa, DRR measures within the south of Durban basin have been designed to incorporate social media as a critical component of disaster early warning communication and dissemination (Skinner & Rampersad, 2014). Ngcamu & Dorasamy (2011) argue that technology in EWS can be used to translate the disseminated early warning information into languages that can be understood by affected communities within eThekwini municipality. In East London, the communities affected by impacts of disasters such as floods confirmed that residents within the affected areas easily understood disaster early warning information disseminated in local languages (Busayo & Kalumba, 2021). According to Kgakatsi & Rautenbach (2014) for the agricultural sector in South Africa, it is critical to develop seasonal climate forecasts (SCF) that disseminate early warning information to farmers on time.

3.5 Evaluation of existing disaster management policies and strategies

Van Niekerk et al. (2018) argue that every government sphere should have existing governance instruments such as policies in place to manage disasters. Policy and regulatory framework forms a critical aspect of DRM (Van Niekerk et al., 2018). Furthermore, the policy for the dissemination of disaster information should factor in the assumption that communication systems might be interrupted (Sithole, 2015). Moreover, in other countries such as Nepal, lack of effective policy

and legal framework contributed to the ineffective and lack of functionality of disaster EWS (Kafle, 2017).

At the center of the dissemination of disaster early warning messages is the implementation of public policies (Marchezini et al., 2018). Marchezini et al. (2018) argue that using public participation policy in disaster early warning dissemination processes should not consider communities at risk as objects but as important participants in the system. Furthermore, it is considered critical for all countries to base development of DRR and early warning procedures on effective policy and institutional framework (ISDR, 2006). Proper policies that guide all the processes should be a requirement for the development of sustainable EWS in each country (ISDR, 2006).

Although some existing policies and strategies guide communication of disaster alerts, lack of trust in government by the communities at risk is still an issue (White & Fu, 2012), the issue of community's trust in government was investigated in this study. In countries such as Uganda for example, DRR policies and legal instruments that inform the development of disaster EWS have been developed (Lumbrosso, 2018), however these are not communicated to the public. Masaba et al. (2017) argue that failure to promulgate the DRR and DRM policy regulations in Uganda resulted in ineffective EWS in that country.

Policies relating to politics and laws are critical in the development of effective EWS as they outline the roles and responsibilities of different stakeholders (Fakhruddin & Chivakidakarm, 2014). In the case of floods, the existing legal framework should clearly state who must provide the communities at risk with disaster and weather information (Fakhruddin & Chivakidakarm, 2014). In addition, policy and legal framework should increase disaster early warning capacity to disseminate messages and increase community ability to respond to the disseminated early warning alerts (Henriksen et al., 2918).

The increasing prevalence of inclement weather that results in disasters such as floods has strengthened the need for the development of information technology (IT) based EWS strategies (Goniewicz & Burkle, 2019). Furthermore, the advantage of developing IT-based EWS strategy is that it can be used to supplement flood risk management strategies within each country (Goniewicz & Burkle, 2019). However, EWS flood management policies should go beyond individual countries to the development of continental flood EWS that can assist to alleviate the impacts of such disasters (Thielen-del Pozo et al., 2015).

As the occurrences and frequency of disaster events such as floods increase, so do the impacts of these disasters (Thapa & Thapa, 2021). Shrestha et al. (2021) argue that there is a need to deal with flood early warning communication through an effective multi-level government strategy. Furthermore, a multi-level government early warning communication system should form part of all DRM strategies (Shrestha et al., 2021). It is argued that the benefits of implementing multi-level EWS strategies transcends beyond costs (Budimir et al., 2020).

It is important to mention that EWS are as effective as the existing disaster management policies at all government levels (Fakhruddin & Chivakidakarn, 2014). In Pandang city in Indonesia, failure to disseminate effective disaster early warning alerts was attributed to misalignment between the existing disaster management policies and the implementation of disaster early warning measures (Rahayu et al., 2020).

3.6 Existing methods used to disseminate early warning messages

Communication methods for disaster incidents such as floods should be embedded within the existing disaster contingency plans (Rochim et al., 2019). Pineda (2015) argues that communication measures to disseminate disaster early warning alerts should incorporate both social and technological aspects of the disaster, especially when crowdsourcing is implemented as a method to collect and disseminate disaster alerts. Furthermore, crowdsourcing as a method to disseminate early warning messages is also preferred as it includes different sources of information collection and dissemination such as sensors, mobile devices, vehicles, and human beings (Rauniyar, 2016). Manalo (2013) contends that methods used to disseminate early warning messages should take into consideration communities living in rural areas as well. Contrary, for urban areas, measures used to disseminate disaster early warning messages can incorporate different methods outlined by Chen et al. (2020) as follows:

- Television;
- Radio;
- Short messages service (SMS); and
- Online social networks.

Different methods to disseminate disaster early warning messages should be used to provide disaster information that is on time, accurate and credible (Al-Taie & Mariyam, 2019). Mambu & Gutierrez (2016) state that EWS for disasters such as tsunamis should be customised to include dissemination methods that serve as an extra channel to supplement existing methods of disaster

early warning dissemination. In Tanzania, the government customised the dissemination of early warning messages by introducing a system whereby government personnel were assigned to specific areas so that they can liaise with the affected communities (Wabanhu, 2017). Hohmann (2021) contends that customising the dissemination methods to be in line with the dynamics of the affected communities should be based on a sound forecasting model, especially for disasters such as floods. For EWS to be considered effective, measures used to disseminate disaster early warning messages should include grass-roots information distribution methods that can be used to communicate alerts to the affected communities (Ohta et al., 2018). Moreover, disaster information dissemination methods that are grassroots based can enable vulnerable communities to share disaster alerts received amongst themselves (Ohta et al., 2018).

Every government should have proactive methods in place to disseminate disaster early warning messages effectively (Busayo & Kalumba, 2020). Chen & Wang (2020) argue that it is critical to develop an early warning message dissemination method that has an added notification time for floods. Similarly, Gomes et al. (2016) contends that the role played by telecommunications methods in the dissemination of disaster alerts is critical for effective EWS. Furthermore, measures to inform the communities of imminent disasters should be based on the type of disaster alert being communicated and the method used to disseminate the disaster information (Omori et al., 2017).

Methods and technology to disseminate early warning messages have improved in recent years, however, existing strategies still lack effective dissemination of disaster alerts (Alhmoudi & Aziz 2016). Furthermore, the lack of efficient governance policy within EWS processes may lead to an opportunity to learn and improve on existing EWS by governments (O'Donovan, 2017); this study also recommended areas for improvement within the CoE dissemination of disaster early warning messages methods. In addition, dissemination of disaster early warning methods that include social media should be based on existing disaster management plans (Zhang et al., 2019). Mustafa et al. (2015) argue that early warning message dissemination methods should incorporate how affected communities will receive and respond to disaster alerts communicated to them. Sutton et al. (2015) support the statement that the methods used to transmit disaster early warning messages from the source to the affected communities should take into consideration informal communication methods of the community at risk.

Over the years, natural disasters have prompted scientists to improve on existing methods to disseminate disaster alerts (Wenzel & Zschau, 2013). Initiatives to incorporate communities and improve on tsunami early warning methods, for example, were established after the 2004 Indian

Ocean tsunami (Wenzel & Zschau, 2013). However, community centred early warning dissemination methods though preferred, could result in several challenges (Baudoin et al., 2016). In Nepal, the effective implementation of CBEWS is hindered by poor socio-economic conditions of the affected communities (Dugar et al., 2017). Perera et al. (2019) argue that operational issues such as technical expertise and manpower might further result in challenges in the implementation of CBEWS for floods. On the contrary, Baudoin et al. (2016) argues that the methods used to disseminate disaster early warning messages should be based on the type of hazard imminent in each area as well.

Methods to disseminate disaster alerts should be reliable, in Bangladesh, residents failed to evacuate a cyclone-prone area because they did not trust the dissemination method used to notify them (Ferdous, 2017). Roy et al. (2015) state that Bangladesh has since developed a three-mobile network-based disaster information dissemination method.

Social media as a medium to disseminate disaster alerts has been implemented through different methods (Chatfield & Brajawidagda, 2012). However, satellite communication methods are also used to disseminate disaster early warning messages in an effective manner (Pecorella et al., 2015). The advantage of the satellite communication method is that it provides end-to-end disaster early warning communication (Pecorella et al., 2015).

Baudoin et al. (2016) argue that one of the informal methods to disseminate disaster alerts is through the involvement of communities in activities of not only collection of weather data but sharing of the disaster early warning information among themselves as well. This study therefore, focused not only on how CoE disseminates the early warning messages to the community of Vosloorus but on also the dissemination methods the community of Vosloorus identified as the preferred one for receiving early warning messages.

Shi et al. (2020) argue that there is a need to improve on the methods used to disseminate disaster early warning messages to include novel methods of collection and dissemination that are practical in nature. In Poland, the methods used to disseminate disaster early warning messages are based on the partnership between the government and mobile phone operators (Goniewicz & Burkle, 2019). Furthermore, mobile phone operators are obliged by the law in Poland to use various methods of early warning message dissemination in cases where there are imminent disasters (Goniewicz & Burkle, 2019).

Howard, Meehan & Parnell (2018) state that disaster early warning dissemination methods should take into consideration vulnerable groups within the affected communities, that is, older people,

people with disabilities, cultural and language differences, and households with below the average income. In addition, dissemination of disaster early warning methods should outline how disseminated messages will be simplified so that affected communities can understand and respond to them on time (Lindell, 2018).

Disaster early warning risk communication methods should be aimed at preparing the community at risk about what to expect and how to protect themselves (Bradley, McFarland & Clarke, 2014). Bradley et al. (2014) argue that there should be a shift from the earlier one-way communication EWS to implementing early warning message dissemination methods that are interactive and focus on behavioural patterns of the community at risk. Newell et al. (2016) contends that some early warning dissemination methods only provided a shortened version of imminent disaster; this made the communities at risk to underestimate the nature and magnitude of the imminent disaster. Dayeuhkolot Sub-district in Indonesia is an area that experiences recurring flood disasters, the early warning message dissemination methods implemented in this district are based on existing community networks that provide the nature and magnitude of imminent disasters (Kurniasih et al., 2018).

According to Bennett (2019), dissemination of disaster early warning methods should make use of a broad range of communication devices and applications. Moreover, dissemination of disaster early warning methods should provide information on the nature of evacuations that can be executed within the affected communities to save lives (Nagarajan et al., 2013). However, in Tana County, in Kenya, the early warning message dissemination methods experienced challenges in communicating messages that could be understood by the affected communities to take measures to protect their lives (Mwinami, 2017). As a result, the methods used to disseminate early warning messages in Kenya had to be reviewed to provide early warning disaster alerts that are helpful and provide guidance (Mwinami, 2017). Although EWS frameworks have been improved by international structures such as United Nations (UN), methods of disaster early warning information dissemination still lack in both technical and social components (Schismenos, 2017).

The national disaster management framework (NDMF, 2005) as a working document supports EWS methods in South Africa for Disaster management practitioners. However, the existing policy framework and legislation does not recognise agencies and methods that collect and disseminate disaster early warning data outside the government (DEFF, 2014). Van Niekerk (2014) argues that both the Disaster Management Act and framework in South Africa do not provide enough guidance to municipalities with regard to implementation of DRM strategies, EWS form part of

DRM strategies; therefore, they should be given more attention when the framework is revised. Accordinng to Solik & Penning-Rowsell (2017) policies for flood management in South Africa have improved since 1994. Furthermore, the process of improving flood management strategies in South Africa should incorporate lessons learnt from previous flood disaster incidents in the country (Solik & Penning-Rowsell, 2017), this study was conducted based on the 2019 floods as the basis to evaluate dissemination measures used during these floods. Musungu, Motala & Smit (2016) argue that effective strategies for collection and management of disaster information for floods within informal settlements in South Africa are critical. Furthermore, an integrated strategy will be used to manage disaster information and communication should be established in South Africa (Kunguma, 2020), this study investigated how early warning information and dissemination in CoE is integrated with community structures.

3.7 Issues hindering the effective functioning of early warning systems

The negative impacts of disasters can be dealt with through a system that communicates disasters within the national, provincial, and local levels of government, including communities (Bui, 2019). Owolabi & Ekechi (2014) argue that it is critical to evaluate disaster dissemination communication methods and techniques to determine factors that hinder the effective dissemination of disaster early warning messages. However, effective dissemination of disaster early warning messages could be hindered by factors relating to technological, organisational, and social issues as well (Fischer et al., 2016). In the 2013 Sultan Abu Bakar Dam overflow in Cameron Highlands (Malaysia), which resulted in flash flood and mudslide, technological failure to provide clear disaster early warning alerts resulted in 3 fatalities (Sukhwani et al., 2019). In addition, in Kenya, drought early warning messages failed to translate into response from the affected communities because of organisational failure that did not provide a holistic approach to the development of EWS (Imeje, 2014). Furthermore, organisational barriers in Kenya that hindered the effective dissemination of drought early warning messages were related to insufficient capacity (Imeje, 2014).

Although social media is preferred by communities as a measure to disseminate disaster early warning messages it can hinder the effective dissemination of disaster information communication flow (Alexander, 2014). Moreover, community members that are 55 years and older may have challenges accessing disaster early warning messages communicated through social media (Alexander, 2014). The information that the community receives from various social media platforms may confuse as to which disaster early warning information the community should act

upon, causing reliability and reputational risk issues for disaster management authorities (Anson et al., 2017).

Vihalemm et al. (2012) argue that the community's perception of the imminent disaster event can hinder the people's understanding of the disseminated disaster early warning alerts and may lead to misinterpretation of the received disaster early warning message. Other social aspects such as illiteracy, gender, culture, and poverty might hinder the effective implementation of EWS (Seager, 2014). Although early warning dissemination methods such as social media are popular, they also come with social challenges such as language, technology, and availability of data that hinder effective implementation of EWS (Anson et al., 2017), these are some of the aspects this study sought to investigate. Moreover, structuring of early warning disaster alerts is still a challenge for government officials (Hiltz et al., 2014). Vosloorus Township is a semi-urban area, in which more than one language is spoken (CoE IDP 2018),early warning messages communicated in one medium may not accommodate multilingual communities, within this study area.

Effective EWS are regarded as one way of mitigating the impacts of disasters, but lack of effective technology and effective investment in early warning disaster processes may hinder the effective functioning of EWS (Pathirage et al., 2012). Comes et al. (2014) argue that there is a need for the establishment of policies that support integration of all phases of EWS to achieve effective functioning. Furthermore, the lack of integration of science and indigenous knowledge negatively affects the effective functioning of EWS (Alessa et al., 2016). Failure to incorporate discussions on effective EWS in decision-making and political forums may pose a challenge in the implementation of EWS (Dutta & Basnayake, 2018). In addition, corruption within government can result in poor implementation of EWS, as it is the case in the slum communities of Lagos (Nigeria), that are forever affected by the negative impacts of flood disasters (Ajibade & McBean, 2014).

In South Africa, factors such as access to electricity, poverty and other related socio-economic resources should be taken into consideration when strategies for dissemination of disaster early warning systems are implemented (Guru & Santha, 2013). In certain areas in South Africa, dissemination of disaster early warning messages failed to trigger a response mechanism from the communities at risk (Macherera & Chimbari, 2016). The lack of response when disaster early warning messages are received by the community members might be attributed to lack of access to accurate weather data by communities and issues around lack of capacity within the local municipalities in South Africa (Macherera & Chimbari, 2016).

3.8 Perceptions of affected communities on existing early warning systems

Perceptions of the Vosloorus Township community towards the early warning messages dissemination methods by the City of Ekurhuleni is critical for this study. Moreover, countries like Bangladesh have in recent years, experienced a decrease in the impacts of disaster events (Roy et al., 2015). Bangladesh attributes the decrease of the disaster impacts to the role played by the affected communities in the collection and dissemination of disaster alerts (Roy et al., 2015). Mohanty et al. (2019) contend that there has been a shift from disaster-based EWS strategies to implementation of climate related disaster community resilience (CDCRF) strategies that focus on EWS. In Indonesia, affected communities believe that EWS are effective since the local government with participation from affected communities developed the systems (Hadian et al., 2017). Muryani et al. (2021) argue that community's perceptions on the existing EWS were shaped by, among others, the following:

- Previous experiences of disaster events;
- Disaster alert information that the affected community received through various communication channels; and
- Trust in local government authorities that provide early warning alerts and the response measures provided.

Samaddar et al. (2012) states that trust in the source that is disseminating early warning disaster alerts contributes to the perception of the affected communities in deciding whether existing EWS are effective or not. Therefore, it was critical for this study to measure the level of community's acceptance towards existing EWS as well (Riama et al., 2021). In Jakarta (Southeast Asia), one of the challenges relating to the effectiveness of the existing EWS in Jakarta was the lack of acceptance of the disseminated early warning information by the affected communities (Riama et al., 2021).

In South Africa, understanding of EWS processes and the perceptions of the affected communities should be addressed to determine the effectiveness of EWS (Fatti, 2014). Moeletis et al. (2013) argue that there is a need for training and capacity building for the farming community in Makhado municipality in Limpopo to change the perception of the farmers towards early warning information provided by the government. Furthermore, the tourism business in Limpopo believed that flood management strategies and plans in this province were not implemented in an effective manner (Southon, 2017).

Walls et al. (2020) contend that the perception of the affected communities towards fire disasters in South Africa could only be addressed through the involvement of the communities in EWS processes. Moreover, involving the affected communities in the processes of fire EWS in South Africa would assist in dealing with common myths and beliefs around fire incidents (Walls et at., 2020). There should be clear lines of communication flow regarding the dissemination of early warning alerts and how these messages will be received (IFRC. 2020), this study focused on investigating measures of early warning dissemination messages regarding floods that are acceptable to the community of Vosloorus Township in CoE.

3.9 Summary

One of the most critical components of DRM is the implementation of effective EWS (Khankeh et al., 2019), this study views EWS as an important component of DRM. Various means of disseminating disaster early warning messages have been deliberated on broadly (Alamdar et al., 2015). However, gaps still exist between scientific collection of disaster weather data and dissemination of the collected data (Alamdar et al., 2015). Also, community response as per the disseminated disaster early warning alerts is still a challenge, especially for women, children and people with disabilities (Hossain, 2013).

In urban areas, the dissemination of disaster early warning strategies implemented should be regarded as a supplement to existing measures (Acosta-Coll et al., 2018). However, there are still challenges relating to the implementation of effective EWS as a mitigation measure to save lives and properties (Dutta & Basnayake, 2018). Therefore, there still exists a need to improve on communication flow measures used to disseminate disaster early warning messages to the affected communities (Dutta & Basnayake, 2018). Furthermore, this study identified a need for a gap analysis between the collection and capturing of early warning data by the government and the dissemination of the collected early warning data to communities (Dutta & Basnayake, 2018). The above is investigated in this study, among others in the CoE with a specific focus on Vosloorus Township. The CoE is comprised of 23 cities and towns (CoE 2018), this study evaluated the strategies used to inform dissemination of disaster early warning messages especially to two informal settlements within Vosloorus Township, in particular with reference to the recurring flood disasters South Africa has been experiencing.

CHAPTER 4: RESEARCH METHODOLOGY

4.1 Introduction

This research was undertaken using mixed-method. The purpose of this study was to assess and analyse the effectiveness of the existing methods used by the City of Ekurhuleni (CoE) in early warning message dissemination to the community of Vosloorus Township. The strategies and methods used during the 2019 floods were taken into consideration by this study, but this research was not limited to this specific disaster when data was collected. The dissemination of flood disaster alerts in particular, from the perspective of Vosloorus community was given more attention as floods have become a hazard that is associated with high risk in terms of loss of lives and properties in South Africa in recent years (Smithers, 2012). Furthermore, many fatalities were reported in the country during the 2019 disaster caused by cyclone Idai, which also affected most neighbouring countries. In Zimbabwe 340 people died, and more than 270 000 people were left destitute (Chatiza, 2019). In Mozambique, 600 people died, and more than 1.8 million people were left destitute by this cyclone (Emerton et al., 2020).

Floods comprise of 72% of all disasters within the Southern Africa region (Jubach and Tokar, 2016). Furthermore, the establishment of flood early warning systems within the vulnerable communities will assist in the development of resilient communities (Fakhruddin et al., 2021). Also, for flood early warning systems to be considered effective, dissemination of early warning messages should form a critical part of the system (Kuller et al., 2021). Consequently, the establishment of flood early warning systems will lessen the impacts of floods, save lives and economy (Musa et al., 2021).

The early warning systems for meteorological hazards such as floods in South Africa are managed by the South African Weather Services (SAWS) as outlined by the act (Act 8 of 2001 as amended). The mixed research method was suitable for this study as it analysed how affected communities constructed meaning within their natural settings (Mothibedi, 2017), together with quantitavie analysis of data through cross tabulations of variants. Moreover, the mixed research method enabled the researcher to understand the dissemination of disaster early warning messages based on the beliefs and experiences of the community of Vosloorus Township in CoE and management thereof (Merriam & Tisdell, 2015). The data collected for this study was analysed statistically to support the main argument of the study pertaining to early warning dissemination in the CoE.

4.2 Research design

This study employed a mixed-method approach to answer the research questions. Several scholars reported that the mixed-method research approach is the combination of qualitative and

quantitative research approaches into a single study (Leedy & Ormrod, 2001; Babbie & Mouton, 2001; Eyisi, 2016). Data was collected to assess people's knowledge and risk perceptions about early warning alert messages by using a data collection instrument that mixed qualitative (open-ended) and quantitative (closed-ended) questions, and both forms of data were integrated and analysed.

Qualitative techniques were used to assess data that represented perceptions of social issues in the community, while quantitative techniques were used to collect measurable data that represented the objective reality of the participants (Almalki, 2016). Both qualitative and quantitative data was collected simultaneously and analysed before being compared and integrated. Almaki (2016) outlines the benefits of adopting a mixed-method approach as follows:

- The project focuses on the benefits of both research approaches while reducing the limitations of both approaches.
- Mixed methods were used to manipulate time, resources, and access issues.
- Mixed methods increase research participation.
- Mixed method approach is suitable for the applied study.

Based on the above benefits and the fact that the questionnaire designed (research tool) for this study encompassed both open and closed-ended questions the mixed method was the best method for this study.

4.2.1 Philosophical worldview

The mixed-method approach required the researcher to understand the philosophical principles and assumptions relating to social sciences data interpretation (Moon & Blackman, 2014). How the researcher conducted the study was linked to the constructivism philosophical worldview. Aliyu et al. (2014) contends that a philosophical worldview is a structure that guides the entire existence of humankind. Ryan (2018) defines philosophical or epistemology perspectives as processes that are based in the researcher's belief system on how to access knowledge in the world. Furthermore, Antwi & Hamza (2015) contend that epistemology is the systematic way the researcher knows and understands reality as it is, for this study reality was understood from constructivism point of view.

The researcher can acquire knowledge from three perspectives which are: epistemology; philosophical perspective and philosophical orientation (Moon & Blackman, 2014). This study was based on the quest to get knowledge and understanding on early warning message dissemination from the community of Vosloorus as this aspect relates to the safety of the community. Al Ahmadi

(2019) argues that to understand knowledge on a specific study topic, the researcher should focus on a philosophical approach that outlines the aspects in the following manner:

- What the researcher believes in;
- Principles that support the researcher's beliefs;
- How data to support the topic will be collected; and
- What instruments could be used to analyse data.

Hall (2013) states that philosophical worldview can be classified into the following: post-positivist; constructivist, transformative and pragmatic. According to Bisel and Adams (2017), post-positivism focuses on the subjectivity of reality and its value to each study. In addition, Denicolo et al. (2016) defined the constructivist approach as the process of acquiring knowledge based on people's perceptions, this study's philosophical view is based on constructivism

4.2.2 Qualitative approach

One of the key aspects of qualitative research method is to interpret the data collected based on historical disaster occurrences (Terrell, 2015). For this study, historical dissemination of floods alert will be used and analysed as secondary data in addition to primary data that was collected from the community and disaster management officials of CoE, using a questionnaire with both open and close-ended questions. In selecting a qualitative research method, the researcher was able to collect the data personally rather than relying on a third party (Cypress, 2015). Moreover, this study required flexibility and adjustment during the implementation process and qualitative research method was more suitable for such adjustments. The qualitative research method enabled the researcher to provide findings that are descriptive in nature (Cypress, 2015). Furthermore, qualitative research method requires an understanding of a social aspect within the community (Mohajan, 2018), which is what this study wanted to achieve.

4.2.3 Quantitative approach

The purpose of this study was to accumulate more knowledge on the dissemination of early warning messages from the community of Vosloorus. It was necessary to understand the variables of early warning systems from a social perspective (Astalin, 2013). Most researchers in social sciences prefer the quantitative method in undertaking research that is descriptive and investigative in nature (Astalin, 2013). Furthermore, by using the quantitative research method, the researcher focuses on deductive measures that look at one or two processes to reach a logical conclusion (Almalki, 2014), this was done for this study. The quantitative method is linked to an enumerative process that states that a systematic scientific mechanism should be followed before

arriving at the conclusion of each study (Brannen, 2017), this is how data analysis for this study was implemented.

Leedy and Ormrod (2014) contend that gathering and analysing statistical data only is not enough, understanding the social aspects that inform the meaning of the data is the advantage that is provided by mixed methods. The mixed-method is preferred for this study because it enabled the researcher to get answers to questions that could not be answered by qualitative and quantitative methods in isolation (Lund, 2012).

4.3 Population sampling

To achieve the objectives of this study, the analysis of what, when, how and who was critical for the research process was undertaken (Merriam & Tisdell, 2015). Furthermore, studying the entire population was impractical and impossible (Acharya et al., 2013); therefore, sampling was used to collect data for this research from the targeted community of Vosloorus Township as opposed to census.

Sampling refers to the process of identifying a group of people that will participate in the collection of data (Terrell, 2016). Purposeful sampling was the most practical method for this study and was adopted. The sampling was based on the specific criterion (Terrell, 2016), the first criterion was that all the respondents were residents of Vosloorus Township. The second criterion, though not a limiting factor was that the respondents experienced the impacts of floods within this area of CoE. Furthermore, sampling provided the researcher with the advantage of working with a small group of community members (Terrell, 2016), to achieve the intended aim of this study. Rai & Thapa (2015), argue that purposive sampling enables the researcher to choose and take decisions on individuals to be incorporated in the sample for the research. Moreover, purposive sampling assisted the researcher to enhance the rigour of the study (Campbell et al., 2020). In addition, the purposive sampling implementation process, for this study was done as outlined by Rai & Thapa (2015):

- Identification of the target population: This research was based on the community of Vosloorus Township in CoE. The individuals that were selected to participate in this study were selected from this community only.
- Specification of the sampling frame: The preferred individuals that participated in this study were selected specifically from 2 informal settlements within Vosloorus Township.

- Management of the Ekurhuleni Disaster Management Centre and officials involved in disaster message dissemination were part of the research.
- Determination of the sample size: The sample size for this study was approximated at 1% of two of the informal settlements within Vosloorus Township.

Therefore, a sample size of 100 was selected for this study (Merriam & Tisdell, 2015). Studies have shown that a sample size of 100 or 1% of the study population is enough to make significant statistical results in social sciences research (Boddy, 2016). The community members who participated in this study were purposively selected based on the househplds within the selected informal settlements that are frequently affected the most by the recurring floods within the study area.

4.4 Data collection

Rigorous data collection was the most important phase of this study, without which no study could take place (Ranney et al., 2015). Primary and secondary data was collected and used to address the objectives of this study. Data for this study was collected from two groups, using two different structured questionnaires pre-developed and approved by the University of the Free State ethics clearance committee (Ethical Clearance number: UFS-HSD2020/1984/102).

The first questionnaire was used to collect data from the community of Vosloorus Township and the second questionnaire was used to collect data from CoE disaster managers, 3 supervisors and 6 call center operators responsible for disseminating notifications within the Northern region (where the study area is located) of CoE. As stipulated by Leedy and Omrod (2001) notifying the respondents of the purpose of the study was important. Therefore, before data collection, the researcher asked permission from the ward councilor of the community to collect the data in the community despite COVID-19. In addition, permission to administer the questionnaire to COE officials was sought from the head of the Ekurhuleni Disaster Management center by email. Furthermore, during data collection, the researcher and the research assistants observed COVID-19 regulations when data was collected. To check the reliability of the research tool, both questionnaires were piloted with 2 CoE employees and 10 community members of Vosloorus Township before it is revised and administered to eliminate redundant questions if any and other unforeseen issues.

4.4.1 Piloting of the research tool

A pilot study was conducted to determine the limitations in the questionnaires (Hurst et al., 2015). Willis (2016) argues that piloting of the data collection tool, which is also known as pre-testing, should be conducted to identify and address the challenges that may arise from the questionnaires. Furthermore, researchers have piloted questionnaires prior to the actual data collection process for years (Willis, 2016).

For a good sample size of 100 community members from Vosloorus, 1% of this sample was also targeted by this study for piloting the questionnaire. A structured questionnaire was chosen as a tool to collect data for this research, due to its flexible nature and because the questions in a structured questionnaire were predetermined and well organised (McGuirk & O'Neill, 2016). This saved time for the researcher and the respondents. Furthermore, flexibility enabled the researcher to collect data from a large group of participants within a specified period (Rowley, 2014). Leedy and Omrod (2001) state that attention should be paid to the timing of the operation (data collection), to address this the researcher recruited, trained, and equipped research assistants prior to administration of the questionnaire in addition to planning the fieldwork in detail.

The main objective of this study was to get an understanding of the processes and interpretations of early warning dissemination measures in CoE and a questionnaire was reported as suitable for such data collection measures (McGuirk & O'Neill, 2016). In addition, the data collected from the questionnaire adminsterd to the community was supplemented by the data collected from disaster managers to get insight into corporate disaster management early warning policies (Rowley, 2014).

It was critical that the community understood the issues raised in the questionnaire. The language used in the questionnaire was at a level that could be understood by the participants (Kazi & Khalid, 2012). Furthermore, questionnaires provided the researcher with an opportunity to get knowledge and understand the perception the community had towards CoE and early warning message dissemination. In addition, questionnaires were used because they allowed for the provision of individual opinions from the respondents (Yaya, 2014). Moreover, the collected data comprised of both primary and secondary data (Kivunja, 2016). Secondary data was gathered through desktop studies, by reviewing literature related to the objectives of this study (Kivunja, 2016). Editing and coding was the 3rd phase in this study process, data for this study was collected by means of a questionnaire; therefore, coding was used to transform the information into numerical data that was analysed by means of a statistical package for social sciences (SPSS).

The information from the questionnaires was coded and then captured on an excel spreadsheet before it was migrated to SPSS, and thereafter further validation using descriptive analysis and cross-tabulation of certain variables was done. The collected data was edited to eliminate obvious errors. All 100 respondents from the community completed their questionnaire even though some skipped a question or two.

4.5 Data analysis

Data analysis was regarded as one of the critical steps in the study (Turhan, 2020). Furthermore, data analysis involved statistical techniques to analyze the collected data. (Schork & Zapala, 2012). Data analysis started by organising and cleaning the data collected throughout the study (Vaismoradi et al., 2013). Moreover, data was tabled, graphically displayed and various other descriptive measures were calculated (Neyeloff et al., 2012).

Through the tables, graphs and values obtained, trends and properties of the collected data, recommendations were identified (Eriksson et al., 2013). Gibson & O'Connor (2017) outlines steps for data analysis as follows:

- Coding the feedback from the community as outlined in the questionnaire;
- The coded data was classified according to common ideas and themes; and
- Once the data was classified, themes relating to the objectives of the study were then identified and deliberated on based on the results.

It was critical for the researcher to understand that coding is the second step of data analysis (Stuckey, 2015), therefore, the first step was to read all the responses from the participants and captured into Microsoft excel program. Grolemund & Wickham (2014) argue that data analysis should seek to build and establish an understanding of what the nature of the study at hand is. It was important for the researcher to keep the data analysis grounded on the relevant themes.

SPSS software was used to analyse data for this study, and all tables and figures were produced using this program. Furthermore, Spearman Rank correlation test and Chi-Squared test using SPSS was used to assess the relationship between certain variables to identify the link between demographics and other impact questions from the study responses. De Winter et al. (2016) contend that Spearman Rank correlation is better suited for psychological studies. Turhan (2020) argues that chi-square test could assist the researcher to analyse the data collected and submit significant results. Sharpe (2015) contends that researchers have been using chi-square testing to analyse data for a number of years.

4.6 Data validity and reliability

Validity and reliability refer to the process of ensuring that collating and interpretation of the data collected provide informed findings (Merriam & Tisdell, 2015). Merriam & Tidell (2015) argue that findings from the collected data should be consistent to be considered as valid and reliable. Bolarinwa (2015) further argues that validity and reliability should assist the researcher to measure the effectiveness of the instrument used to collect data. Moreover, the data collection instrument was based on equal conditions of measure, stability, and consistency internally, to produce outcomes that were valid and reliable (Bolarinwa, 2015). Validity is defined as the process of ensuring that the data collected addresses the specific area of the research (Taherdoost, 2016).

Reliability is defined as a method of collating data that enables the researcher to account for individual and research instrument biases (Noble & Smith, 2015). This study ensured that the measurement process that was used to collect data yielded consistent feedback across all participants (Taherdoost, 2016). Bonett & Wright (2015) argue that Cronbach Alpha method is one of the most utilised measures to determine data reliability in social science studies. Furthermore, data collected from social science studies should be based on opinions and attitudes of the participants, therefore the Cronbach Alpha method was suitable for this study to measure validity (Quansah, 2017). Social scientists reported the Cronbach value of 70 and above to be acceptable (Taber, 2018), therefore this study measured consistency based on that.

This study also ensured that the findings were based on the trustworthiness of the information provided by the participants (Noble & Smith, 2015). To ensure rigor, this study incorporated data validity and reliability aspects by Noble & Smith (2015) outlined as follows:

- In ensuring validity, the study findings were based on collating the exact feedback the participants provided through the questionnaires.
- To ensure reliability, this study acknowledged within the findings, the differentiated participants opinions.

Furthermore, to ensure data validity and reliability, the questionnaires were piloted first as a pretesting measure for this study; pretest has been reported as another reliability measure (Jaeger et al., 2013).

4.7 Study limitations and delimitations

Limitations are situations and circumstances that are beyond the researcher's control but may have an impact on the outcome of the study (Simon & Goes, 2013). Theofanidis & Fountouki (2018) contend that limitations of a study refer to the weaknesses that might be embedded in the implementation process of each study. Furthermore, Connelly (2013) argues that it is critical for the researcher to acknowledge the limitations relating to the study so that the identified limitations can be addressed. Moreover, all studies have limitations (Ross & Zaidi, 2019).

Delimitations outline the reasons why the researcher preferred a particular process to the other, for example, the process of data collection (Theofanidis and Fountouki, 2018). Furthermore, delimitation enables the researcher to determine the boundaries of the study at hand (Simon, 2011). According to Leedy & Ormrod (2014) delimitations state what the researcher is not going to do during the implementation of the research project.

Focus group sessions were initially going to be used to collect data for this study, but due to the risks posed by Covid-19, this was later identified as a limitation. Moreover, since this was the researcher's first study, it would have been naïve to think that once the research method was selected, the implementation of this study would continue without any challenges.

4.7.1 Limitations

It was a challenge to get the correct and planned sample size since people were skeptical to accept visitors in their homes due to the COVID-19 pandemic. Leedy & Ormrod (2016) argue that for the qualitative research method, if the sample size iis not properly selected, it might not provide a true reflection of the views of the whole community, hence the mixed-method approach was used in this study. Furthermore, the study's limitation in the data collection methodology was that only house-to-house questionnaires would be administered and the focus group data collection was omitted because of the COVID-19 social gathering regulation. This study could not risk gathering people in one place even if they were less than the required number to avoid risk of Covid -19 infections.

4.7.2 Delimitations

This research was supposed to cover all the townships within COE, but due to financial and capacity related challenges, this research focused on the community of Volsoorus Township. This research acknowledged the fact that if the study was conducted in all the townships of CoE, the

findings might have been different. To address the issues relating to sample size, the findings for this research will be generalised to:

- All communities that reside within the Townships in CoE; and
- Predominantly black communities within CoE that live in similar conditions as the study area.

4.8 Ethical considerations

This research was conducted during Level 2 of the pandemic, COVID -19 era, that has resulted in a lot of devastation worldwide and within the communities in South Africa. In engaging with the participants for this study, it was critical to ensure that the safety of all those who participated was given priority. Furthermore, the collection of data from participants was done without putting any of the participants in danger. According to COVID-19 regulations (Regulations and guidelines, 2020), the following safety measures were observed when engaging with the participants:

- Everyone involved during data collection for this study was asked to wear masks at all times during the interviews;
- Individual houses were visited to administer the questionnaire instead of having a group of people in one place;
- The initial design of this study included focus groups, however, due to COVID-19 regulations this data collection method was eliminated with the advice of the research supervisor citing safety issues; and
- Social distancing of one and half meters was adhered to during interviews.

Ethical issues for this research were in line with the cultural ethical issues of the target community as well (Msoroka & Amundsen, 2018). In addition, this research was based on the three ethical issues outlined by Terrel (2016) as follows:

- Informed consent of participants;
- Assessment of risks regarding the participation of the community in the research; and
- Fair processes of participation in this research.

This study also sought human ethics clearance from the University of the Free State and adhered to the university's ethics principles (UFS-HSD2020/1984/102.

4.9 Summary

This research sought to provide findings that were based on the community's life experiences, emotions, and feelings (Rahman, 2020), regarding the effectiveness of CoE dissemination of early warning messages. Therefore, the mixed research method used enabled the researcher to produce findings based on the experiences of flood incidents within the community of Vosloorus Township. While the findings for this research were not feedback from all the communities within CoE, the findings nonetheless provided an insight into the early warning message dissemination challenges faced by township communities within the CoE.

CHAPTER 5: PRESENTATION AND DISCUSSION OF RESULTS

5.1 Introduction

The research questionnaire used for this study was administered to 100 community members from two informal settlements in Vosloorus Township, with the help of three research assistants. The research assistants were selected from Vosloorus Township and they were trained to administer the questionnaire and the associated research protocols. The research took place during the less harsh lockdown level 2 of COVID 19 pandemic, but it was not possible to administer the questionnaire through focus groups as group gatherings were still limited and prohibited, as a result, this study only used and analysed 100 questionnaire data from 100 participants to come up with the results for this chapter. All 100 participants were attended to individually with all COVID 19 protocols, regulations and restrictions observed. Each participant was given the option to accept or refuse participation in this study as per the study's consent form (Annexure C), and the respondents who chose to participate in the study were requested to sign the consent form. Furthermore, engagements with each participant took 20 – 30 minutes for a questionnaire to be completed.

The participants completed all 100 questionnaires with the assistance of the researcher and the research assistants. However, some questions in the questionnaires were not answered, as the respondents were told to feel free and had a choice not to answer questions they were not comfortable with, such questions were coded as no responses during data analysis.

5.2 Format of the questionnaires

The questionnaire administered to the community consisted of 3 sections as follows:

- Section A: Demographics information;
- Section B: Early warning systems impact questions; and
- Section C: Community-based strategies for coping with floods.

Only adults 18 years and above were allowed to participate in this study to adhere to children's rights policy recommendations and ethics concerning children as stipulated in the University of the Free State ethics guidelines.

5.3 Demographics analysis

All demographic questions were analysed descriptively, and inferential statistics was applied to to gauge the correlation between the responses to some of the questions.

Out of the 100 questionnaires administered, most of the respondents (n = 71) were females, (n = 28) were males and one person chose not to reveal their gender. Furthermore, n = 70 of the participants stated that they were single, n = 20 were married, and n = 7 were widowed. In addition, only n = 1 of the respondents did not answer the marital status questions, those who reported to be divorced and those who indicated that they are separated made up n = 2 of this study at n = 1 representation for each category.

The majority of the respondents were between the ages of 29 – 39 years (n = 33), followed by the age group 40 – 50 years (n = 29) of the age group 51 – 60 years is (n = 16); 61 and older (n = 10) and the age group 18 – 28 (n = 9). Only n = 3 participants did not respond to the age question.

The majority, n = 66 respondents reported that they were unemployed, followed by n = 21 that indicated that they had part-time jobs and those who were self-employed at 6%, those that did not respond to this question (n = 3), a further n = 3 indicated that they have full-time jobs and only one respondent reported to be a student.

Furthermore, the majority of the respondents (n = 31) stated their highest level of education as secondary schooling. Primary school level was next with (n = 30), respondents who obtained matric were (n = 18), and those with no schooling were (n = 16) and participants that did not respond to this question were (n = 3), with a negligible number of respondents (n = 2) who indicated that they have tertiary education.

5.4 Early warning systems and disasters

Respondents were asked whether they understood the term disaster and the majority of the respondents (n = 68) answered yes to understanding the term disaster followed by respondents who answered no (n = 29) to the question, and a negligible number of respondents (n = 3) did not answer this question (Figure 5.1).

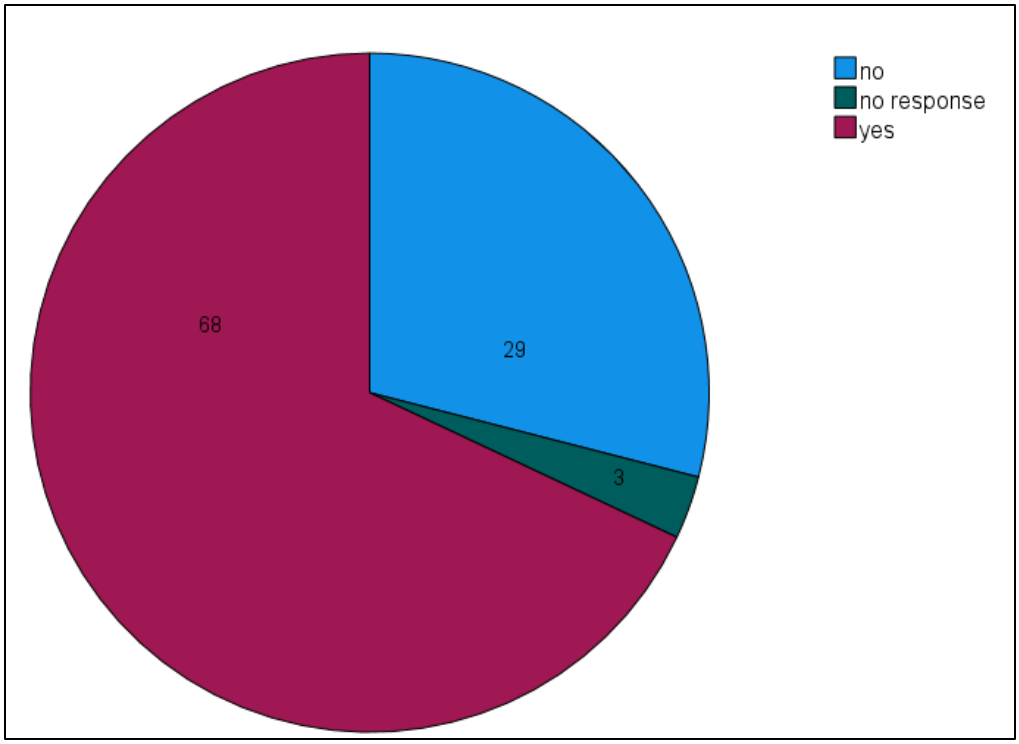

Figure 5.1: Respondents understanding of the term disaster.

The respondents were further asked the question, do you understand the term early warning systems (EWS.)?. Most of the respondents, n = 53 responded no, 44% responded yes and n = 3 chose not to respond to this question. Furthermore, the respondents were asked to state the type *of disasters that occur frequently in their area*, the majority,n = 60 reported fires, followed by n = 29 that reported heavy thunderstorms with floods. Six percent (n = 6) did not respond to this question, n = 2 reported drought and a further n = 2 reported heavy rain with hail, with only one respondent who reported other disasters without specifying them. It should be noted that respondents referred to fires as the most common disasters within the study area, fires have not been declared as disasters in this areas, this may indicate that the respondents actual referred to the most common hazard instead of declared disasters.

The study applied the Chi-square test (χ^2) of independence to assess the relationship between the responses for the question which asked if the respondents understood the term disaster and the frequency of common disasters occurring in the study area. The Chi-square test showed no significant difference (χ^2= 8.2; df = 10; *P*=0.609) between the responses when the question of understanding the term disaster and which disasters are frequenting the study area were cross-tabulated, the P-value was greater than 0.005, meaning there was no statistical relationship

between these two questions. In addition, the majority of the respondents who answered yes to understanding the term disaster, n = 37 stated fires as the most common disaster, followed by heavy thunderstorms with floods at 23%; no responses at n = 4; heavy rainfall with hail and drought were reported equally at n = 2 each by the respondents (Figure 5.2).

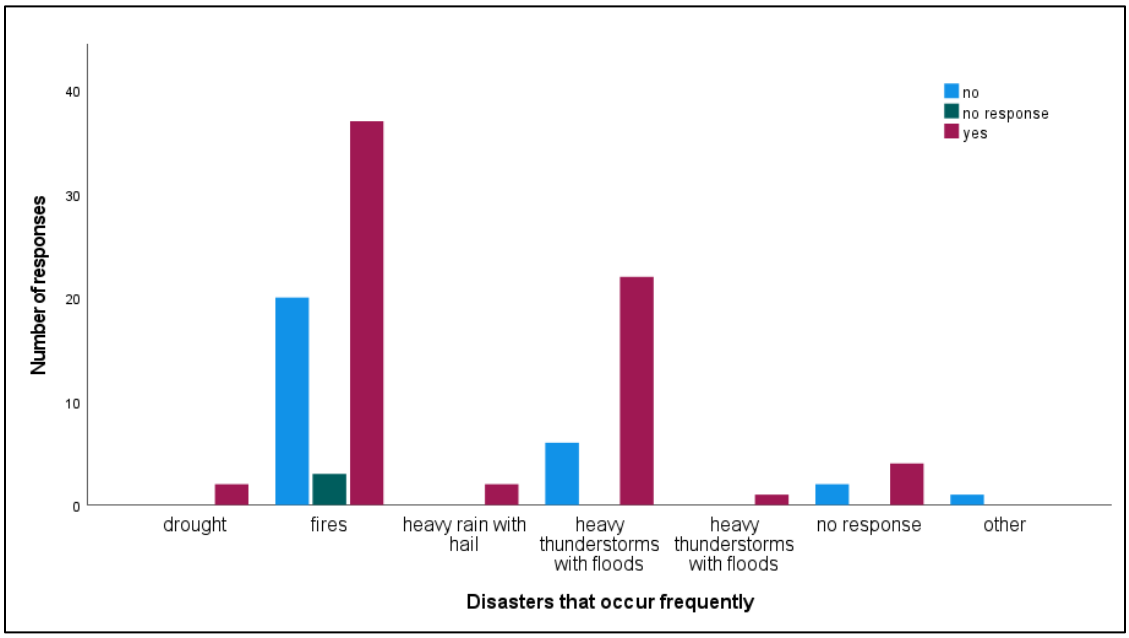

Figure 5.2: Correlation between understanding the term disaster and which disaster commonly occurs in the study area.

5.5 Communication flow

To ascertain communication flow between the municipality and community members, this study asked the respondents if they own a cellphone. The majority (n = 82) reported that they own a cellphone, followed by (n = 17) who reported not owning a cellphone and only one respondent chose not to respond to the question of owning a cellphone (Table 5.1). The study further asked the respondents if they understood what is meant by disaster early warning messages and the majority of the respondents, n = 53 responded no to this question, whereas n = 44 responded yes, and n = 3 of the respondents chose not to respond to this question (Table 5.1).

As a follow-up question, this study asked the respondents if they had ever received early warning messages from the municipality and if the messages were received on time. Most of the respondents (n = 75) said no, followed by (n = 22) respondents who said yes and (n = 3) number of respondents did not respond to the question of receiving early warning messages (Table 5.1). Consequently, and almost consistent with the number of the respondents that reported yes to

receiving early warning messages, the worrying number of respondents (n = 4) reported that the early warning messages they received were not on time. Nevertheless, the study recorded most of the respondents reported that early warning messages are not received on time (n = 67), and a negligible number of respondents (n = 13) chose not to respond to this question (Table 5.1).

In addition, most respondents (n = 53) reported that they understand the early warning messages, whereas (n = 44) respondents reported that they do not understand the early warning messages, and a negligible number of respondents n = 3 chose not to respond to this question (Table 5.1).

Table 5.1: Early warning messages

Questions	**yes**	**no**	**no responses**
Do you own a cellphone?	82	17	1
Have you ever received early warning messages from the municipality?	22	75	3
Are the warning messages received on time?	20	67	13
Do you understand early warning messages?	53	44	3

Source: survey results, 2020

Respondents who answered no (n = 75) to not receiving the early warning messages from the municipality, n = 46 stated the reason why they thought they had not received the early warning messages from the municipality. They cited lack of electricity and data, even though sms do not require data, followed by n = 29 who did not specify why they thought they did not receive early warning messages from the municipality.

When the respondents were asked, which methods the municipality uses to disseminate early warning messages to the community, the majority of the respondents (n = 54) did not respond to this question. Thirteen percent (n = 13) indicated that they received early warning messages through community leaders, followed by n = 12 that reported social media, those who indicated other sources were 9%, those who indicated that they received early warning messages through short message service (SMS) was n = 7, the least percentage of respondents n = 5 reported to receiving messages through the councilors (Figure 5. 3).

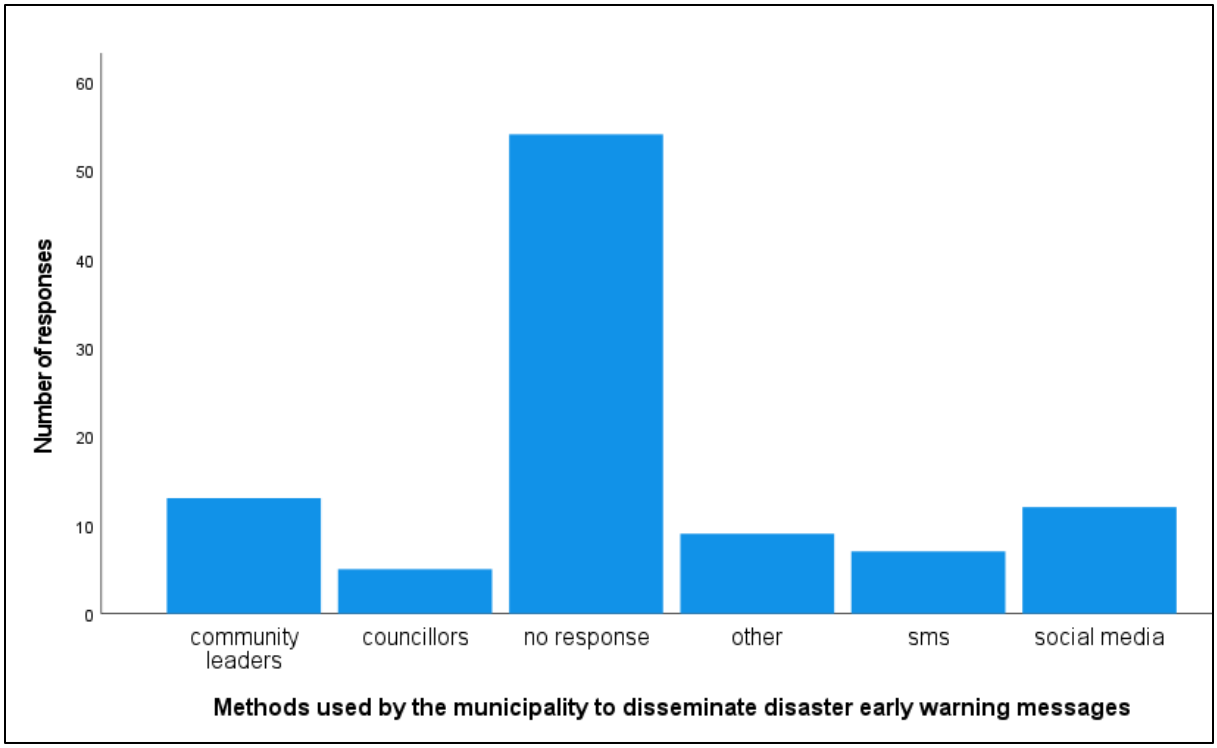

Figure 5.3: Methods used by the municipality to disseminate early warning messages

Respondents were asked who communicated early warning messages to them. The majority of the respondents n = 50 highlighted community leaders as the source of their early warning messages. Twenty-six (n = 26) did not respond to the question, n = 9 selected disaster management officials, n = 8 selected other but did not specify which other sources of information, n = 4 selected metro police and n = 3 indicated that they received their early warning messages from councilors (Figure 5.4).

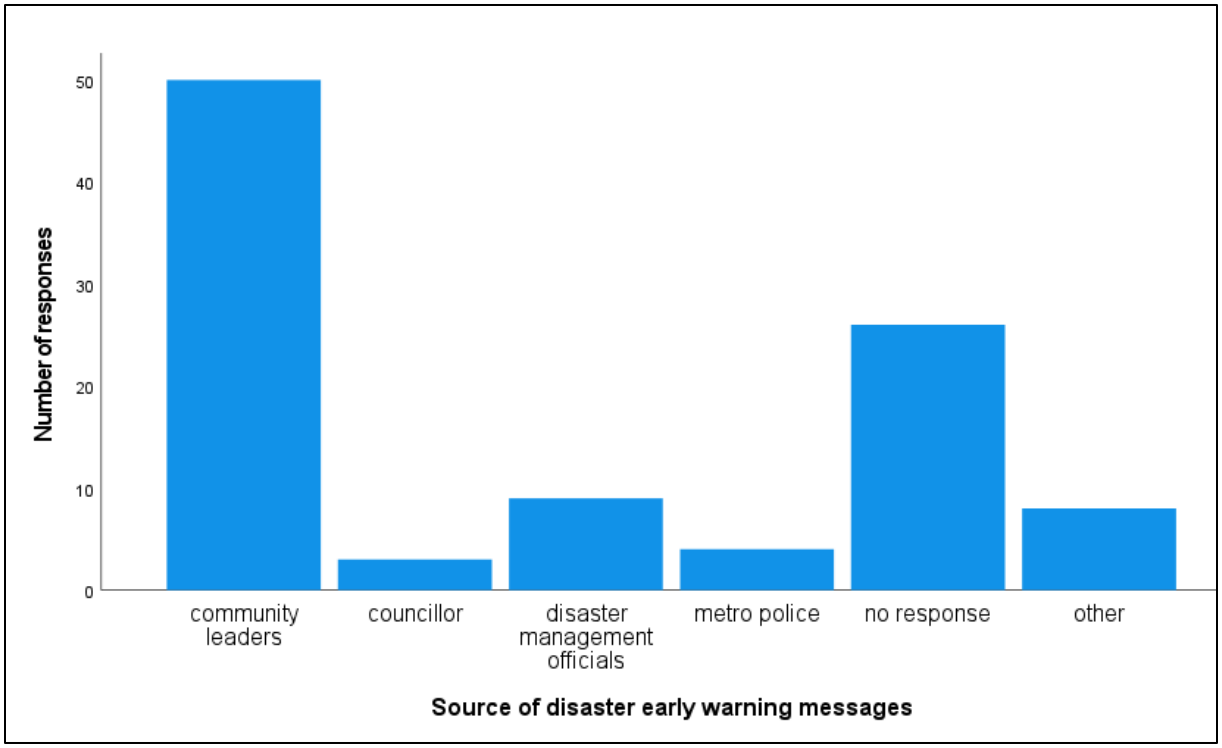

Figure 5.4: Source of early warning messages.

5.6 Opinions and perceptions on early warning messages

To gauge the opinions and perceptions of the community on information relating to early warning systems, this study used the most important question of the study "Do you receive early warning messages from the municipality?" and the responses to this question were correlated with ten Likert scale questions of this study. This question was singled out of other questions as it is very important in addressing the main objective of this study and because most of the respondents, 75% reported "*no*" to receiving early warning messages from the municipality. Therefore, some relationships between responses could exist and these relationships can assist in putting the study into perspective. Ten Likert scale questions were cross-tabulated with this question as follows.

5.6.1 Understandability of early warning messages

In total 75 out of 100 respondents reported "*no*" and 22 reported "*yes*" to receiving early warning messages. In addition, there was a significant difference between the number of yes and no response (χ^2= 28.1; df = 10; *P*=0.002). Three respondents chose not to answer this question. Of the 75 respondents who indicated that they have not received early warning messages from the

municipality, the majority n = 49 strongly disagreed with the statement that the early warning messages communicated to them are always easy to understand. This was followed by n = 10 who neither agreed nor disagreed with this question, n = 7 did not respond to the question, n = 5 slightly agreed with the statement and 4% strongly agreed with this statement (Figure 5.5; Table 5.2). Twenty-two percent (n = 22) of the respondents who answered yes to receiving early warning messages n = 8 slightly agreed to the question that the early warning messages communicated are easy to understand, n = 7 neither agreed nor disagreed with the question, 4% strongly disagreed, n = 1 strongly agreed, another n = 1 slightly disagreed and a further n = 1 did not respond to the question. Of the 3% who did not respond to the question of receiving early warning messages, all 3 disagreed to the question that early warning messages communicated by the Municipality are easy to understand.

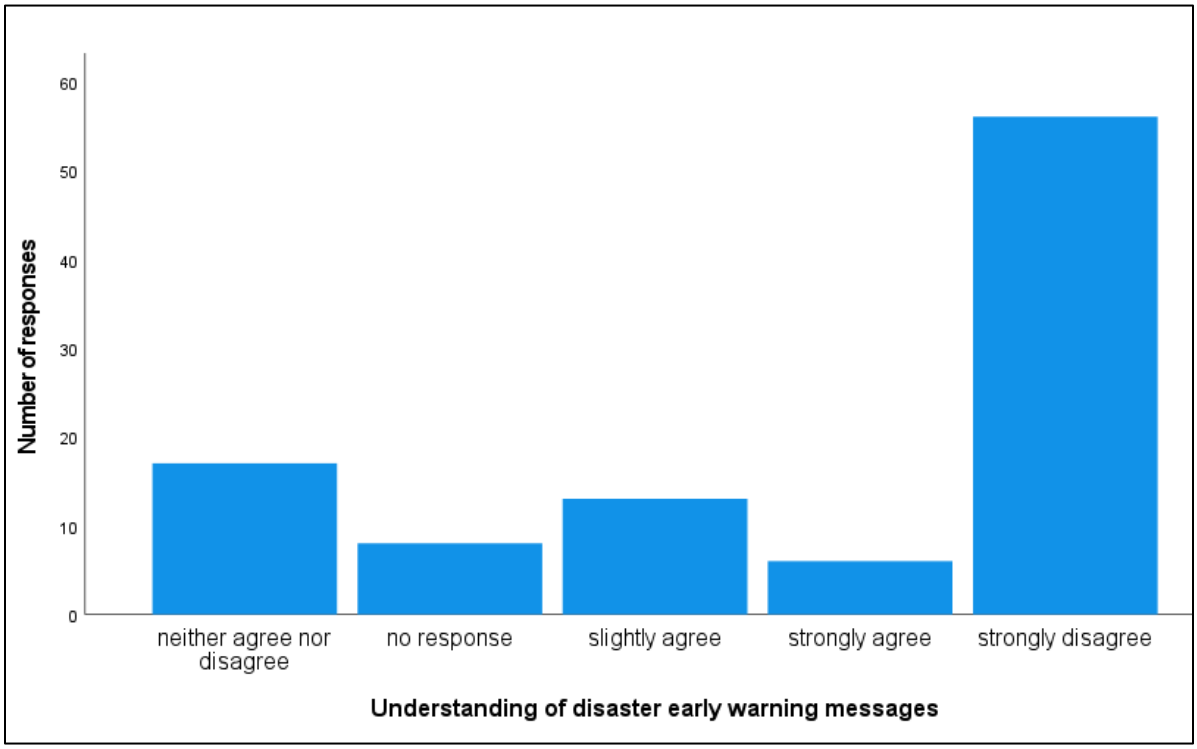

Figure 5.5: Understandability of early warning messages.

Abur-Bader (2021) states if the P-value of the chi-square results is lower than the designated standard of 0.005 that means that there is a significant relationship that should be discussed between the variables correlated. The P-value of <0.002 in this question indicates that there is a relationship between receiving disaster early warning messages and understanding the received disaster messages. The association between the respondent's responses to the main question of

this study could not be ignored. A high number of respondents said no to receiving early warning messages and a high number strongly disagreed with the statement that the early warning messages are easy to understand. These findings imply that there is a significant problem between the City and the study community when it comes to communication. There seems to be a communication breakdown between the Municipality and the community of Vosloorus.

The Municipality must provide the community with disaster alerts and communication about what has to be done during the floods (Intrieri et al., 2020). It is important for the Municipality to outline how social media can be incorporated effectively in the dissemination of early warning messages to bridge the communication gap between the City of Ekurhuleni and the affected communities (Brynielsson et al., 2018), social media should be implemented in a manner that will take into consideration that access to cellphone and data may be a challenge for some community members . On the question whether the language used to disseminate early warning messages is easily understood by the community members, n = strongly disagreed. This may indicate that, the Municipality should consider translation of the communicated early warning messages into the local languages of the affected communities (O'Brien & Federici, 2019).

Table 5.2 is a representation of the cross-tabulation of the yes, no and no responses to the question, "have you ever received early warning messages from the municipality" and the question "are the early warning messages communicated to you always understandable"?

Table 5.2: Cross-tabulation of responses of whether respondents received early warning messages and if they understood the messages

Parameters	**yes**	**no**	**no responses**	**Total**
Neither agree nor disagree	7	10	0	**17**
No response	1	7	0	**8**
Slightly agree	8	5	0	**13**
Slightly disagree	1	0	0	**1**
Strongly agree	1	4	0	**5**
Strongly disagree	4	49	3	**56**
Total	**22**	**75**	**3**	**100**

5.6.2 Early warning messages and levels of literacy

To ascertain that recipients of early warning messages are able to read the messages they received from the Municipality, this study asked the respondents if the early warning messages communicated by the Municipality accommodated people who cannot read, and cross tabulated the responses with the question of receiving early warning messages. The majority, n = 55 of the respondents out of the n = 75 who answered no to receiving early warning messages strongly disagreed with the question that the early warning messages communicated by the Municipality accommodate people who cannot read. Seven percent (n = 7) neither agreed nor disagreed with the question, n = 6 strongly agreed, 3% did not respond to the question, n = 2 slightly agreed and a further n = 2 slightly disagreed.

Nine of the 22 respondents who agreed to receiving early warning messages neither agreed nor disagreed with the question whether early warning messages received by the community accommodated people who cannot read, n = 8 slightly agreed, n = 3 strongly disagreed and n = 2 strongly agreed (Figure 5.6).

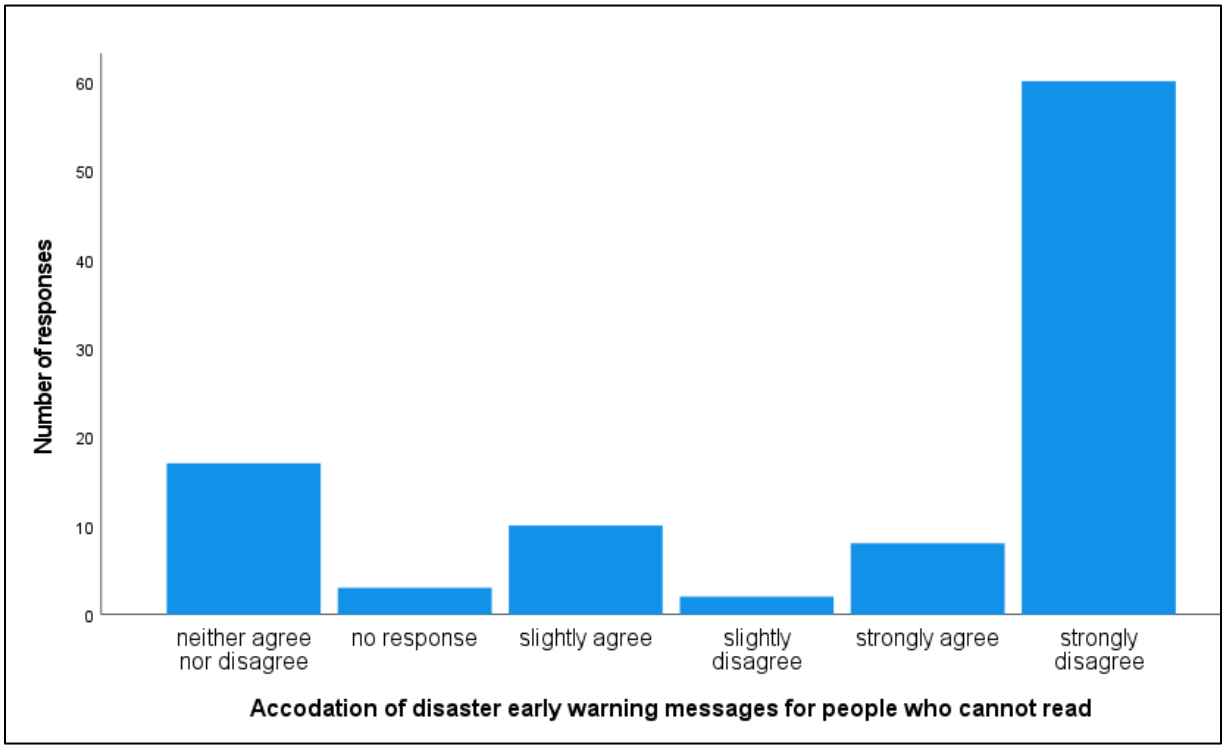

Figure 5.6: Accommodation of early warning messages for people who cannot read

Of the n = 3 who did not respond to the question, "*have you ever received early warning message"?*, n = 2 strongly disagreed that the received early warning messages accommodate people who cannot read and n = 1 neither agreed nor disagreed. This finding is not surprising as Vosloorus is a close knit community, affected mostly by floods, therefore the 2 respondents could have heard from their neighbours and friends that the messages they receive are not accommodating people who cannot read.

Table 5.3 represents the cross-tabulation of the yes, no, and no responses to the question, "Have you ever received early warning messages from the municipality", and the question; "Do the early warning messages communicated to your community members accommodate people who cannot read"?

Table 5.3: Early warning messages and levels of literacy

Parameters	**yes**	**no**	**no responses**	**Total**
Neither agree nor disagree	9	7	1	**17**
No response	0	3	0	**3**
Slightly agree	8	2	0	**10**
Slightly disagree	0	2	0	**2**
Strongly agree	2	6	0	**8**
Strongly disagree	3	55	2	**60**
Total	**22**	**75**	**3**	**100**

5.6.3 Early warning messages and dissemination language

Of the 22 respondents who reported yes to receiving early warning messages from the municipality, the majority, n = 8 slightly agreed, n = 7 neither agreed nor disagreed. Five strongly disagreed, n = 1 slightly disagreed and n = 1 strongly agreed that the language used to communicate the disaster early warning messages is commonly understood by the community members in their area (Figure 5.7). The three respondents who did not answer the question on receiving early warning messages strongly disagreed with the question that language used in early warning messages is commonly understood.

The findings also indicated that five respondents strongly disagreed that the language used to disseminate early warning messages is commonly understood. The inclusion of the three

respondents that did not indicate that they are receiving early warning messages makes the majority of the respondents (n=8 in total). This might imply that 8 out of 22 people who are currently receiving the early warning messages could be in danger of the impending disaster because of the language the Municipality is using to disseminate the early warning messages. This implication should be a concern in terms of evacuation procedure should warning messages be about evacuation. CoE should take into consideration that there are multi languages spoken by the community of Vosloorus Township, this aspect should be incorporated in the messages that are disseminated to this community.

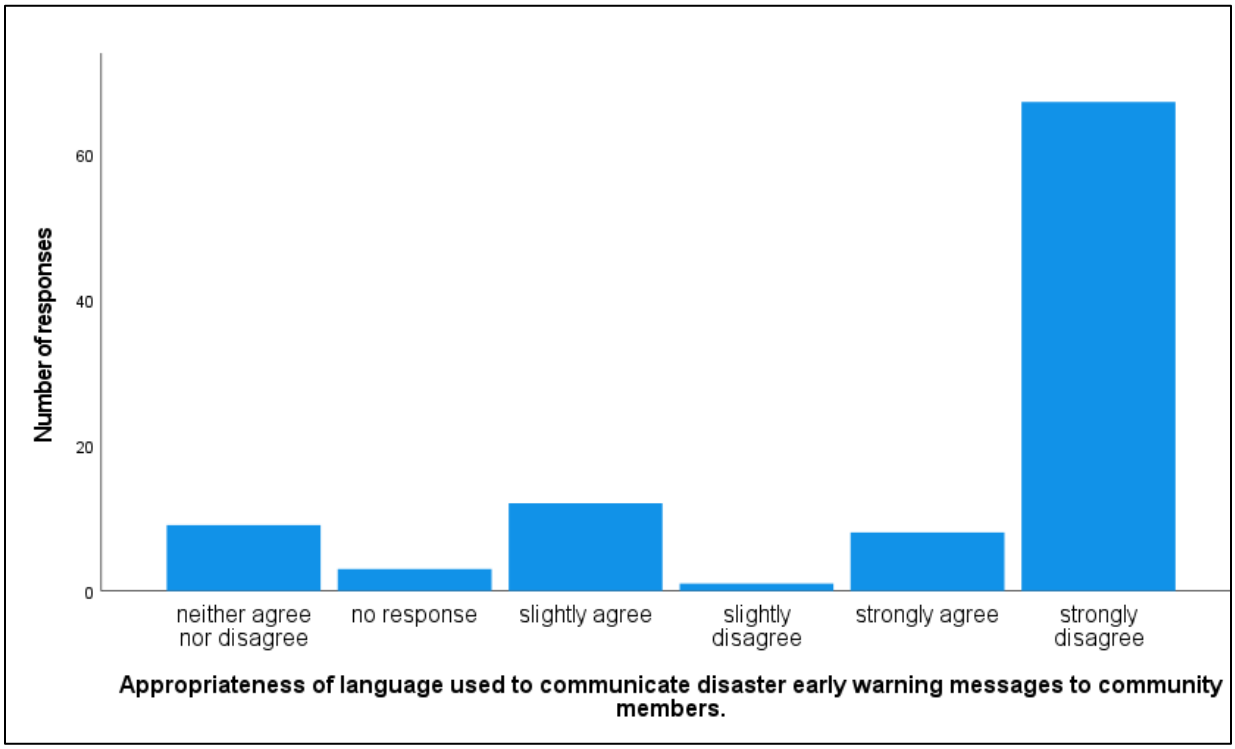

Figure 5.7: Appropriateness of language used to communicate disaster early warning messages to community members.

5.6.4 Early warning messages specific to each area

The 22 respondents who answered "*yes*" to receiving early warning messages, n = 6 strongly disagreed that the disaster early warning messages communicated were specific to each area, n = 6 slightly agreed, n = 6 neither agreed nor disagreed, n = 2 strongly agreed and a further n = 2 slightly disagreed (Figure 5.8). Furthermore, the n = 3 that did not respond to the question of whether they ever received early warning message, strongly disagreed with the question whether the disaster early warning messages are specific to each area. This makes the number of

respondents who strongly disagreed that the disaster early warning messages are specific to each area the highest (n = 9). This finding indicates that the City of Ekurhuleni Municipality could be disseminating early warning messages randomly, without being specific to the area likely to be affected by the looming disaster.

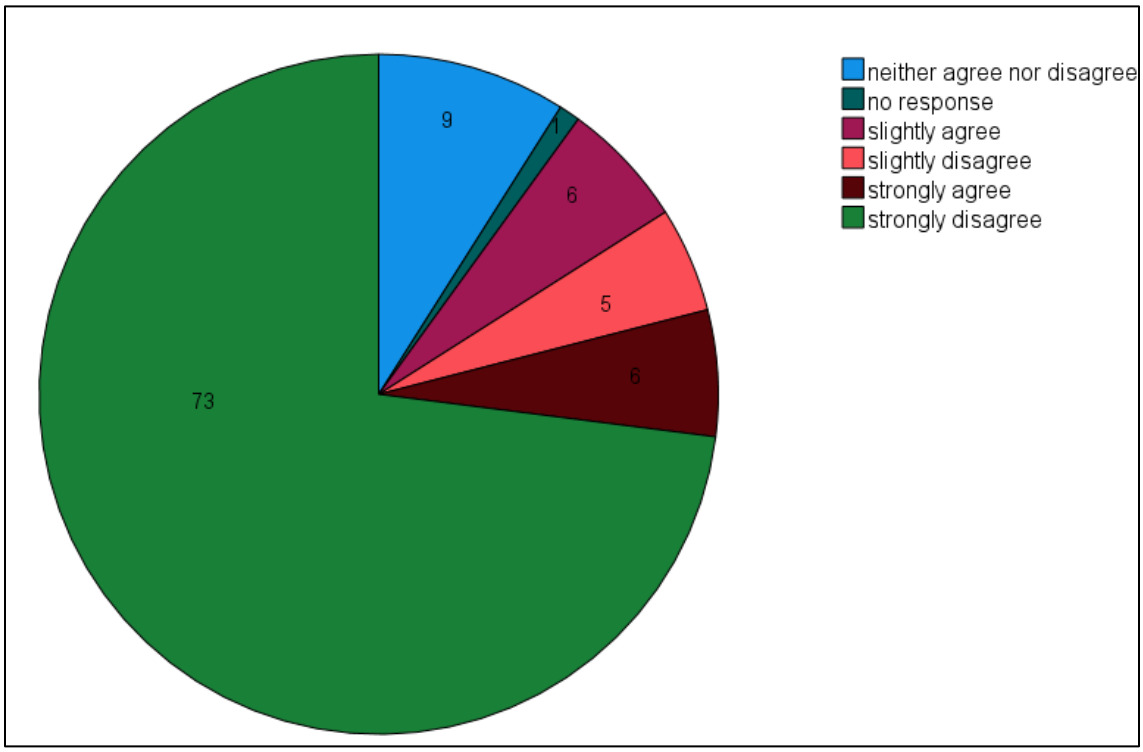

Figure 5.8: Disaster early warning messages specific to each area.

5.6.5 Timeous dissemination of early warning messages

From the 22 respondents who answered “yes” to receiving early warning messages, the majority, n = 8 strongly disagreed to the question of whether disaster early warning messages were communicated early enough to allow the community to take protective measures? n = 7 neither agreed nor disagreed with the question, n = 6 slightly agreed, and n = 1 slightly disagreed (Figure 5.9). Of the n = 3 who did not respond to the question about receiving early warning message, even though they did not respond to the question on receiving early warning messages, n = 3 strongly disagreed with the question about disaster early warning messages being communicated early enough to allow the community to take protective measures. This makes the number of respondents who disagreed with the question the highest at n=11. This finding implies that 11 people in the study might not be able to take protective measures amidst a looming disaster, and

therefore, they might be vulnerable to the said disaster because of the messages not being communicated early enough for them to take protective measures.

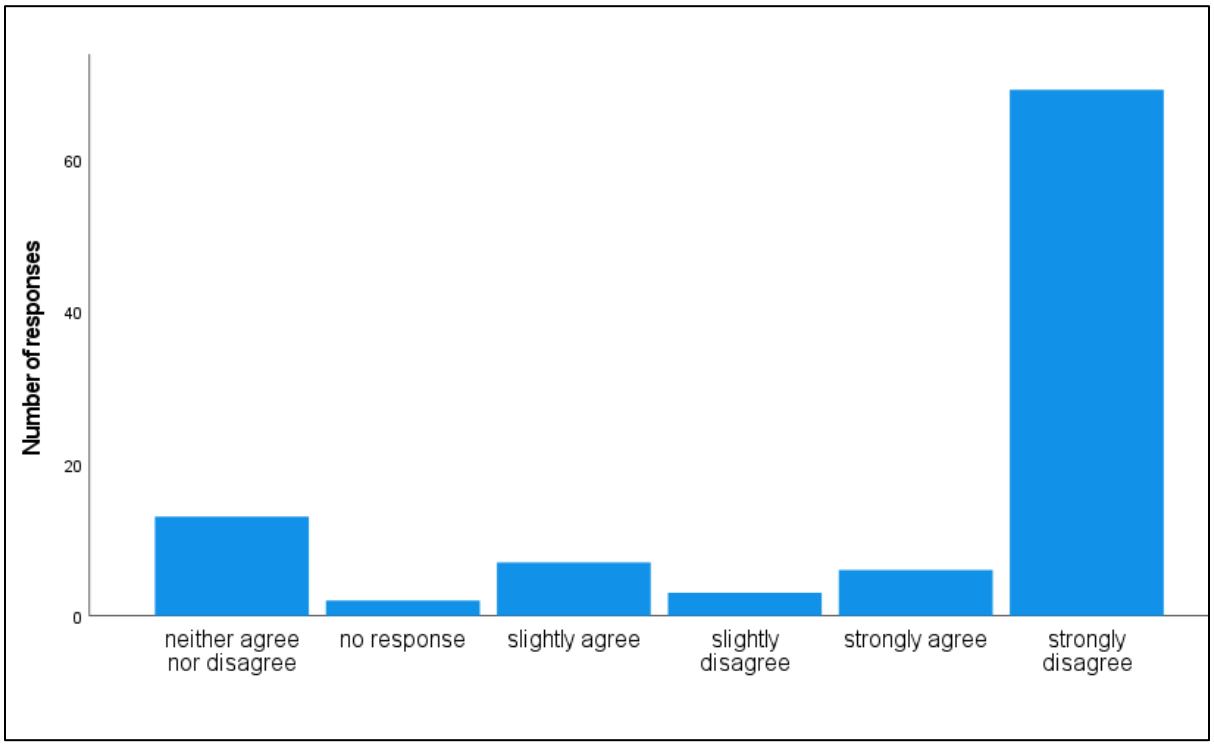

Figure 5.9: Timeous dissemination of disaster early warning messages to allow community members to take protective measures.

5.6.6 Effectiveness of the early warning messages

The respondents who answered "*yes*" to receiving early warning messages, n = 8 neither agreed nor disagreed, 6% strongly disagreed, n = 6 slightly agreed, n = 1 strongly agreed and a further n = 1 slightly disagreed with the statement, "*the disaster early warning messages communicated state clear actions to be taken by the community members in your area*" (Figure 5.10).

Even though n = 3 did not respond to the question regarding receiving early warning messages, the n = 3 strongly disagreed with the question that the disaster early warning messages communicated state clear actions to be taken by the community members. This makes the number of respondents who strongly disagreed with the statement, "*the disaster early warning messages communicated state clear actions to be taken by the community members in your area*" the highest at n = 9.

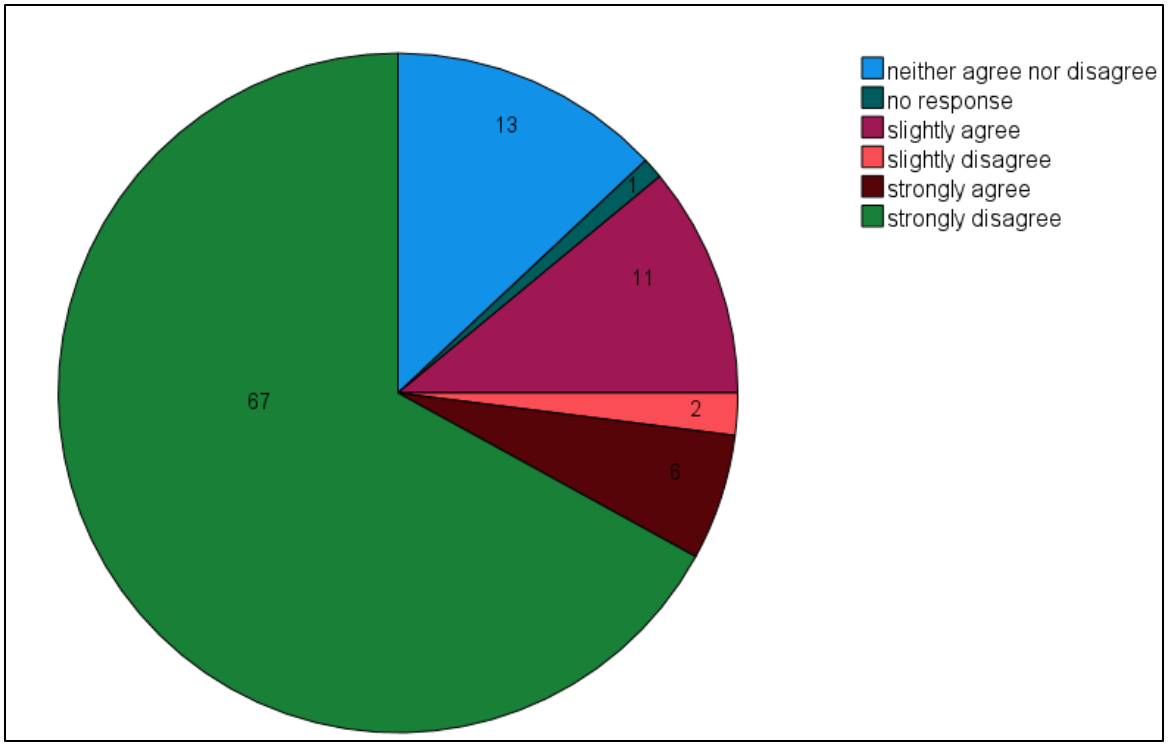

Figure 5.10: Communication of disaster early warning messages with clear actions to be taken by community members.

5.6.7 Early warning messages and social media

The respondents, n = 22 who answered "*yes*" to the question about receiving early warning messages, n = 8 slightly agreed with the question "*would you act on disaster early warning messages communicated to you through social media*? n = 6 strongly disagreed, n = 4 strongly agreed and a further n = 4 neither agreed nor disagreed (Figure 5.11). Of the n = 3 who did not respond to the question about receiving early warning messages n = 3 strongly disagreed with the question of whether they would act on early warning messages communicated through social media. This again makes the number of respondents disagreeing with taking actions if the early warning messages are received through social media the highest at n=9 respondents. According to Budimir et al. (2020), most people around the world are sceptical about information received through social media.

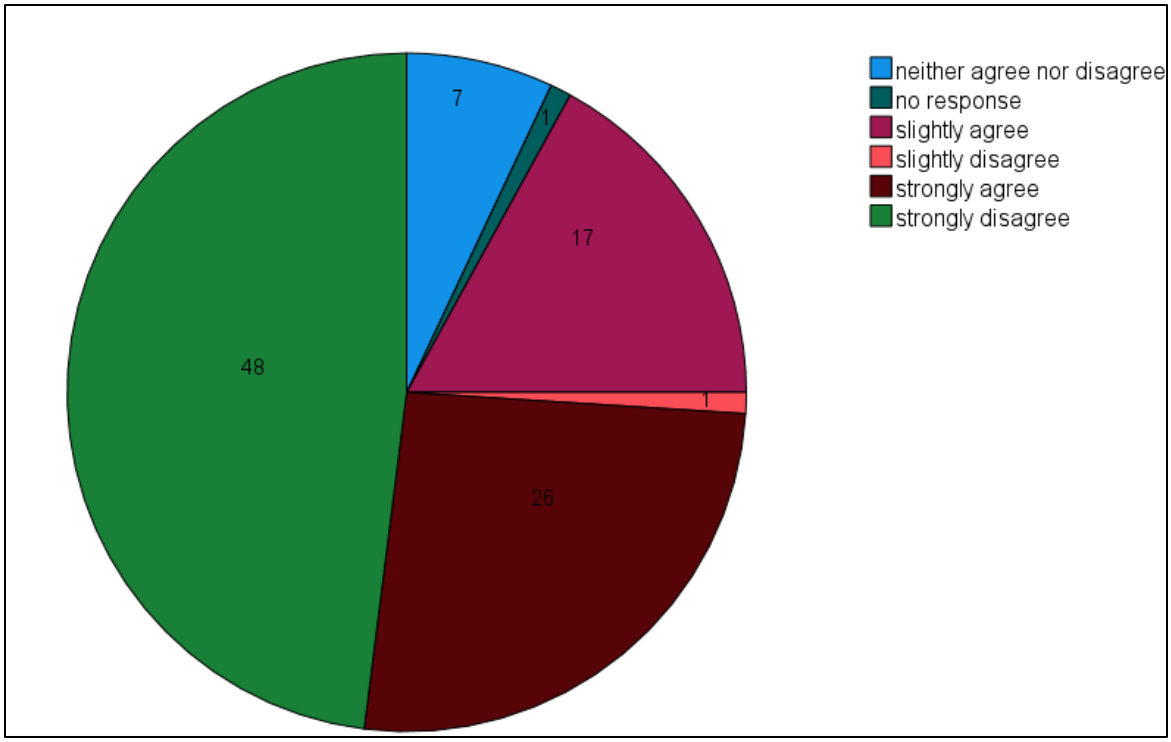

Figure 5.11: Opinions regarding whether respondents would act on disaster early warning messages communicated through social media.

5.6.8 Early warning messages and radio stations

To gauge the reliance of respondents on community radio stations, this study asked the respondents *if they would act on disaster early warning messages communicated through announcements on the community radio station*. Of the n = 22 respondents who reported yes to receiving early warning messages, n = 9 of the respondents neither agreed nor disagreed with the question regarding whether they would act on disaster early warning messages communicated through announcements on the community radio station. Whereas n = 5 slightly agreed, n = 4 strongly agreed, 3% strongly disagreed and n = 1 slightly disagreed. Even though n = 3 did not respond to the question on whether they have ever received early warning systems, the n = 3% slightly disagreed with the question regarding if they would act on disaster early warning messages communicated to them through announcements on the community radio station (Table 5.4).

The finding of the majority of respondents being neutral (neither agree nor disagree) was not surprising, since people tend to rely on traditional news sources more as compared to social media. Table 5.4 represented responses and opinions pertaining to the question whether

respondents would act on disaster early warning messages communicated through announcements on the community radio station.

Table 5:4: Reponses from respondents regarding whether they would respond to early warning messages communicated via the community radio station

Parameters	yes	no	no responses	Total
Neither agree nor disagree	9	7	0	**16**
Slightly agree	5	5	3	**13**
Slightly disagree	1	2	0	**3**
Strongly agree	4	6	0	**10**
Strongly disagree	3	55	0	**58**
Total	**22**	**75**	**3**	**100**

5.6.9 Early warning messages and community trust

There are trust issues regarding disaster information communicated by the Municipality. The respondents, n = 22 who answered yes to receiving early warning messages, n = 8 neither agreed nor disagreed to the question whether the community trusted the early warning messages communicated by the Municipality, n = 7 slightly agreed, n = 4 strongly disagreed and n = 3 strongly agreed (Table 5.5). Some responses were neutral as the majority indicated some level of trust and hesitancy to the question.

Table 5.5 represented responses and opinions to the question of whether community members trust disaster early warning information communicated by the Municipality.

Table 5.5: Reponses regarding community members trust of disaster early warning information communicated by the municipality

Parameters	yes	no	no responses	Total
Neither agree nor disagree	8	3	0	**11**
Slightly agree	7	7	0	**14**
Slightly disagree	0	1	0	**1**
Strongly agree	3	40	2	**45**
Strongly disagree No response	4 0	23 1	1 0	**28** **1**
Total	**22**	**75**	**3**	**100**

5.6.10 Effectiveness of early warning messages disseminated by the municipality

The majority, n = 53 of the respondents who answered "*no*" to receiving early warning messages strongly disagreed that the way the Municipality disseminates early warning messages is effective. These results may indicate that there is room for improvement in the manner in which the City of Ekurhuleni disseminates disaster early warning messages, this improvement may be incorporated in disaster communication strategies and policies that will ensure that the Municipality implements disaster risk management holistically.

Regarding early warning systems and their effectiveness, of the n = 22 of the respondents who answered "*yes*" to receiving early warning messages, n = 9 neither agreed nor disagreed to the question regarding whether the way the municipality disseminates disaster early warning messages is effective, n = 6 slightly agreed, 5% strongly disagreed, n = 2 strongly agreed (Figure 5.12).

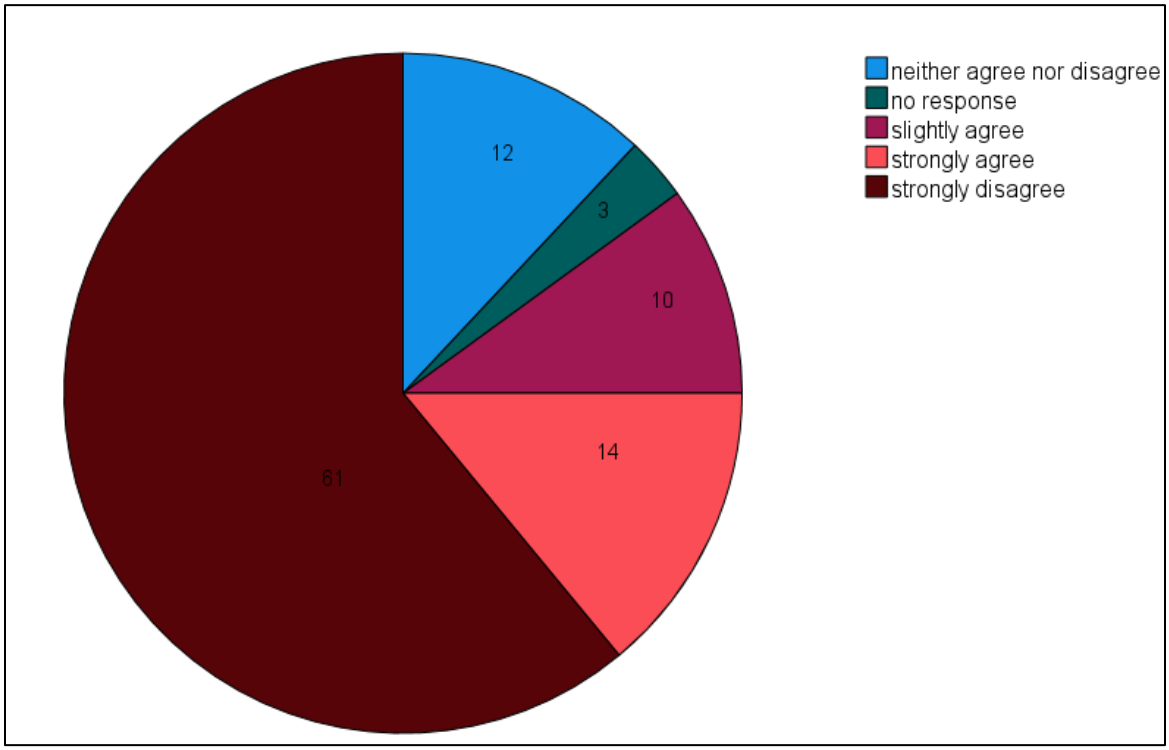

Figure 5.12: Effectiveness of early warning messages disseminated by the municipality

Although, n = 3 did not respond to the question on whether they have ever received early warning messages, the entire n = 3 strongly disagreed with the question about whether the way the

municipality disseminate's disaster early warning messages is effective. The results show the number of respondents who are neutral, neither agreed nor disagreed to be n = 9, when respondents were asked the question of the effectiveness of the early warning messages. The neutral response could imply that community members might not be aware of how everyone reacts to early warning messages because during impending disasters, people tend to panic and only focus on themselves and their families (Gan and Dwirahmadi, 2020).

5.7 Impacts of floods

Respondents were asked if they had received early warning messages during the recent 2019 floods, and of the 100 respondents, the majority (n = 81) said they had not received early warning messages. A negligible number of respondents (n = 18) reported that they had received early warning messages for the 2019 floods, and n = 1 respondent chose not to answer this question.

Consequently, the questions that focused on community-based strategies for coping with floods were analysed descriptively, the respondents were asked, what was the impact of the 2019 floods in their household? The majority, n = 55 of the 81 respondents who answered "no" to receiving early warning messages before the 2019 floods stated flooded homes as the impact of the 2019 floods. This was followed by 17% who said they lost important documents, n = 4 dropped out of school, n = 3 did not respond to the question, 1% said they experienced flood-related deaths and a further n = 1 stated flood-related illness.

The respondents who said yes (n = 18) to receiving early warning messages for 2019 floods, n = 8 did not respond to the question, n = 6 stated that their homes were flooded, n = 2 said they dropped out of school, n = 1 experienced flood-related deaths and n = 1 stated flood-related illness. However, the n = 1 who did not respond to the question of what the impact of those floods in their household was, stated that their homes were flooded. In disaster-prone areas people tend to contradict themselves, hence, this study found contradiction with 1 respondent who chose not to respond to the question, but later responded to the follow-up question which was not applicable to them (Table 5. 6).

Table 5:6: Cross-tabulation of responses regarding not receiving warnings and the impacts of 2019 floods on respondents' homes

Flood impacts	No	Yes	No responses	Total
Flooded homes	55	6	1	62
Loss of documents	17	0		17
Dropped out of school	4	2		6
No response	3	8		11
Flood related deaths and illnesses	2	2		4
Total	**81**	**18**	**1**	**100**

5.8 Flood mitigation measures

The majority of the respondents (n = 65) think the formation of flood management committees will work best as flood mitigation measures in their area. This is followed by (n = 17) who think training community members in warning and evacuation plans will work best as flood mitigation measure in their area. An equal number of respondents (n = 3) each think availability of flood action plans for the community and provision of communication equipment for efficient information dissemination will work best as mitigation for flood disasters in their area. One respondent thought raising awareness and preparedness programmes amongst community members pending floods will work best for their community as a mitigation measure in their area and (n = 11) respondents chose not to answer this question (Figure 5.13).

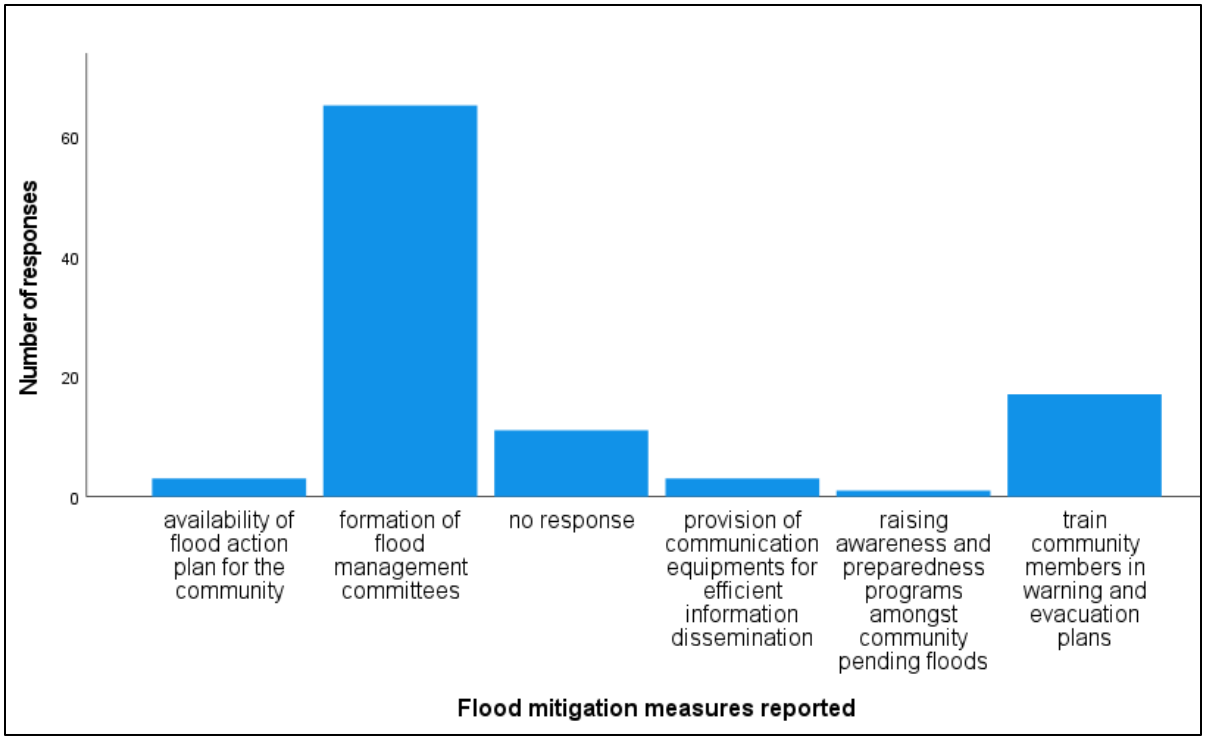

Figure 5.13 Flood mitigation measures.

5.9 Summary of the research findings

This section of the chapter presents a summary of the research findings based on the study's objectives. The research study revolved around 4 objectives as follows.

Objective 1: focused on reviewing strategies that inform choice of methods used for dissemination of disaster early warning messages by Ekurhuleni metropolitan to the community of Vosloorus. The majority of the respondents n = 54 did not respond to the question, which method does the municipality use to disseminate early warning messages, this may indicate that startegies underpinning dissemination of early warning messages do not take the needs of the community of Vosloorus into considertaion. Acosta-Coll et al. (2021) state that it is critical to choose appropriate strategies that will inform dissemination of early warning messages to affected communities. It is critical for the City of Ekurhuleni to consider implementation of people centred early warning dissemination strategies.

Objective 2 of the study set to identify methods previously used to disseminate early warning messages within the townships in Ekurhuleni municipality. This study found that the majority of the respondents n = 13 reported community leaders as their source for receving early warning

messages, followed by social media (n=12) as the two leading sources of early warning messages. Again, community radio stations were reported by this study as a reliable source for early warning messages. This result may indicate that the community members of Vosloorus Township did not support the methods previously used by CoE to disseminate disaster early warning messages. Therefore, the majority of the respondents reporting community leaders as their source of early warning messages may also ascertain that existing communication between CoE and the leaders of the communities should be intensified to ensure effective dissemination of early warning messages. In KwaZulu Natal province, for example, involving community leaders in dissemination of early warning messages proved beneficial (Mahomed et al., 2021). Moreover, including community leaders in community based EWS will assist the CoE in disseminating early warning messages effectively. Mahomed et al. (2021) reported that community based EWS assisted by providing effective communication flow of early warning messages.

Objective 3 set out to evaluate issues that hinder early warning systems to function in a successful manner within the community of Vosloorus. The City of Ekurhuleni should look at community engagements that will assess the impact made by the existing early warning systems and identify issues that hinder their effectiveness. It is therefore, imperative for government to plan for community engagements that will enable the community to be more receptive to existing early warning systems (Sufri et al., 2020). Furthermore, budget limitations that hinder the City of Ekurhuleni from implementing effective early warning systems should be addressed as well. Lumbroso et al. (2018) indicate that countries such as Uganda have failed to implement effective early warning systems due to challenges relating to budget. CoE IDP does not state any existing disaster early warning dissemination policies.

Objective 4 evaluated aspects of existing disaster policies and procedures that are hindering current communication processes not to be implemented in an effective manner. It is critical for the City of Ekurhuleni to develop policies that are accompanied by standard operating procedures that will address challenges relating to the effective implementation of existing early warning systems (Ibrahim et al., 2021). The standard operating procedure developed for early warning policies should assist the City of Ekurhuleni in identifying gaps in procedures used for response and evacuation once disaster alerts have been disseminated to the community (Jayasekara et al., 2021). This study recommends that the City of Ekurhuleni outlines in the existing policies, how challenges relating to human resoureces, funding and response measures will be addressed to implement high quality early warning warning systems (Husna et al., 2021). Initiatives by the City

of Ekurhuleni in addressing issues relating to policy that hinders successful implementation of early warning systems will save lives from disasters such as floods.

5.9.1 Early warning systems and the impacts floods

This study found that the majority of the respondents n = 62 indicated that the impacts of the 2019 floods resulted in their homes being flooded. This may be attributed to the failure of early warning systems to provide disaster alerts that are informative enough for the community to take actions that will lessen the impacts of such disasters. Yore and Walker (2021) argue that it is critical for early warning systems to provide guidelines of what the community must do when disaster alerts are received to lessen the impacts of pending disasters. Furthermore, early warning systems should disseminate messages that will build resilience and lessen the impacts of disasters such as floods within the affected communities (Baudoin et al., 2014). Also, flood early warning systems should be linked to response measures that will assist the affected communities' to lessen impacts of flooded homes during disaster events, this is important for communities such as Vosloorus (Hammood et al., 2020). Such measures will ensure that implemented early warning systems are effective and efficient.

The relationship revealed by the chi-squared test between the understanding of the term disaster and the disaster that is prevalent in the study area ascertains that communities in bigger cities know and understand disasters (Gianisa and Le De, 2018) as the majority of the respondents also reported fires that are frequently experienced in their area.

5.9.2 Communication flow

The issue of how communication flows to the study communities forms the central part of this study and any other study about disaster early warning message dissemination. The participants were asked if they own a cellphone as it is the quickest form of communication as the world is moving towards the 4th Industrial Revolution. This study found that most of the respondents, n = 82 stated that they own a cellphone, this indicates that the community can receive the early warning messages if communicated to them through cellphones.

The respondents (n = 9) who disagreed with taking actions if the early warning messages are received through social media, are in contrast with a study by Mavrodieva & Shaw (2021) that reported that the use of social media to alert communities of imminent disasters and solicit response has become a critical part of EWS communication flow strategies. Furthermore, Facebook and twitter are among the social media software used not only as measures to ensure

effective communication flow that provides disaster alerts on time but also to map vulnerable areas that require assistance during disasters (Mavrodieva & Shaw, 2021).

The communication flow measures used to disseminate disaster alerts has its own challenges. These include lack of clear actions to be taken by the community members amidst the message and whether the disaster early warning messages are communicated early enough to allow the community to take protective measures (Budimir et al., 2020).

This study found that the number of the respondents who strongly disagreed that disaster early warning messages communicated clear actions to be taken by the community members in their area was the highest (n = 9). Also, the number of respondents who disagreed with the question of whether disaster early warning messages are communicated early enough to allow the community to take protective measures was found to be the highest at (n = 11). This finding implies that 11 people in this study might not be able to take protective measures amidst a looming disaster, and therefore, they might be vulnerable to the said disaster because of messages not being communicated early enough for them to take protective measures. Clear messages in communicating impending disasters are necessary for the avoidance of disasters. The disaster management policies in South Africa provides for disaster communication, as it is required to save lives.

The majority, n = 8 out of 22 of the respondents indicated that the language used to communicate disaster alerts by the CoE is not always understood by the community of Vosloorus. This may be attributed to the formal language used to communicate early warning messages. O'Brien & Federic (2019) state that it is critical to incorporate translation within the communication dissemination measures that are used to notify communities of the impending disasters.In addition, communication flow measures should ensure that disaster alerts are understood by all, especially in multilingual urban communities such as the study area (Hopkins & Van den Hoven, 2021). Similarly, for early warning messages not to be compromised, pictures and color-coding should be incorporated within the communication flow measures to accommodate community members who cannot read (Liu et al., 2017).

5.9.3 Opinions and perceptions of early warning messages

The purpose of this study was to evaluate the effectiveness of disaster early warning dissemination measures implemented by the City of Ekurhuleni. Furthermore, to understand this in context, the question about whether they received early warning messages from the municipality was asked. The majority n = 75 said no, of this, the majority, n = 49 respondents

strongly disagreed with the statement, that early warning messages communicated are always easy to understand. These results may indicate that the municipality is not using the language used by the majority of the respondents, or that disaster management terminologies are used and not translated for the community to understand them.

This study further asked the respondents if the early warning messages communicated by the Municipality accommodated people who cannot read, of the respondents who answered no to receiving early warning messages 55%, which is the majority of the respondents strongly disagreed that early warning messages accommodated people who cannot read. These results may indicate that the early warning dissemination strategies and disaster communication policies implemented by the Municipality do not take into consideration the high level of illiteracy within affected communities.

Regarding the question of whether the language used to communicate the disaster early warning messages and their understandability, by community members in the study area, the majority 59% of the respondents who said no to receiving early warning messages strongly disagreed that the early warning messages are understandable by the community members. This result may indicate that there might be a need for the Municipality to consider other measures of communicating disaster alerts that includes more than one language. In addition, the majority, n = 64 strongly disagreed with the question that the communicated early warning messages are specific to the study area. This finding may indicate that the Municipality should consider disaster communication strategies that can disseminate localised disaster early warning messages instead of randomised dissemination of messages as study participants reported. The respondents who answered no to receiving early warning messages, the majority (n = 58) believed and strongly disagreed that early warning messages communicated to them were early enough to allow them to take protective measures. These results may further indicate that the CoE has to consider using methods that will ensure that affected communities receive disaster alerts well in advance before the disaster.

Evacuation forms a critical part of disaster risk management. Therefore, to ascertain this aspect, the respondents were asked whether the early warning messages communicated to them stated clear actions to be taken by the community members in the event of a disaster. The majority, n = 58 of the respondents who said no to receiving early warning messages disagreed with this statement, those who strongly agreed, slightly agreed and those who neither agreed nor disagreed made up n = 15 of the respondents with n = 5 for each category. As the study area comprised of informal settlements that experienced the negative impacts of floods during rainy

seasons, these results may indicate that the CoE should incorporate evacuation guidelines for informal settlements in emergency response standard operating procedures and guidelines. The P-value = 0.002 indicates that there is a relationship between the communicated early warning messages and the response measures that should be taken by the affected communities, this may be considered as an area of improvement by the CoE.

To ascertain the level of receptiveness to the methods used by the Municipality in the dissemination of early warning messages, the respondents were asked whether they would act on disaster early warning messages communicated through social media during an emergency. The majority n = 42 of the respondents who answered no to receiving early warning messages strongly disagreed that they would act on early warning alerts communicated through social media, n = 19 strongly agreed, n = 9 slightly agreed, n = 3 neither agreed nor disagreed. Respondents who slightly disagreed and those who did not respond to the question were at n = 1 each. The P-value = 0.009 indicates that there is a statistical significance between early warning messages and the use of social media as a method to communicate disaster alerts. These results may indicate that the community within the study area may have other dissemination methods that they prefer.

The majority, n = 40 of the respondents strongly disagreed that the community members in their area trust the disaster early warning information communicated by the municipality. This finding may indicate that the level of trust of the community in the study area may have been affected by historical disaster events where the municipality may not have provided adequate disaster alerts or the alerts did not materialise.

The perception of the community on EWS in CoE is drawn from the relationship that exists between receiving early warning messages and the effectiveness of the dissemination methods. Rana et al. (2021) argue that the community's perception of the E.W.S implemented by the government is largely informed by the community's lack of trust in government communication channels. Moreover, the poor perception of the affected communities on government E.W.S coupled with lack of faith on the disaster alerts received may result in the affected communities not taking protective measures after early warning messages have been received (Gwimbi, 2021). Furthermore, it is critical to note that the community's opinions and perceptions on existing EWS are shaped by the community's reflections on past similar disaster events (Reksa, 2021).

5.10 Impacts of floods

In this study, most respondents (n = 81) indicated that they never received early warning messages for 2019 floods and the majority (n = 51) stated that their homes were flooded in the 2019 floods. There is a relationship between communities receiving early warning messages on time and the coping strategies employed to deal with disasters such as floods. Furthermore, notification of affected communities on pending disasters and their response measures to cope with the imminent disasters cannot be separated (Hammond et al., 2021). Moreover, for the dissemination of early warning messages to be considered effective, the disseminated alerts should be accompanied by response guidelines that will enable the affected communities to cope better with the impacts of disasters such as floods (Kreibich et al., 2021). Strategies that emphasize the relationship between flood early warning systems and the measures put in place by the government to communicate risks, training of affected communities on flood evacuation measures and provision of financial support for affected communities will assist vulnerable communities to cope better with the impacts of floods (Kreibich et al., 2021).

Contrary to the above, dissemination of early warning messages with no clear evacuation messages will not assist affected communities to cope with the imminent disasters (Kitazawa & Hale, 2021). Krishna et al. (2021) argue that the gap that exists between communication of early warning messages and provision of the necessary support is crucial for enabling the affected communities to cope better with disasters such as floods. During the south India 2015 floods, as much as the affected communities received early warning alerts, the affected communities had to cope with the impacts of these floods using their own resources (Krishna et al., 2021). Furthermore, receiving disaster alerts on time is critical for communities to cope better with the impacts of disasters such as floods (Sansom et al., 2021). Consequently, the chi-square results of P=0.001 reveals that there is a significant relationship between communities receiving flood early warning messages that are effective and flood coping measures by communities.

5.11 Flood mitigation measures

The majority of the respondents, n = 65 stated formation of flood management committees as one of the important measures for flood mitigation within the community. Community participatory measures for disasters are implemented by different countries as a mechanism to mitigate the impacts of disasters such as floods (Makita, 2021). Consequently, awareness campaigns to mitigate floods have been conducted by various countries as well, even though these are not considered to be effective enough (Osbrghaus & Hinrichs, 2021). In this study, only 1 respondent

mentioned awareness campaigns (Figure 5.13) Wolff (2021) argues that, by choosing the formation of a flood management committee for mitigation, it displays the level of trust the community has in information sharing through peers. Moreover, community-based flood early warning systems assist the affected communities not only to access flood alerts on time but to build a flood resilient community (Bajracharya et al., 2021). Sansom et al. (2021) reported that mitigation measures that take into consideration communal requirements perform better than the old measures that did not include the affected communities. Furthermore, flood mitigation measures that do not consider socio-economic issues such as poverty and vulnerability of the affected communities cannot provide successful disaster risk reduction and flood mitigation measures (Krishna et al., 2021). The study community decided on flood mitigation measures based on their experiences of past disasters and the fact that similar disasters may occur in the future (Mongal et al., 2021). Therefore, measures to reduce the possibility of future risks by the same disasters are put in place by communities who have previously experienced negative impacts of disasters such as floods (Neußner, 2021).

In Nepal for example, Pandeya et al. (2021) reported that an effective community participatory monitoring network was developed as a flood mitigation measure that is operated and run by the community. Furthermore, the involvement of communities in monitoring and dissemination of flood early warning messages in the Kamali river assisted in bridging the communication gap between collection of weather data and ensuring that the affected communities receive alerts, that were identified within traditional EWS (Pandeya et al., 2021). In Namibia, in the Cuvelei-Etosha Basin, failure by government to involve affected communities in flood mitigation measures resulted in the suffering of rural communities within those areas due to the impacts of recurring flood events (Shaamhula et al., 2021).

In addition, flood community-based mitigation measures do not only provide affected communities with early warning messages, but they provide the communities with response measures that will assist the affected communities to build resilience and protect themselves and their properties (Sharma, 2021). In strengthening mitigation measures for floods within informal settlements, the City of Cape Town has adopted community-based adaptation measures to deal with the impacts of floods within the vulnerable communities of the city (Fox, Ziervogel & Scheba., 2021); this is what the majority of the results for this study on flood mitigation intends to do.

5.12 Summary

Challenges relating to the community's inability to understand the official language used to communicate early warning messages as a result fail to take necessary protective measures should be taken into consideration (Ferdous, 2017). This study focused on the measures used previously by CoE to disseminate early warning messages to the community of Vosloorus and the mitigation measures used by the community to cope with floods and found many problems that can be solved by some of the recommendations from this study in the following chapter. Furthermore, the results of the study indicate that social, cultural and economic issues, for example, lack of electricity, shape the community's perception of how the municipality handles E.W.S. Moreover, in circumstances where communities continue to suffer the impacts of floods and failure in the early warning chain may result in loss of lives and households' livelihoods (Reksa, 2021). The results of this study further indicate that other alternative measures to notify the community of Vosloorus on eminent floods should be put in place by CoE. Dissemination of disaster early warning messages through schools for example, is regarded as one of the measures that can assist in ensuring that vulnerable communities receive disaster alerts on time (Islam et al., 2021). The gaps identified through the results of this study suggest that CoE can improve on existing EWS.

CHAPTER 6: CONCLUSION AND RECOMMENDATIONS

6.1 Introduction

Meteorological disasters cannot be avoided, municipalities need to put measures in place that will assist in notifying the affected communities of imminent disasters (Lanka, 2019). This study focused on the dissemination of early warning messages to the community of Vosloorus by the City of Ekurhuleni (CoE).

6.2 Results based recommendations

Since this study was based in CoE, the results warrant recommendations based on the opinions and perceptions of the respondents. A city that considers the opinion of its people is a city that cares about its communities.

6.2.1 City of Ekurhuleni recommendations

The highest number of respondents who said no to receiving early warning messages and also the number of respondents who strongly disagreed with the statement that early warning messages are easy to understand showed that there is an information gap between the CoE and the community. This study therefore recommends the following.

The CoE develops a standard operating procedure that will guide the dissemination of early warning messages in this municipality. Rana, Bhatti & Jamshed (2021) contends that one of the reasons communities do not receive early warning alerts relates to a lack of effective communication policies that provides clear processes of how to disseminate disaster early warning messages. Moreover, CoE should engage with representatives from the affected communities when drafting disaster communication flow measures, in particular community leaders, since the majority of the respondents reported receiving their early warning information from community leaders. The involvement of community leaders within the communication flow will assist in building trust between the affected communities and the municipality. Furthermore, the involvement of the affected communities in the development of guidelines for disaster communication will give communities a sense of ownership of the documents and will assist in the implementation of these guidelines. The CoE should consider a bottom-up approach in this regard.

This study also recommends that CoE incorporate measures to communicate early warning messages through colour coding to accommodate messages that are understandable by everyone in the community. This recommendation will include illiterate community members and

those that are unable to read. The study showed a lower level of literacy amongst the respondents. Furthermore, the advantages of incorporating colour coding in the dissemination of early warning messages will benefit community members who cannot read and also foreign nationals that have found homes in the study area and do not understand the local languages (Sidek et al., 2021). Colour coding will assist in addressing the challenges relating to language and illiteracy within the community.

The highest number of respondents that strongly disagreed that the disaster early warning messages communicated were specific to each area gave rise to the following recommendations.

That CoE incorporates within the communication flow strategy the use of short message service (SMS) that will be shared with community leaders within the affected communities. Dissemination of disaster early warning messages through community leaders has its benefits, in Samarinda City in Indonesia, early warning messages are disseminated through the mosque (Sukmara & Wu, 2021). The difference is that the communication process for CoE is that the alerts will be disseminated to community leaders through SMS notification and these leaders will disseminate the information to community members, as the study identified some level of trust between community members and leaders.

According to the information provided in the CoE IDP, loud hailing is one the frequently used method to disseminate early warning messages (CoE IDP, 2018), the municipality should consider other alternative methods. Since the majority of the respondents indicated ownership of a cell phone even though the majority of those with cell phones indicated that, they could not receive early warning messages because of lack of data. SMS notifications can be received even in instances where the receiver has no access to the internet or data. This study recommends SMS to be the major mode of information dissemination as it is cost-effective, the SMS is received in real time and does not require a person to have special applications to receive the SMS. Instant messaging will be beneficial to the community without any cost. Moreover, in situations where community members have access to cell phones, government entities in various countries resorted to the dissemination of disaster alerts through messaging (Goniewicz, & Burkle, 2019). SMS notifications to community leaders can be designed in such a manner that the municipality will be aware the message has been delivered. Budimir et al. (2020) outline the advantages of using SMS notification to disseminate early warning messages as follows:

- SMS notifications are cheaper for both the sender (municipality) and the receiver (the community leaders);
- SMS notifications can be sent to a larger number of people at the same time; and

- SMS notification can be customised and disseminated to a specific area within the community.

The CoE can make use of local schools to disseminate disaster early warning messages. Moreover, once disaster alerts have been received from the custodians of weather data, municipal officials can be dispatched to local schools within the affected areas to communicate the disaster alerts to the pupils and measures that can be taken to protect lives and properties can be implemented when necessary. Marchezini et al. (2017) states that for the establishment of EWS and related processes to be considered effective, the system should include pupils in high schools. In Asia, it was discovered that even though early warning systems were in place, an integrated mechanism that involved higher education institutions could improve the effectiveness of the existing early warning systems (Hemachandra, Haigh & Amaratunga et al., 2020).

Moreover, the neutral responses that neither agreed nor disagreed to the question "*Would you say the way the municipality disseminates disaster early warning messages is effective*", gave rise to the following recommendation.

In this study, most respondents (81%) indicated that they never received early warning messages for 2019 floods. Based on this finding, this study, therefore, recommends that CoE should carry out stakeholder engagement that will determine processes that will make it easier for the community to receive early warning messages in place.

The CoE disaster management plan does not indicate flood mitigation measures implemented in Vosloorus Township. The majority of the respondents thought that the formation of flood management committees would work best as flood mitigation measures in their area. This study, therefore, recommends that flood management committees be established per ward and be capacitated with disaster early warning information and other related resources for the benefit of the community.

6.2.2 Recommendations from the main findings of the study

The finding that the majority of the respondents report community leaders as their source of early warning messages, is a positive finding, and the CoE can capitalise on that to build a safer community. This study, therefore, based on this finding, recommends that the CoE invest in training community leaders and having a pool of more community leaders for each of their communities, for efficient dissemination of early warning messages. If the CoE can also form a WhatsApp group for all their community leaders so that they can send messages about impending disasters to the leaders and the leaders can disseminate the messages to the community, as the

world is moving towards the 4th Industrial Revolution, WhatsApp is one of the quickest way to get information across.

This study is aware that the CoE is using Twitter to disseminate information to their respondents, but this study, found most of the respondents disagreeing with taking actions if the early warning messages are received through social media. Therefore, this study recommends that the CoE create a Twitter and maybe Facebook accounts specifically for community leaders. Community leaders can disseminate the messages to their community as community as community members have shown some trust in their leaders when it comes to acting to early warning messages and alerts as opposed to social media alerts and warnings.

The majority of the respondents strongly disagreed that the disaster early warning messages communicated state clear actions to be taken by the community members in their area, this gave rise to the following recommendations:

1) This study recommends that the CoE involve their communications and marketing department in every disaster communication that goes out to the community.
2) The CoE to employ a specialist in communications and marketing for clear communications for all disaster communications if they do not have a designated person already.

To accommodate the majority of the respondents that reported that the language used to communicate disaster alerts by CoE is not always understood by the community of Vosloorus, this study recommends that the CoE employ a full-time translator. The translator will translate the message to be disseminated into the local language in and around the CoE to accommodate all literacy levels in the city.

Furthermore, the respondents who disagreed with the question of whether the disaster early warning messages are communicated early enough to allow the community to take protective measures gave rise to the recommendation that the CoE should form strong collaboration with the stakeholders. This includes the South African Weather Services, for them to receive weather-related warning any time of the day so that the CoE can warn communities on time. This study is aware that the CoE has 24 hours operational call centre, which can be used for receiving and disseminating such messages.

6.2.3 Further study recommendations

This study focussed on the dissemination of disaster early warning as determined by the community's perception. The areas that were covered include language and methods used by CoE to disseminate early warning messages to the community of Vosloorus, as well as flood mitigation measures. This study did not cover possible partnerships and institutional arrangements that can be put in place by CoE to ensure that early warning messages are disseminated on time. Future study recommendations include possible partnerships that can be forged with mobile phone companies. In addition, such partnerships with mobile phone companies can promote the dissemination of real time alerts to the affected communities.

Furthermore, this study recommends that CoE should strengthen institutional arrangements with entities that are custodians of weather and climate data, institutions such as South African Weather Services and the National Disaster Management Centre (NDMC). NDMC through its GIS directorate has developed a system where municipalities are able to access disaster alerts and seasonal forecasts as they are issued (COGTA-NDMC, 2018). Furthermore, such institutional arrangements will enable CoE to access and disseminate early warning alerts on time.

6.3 Conclusion of the study

Recurring disasters such as floods cannot be avoided, therefore, identification of gaps to address poor communication to the affected communities should form part of continuous studies (Khoza & Nhamo, 2021). Furthermore, disseminating early warning messages that are easy to understand and can be acted upon by the affected communities is still a challenge. Moreover, the results for this study indicate that the early warning messages disseminated by CoE are not received on time; therefore, it is a challenge for community members to evacuate the areas that are prone to floods. Failure by the community to understand the communicated early warning messages indicate that CoE is implementing a top-down early warning approach that does not take into consideration the socio-economic dynamics of the affected communities.

It is critical for CoE to take into consideration the level of literacy of the affected communities and disseminate early warning messages that will be easily understood by the community. The involvement of community leaders within the communication flow of early warning messages is critical, as the received disaster alerts can be communicated to the community by their leaders in a language that they understand. The results for this study indicate that the community members have more trust regarding disaster information received through the community members.

Shehara et al. (2021) state that the attitude and perception of the affected community determines how the community responds to the disaster alerts received. Furthermore, if the implemented dissemination of early warning strategies does not include the community's requirements, such strategies will not yield good results (Sansom et al., 2021). The results of this study therefore indicate that if CoE can take into consideration the requirements of the affected communities within the existing communication flow strategies, trust and adherence to disaster alerts disseminated will improve.

6.4 Concluding remarks

This study investigated the dissemination of disaster early warning messages within the community of Vosloorus Township in the City of Ekurhuleni, Gauteng, South Africa. The study sought to investigate the methods used to disseminate early warning messages and the mitigation measures implemented by the community of Vosloorus. The results of the study indicate that the third component of disaster early warning systems that is "dissemination and communication of early warning messages" is a critical one. This study found that there are certain variables that have to be taken into consideration when early warning systems are developed. These variables are level of literacy of the affected community, access to basic services such as electricity, data availability and involvement of the affected communities within the communication flow strategies of early warning systems. This study found that the methods used to disseminate early warning messages to vulnerable communities are also key. Therefore, if the representatives of the affected are not included in the communication flow strategies for disaster alerts, effective early warning systems will not be achieved.

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8. APPENDICES

ANNEXURE A ETHICS APPROVAL LETTER

UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA

UFS UV

GENERAL/HUMAN RESEARCH ETHICS COMMITTEE (GHREC)

10-Feb-2021

Dear Mrs Nompumelelo Ekeke

Application Approved

Research Project Title:
Dissemination of disaster early warning messages within Vosloorus township.

Ethical Clearance number:
UFS-HSD2020/1984/102

We are pleased to inform you that your application for ethical clearance has been approved. Your ethical clearance is valid for twelve (12) months from the date of issue. We request that any changes that may take place during the course of your study/research project be submitted to the ethics office to ensure ethical transparency. furthermore, you are requested to submit the final report of your study/research project to the ethics office. Should you require more time to complete this research, please apply for an extension. Thank you for submitting your proposal for ethical clearance; we wish you the best of luck and success with your research.

Yours sincerely
Dr Adri Du Plessis
Chairperson: General/Human Research Ethics Committee

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ANNEXURE B: RESEARCH STUDY INFORMATION LEAFLET AND CONSENT FORM

DATE

TITLE OF THE RESEARCH PROJECT

Dissemination of disaster early warning messages within the Vosloorus Township, in the City of Ekurhuleni (CoE), in Gauteng South Africa.

PRINCIPLE INVESTIGATOR / RESEARCHER(S) NAME(S) AND CONTACT NUMBER(S):

Nompumelelo Sibongile Ekeke Student No: 2017392370 0767506586

FACULTY AND DEPARTMENT:

Natural and Agricultural Sciences

Disaster Management Training and Education Centre for Africa

STUDY LEADER(S) NAME AND CONTACT NUMBER:

Dr Tlou Daisy Raphela (0865999)

Contact number 0721084987

WHAT IS THE AIM / PURPOSE OF THE STUDY?

Through the use of questionnaire, this study aims to examine whether the community of Vosloorus Township understand disaster early warning messages disseminated by CoE, and whether the community think the received messages are effective.

WHO IS DOING THE RESEARCH?

I am student at UFS in the DiMTEC Departments and I am more interested in social studies in particular the impact studies.

HAS THE STUDY RECEIVED ETHICAL APPROVAL?

Yes

Approval number: *UFS-HSD2020/1984/102*

WHY ARE YOU INVITED TO TAKE PART IN THIS RESEARCH PROJECT?

You are chosen to participate in this study to answer the overarching question of this study which is "how effective are the methods used to dissemination of disaster early warning messages within the Vosloorus Township" You are chosen because you reside in Vosloorus

Township and may have experienced impacts of natural disasters like floods within this area. The approximate number of participants will be approximately 60 community members from informal settlements in Vosloorus

WHAT IS THE NATURE OF PARTICIPATION IN THIS STUDY?

The study involves questionnaire that include multiple choice questions that asks you about your demography and your opinion pertaining disaster early warning systems within CoE The questionnaire will take approximately 30 minutes to complete.

CAN THE PARTICIPANT WITHDRAW FROM THE STUDY?

Participation in this study is voluntary and there is no penalty or loss of benefit for non-participation. Being in this study is voluntary and you are under no obligation to consent to participation. If you do decide to take part, you will be given this information sheet to keep and be asked to sign a written consent form. You are free to withdraw at any time and without giving a reason.

WHAT ARE THE POTENTIAL BENEFITS OF TAKING PART IN THIS STUDY?

These study findings will inform the CoE of the important played by disaster information sharing prior to disaster events. Your participation in the study will be kept confidential and will not be given to any other third party

WHAT IS THE ANTICIPATED INCONVENIENCE OF TAKING PART IN THIS STUDY?

The only possible inconvenience identified by this study is loss of study/work time.

WILL WHAT I SAY BE KEPT CONFIDENTIAL?

Participants' name will not be recorded anywhere, and no one will be able to connect you to the answers you give. All questionnaires will be identified by numbers. All answers will be given a pseudonym and will be referred to in this way in the data, any publications, or other research reporting methods such as conference proceedings. The primary research is the only one who will have access to the data. The anonymous data for this study may be used for other research purposes such as journal articles and conference presentation. When required Pseudonyms will be used in any publication of the information. A report of the study will be submitted for publication, but individual participants will not be identifiable in such a report). You may withdraw from the study at any stage without any repercussions. You will not be

required to disclose any personal identifying details instead a code will be used to number the questionnaires. Data will not be accessed by any third party.

HOW WILL THE INFORMATION BE STORED AND ULTIMATELY DESTROYED?

Hard copies of your answers will be stored by the researcher for a period of five years in a locked cupboard/filing cabinet (at DiMTEC offices) for future research or academic purposes. Future use of the stored data will be subject to further Research Ethics Review and approval if applicable. All signed copies of informed consent form will be kept on record by the researcher for at least a year after the completion of the research. Hard copies will be burned in a fire safe area. The only inconvenience for participating in this study will be loss study/work time. The risk of time loss is noted by the researcher and acknowledged. Since the survey will be taken during COVID 19 pandemic, all precautionary measures of social distancing, sanitizing, and wearing of face masks will be adhered to during the collection of, as stipulated by the COVID 19 regulations.

WILL I RECEIVE PAYMENT OR ANY INCENTIVES FOR PARTICPATING IN THIS STUDY?

Your participation is voluntary, and you will not bear any costs for participating in the study. There will also be no payment or any incentive for participating in this study. The researcher will not be able to mitigate the loss of study /work time but, the participants will be asked to voluntarily sacrifice at least 30 minutes of their work or study time to answer the questionnaire. There will be no harm associated with this risk as only the risk of time loss is identified for this study.

HOW WILL THE PARTICIPANT BE INFORMED OF THE FINDINGS / RESULTS OF THE STUDY?

If you would like to be informed of the final research findings, please contact Nompumelelo Sibongile Ekeke on 0767506586 or email: mpumiekeke25@gmail.com. The findings are accessible from the date of publishing. Should you require any further information or want to contact the researcher about any aspect of this study, please contact: Nompumelelo Sibongile Ekeke, mpumiekeke25@gmail.com; 0767506586. Should you have concerns about the way in which the research has been conducted, you may contact: Amanda Smith, SmithAM@ufs.ac.za. Natural and Agricultural Science GHREC Administrator; 051 401 3942.

Thank you for taking time to read this information sheet and for participating in this study.

ANNEXURE C CONSENT TO PARTICIPATE IN THIS STUDY

I, _____ (participant name), confirm that the person asking my consent to take part in this research has told me about the nature, procedure, potential benefits and anticipated inconvenience of participation.

I have read and understood the study as explained in the information sheet. I have had sufficient opportunity to ask questions and am prepared to participate in the study. I understand that my participation is voluntary and that I am free to withdraw at any time without penalty. I am aware that the findings of this study will be anonymously processed into a research report, journal publications and/or conference proceedings.

I agree to the recording of the *questionnaire*.

I have received a signed copy of the informed consent agreement.

Full Name of Participant: _____

Signature of Participant: _____ Date: _____

Full Name(s) of Researcher(s): _____

Signature of Researcher: _____ Date: _____

ANNEXURE D QUESTIONNAIRE FOR THE COMMUNITY

Student Name: Nompumelelo Ekeke

University of Free State

Disaster Management Training and Education Centre

Student Number: 2017392370

I would like to invite you to take part in my research study by completing the below questionnaire.

Topic: Dissemination of disaster early warning messages within Vosloorus Township

Please assist by responding to the questions with honesty, indicate your choice of response with a cross (an "X") and also make use of the spaces provided to respond to open-ended questions. The questionnaire consists of 20 questions. The data collected will be kept strictly confidential and findings will be used for academic purposes only.

Section A: Demographics Information

1. Gender

Female	
Male	

2. Marital status

Single	
Married	
Widowed	
Divorced	

Separated	

3. Age

18-28 yrs	
29-39 yrs	
40-50 yrs	
51-60 yrs	
61+	

4. Employment Status

Full time job	
Part time job	
Self employed	
Unemployed	
Student	

5. Educational Level

No Schooling	
Primary Schooling	
Secondary Schooling	
Matric	

Tertiary Education	

Section B: Early warning systems impact questions

6. Do you understand the term “disasters”?

Yes	
No	

7. Do you understand what is meant by disaster early warning messages?

Yes	
No	

8. Which Disasters occurs frequently in your area?

Fires	
Drought	
Heavy thunderstorms with floods	
Heavy rain with hail	
Other, Specify…….	

9. Do you own a cellphone?

Yes	
No	

10. Have you ever received an early warning message from the municipality?

Yes	
No	

11. If yes was the warning received on time?

Yes	
No	

12. If no please state the reason why you think you have not received the message from the Municipality……...
13. Which method does the municipality usually use to disseminate early warning messages?

SMS system	
Social media	
Councillors	
Community leaders	
Other, specify……	

14. Please select the source of your early warning messages

Disaster Management officials	
Metro police	
Councillor	
Community leaders	
Other, specify……	

15. Are the disaster early warning messages communicated to you always easy to understand?

Strongly agree	
Slightly agree	
Neither agree nor disagree	
Strongly disagree	
Slightly disagree	

16. Are the early warning messages communicated to your community members accommodate people who cannot read?

Strongly agree	
Slightly agree	
Neither agree nor disagree	
Strongly disagree	
Slightly disagree	

17. Is the language used to communicate the disaster early warning messages commonly understood by the community members in your area?

Strongly agree	
Slightly agree	
Neither agree nor disagree	
Strongly disagree	
Slightly disagree	

18. Are the disaster early warning messages specific to your area?

Strongly agree	
Slightly agree	
Neither agree nor disagree	
Strongly disagree	
Slightly disagree	

19. Are the disaster early warning messages communicated to you early enough to allow you to take protective measures?

Strongly agree	
Slightly agree	
Neither agree nor disagree	
Strongly disagree	
Slightly disagree	

20. Are the disaster early warning messages communicated state clear actions to be taken by the community members in your area?

Strongly agree	
Slightly agree	
Neither agree nor disagree	
Strongly disagree	
Slightly disagree	

21. Would you act on disaster early warning messages communicated to you through social media, during an emergency?

Strongly agree	

Slightly agree	
Neither agree nor disagree	
Strongly disagree	
Slightly disagree	

22. Would you act on disaster early warning messages communicated to you through announcements on the community radio station?

Strongly agree	
Slightly agree	
Neither agree nor disagree	
Strongly disagree	
Slightly disagree	

23. Would you say the community members in your area trust the disaster early information communicated by the municipality?

Strongly agree	
Slightly agree	
Neither agree nor disagree	
Strongly disagree	
Slightly disagree	

24. In your opinion, would you say the way the municipality disseminate disaster early warning messages is effective?

Strongly agree	
Slightly agree	

Neither agree nor disagree	
Strongly disagree	
Slightly disagree	

SECTION C: COMMUNITY BASED STRATEGIES FOR COPING WITH FLOODS

25. Have your received early warning messages during the recent 2019 Floods?

Yes	
No	

26. What was the impact of those floods in your household?

Home flooded	
Flood related illness	
Flood related death	
Drop out from school	
Loss of important document	
Other, specify……	

27. Which flood mitigation measures do you think will work for you community?

Availability of flood action plan for the community	
Formation of flood management committees	
Raising if awareness and preparedness programs amongst community of pending floods well in advance	
Provision of communication equipments for efficient information dissemination	
Train community members in in warning and evacuation plans	

Other, specify……	

THANK YOU VERY MUCH FOR YOUR TIME

ANNEXURE E: CONFIRMATION OF EDITING

D K M
LANGUAGE AND TECHNICAL EDITING • PROOFREADING • PLAGARISM CHECKING • ACADEMIC RESEARCH (HONS AND MASTERS) AND PROJECT SUPERVISION • BUSINESS PROPOSAL

27 October 2021

LETTER OF CONFIRMATION

I hereby confirm that I have done the language editing for the following dissertation:

Author: Mrs N Ekeke
Title: Dissemination of disaster early warning messages in Vosloorus Township

Document: Master of Disaster Management

I have edited Mrs N Ekeke's document and made appropriate changes and highlighted areas that the student needs to revisit. The document was edited using track changes and comments in Microsoft word.

I am not responsible for any additional information that is added to the document after I have edited it. The student is responsible for the final document submitted.

I trust you find the above in order.

Regards

Hazvinei Majonga
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