



RESEARCH PAPER

# Utilization of Early Warning Information and the Factors Influencing Actionability of Early Warning Messages Among Last Mile Communities in Drought-Prone Areas In Eswatini



Photo: Luuk de Vocht, IFRC

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## Acknowledgments

The research team and authors want to extend their sincere gratitude to the Global Disaster Preparedness Center (GDPC) for the financial support towards this research project. Sincere thanks also go to the various collaborating institutions and stakeholders (including participating communities) who have been supportive in the duration of this research project.

## Conflicts of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Research funded by the Global Disaster Preparedness Center of the American Red Cross.



# Table of Contents

<b>Abstract</b> .....	<b>3</b>
<b>1. Introduction</b> .....	<b>4</b>
<b>2. Literature Review</b> .....	<b>6</b>
2.1. Eswatini’s Vulnerability to Droughts .....	6
2.2. Historic Drought Impacts .....	7
2.3. Drought Monitoring and Early Warning .....	9
2.4. Barriers to Access to Drought Information .....	10
2.5. Policy Environment and Drought Legislation .....	12
2.6. Existing Knowledge Gap on Early Warning Discourse .....	15
<b>3. Methodology</b> .....	<b>17</b>
3.1. Study Area and Research Design .....	17
3.2. Data Collection .....	18
3.3. Sampling and Sample Size Determination .....	18
3.4. Ethical Consideration.....	20
3.5. Limitations of the Study .....	21
<b>4. Results And Discussion</b> .....	<b>21</b>
4.1. Demographic Characteristics and Livelihoods.....	21
4.2. Experience of Disasters and Drought Impacts in the Study Area .....	25
4.3. Access to and Utilization of Early Warning Information .....	30
4.4. Factors Affecting Utilization of Early Warning Messages.....	34
<b>5. Conclusion</b> .....	<b>44</b>
5.1. Recommendations for Action .....	45
5.2. Recommendations for Future Research .....	48
<b>References</b> .....	<b>50</b>

## Abstract

The study contributes to the disaster risk reduction discourse by exploring the utilization of early warning information and the factors influencing actionability of early warning messages among last mile communities in order to increase their resilience against drought impacts and shocks in the drought prone areas of Eswatini. The main objective of the study is to understand if marginalized farming communities utilize early warning messages and if they are able to take preventive actions which are informed by early warning messages, and the factors that influence the actionability of received early warning messages among last mile communities in drought prone areas.

The study drew from both the positivists and interpretivists research paradigms and adopts the mixed methodologies (qualitative and quantitative) in trying to understand the early warning and community response nexus. The study found that some households in the drought-prone areas of the lowveld have challenges accessing early warning information.

Among the main factors limiting access to early warning messages among last mile communities in Eswatini are, but not limited to, the high technicality of disseminated early warning information, lack of education on the proper interpretation of predicted messages, untimely information, and lack of practical application or relevance of predicted information to day-to-day household activities. Additionally, there is a lack of decision-making authority, especially among women, and a lack of trust in the received early warning messages due to their alleged inaccuracy, among other factors.

The study concluded that access to early warning information and the utilization of early warning messages are still low in remote rural areas in Eswatini, hindering resilience building and the protection of livelihoods for marginalized communities. There is a need to improve access to early warning information in remote rural areas in Eswatini and to implement capacity-building initiatives to help the rural population properly interpret the information. Furthermore, there is a need to improve the clarity of early warning information through the use of simpler terminologies and the translation of early warning messages into local languages.

**Key words:** Early warning; Actionability; Last mile communities, Drought-prone areas, Eswatini

# 1. Introduction

The Kingdom of Eswatini is vulnerable to drought and other climate-related hazards such as cyclones, flash floods, and windstorms, as well as human-induced hazards (Manyatsi et al., 2014; Mutasa, 2022). These shocks and hazards adversely affect the country's development and continue to be a concern for socio-economic and sustainable development. Of all the shocks experienced in the country, the highest losses and damages occur during droughts (Manyatsi et al., 2010). In the last decade, Eswatini has been affected by moderate to severe droughts, leading to significant impacts on the economy, environment, and society (Tfwala et al., 2020). These El Niño-induced drought episodes have resulted in multi-faceted negative outcomes, including adverse effects on health, food security, and economic activity, while significantly affecting the marginalized population in remote rural areas (Jordaan et al., 2019).

The 2015/2016 drought resulted in 30% of the population being vulnerable to food insecurity (Swaziland Vulnerability Assessment Committee [SVAC], 2016). The regions with the highest prevalence of food insecurity were Lubombo and Shiselweni, areas historically affected by drought in the country. The socio-economic impacts of the 2015/16 El Niño-induced drought were estimated to cost Eswatini E3.843 billion, comparable to 7.01% of Eswatini's Gross Domestic Product (GDP) in 2016 or 18.58% of Government expenditure in 2016 (NDMA, 2017). Drought vulnerability in Eswatini is further compounded by the poor economy and the subsistence nature of agriculture, where substantial farming is done on a small scale under rain-fed condition, and is typically only sufficient to feed the farmer's immediate household.

Most climate prediction models project an increase in the frequency and magnitude of drought in the coming years due to climate change, emphasizing the importance of preparedness. Climate change is now recognized to have a significant impact on disaster management efforts to meet the growing needs of the most vulnerable population (Seddon et al., 2020; Abbass et al., 2022). In view of the impacts of drought, it is important to monitor drought in near real-time and provide clear, concise, and reliable early warning information to all Swazi citizens. Timely communication of this early warning information would lead to individual actions that help prevent losses and damages and facilitate effective response after the drought.

In 2020, the country updated the National Drought Plan, which has several specific purposes, including providing a compendium of the most up-to-date information on drought occurrence, impacts, and risk in Eswatini. Furthermore, it identifies a series of short-term immediate monitoring, communication, and response actions to address

imminent drought impacts (Ministry of Agriculture [MoA], 2020). The National Disaster Management Agency (NDMA) is also currently embarking on projects focused on understanding drought preparedness and Disaster Risk Management (DRM) through developing the country risk profiles and drought monitoring systems such as the composite drought index (CDI-E). With the support of Baphalali Eswatini Red Cross Society (BERCS), the country has also continued to strengthen preparedness by adopting Drought Forecast-based Financing (FbF). This anticipatory action approach enables the implementation and financing of pre-agreed early actions prior to a forecasted drought to reduce loss and damage (BERCS, 2021; 2022). Preparing for drought, reducing risk, and mitigating the impacts of drought are paramount, given the significant vulnerabilities in the country. Such drought preparedness and risk mitigation programs will help lower the eventual drought relief costs, protect food security, and reduce the humanitarian impact on the population.

An evaluation of the Early Warning System in Eswatini was conducted in 2020 by the National Disaster Management Agency (NDMA) to identify existing gaps and opportunities for improvement within the country's multi-hazard early warning system. The goal was to provide timely and better services to communities. The assessment findings revealed that, while the country has made progress in dissemination, communication, and response capability, as well as the governance of early warnings, deficits persist in the areas of risk knowledge and the monitoring of warning services' effectiveness (NDMA, 2020; IFRC, 2023). Another study by Baphalali Eswatini Red Cross Society on indigenous knowledge of weather-related disasters and their consequences in Eswatini revealed that rural communities face challenges in interpreting forecasts and understanding disseminated weather-related information. The study also found that farmers in rural communities possess important indigenous knowledge, which they use to forecast weather and climate to inform their actions, especially during the farming season (BERCS, 2023). This indicates that understanding the dynamics of early warning in the country still needs improvement as Eswatini strives towards an efficient and effective early warning system.

This study, therefore, aims to contribute to the emerging debate on early warning systems in Eswatini by investigating the utilization of early warning messages by marginalized farming communities. The study will assess if they are able to take preventive actions informed by early warning messages and bring understanding of the factors that influence the actionability of received early warning messages in drought-prone areas. The study will then draw various conclusions and make policy recommendations regarding early warning, particularly the utilization of early warning messages by remote drought-prone communities.

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## 2. Literature Review

### 2.1. Eswatini's Vulnerability to Droughts

Drought occurs in most climatic regions throughout the world with varying frequencies and intensities. It potentially has major direct and indirect impacts on human and natural systems, including terrestrial and freshwater ecosystems, agricultural systems, public health, water supply, water quality, food security, energy, and economies (e.g., tourism, forestry). Droughts have impacted Eswatini differently in space and time, depending on their magnitude, duration, intensity, and spatial extent (Mangaliso & Dlamini, 2018).

Drought, as a slow-onset hazard, has a different exposure profile compared to sudden hazards like earthquakes or storms. Although many droughts lead to severe social and economic impacts, few have recorded mortality in international disaster databases (Peduzzi et al., 2009). Those drought events that have caused mortality generally occurred during political crises or civil conflicts where humanitarian aid could not reach the affected population. Therefore, since available impact datasets do not provide information on the factors contributing directly to human casualties, mortality is not a good proxy for drought exposure (United Nations International Strategy for Disaster Reduction [UNISDR], 2009a, b). Understanding exposure is crucial but cannot be deemed a sufficient determinant of risk on its own. This is because, for similar drought events, equally exposed areas may experience varying impacts according to their levels of development, land-use planning, livelihood pursued, and mitigation strategies, among others. Therefore, vulnerability information should not neglect these factors (Naumann et al., 2019).

Rural areas are the most susceptible to drought risks in Eswatini because almost 70% of the population relies on rain-fed agriculture and largely characterised with high levels of poverty (SVAC, 2015). Additionally, over 40% of the country falls within the Lowveld agro-ecological zone, which receives an annual average rainfall of below 500 mm (Mangaliso & Dlamini, 2018). Eswatini's exposure to droughts and extreme temperatures has resulted in the loss of both crop and livestock productivity, highlighting the relationship between climate change and food insecurity (Oseni & Masarirambi, 2011).

Vulnerability of a system (its susceptibility and degree to which it cannot adapt to shocks) can be affected by social factors such as population growth and migration trends, urbanization, changes in land use, government policies, water use trends, diversity of economic base, and cultural composition, among other factors (Rudi et al., 2011; Mohammed et al., 2018). Having a clear understanding of a country's drought vulnerability is the starting point to improve its preparedness and determine effective

means of remedial actions to reduce the devastating impacts by promoting drought mitigation strategies (Iglesias et al., 2007; Naumann et al., 2019). Prevention, mitigation, and preparedness are the most desirable drought management measures for decreasing the adverse impact of droughts on the economy, environment, and society. Thus, drought vulnerability information can support the decision-making processes for drought management policymakers who often must prioritize limited resources when designing interventions (Makaya et al., 2020).

The concept of drought vulnerability has become increasingly popular in recent years, prompted by the high economic costs and social vulnerabilities associated with drought (Sonmez et al., 2005). The increased number and severity of drought events worldwide and in Eswatini, in particular have amplified the losses from these events. The impacts of drought are dependent on the existing societal vulnerability at the time of occurrence. Moreover, drought vulnerability varies among individuals, geographic location and nations. According to Brooks et al. (2005), it is essential to note that factors making a rural community in a developing country vulnerable to drought could differ from those affecting a wealthy industrialized nation. In developing countries, drought vulnerability threatens livelihoods, productive systems, and healthy economies (Brooks et al., 2005). For instance, in Eswatini, 70% of the rural population depends on rain-fed agriculture. Thus, the agriculture sector faces pronounced vulnerability to drought, stemming from critical factors such as crop selection, farming methodologies, resource accessibility, and income diversification. In developed countries, drought exposes the country to substantial economic risks and costs for individuals, public enterprises, commercial organizations, and governments. The characteristics and extent of drought vulnerability can differ from country to country, region to region, and family to family, given the dynamic state of vulnerability (Downing & Bakker, 2000).

## 2.2. Historic Drought Impacts

Drought is among the costliest natural hazards due to its slow onset, large spatial extent, and prolonged duration. It stands out as the natural hazard with the highest economic losses in Eswatini. Over the last 42 years, Eswatini has been affected by moderate to severe droughts, resulting in significant impacts on agriculture, the economy, the environment, and society. According to the Emergency Events Database (EM-DAT, 2024), Eswatini has experienced an increase in the frequency and magnitude of droughts due to climate change and human activities. Recorded drought events in the country include those in 1986, 1990, 1992, 2006, 2012, 2014, and 2016.



The country has faced several socio-economic and environmental impacts from drought in past years. The 2015/2016 El Niño drought, for instance, was the worst drought Eswatini has experienced since 1992, costing an estimated \$3.843 billion, equivalent to 7.01% of Eswatini's gross domestic product. Essentially, a drought's economic cost relates to how it negatively affects income generation, investment, consumption, production, employment, and financial flows (Benson & Clay, 2003). During a drought, sectors of the economy that directly use water as an input for production, such as agriculture and hydropower, are likely to decrease their activities and production, generate less revenue, lay off staff, and suspend all but critical investments (Markandya and Mysiak, 2010). The major impacts in the agriculture sector are mainly on food, fiber production, and livestock husbandry. With less rainfall, commercial agricultural production is also affected, with limited water available for irrigation to sustain the sugar crop (Rocha et al., 2020). A total of 1,200 hectares out of 60,000 hectares had to be abandoned during the 2015/2016 drought, leading to a reduction in revenue from sugar exports (NDMA, 2017).

At the household level, drought impacts include food insecurity, crop losses, livestock deaths, forced sale of land/farm, increased crime rate, sale of household productive assets, reduction of water for agriculture, reduction of water for human use, decline in health conditions, and inconveniences and stress for women, children, the elderly, and people living with disabilities (NDMA, 2017). The environment is also directly affected by drought, which limits physiological and biological processes that maintain flora and fauna as well as agricultural production systems (Cotrina Cabello et al., 2023). The water level in reservoirs, amount of rainfall, soil moisture, and groundwater depths are part of the environmental indicators of drought. According to the Eswatini Environmental Authority (EEA), during the 2015/16 drought, there was an expansion of areas presenting signs of desertification throughout the country. Areas that were green zones became semi-arid. Most vegetation died, and land remained uncovered and vulnerable to erosion (EEA, 2020). Drought has also been found to reduce water quantity in wetland areas (e.g., lakes, rivers, and ponds) as well as the groundwater table, and it reduces soil moisture content. This, in turn, affects biodiversity, which depends on various forms of water, including moisture in soil and atmosphere, for survival. Reduced water may modify the food supply to different life forms, potentially altering the food web. Animals, especially wildlife, may become susceptible to diseases due to water shortages.

## 2.3. Drought Monitoring and Early Warning

Widespread droughts (and their associated challenges of famine and economic hardships) provided strong motivation for the establishment of monitoring systems within Eastern and Southern Africa. Drought Monitoring for Eastern and Southern Africa recognized that mitigating the impacts of drought in the region could not be effectively addressed in isolation, but through well-coordinated regional partnerships. Thus, the Nairobi and Harare operational drought monitoring centers for Eastern and Southern Africa were formed. The project included 24 participating countries: Angola, Botswana, Burundi, Comoros, Djibouti, Ethiopia, Eritrea, Kenya, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Rwanda, Seychelles, Somalia, South Africa, Sudan, Eswatini, Tanzania, Uganda, Zambia, and Zimbabwe. Two operational centers were established and tasked with timely monitoring of drought, including its intensity, geographical coverage, duration, and effects on agricultural production; and providing early warnings to support the formulation of applicable strategies to combat its unfavorable effects. This was to be accomplished through improving the application of meteorological and hydrological data and products (Ambenje, 2004).

The spatial variance and context-dependent nature of drought makes it difficult to describe accurately. The effects and impacts of drought events are well documented; however, a standardized method for monitoring drought conditions and quantifying the severity of drought does not exist. A review of global, national, and regional drought monitoring tools has shown that a variety of tools are used (Liu et al., 2020; Mahmoudi et al., 2021). Among these tools are the Palmer Drought Severity Index (the first drought index developed to assess relative drought severity at a national scale), the PDSI (adopted for policy implementation by various federal drought programs), NDVI (widely used for vegetation monitoring, crop yield assessment, and drought detection), Surface Water Supply Index, and Standardized Precipitation Index (the most commonly used), among others (Hayes et al., 2021; Benedetti & Rossini, 1993; Moulin et al., 1998). The World Meteorological Organization (WMO) in 2009 recommended the SPI as the main meteorological drought index that countries should use to monitor and follow drought conditions. The SPI was designed to quantify the precipitation deficit for multiple timescales, understanding that a deficit has different impacts on groundwater, reservoir storage, soil moisture, snowpack, and stream flow. An SPI value places the severity of a current event (either dry or wet) in a historical perspective, as the frequency of each value is known (McKee et al., 1995).

In the past decade, substantial progress has been made in developing new drought monitoring tools and reviewing some existing tools. These developments have mainly improved the temporal and spatial resolution of drought monitoring, offering better

information to decision-makers regarding specific events. Other developments involve real-time access to data and improved information dissemination, made possible by the Internet, satellite technology, geographic information systems (GIS), and supercomputing capabilities (Mlenga & Jordaan, 2020). Through its National Drought Plan, Eswatini has crafted a proactive plan to enhance its early warning systems and is also developing a composite drought index (CDI). The CDI will advance drought resilience, mitigate drought impacts, coordinate drought preparedness programs, and inform effective and efficient response actions. This CDI will improve cooperation with stakeholders on drought information, enhance monitoring systems, and improve information dissemination for preparedness and reduced drought impacts. It is envisaged that this will lead to a more proactive drought mitigation system and more functional and sustained drought preparedness and resilience programming in the country.

## 2.4. Barriers to Access to Drought Information

According to the 2023 Africa Summit report, less than 20% of sub-Saharan African countries provide reliable weather services (Adenuga et al., 2021). This is partly because, in sub-Saharan African countries, climate information and prediction services are typically led by government meteorological services, universities, and other research institutions, with poor coordination of collected data between agencies and ministries due to government structures in most of the countries (Wilhite, 2006). Challenges of inadequate infrastructure and data collection instruments are some of the major issues facing these countries, contributing to ineffective climate information prediction and dissemination (Perera, 2020). Weather stations are often so far apart that their data cannot be extrapolated to the local level due to varying terrain and altitude, which poses a challenge to drought monitoring, which requires consistent and accurate precipitation and temperature data (Sigudla, 2015). African countries are affected by a deficiency of funds for establishing and maintaining weather forecasting systems. These include setting up and maintaining hydrometeorological observation networks (rain and river gauge stations), data assimilation systems, computer processing capacity, and effective dissemination facilities. Limited funding for maintaining systems may lead to the discontinuation of system operations (Moisès, 2023).

In Eswatini, like in other sub-Saharan African countries, there are observed issues with the lack of continuous data sets from meteorological services. Since the stations are insufficiently manned, there are difficulties in carrying out observations over the weekends (Sigudla, 2015). Not all weather stations have skilled and qualified personnel deployed to run them, which impacts data reliability. There are also limited capacities in

government technical units to produce and analyze data that would contribute to proper risk assessment. The Eswatini economy is agro-based, and the nation's agricultural planning is primarily dependent on the reliable and accurate prediction of the total amount of rainfall from the beginning of October to the end of March for optimal production. Thus, the lack of continuous data sets for accurate rainfall prediction negatively impacts agricultural production in the country.

Antwi-Agyei et al. (2021) state that aside from the technical challenges, there are numerous multifaceted barriers faced by vulnerable last-mile communities in accessing early warning information. Such information uptake is often confronted by socioeconomic and cultural barriers, militating against the successful uptake of early warning information. The country is faced with accessibility issues experienced by communities in remote locations with limited mobile signals and broadcast services, which may lead to delays or to not receiving the warning messages at all (Perera et al. 2020; Fakhrudin et al. 2020). Moreover, if information is not translated into local languages, or if technical or unclear language is used, individuals who receive the information may be unable to understand it (Dilling & Lemos, 2011; Alexander & Pescaroli, 2020; Chmutina et al., 2021). The use of unclear and highly technical language that is often not understood by laymen has been one of the drought information challenges reported by farmers in Eswatini (BERCS, 2023). Drought information is only beneficial in addressing the risks posed by climate change when it can be accessed in a form easily understood by people (Weitkamp et al., 2020). In addition to technical language clarity, for the information to be useful to farmers, the communication of climate information or forecasts needs to be supplemented with agronomic advice that will be meaningful for farm management decision-making to counteract climate risks (Nkiaka et al., 2019; Dilling and Lemos, 2011). Several authors (Antwi-Agyei et al., 2021) have also highlighted the delayed issuance of forecasts and inconsistency (with respect to time) in issuing forecasts, which becomes a barrier for effective decision-making to respond to climate shocks in sub-Saharan Africa, including Eswatini.

Another barrier affecting drought information is the lack of information on what remedial actions to take. People may fear losing their possessions, not have somewhere safe to go, or lack decision-making authority, preventing them from acting on the information (Bandurska, 2022). The lack of inclusion of people at the community level in response planning and decision-making, and poor community preparedness for response, are other main factors that affect the effectiveness of early warnings (Sufri et al., 2020; Tarchiani et al., 2020). The lack of participation by the community in response planning can lead to poor implementation of a response plan for localized needs (Sufri et al., 2020). Within these vulnerable last-mile communities, factors such as age, gender, ethnicity, literacy levels, physical capacity, and poverty affect the needs, priorities, and

abilities of people to access, understand, and respond to drought information (Lottering et al., 2021). When minority groups are not included in response planning, respecting Gender Equality and Social Inclusion in preparedness activities to increase their interest, this results in a lack of ownership and leads to less participation in the response (Henriksson et al., 2021).

In Eswatini, understanding climate change issues, including drought and weather forecasting, is still a challenge among rural communities in drought-prone areas. A large proportion of Emaswati have access to weather forecast information, and the dissemination and access to weather forecast information is generally satisfactory. However, understanding and interpreting the accessed climate information is still a challenge for some rural communities (BERCS, 2023). Thus, Indigenous Knowledge Systems (IKS) remain valuable and a pillar for most rural communities to help them make important decisions on a day-to-day basis and, most importantly, on whether they can make significant investments in their farming activities. Others use this IKS to validate and/or complement the meteorological services' weather data (BERCS, 2023).

## 2.5. Policy Environment and Drought Legislation

In the last three decades, Eswatini has seen significant surges in climate-related hazards such as drought incidences that are becoming longer and severely worsening poor agricultural outputs, livestock production, and poor health and wellbeing (Kamara et al., 2020). The governments of Eswatini have responded with various policy instruments aimed at addressing the risk of recurrent drought. Nonetheless, recurrent droughts remain the most detrimental of all environmental hazards, often affecting large populations over an extended period and geographical area (Zarafshan et al., 2020). Eswatini's legal instruments aim to enhance water security, reduce risks associated with natural disasters, conserve natural resources, and increase the nation's resilience to climate change. These instruments are directly relevant to national drought planning and risk reduction. Each of these legal instruments has important components that address areas that will assist the country to be better prepared for and reduce the risk of drought. The key policies relevant to drought preparation and risk reduction include the Eswatini National Drought Plan (2020); the National Development Plan (NDP) (2020–2030); the National Disaster Management Act (2006); the National Disaster Risk Management Policy (2010); the Water Management Act (2003); the National Water Policy (2018); the National Irrigation Policy (2005); Eswatini Multi-Hazard Contingency Plans; the National Climate Change Policy (2016); and the Eswatini Gender Policy (2023).

In 2020, the country updated the National Drought Plan (2020-2030), which has several specific purposes, including the provision of a compendium of the most up-to-date information on drought occurrence, impacts, and risk in Eswatini. It is time-bound (10 years) and definitive in its goals and actions, following best-practice models for disaster management, which include, but are not limited to, the Sendai Framework and the Integrated Drought Risk Management three pillars. Furthermore, it identifies a series of short-term immediate monitoring, communication, and response actions to address imminent drought impacts. The plan also identifies longer-term responses that may assist in preparing for future droughts by decreasing drought risk. Finally, it provides a coordinated and coherent approach for government, civil society, donors, and the private sector to lessen the impacts of drought. The drought plan is in alignment with the NDP, which envisions a drought-resilient Eswatini by 2030 through a paradigm shift from a reactive emergency response to a proactive response that will reduce the country's vulnerability and increase drought resilience (Eswatini National Drought Plan, 2020). Arguably, the most comprehensive and progressive policy instrument for drought is the NDP. The NDP drives towards a major change in normal practices to a proactive approach at reducing the country's vulnerability and expanding drought resilience.

According to Kamara et al. (2020), the Disaster Management Act (2006) and the National Disaster Risk Management Policy (2010) are important in drought response for the provision of disaster relief to support affected communities in coping with and surviving drought-induced disasters. Disaster relief is anchored in the Disaster Management Act of Eswatini through the provision of disaster relief, which includes preparedness and vulnerability assessment. This involves the identification of the most vulnerable and at risk of drought impacts that require humanitarian assistance. The National Disaster Management Agency is mandated to coordinate and monitor all relief response actions for supporting communities in preparing for, coping with, and living through hazardous events. However, the 2006 Disaster Management Act does not demonstrate the inclusion of resilience building, which is the main goal of the National Development Plan, but it provides evidence of the intention. This is a gap that needs to be filled as the country is a signatory to the Sendai Framework for Disaster Risk Reduction and the United Nations Convention to Combat Desertification (UNCCD), which focus on creating resilient communities.

Eswatini, being an agrarian country dependent on rain-fed agriculture, makes farming susceptible to recurrent drought and climate variability, leading to contraction of agricultural production and impoverished rural subsistence farmers. In the country, agriculture employs a large proportion of the population through both commercial and subsistence farming. Therefore, recurring and prolonged drought incidences negatively affect the subsistence agriculture on which much of the population depends. The Water

Management Act of 2003 and the National Water Policy of 2018 seek to attain national economic prosperity and social upliftment through equitable, productive, and optimum utilization of water resources while ensuring environmental sustainability. These documents have provisions for investment in irrigation systems; increased accessibility and affordability of smallholder irrigation schemes; partnerships with research institutions to mitigate vulnerability to crop failure; and stimulating synergies with the private sector, nongovernmental organizations (NGOs), and community groups to reduce household-level water vulnerability (Kamara et al., 2020).

The Climate Change Policy, 2016 aims to provide the enabling policy framework to guide Eswatini in addressing the challenges posed by climate change. It creates an enabling environment for communities and investors to take advantage of the opportunities presented by climate change to invest in initiatives that can eliminate poverty and build a climate-resilient Eswatini. Reoccurring droughts result in food insecurity, hunger, and limited access to food, especially within rural subsistence farming communities. Actions to address hunger and reduced access to food in the climate change policy include encouraging and promoting drought-tolerant crop varieties, including indigenous crops; strengthening drought early-warning systems to provide timely advice to farmers; stimulating agroforestry and intercropping to increase productivity; and encouraging agro-ecological zoning corresponding with appropriate cropping. The National Climate Change Policy aligns with national priority sectors and national policy documents. Several national policies address actions on how to mitigate and adapt to climate change impacts to a satisfactory level.

According to Dehingia et al. (2024), recurrent drought has been seen to worsen gender inequality and gender-based violence, mainly sexual violence, in affected communities. Moreover, women and girls in some cultures are excluded from control of productive resources and entitlements, undermining their ability to cope with disaster impacts. The Gender Policy (2023) proposes responses that can address gender-based violence and inequalities, such as the provision of gender-sensitive guidelines and inclusive participation; accelerating socio-economic development to redistribute wealth; encouraging educational attainment for women; empowering women by encouraging female participation in political leadership and training programs; and social welfare to swiftly and effectively respond to gender-based violence.

A critical evaluation of the country's disaster risk reduction (DRR) legal instruments reveals some strengths and significant gaps that can undermine disaster risk reduction initiatives. Among the key identified strengths is the emphasis on a paradigm shift towards a proactive drought management stance (placing emphasis on risk reduction as opposed to crisis management) in the country's National Development Plan (2020-

2023); however, the implementation of this important legal instrument is undermined by resource constraints and insufficient stakeholder engagement (Kamara et al., 2020). Additionally, the country's National Disaster Management Act (2006) and the National Disaster Risk Management Policy (2010) outline critical frameworks for disaster relief, however, lack specific guidelines for building long-term community resilience (Zarafshan et al., 2020). Such inconsistencies raise concerns regarding the cohesiveness of the legal framework.

Among the major gaps identified across all these legal instruments is the integration of gender considerations in drought response strategies in the country. Although the Gender Policy (2023) proposes several strategies aimed at addressing gender inequalities, its actual impact on the decision-making processes at the community level remains limited (Dehingia et al., 2024). While women play a crucial role in agricultural and household decision-making, policies aimed at empowering them through inclusive practices are usually confronted by weak implementation. In addition, women's voices are frequently marginalized in decision-making processes regarding early warning systems. It is important to also note that the country's DRR legal instruments advocate for diverse dissemination channels, however, access to these channels varies significantly across regions. Limited infrastructure in remote areas hampers the effectiveness of these channels. More localized approaches tailored to specific community needs are necessary.

In addition, indigenous knowledge systems are crucial in enhancing the understanding of local environments and climate patterns in Eswatini, and their incorporation into formal early warning systems could enhance community engagement and response; however, current policies often overlook this important knowledge system, and this leads to a disconnect between formal systems and traditional systems where IKS is a vital weather prediction and early warning tool. There is a need for a multi-sectoral approach that includes local communities in the planning and implementation phases in order to improve the efficacy of the DRR policies for Eswatini. Meaningful local stakeholder engagement is crucial in enhancing policy relevance and fostering ownership, sustainability, and increasing the likelihood of successful policy implementation (Lottering et al., 2021). Moreover, regular reviews of the existing legal instruments, aligned with emerging climate data and community feedback, can help identify gaps and areas of improvement and adjustment.

## **2.6. Existing Knowledge Gap on Early Warning Discourse**

Although the current discourses on early warning systems (EWS) in drought-prone areas of global South countries provide a comprehensive synopsis of the policy environment



and challenges surrounding early warning systems, there exist notable gaps in critical research that warrant scholarly attention. While existing studies highlight the importance of timely dissemination of early warning information to improve community resilience (Berland et al., 2022), these studies tend to overlook the nuanced barriers faced by last-mile communities, especially in the context of Eswatini. There is also a tendency among disaster risk reduction scholars to focus on the technical aspects of EWS, such as development of new monitoring tools and indices (Hayes et al., 2021), data collection and dissemination methods, often neglecting the socio-cultural dynamics that influence the reception and actionability (how communities interpret and act upon) of received early warning messages. Scholars such as Antwi-Agyei et al. (2021), while emphasizing the importance of using local language in the translation and interpretation of early warning messages, do not provide empirical evidence on the effectiveness of multilingual dissemination strategies.

Moreover, there is insufficient evidence on the effectiveness of early warning messages in fostering actionable responses among last-mile communities, particularly in drought hotspots. Most research often overlooks the lived experiences of these communities, which can lead to a disconnect between the information provided and the actual needs and capacities of the recipients, leading to insufficient utilization of early warning messages. Additionally, while a number of scholars discuss the major role of indigenous knowledge systems in drought prediction (BERCS, 2023), there is a lack of systematic studies that explore how these systems can be integrated into formal EWS in order to enhance community engagement and trust. Most recent research often fails to critically assess the inclusivity of these systems, particularly regarding gender and socio-economic disparities (Dehingia et al., 2024).

This study addresses these gaps by exploring how marginalized farming communities in Eswatini utilize early warning information. By focusing on the interpretative frameworks and decision-making processes of these communities, the research aims to uncover the barriers to actionability and enhance the relevance of early warning messages. Furthermore, this study will analyze the interplay between formal early warning systems and indigenous knowledge, providing a more holistic understanding of resilience-building strategies in the face of drought. This study addresses these gaps by not only quantifying the accessibility of early warning information among last-mile communities but also qualitatively exploring their perceptions, challenges, and potential solutions. By focusing on the lived experiences of marginalized farming communities in the Lubombo and Shiselweni regions, this research seeks to provide a more comprehensive understanding of the barriers to effective early warning information utilization and identify practical strategies for enhancing community resilience against drought in the context of Eswatini.

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## 3. Methodology

### 3.1. Study Area and Research Design

The research took place in the Lubombo and Shiselweni regions of Eswatini, which are known as the areas in the country most affected by drought. These regions are situated in the Lowveld region of Eswatini, an area with little rainfall located in the eastern and southern parts of the country, on the sheltered side of the Lubombo Mountain range. With an average annual rainfall of around 500mm, this marginalized region experiences ongoing crop failure, high livestock deaths, increasing poverty, and severe food insecurity. The study utilized a combination of positivist and interpretivist research paradigms and employed both qualitative and quantitative research methods to capture the experiences of communities located in remote areas, focusing on their access to early warning messages, the challenges they encounter in obtaining and using this information, and possible solutions to these challenges. This approach allowed for a comprehensive understanding of the issues being studied by leveraging the strengths of each research method. Methodological triangulation was also used to enhance the reliability of the findings by enabling the analysis of a wide range of variables and uncovering knowledge that would be difficult to capture using only one method.

Quantitative methods were useful for quantifying issues and understanding patterns. Specifically, the quantitative data helped to reveal patterns of access to early warning information across various demographic in Lubombo and Shiselweni, providing statistical evidence of utilization rates. For instance, the structured household questionnaire captures data on the frequency and type of early warning messages received, driver of vulnerability and factors affecting utilization of early warning messages, among other variables. This aligns with previous findings that suggest quantitative assessments are crucial for identifying access disparities (Antwi-Agyei et al., 2021).

Qualitative data provided rich, descriptive insights into how into how these communities interpret and act upon early warning messages. This is particularly important in understanding the barriers to actionability, such as the high technicality of the information and cultural factors influencing decision-making. Previous research highlights that qualitative methods are essential for exploring the nuances of community experiences (Dilling & Lemos, 2011).

### 3.2. Data Collection

The research involved the use of both primary and secondary data sources. In terms of secondary data, academic and grey literature related to the discussion of early warning, early action, and building resilience, as well as the accessibility of early warning messages within last-mile farming communities was examined. This included important government reports such as the Eswatini National Drought Plan, National Emergency Response Mitigation and Adaptation Plan, Eswatini Climate Change Adaptation Plan, Eswatini Vulnerability Assessment and Analysis (VACs) reports, and Drought Assessment reports, among others. Recent book chapters, journal articles, and internet sources were also consulted to gain a comprehensive understanding of the early warning and early action debate in the context of marginalized rural communities in the global South.

To gather quantitative data, a structured and non-structured household questionnaire was used in the study area of the drought-prone Lubombo and Shiselweni regions in the Lowveld area of Eswatini. This aimed to understand how marginalized rural communities access and use early warning messages. The data collection tool was pre-coded and entered into the Kobo Toolbox system to ensure accuracy. In addition to this, qualitative data was gathered through in-depth interviews and focused group discussions. The FGD participants were carefully selected to ensure representation of different societal groups, including people with disabilities, the elderly, and the young. The information collected included livelihood activities, access to early warning information, barriers to access, strategies to improve accessibility, and policy measures to enhance access and utilization of early warning messages.

### 3.3. Sampling and Sample Size Determination

The study used a multi-stage sampling method to select a sample size that would accurately represent the population of the study area. Initially, the researchers purposefully selected participants from the Lubombo and Shiselweni regions, both of which are located in the drought-prone Lowveld region of Eswatini. Following this, a stratified simple random sampling technique was used to select a proportionate number of households from the two regions. The sample size was determined using Israel's well-known formula (Equation 1) to ensure it accurately represented the population.

$$n = \frac{N}{1 + N(e)^2} \quad \text{Equation 1}$$

Where  $N$  is the size of the population,  $e$  is the level of precision and  $n$  is the sample size.

The confidence Level was set at 95% and a sampling error of 5 % was allowed. Since the variability in the population are not known, a maximum variability (p=5) assumed.

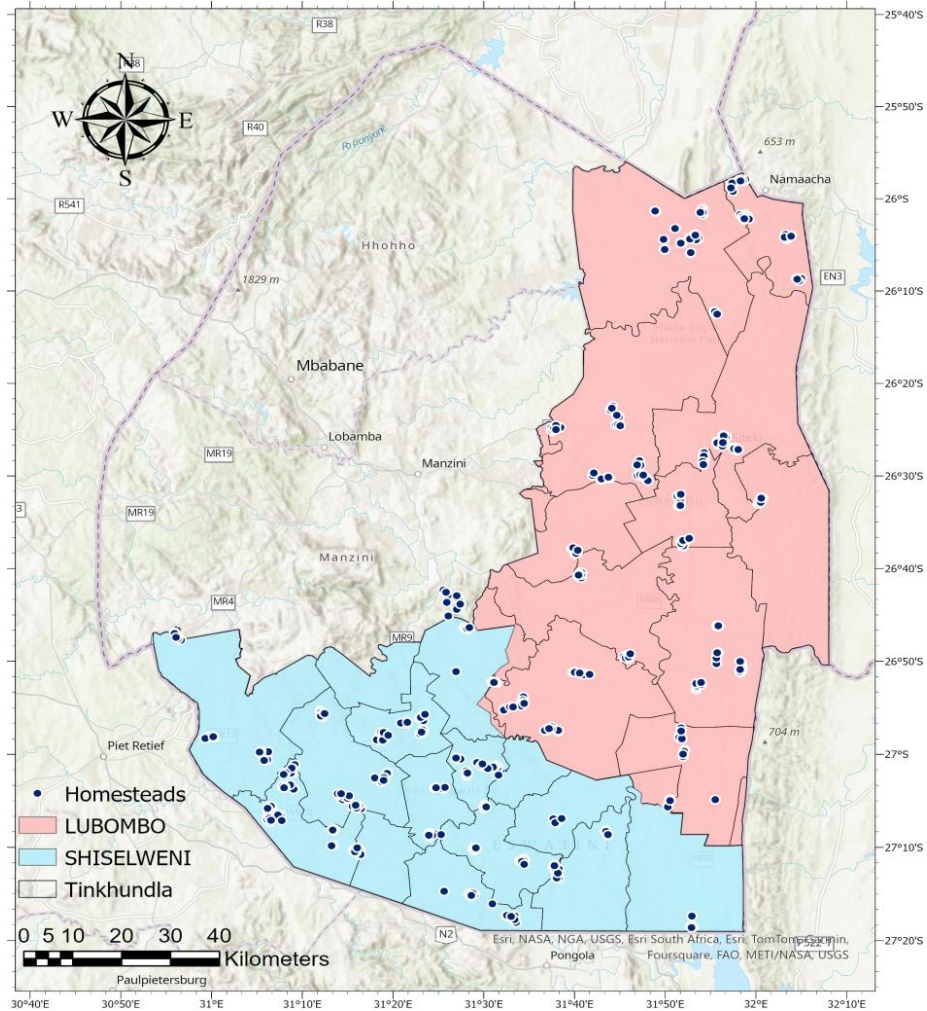
**Example: Sample computation for Shiselweni Region**

$$n = \frac{N}{1 + N(e)^2} = \frac{37066}{1 + 37066(.052)^2} = 367 \text{ households}$$

The computed minimum sample for the survey was 735 households. A sample adjustment (oversampling) of 5% was then done to ensure the minimum sample is achieved for the purposes of representativeness and generalization of findings. This gave a targeted total sample of 772 households. A total of 796 households were eventually visited to obtain their insights on the utilization and actionability of early warning messages in the drought-prone areas of the Shiselweni and Lubombo regions (Table 1).

**Table 1: Sampled and total number of households in the study area**

Region	Total number of households	Targeted/ minimum sample	Sampled number of households
<b>Shiselweni</b>	37, 066	367	409
<b>Lubombo</b>	42, 296	368	387
<b>Total sample</b>	79, 362	735	796



**Map 1:** Map of Eswatini showing sampled households in the Lubombo and Shiselweni regions

### 3.4. Ethical Consideration

The researchers in this study adhered to all ethical procedures to ensure compliance with protocols governing academic studies involving human subjects. They consulted relevant local authorities for permission to conduct the study. Being familiar with the locations and local cultures, the researcher ensured that all processes were conducted in accordance with local customs and norms. The study's intentions were clearly explained before permission was granted. Participation was strictly voluntary, with no coercion, and all potential participants were informed of the study's objectives, purpose, and their rights to participate or refuse. Respondents were also allowed to withdraw at any stage of the interview process.

Privacy was respected throughout the research process, from data collection to the final survey product (Creswell, 2003). The researcher ensured that all respondents could choose a quiet and private location for the interviews. This was done to minimize

interruptions and ensure that respondents were away from relatives and family members who might influence their responses. This also ensured maximum concentration during the interviews. Both measures served as quality assurance mechanisms.

### 3.5. Limitations of the Study

**Limited Scope of Participants:** The study primarily focused on specific marginalized farming communities in drought-prone areas, which may not fully represent the diverse experiences and challenges faced by all last-mile communities in Eswatini.

**Lack of Longitudinal Data:** The reliance on cross-sectional data limits the ability to assess changes in community behavior and resilience over time, particularly in response to evolving climate conditions.

## 4. Results And Discussion

### 4.1. Demographic Characteristics and Livelihoods

#### 4.1.1. Demographic Characteristics of Surveyed Households

The demographic profile of the sampled population reflects a somewhat fair representation of both male and female respondents, at approximately 48.7% and 51.3%, respectively. The Lubombo region is predominantly female-headed (54.5% female-headed vs. 48.2% male-headed). Most households in the study area are small-sized (1-5 members) to average-sized (6-10 members), at 56.8% and 37.2%, respectively. Very few households (6.0%) have more than 10 members.

It is important to note that the surveyed sites include different age groups, with a larger proportion of households (41.3%) headed by individuals aged 19-49. The study area also has a significant elderly population (38.7%) in their early 60s. The area is marked by high unemployment rates (67.2%), particularly in Shiselweni (71.6%) (Table 1). The low level of education (only 4.8% with tertiary education and 29.5% with no education) partly explains the low employment levels. However, a reasonable proportion (45.7%) of households have attained secondary/high school education.

Over half of the household heads in the study area are married, either through Swazi Law and Customs (47.6%) or Civil Rights (10.1%), with a few being widowed (19%) or single (17.2%).

**Table 1: Demographic characteristics of respondents**

Variable	Shiselweni		Lubombo		Total	
	(f)	(%)	(f)	(%)	(f)	(%)
<b>Household Head:</b>						
Male	212	51.8%	176	45.5%	388	48.7%
Female	197	48.2%	211	54.5%	408	51.3%
Total	409	100%	387	100%	796	100%
<b>Household size</b>						
1 - 5	250	61.1%	202	52.2%	452	56.8%
6 - 10	141	34.5%	155	40.1%	296	37.2%
10<	18	4.4%	30	7.8%	48	6.0%
Total	409	100%	387	100%	796	100%
<b>Age:</b>						
≤18	0	0%	0	0%	0	0%
19-49	125	30.6%	204	52.7%	329	41.3%
50-59	94	23.0%	65	16.8%	159	20.0%
60≤	190	46.5%	118	30.5%	308	38.7%
Total	409	100%	387	100%	796	100%
<b>Education level</b>						
Primary	62	15.0%	85	22.0%	147	18.5%
Secondary/high	153	37.4%	211	54.5%	364	45.7%
Vocational	3	0.7%	9	2.3%	12	1.5%
Tertiary	14	3.4%	24	6.2%	38	4.8%

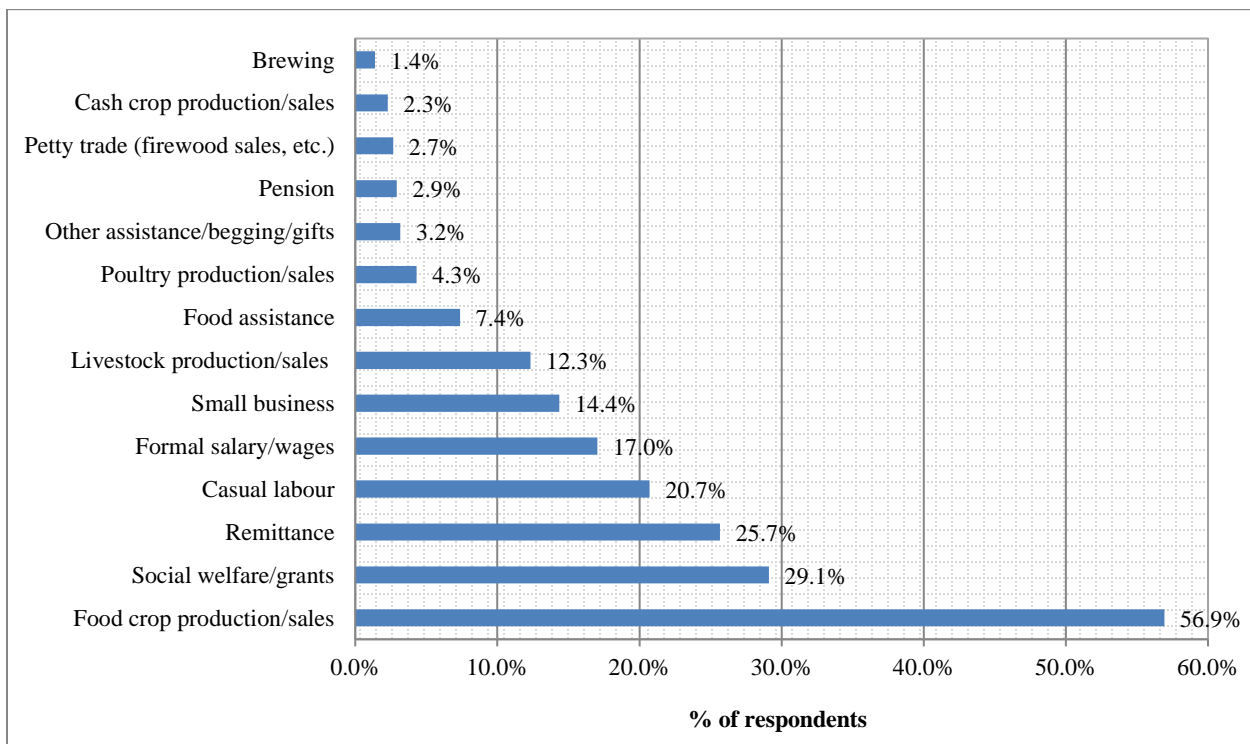
No education	177	43.3%	58	15.0%	235	29.5%
Total	409	100%	387	100%	796	100%
<b>Employment status</b>						
Employed	74	18.1%	114	29.5%	188	23.6%
Self-employed	42	10.3%	30	7.8%	72	9.0%
Unemployed	293	71.6%	242	62.5%	535	67.2%
Don't know	0	0%	1	0.3%	1	0.1
Total	409	100%	387	100%	796	100%
<b>Marital status</b>						
Single	53	13.0%	84	21.7%	137	17.2%
Married Swazi	204	49.9%	175	45.2%	379	47.6%
Married Civil	35	8.6%	45	11.6%	80	10.1%
Cohabiting	11	2.7%	22	5.7%	33	4.1%
Separated	8	2.0%	4	1.0%	12	1.5%
Divorced	3	0.7%	1	0.3%	4	0.5%
Widowed	95	23.2%	56	14.5%	151	19.0%
Total	409	100%	387	100%	796	100%

It is important to note that the general level of education in the area should facilitate a better understanding and interpretation of weather and climate-related information for those with access to early warning messages. Eswatini is a patriarchal society, thus the high percentage of women in the study calls for consideration of gender inequality in education/literacy as a possible limiting factor on the capacity to receive and act on early warning information. The large proportion of elderly-headed households in the study area also provides a context for the utilization of Indigenous knowledge, which is widely advocated by rural communities in Eswatini, to compensate for limited access to early warning information from the Eswatini Meteorological Services (BERCS, 2022).



#### 4.1.2. Livelihoods Pursued by Households in the Study Area

In order to appreciate the importance of access to and proper interpretation of early warning information in the study area, it was necessary to first capture the livelihoods pursued by the people and their relationship with weather and climate variables. The results indicate that agriculture is the most dominant livelihood option for most households, with food crop production being the leading activity, practiced by more than half (56.9%) of the surveyed households. Other agriculture-related activities include livestock rearing (12.3%), poultry production (4.3%), and cash crop production (2.3%), among others (Figure 1). Additionally, households in the region rely on remittances (25.7%), social protection initiatives such as elderly grants (29.1%), and casual labor (20.7%), among other sources (Figure 1).



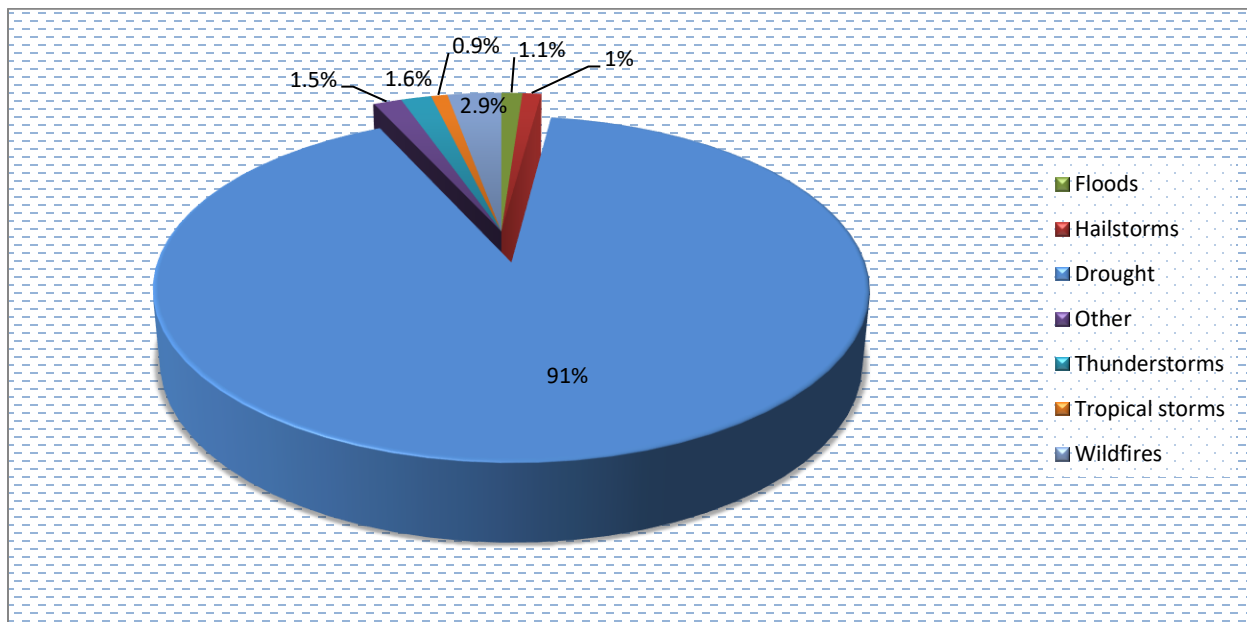
**Figure 1: Livelihood pursued in the study area**

It is worth noting the high reliance on agricultural activities in the study area. Farmers here depend almost exclusively on rain-fed agriculture as a major form of livelihood. Naumann et al. (2019) and Brooks et al. (2005) note that equally exposed areas may experience varying impacts according to the livelihood pursued. The reliance on climate-sensitive livelihood make these communities highly exposed to drought impacts, making access to and proper interpretation of early warning information crucial for investment

decisions. Additionally, there is a significant reliance on social grants, remittances, and casual labor, reflecting the vulnerability of households in the study area (Figure 1).

## 4.2. Experience of Disasters and Drought Impacts in the Study Area

It was necessary to capture the types of natural disasters to which the study area is prone. This was important to understand the different types of disasters shaping vulnerabilities in the study site and to identify the major hydrological disasters characterizing rural communities in the Lubombo and Shiselweni regions. A larger proportion of the population (91%) reported experiencing drought or prolonged dry spell conditions. Other disasters reported by households include but are not limited to, wildfires (2.9%), thunderstorms (1.6%), and hailstorms, among others (Figure 2)



**Figure 2:** Types of natural disasters experienced in Eswatini

It is important to note the dominance of drought as a major natural disaster characterizing the study area and the crucial need for access to early warning messages for farming communities reliant on rain-fed agriculture. Poor access to early warning information would be detrimental for a community whose livelihood is largely dependent on agriculture – an increasingly risky and precarious activity given the prevailing climatic conditions in the study site.

The exposure and vulnerability to different types of disasters, particularly recurrent drought conditions, was also supported by one respondent in an interview who had this to say:

*...we are prone to several disasters in this area; however, we are really struggling with drought and prolonged dry spell conditions that have devastating impacts on our livelihoods. As you know, we don't have any irrigation facilities due to water scarcity and rely on rainfall, hence our high exposure to devastating drought impacts that compromise our livelihood and food security situation. It has become hard even to know the start and end of the farming season due to the ever-shifting onset of the farming season, as rainfall has become highly unpredictable (Female farmer – Shiselweni).*

The dominance of drought as a major hydrological disaster in Eswatini, especially in the Lowveld region, coupled with the challenges brought about by drought to farmers in the country, is also supported by several scholars such as Manyatsi et al. (2012), Mamba (2019), Manyatsi et al. (2010), Manyatsi and Mhazo (2014), and Mamba et al. (2015), who confirm drought to be a major challenge faced by farming rural communities in the country.

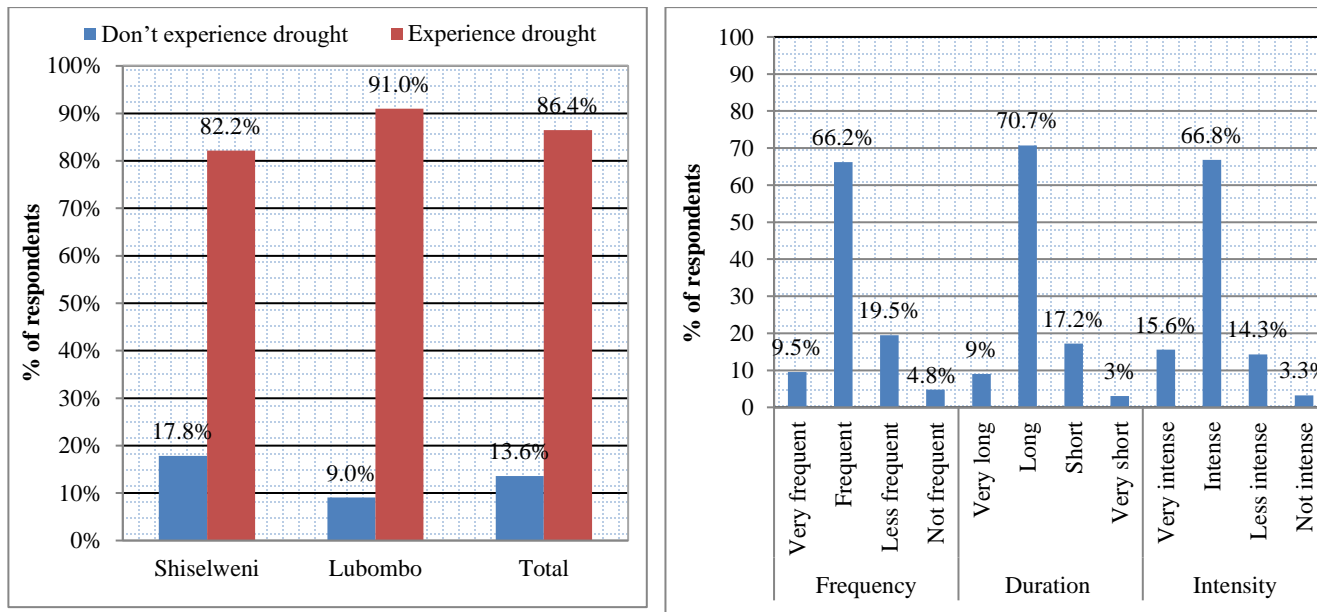


*Some of the respondents during the FGD in the Shiselweni Region*

Having learned that drought was the major natural disaster experienced in the study area, it was necessary to determine the proportion of households who consider drought to be a serious threat in their household in the two surveyed regions (Shiselweni and Lubombo). Therefore, households were specifically asked if they experience drought and its related impacts. An overwhelming majority of households (86.4%) responded

affirmatively, especially in the Lubombo region, where 91% confirmed experiencing drought conditions and their devastating impacts. Similarly, 82.2% in Shiselweni confirmed the severe effects of drought on their households.

It is also worth noting that households in the study area perceive the severity of drought to have worsened in terms of intensity, duration and frequency (Figure 3).

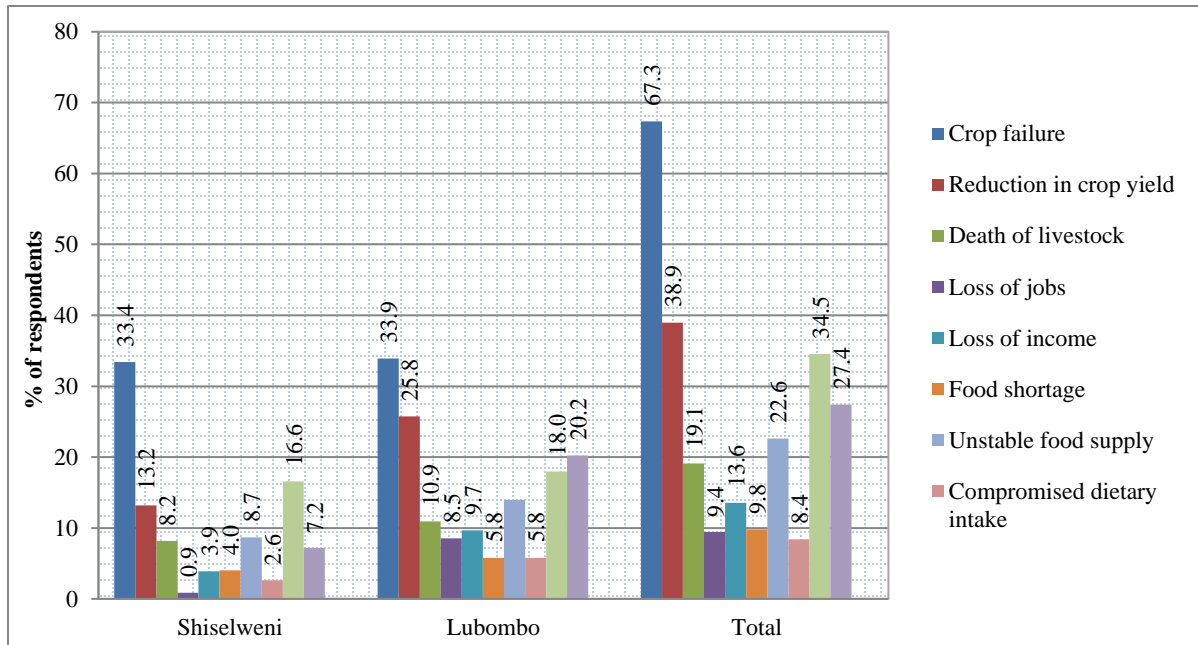


**Figure 3:** Experience of drought and drought severity as perceived by rural communities in the study area

Figure 3 above affirms the level of vulnerability of households to drought in the study area, where drought has become more frequent, intense, and long-lasting than before (Manyatsi et al., 2012). The extract above also highlights the predicament that farmers in the study area occasionally face due to recurring drought conditions that characterize the area. While there are several other shocks and disasters to which the area is prone, and which also negatively impact their livelihoods, drought is considered the major shock and disaster that compromises their livelihood and economic conditions, owing to their reliance on rain-fed agriculture.

Among the negative impacts of drought reported by households in the surveyed communities are crop failure (67.3%), which is the most predominant impact, and reduction in crop yield (38.9%), especially in the Lubombo region where 25.8% of the surveyed households reported grappling with this impact. Additionally, at least 19.1% of the surveyed households experienced the death of livestock (owing to poor pasture conditions) (See picture below). Other drought impacts reported by households include

job and income losses, food shortages, increases in food prices, water shortages, and instability in food supply (Figure 4).



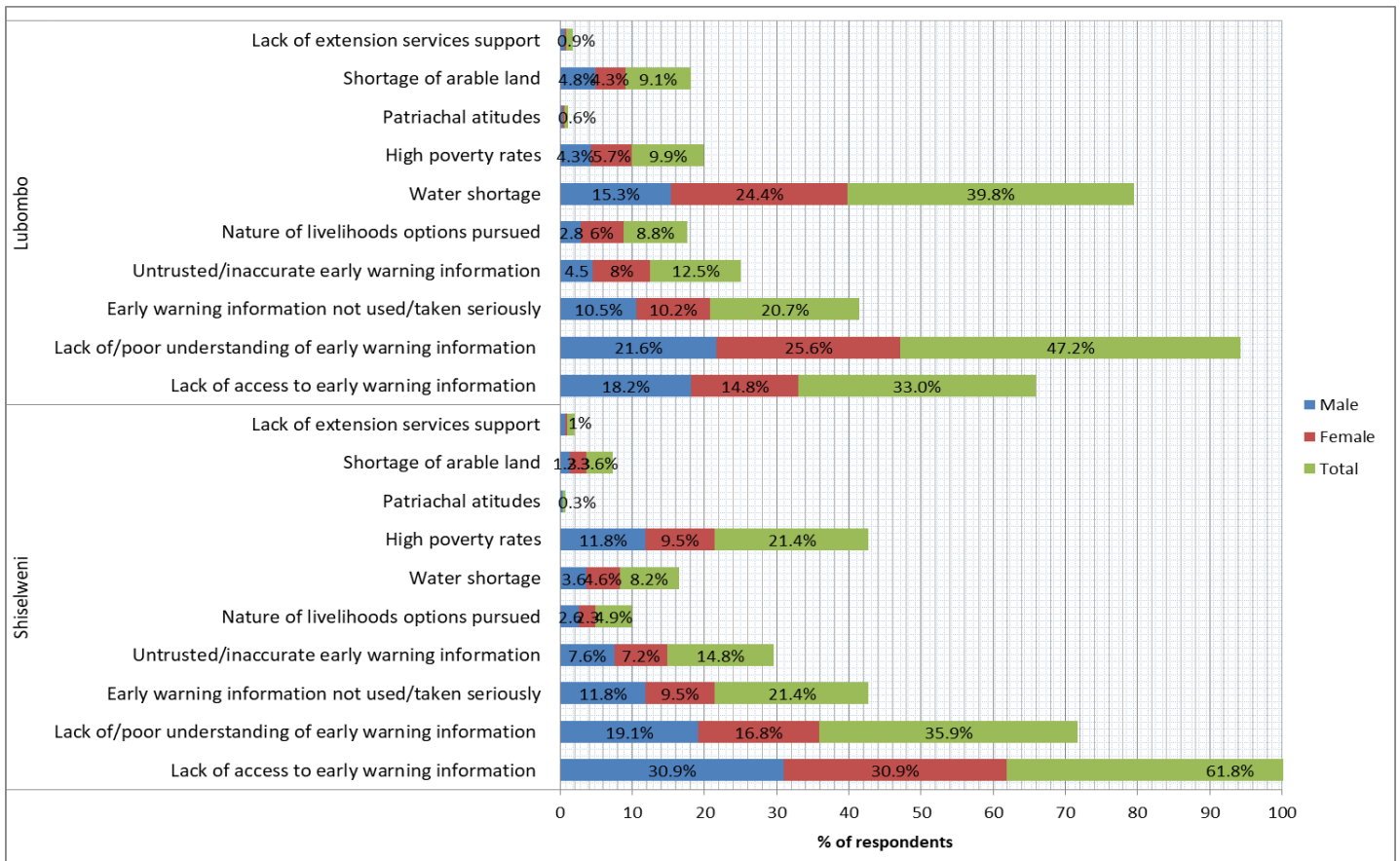
**Figure 4: Drought impacts in Shiselweni and Lubombo regions**

It is important to note that the top three drought impacts reported by the last-mile communities in the study area are directly related to and influenced by prevailing climatic conditions and existing weather patterns, owing to the overreliance of these communities on rain-fed agriculture and pastoral farming. As Pienaaah et al. (2023) rightly note, poor access, interpretation, and utilization of early warning information for most households in these communities would undoubtedly exacerbate such impacts and ultimately increase community exposure and vulnerability to other weather-related shocks.



*Pasture conditions in the semi-arid region of the lowveld during the 2015/16 drought condition*

When respondents were asked to share insights on what contributes to or increase their vulnerability to drought impacts, lack of access to early warning information (61.8%) and poor understanding of early warning messages (47.2%) were cited as major drivers of vulnerability in Shiselweni and Lubombo, respectively. Other major drivers cited by respondents include, but are not limited to, water shortages, particularly in the Lubombo region compared to Shiselweni (39.8% vs. 8.2%), poor utilization of early warning information, and high rates of poverty, among other drivers (Figure 5).



**Figure 5: Drivers of households' vulnerability to drought impacts in Shiselweni and Lubombo regions**

Although there are no significant differences in the drivers of vulnerability between males and females (as reported by households), the data suggests that there are some gender-based differences in the vulnerabilities experienced by households, with female respondents generally reporting high percentages for factors such as water shortages and lack of/poor understanding of early warning information, especially in the Lubombo region where the percentage of female respondents is significantly higher than male respondents. Some differing vulnerabilities between regions in the study area are also highlighted in some factors such as water shortages (with Lubombo recording the

highest). This highlights the need for targeted interventions and support to address these regional and gender-based disparities in vulnerability.

### 4.3. Access to and Utilization of Early Warning Information

Access to early warning information and its utilization are crucial for minimizing households' exposure and vulnerability to drought and similar climate change extreme events such as floods, tropical storms, and hailstorms. Therefore, it is crucial to determine the proportion of households who have access to weather, seasonal forecasts, and alert early warning information among the last-mile communities in the Shiselweni and Lubombo regions. The results reveal that a large majority of the population (75%) has access to early warning information, with male-headed households recording a larger proportion (76.8%) with access to early warning messages as opposed to female-headed households with 73.5% (Figure 6). This lack of access for women points to their higher risk of exposure to drought impacts and its related drivers, which can potentially compromise their ability to provide for their families, increasing their vulnerability to gender-based violence and exploitation (Auya, 2023). This exacerbates existing inequalities in access to resources and opportunities, further perpetuating the cycle of oppression and marginalization, especially in rural and remote areas where traditional gender norms are deeply entrenched (Breakfast et al., 2021).

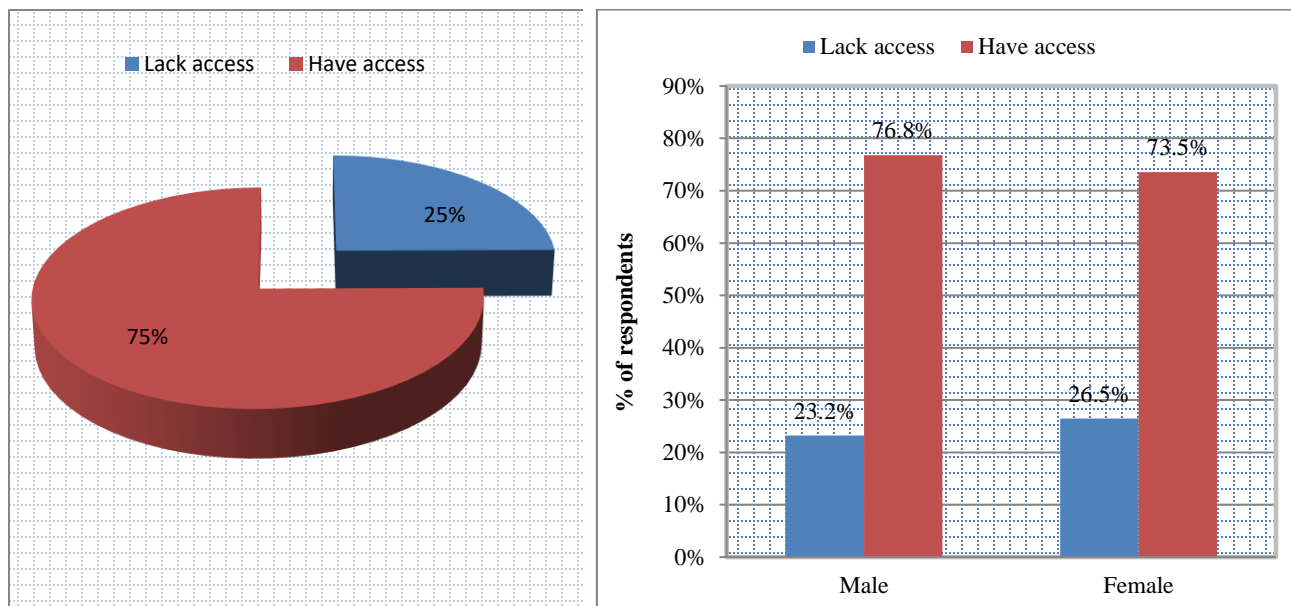
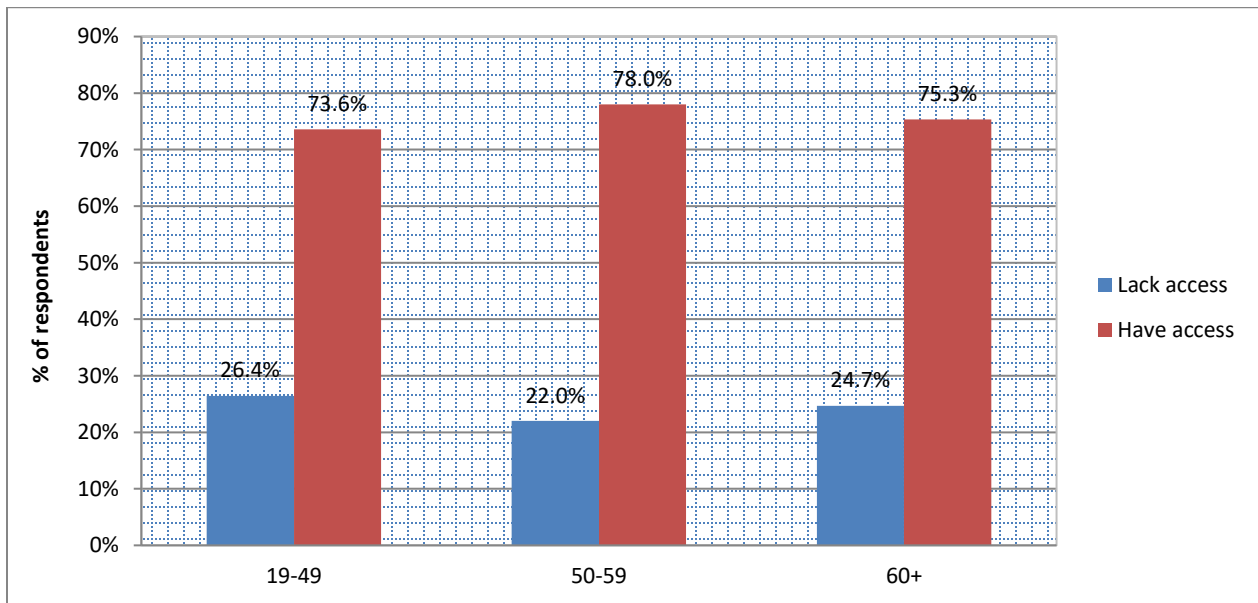


Figure 6: Access to early warning information

It is important to note that although a large proportion of households reported having access to early warning information, the 25% who reported lacking access to early warning messages are a significant proportion and a cause for concern. Interestingly, the population that has the least access to early warning information are in the age group of 19-49 years old with 73.6%. (Figure 7). The challenge of accessing early warning information for some households in the study area was also highlighted by respondents and raised as a major setback when they were asked to share insights on what contributes to or increases their vulnerability to drought impacts. Those who don't receive early warning information remain excluded from national disaster-related alerts, which heightens their vulnerability to weather shocks, This finding corroborates Kearn and Vogel's (2023) observation that a lack of access to early warning information leaves marginalized rural populations unprepared and at high risk when faced with unpredicted natural calamities. This underscores the urgent need to improve early warning information dissemination to ensure that all households, regardless of their geographic location, have equal access to life-saving notifications and warnings for preparedness and proactive response in times of disaster (Gallego & Tejero, 2023).

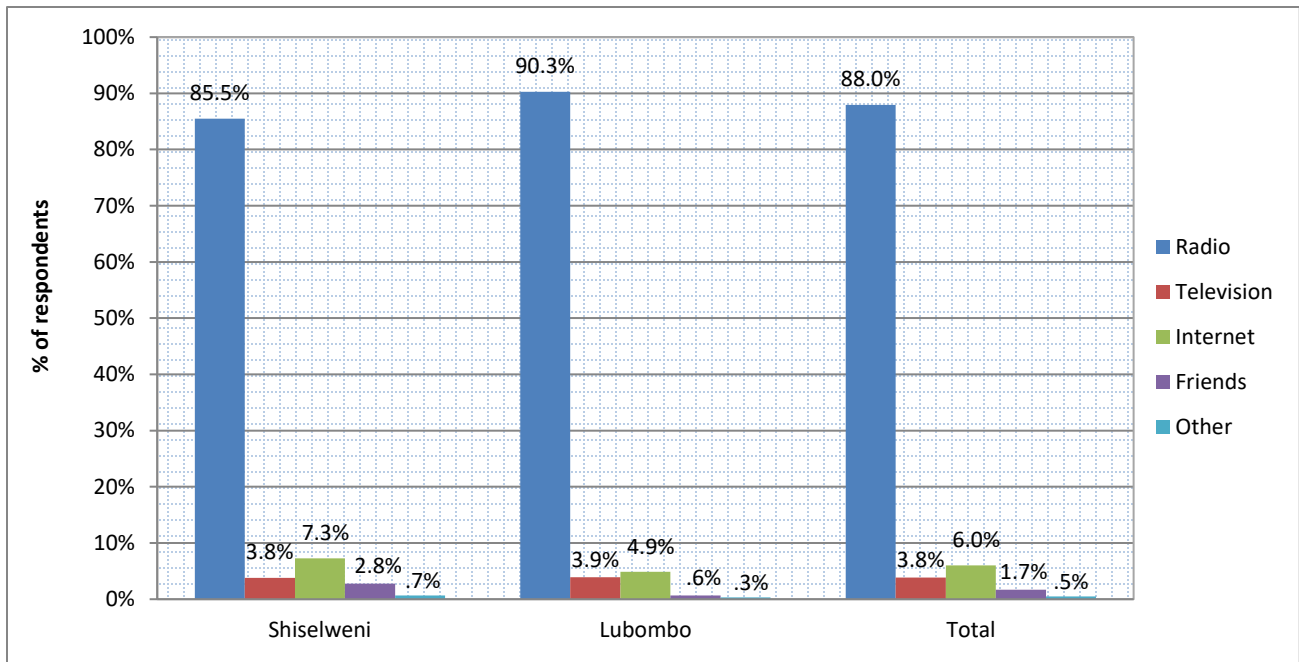


**Figure 7:** Access to early warning information by age group

Access to early warning information in Eswatini is influenced by the mode of information delivery and transmission (BERCS, 2022). Therefore, it was important to determine how early warning information is received in the study area. The results indicated that radio is the major mode of early warning information transmission, with over 80% of households in the study area receiving early warning messages this way. This is particularly true in the Lubombo region, where at least 90% use radios as the main mode of information transmission. Other modes of early warning information dissemination used in Eswatini



include television (3.8%) and the internet (6%), while others rely on friends as their source of information (Figure 8).



**Figure 8:** Mode of delivery of early warning information in Shiselweni and Lubombo regions

It is important to note that radio remains the major mode of early warning information dissemination in Eswatini. Limited access to radios may compromise access for last-mile communities, especially those living in the most remote areas with limited 3G network coverage and weak radio signals. This is what one respondent said in an interview:

*Radios are the main sources of early warning information in the area. However, the challenge is that some homesteads don't have radios, and besides, radios are slowly losing popularity in the country as people migrate to televisions. Unfortunately, in this area, we hardly receive Swati TV (the local TV channel through which early warning information is shared with the public). The use of cellular phones and social media platforms such as Facebook and WhatsApp can help improve access to early warning messages since these are the most commonly used communication mediums, particularly by young people (Female respondent - Lubombo).*

As highlighted in the extract above, the high dependence on radios as the main information dissemination platform compromises access to early warning information in remote communities in Eswatini. This issue is exacerbated by the introduction of visual information dissemination devices such as televisions, which unfortunately still have poor signals in most rural communities and remote areas. Other modes of transmission

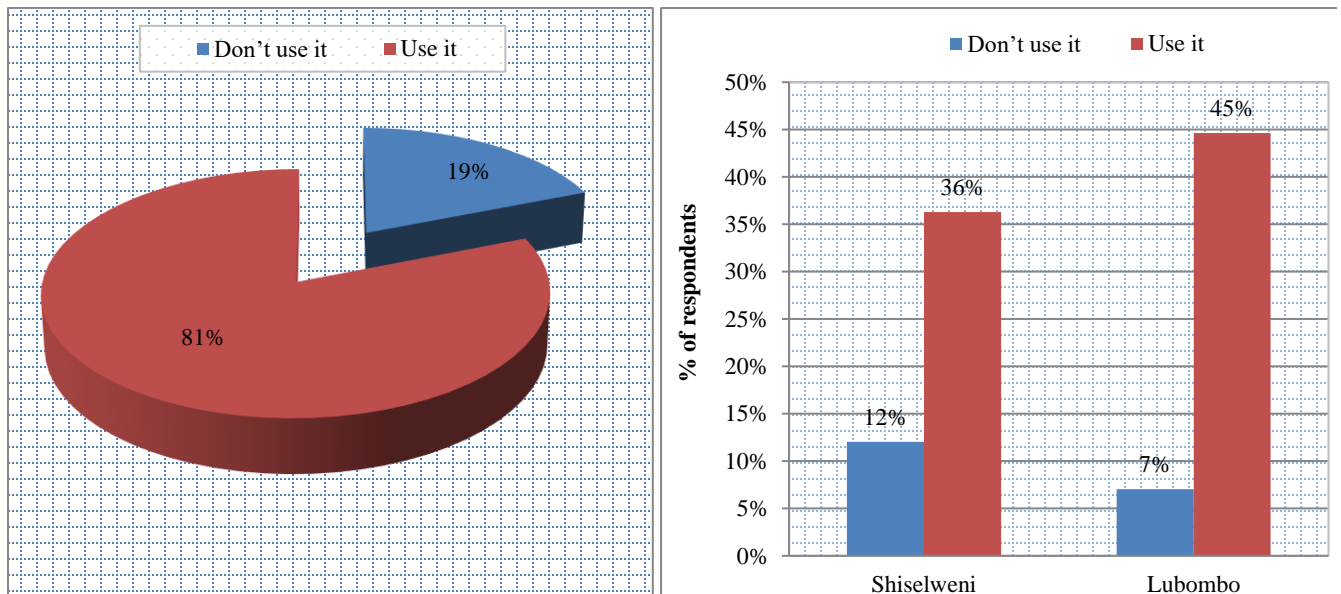
are currently less popular in Eswatini, and their contribution to information dissemination is less significant. There is advocacy for the utilization of popular social media platforms and gadgets such as cell phones, owing to the good network coverage across the country, which currently stands at least 90% (approximately 99% for 2G, which mainly supports voice calls and texts, and 3G network, which covers almost 90% and enables internet connectivity). The rural population in the study area in Eswatini believes that the underutilization of internet-driven information dissemination mediums and the failure to utilize popular social media platforms such as TikTok, Facebook, and WhatsApp also compromises access to early warning information. Social media platforms in Eswatini (and other countries) are the most popular communication mediums, which can potentially improve access to early warning information, especially for the youth who are most active on social media.

These findings from this study find support from scholars such as Perera et al. (2020) and Fakhrudin et al. (2020) who also observe that the Kingdom of Eswatini is faced with accessibility issues experienced by communities in remote locations with limited mobile signals and broadcast services and that this may lead to delays or to not receiving the warning messages at all which can compromise response ability during emergency. This highlights the need for the improvement of the mode of information dissemination in the country by exploring available information that may be accessible to rural communities in remote areas.



*Some of the respondents during a FGD discussion in the Lubombo region*

Having determined the proportion of the population with access to early warning messages and the mode through which this information is received, it was necessary to determine if the received early warning information is used by the rural communities and households who have access to it. The results indicate that the majority of the households confirmed to use (utilize) the early warning messages to inform risk reduction response action (81%). Few households (19%) were found not to use or utilize the information they receive (Figure 9). It is important to note that the Lubombo region tends to utilize received early warning information more compared to the Shiselweni region (45% vs 36%); this is encouraging to note as the population in this region happens to be the most affected by drought impacts. However, this observed utilization of the early warning messages raises a thought-provoking question with regard to the level of comprehension and correct application of the received early warning messages within the Lubombo region. Considering the undeniable fact that this region (Lubombo) constantly grapples with drought impacts due to its considerably higher exposure to the catastrophic consequences of drought, it becomes imperative to explore whether this crucial information is being fully comprehended and implemented correctly, ultimately contributing to the overarching goal of resilience building in this region.

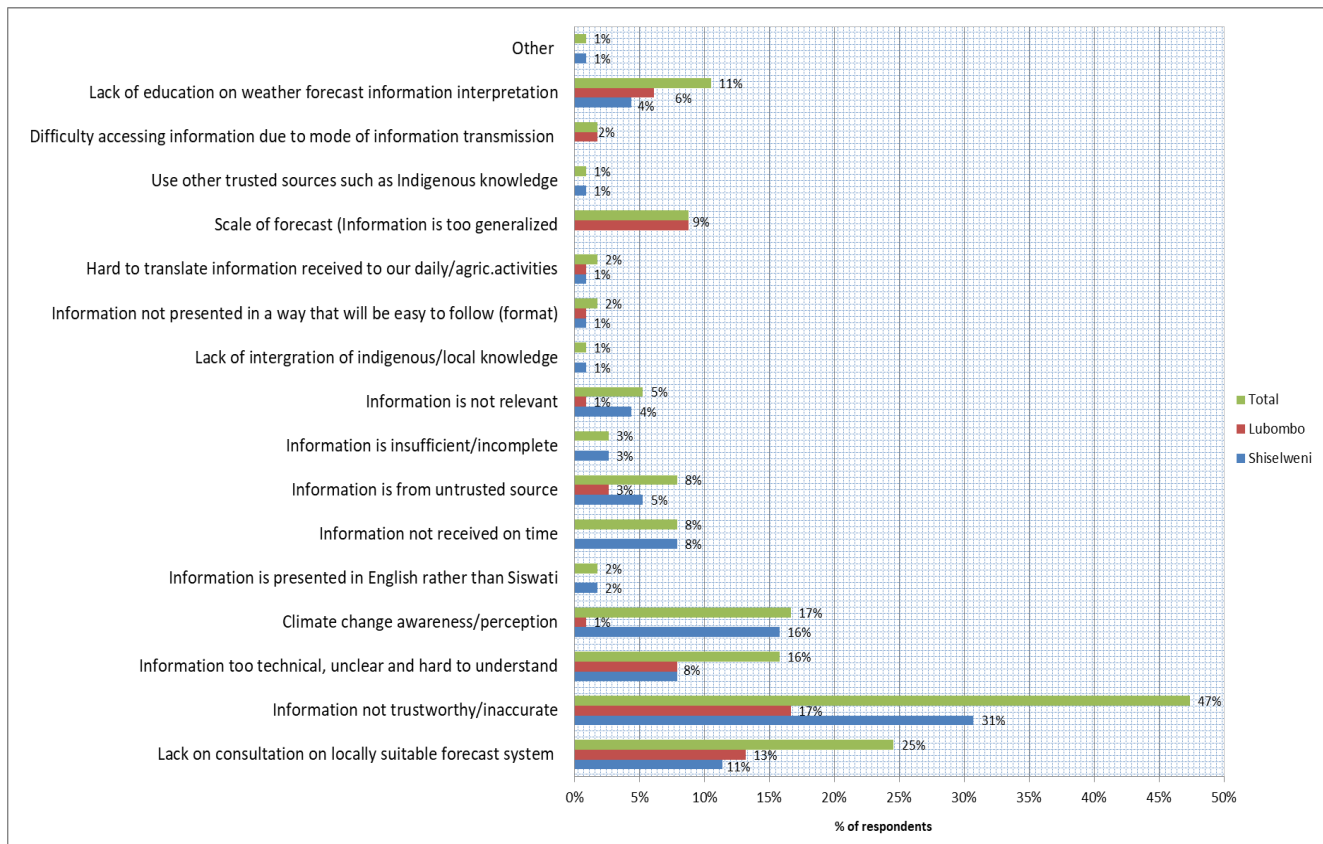


**Figure 9: Utilization of early warning messages**

#### 4.4. Factors Affecting Utilization of Early Warning Messages

The results reveal that although a larger proportion of households in the study area (75%) have access to early warning information, some of these (about 19%) do not use (utilize) the information they receive. Even among those who use it, there seem to be

some challenges they face, hence the received early warning messages seem to add less value to resilience building in some households in the study area. It was, therefore, necessary to capture the various factors that affect the utilization of the received early warning messages among the last-mile communities in the study area. The results reveal a myriad of challenges or factors contributing to the inadequate utilization of early warning information in Eswatini. Among the major challenges are, but are not limited to, a lack of trust in the received early warning messages due to their alleged inaccuracy (47%), with such discontent largely reported in Shiselweni (31%); reactions against a ‘foreign prediction system’ that lacks local relevance due to a lack of consultation on the most locally suitable prediction system (25%); perception and awareness of climate change issues (17%); the technicality of disseminated early warning information (16%); and a lack of education on the proper interpretation of predicted messages (11%), among other factors (Figure 10).

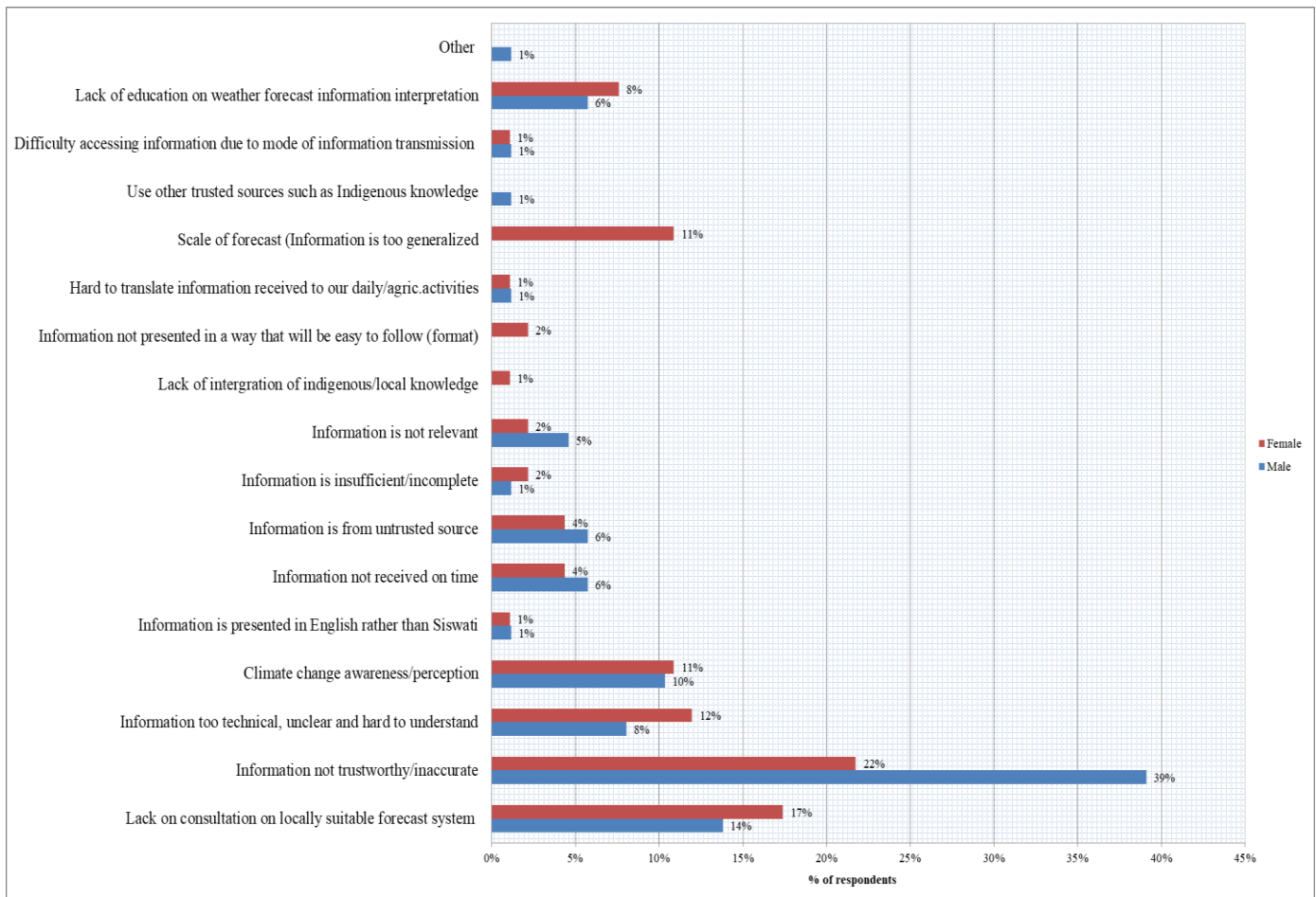


**Figure 10: Factors affecting utilization of early warning messages by region**

Scholars such as Dilling and Lemos (2011), Antwi-Agyei et al. (2021), Weitkamp et al. (2020), and Nkiaka et al. (2019) also note that the use of technical language, lack of education and training (on proper interpretation of early warning information), use of foreign language in the drafting of early warning messages, and limited public

participation in the design of early warning activities tend to affect the utilization and actionability of early warning messages in developing countries.

When the factors were disaggregated by gender, a distinguishable difference between the factors affecting females and males became clear. This is important to uncover for patriarchal societies such as Eswatini, where most household chores, such as farming, are done by females while males are the major decision-makers. It is important to note that most of the constraining factors to the utilization of early warning messages were dominated by females, such as challenges with the technicality of early warning information (12% vs. 8%), reactions against the lack of consultation with local communities on the most appropriate forecast system (17% vs. 14%), awareness of climate change/perception issues (11% vs. 10%), scale of forecast and generalization of early warning information (11% vs. 0%), and lack of education on weather forecast information interpretation (8% vs. 6%), among other factors (Figure 11). It is also a cause for concern that males—the main decision-makers at the household level—perceive early warning messages as inaccurate and, therefore, untrustworthy (39%) (Figure 11).



**Figure 11: Factors affecting utilization of early warning messages by gender**

Different views and insights on the usability of received early warning messages were also shared by respondents during discussions who had this to say:

*Often, we don't understand the forecast and climate change (early warning) information we receive, even though we hear what the meteorologists say. Those of you who are educated might not have this problem, but for us who only completed up to standard six, it can be confusing. When they mention that we will receive normal to above-normal rainfall, we are left puzzled because we don't even know what normal rainfall is. Additionally, when they talk about receiving 20mm of rainfall in Shiselweni, it confuses us older folks even more (Male farmer, Shiselweni).*

Another respondent noted:

*In addition to the highly technical nature of the information we receive, there is something missing that the government needs to address to help us as farmers use this information effectively and avoid losses from disasters. We need assistance in relating this information to our day-to-day activities so that we can act on it. Simply informing us that above-normal rainfall is expected is not sufficient; this information needs to be linked to specific actions we should take. We need the government to tell us, 'This is what will happen, and this is what you should do...'* (Female farmer, Shiselweni).

Females also raised concerns about existing traditional norms that tend to promote their marginalization and heighten their exposure and vulnerability to shocks due to inaction. They had this to say:

*As women, we are sometimes disadvantaged by existing traditional or cultural norms, which heighten our vulnerability. Even if we receive the information in time and want to act on it, we are restricted by our position in the family hierarchy, which does not allow us to make certain crucial decisions. For example, even if I receive early warning messages predicting a favorable year for adequate investment in farming and the resources are available, if the head of the household (husband) is not in favor of preparing for investment that year—acting on the advice from the Ministry of Agriculture and Meteorological Services—my hands would be tied, and I would not be able to take any action. This is, actually one of the major challenges we face as women which tend to create a perpetual cycle of food deficit and poverty (Female, Lubombo).*

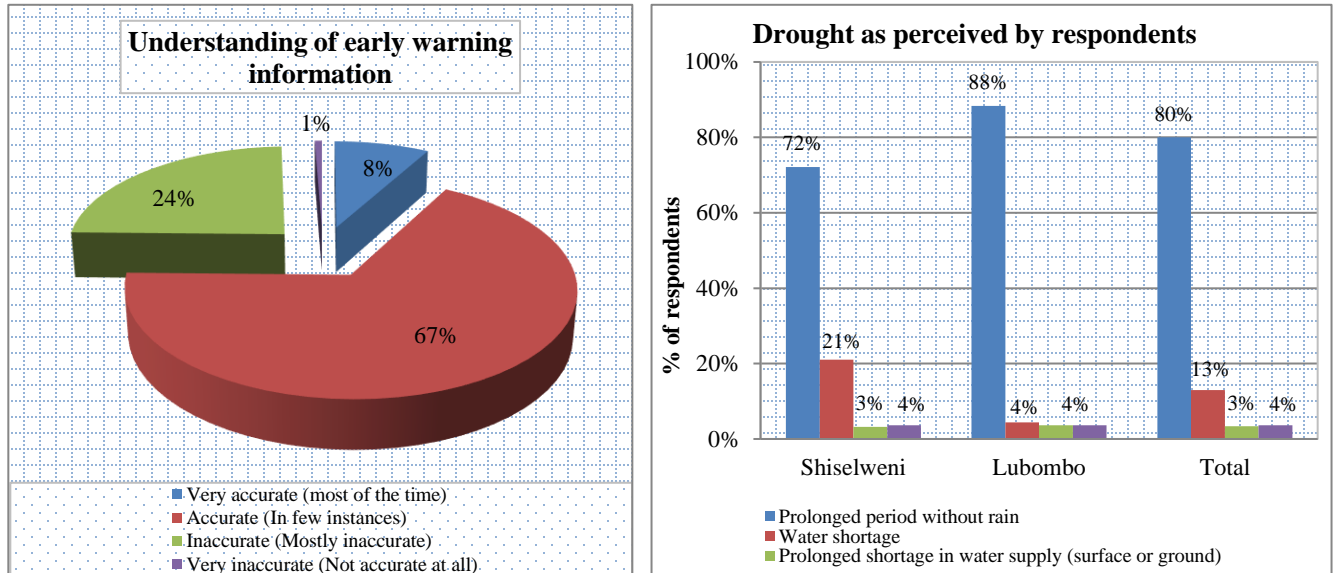
The findings above are supported by various scholars such as Weitkamp et al. (2020), Nkiaka et al. (2019), Dilling and Lemos (2011), and Antwi-Agyei et al. (2021). They agree that a lack of education and training on the proper interpretation of early warning messages, the use of highly technical language, failure to involve local people in the

planning of disaster-related activities, and the failure to translate early warning messages into local languages can pose major obstacles to the use of early warning information. Alexander and Pescaroli (2020), for instance, state that if information is not translated into local languages, or if technical or unclear language is used, individuals who receive the information may be unable to understand it. In addition to technical language clarity, scholars add that, for the information to be useful to farmers, the communication of climate information or forecasts needs to be supplemented with agronomic advice that will be meaningful for farm management decision-making to counteract climate risks (Nkiaka et al., 2019; Dilling and Lemos, 2011).

Lack of decision-making authority also prevents marginalized communities from acting on received early warning information (Bandurska, 2022). This is particularly true in patriarchal societies where the voices of women are rarely heard, despite women being most active in food production and household activities. The lack of consultation with local people on locally relevant early warning systems was also highlighted as an obstacle to the utilization of early warning information. The lack of inclusion of community members in response planning and decision-making affects the effectiveness of early warnings (Sufri et al., 2020; Tarchiani et al., 2020). When the community is not involved in response planning, it leads to poor implementation of response plans tailored to localized needs (Sufri et al., 2020). When minority groups are excluded from response planning, and Gender Equality and Social Inclusion are not respected in preparedness activities, it results in a lack of ownership and reduced participation in the response (Henriksson et al., 2021).

Within vulnerable last-mile communities, factors such as age, gender, ethnicity, literacy levels, physical capacity, and poverty affect the needs, priorities, and abilities of people to access, understand, and respond to drought information (Lottering et al., 2021).

Other authors such as Antwi-Agyei et al (2021) have also highlighted the delayed issuance of forecasts and inconsistency (with respect to time) in issuing forecasts, which becomes a barrier for effective decision-making to respond to climate shocks in sub-Saharan Africa, including Eswatini. The issue of the untrustworthiness of disseminated information is also highlighted as a barrier to the usability (actionability) of early warning information, especially where a major decision has to be taken and any form of uncertainty can compromise action.



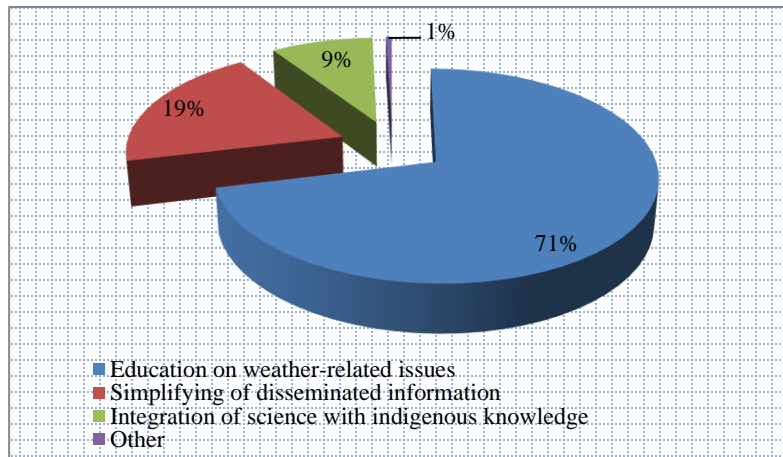
**Figure 12: Understanding of early warning information and perception of drought in the study area**

The lack of confidence in the ability to correctly interpret early warning messages in the drought-prone communities of Lubombo and Shiselweni in Eswatini underscores the importance of capacity building through educational programs to enhance the communities' ability to understand and properly interpret early warning information.

It was also disturbing to note that the majority of the population could not properly define drought conditions and tended to confuse drought with dry spells. For example, the largest proportion of the surveyed population (80%) perceive drought as a prolonged period without rain, while others (13%) perceive water shortage as drought (Figure 12). It is important to note that farming communities in the most drought-prone areas of Eswatini cannot accurately define drought conditions, especially in the most drought-exposed communities of Lubombo, where at least 92% of the surveyed households wrongly define drought as either a prolonged period without rain (88%) or water shortage (4%), with very few (4%) accurately defining drought as a prolonged shortage in water supply (surface or groundwater). This underscores the importance of education to capacitate communities on drought and climate change-related issues.

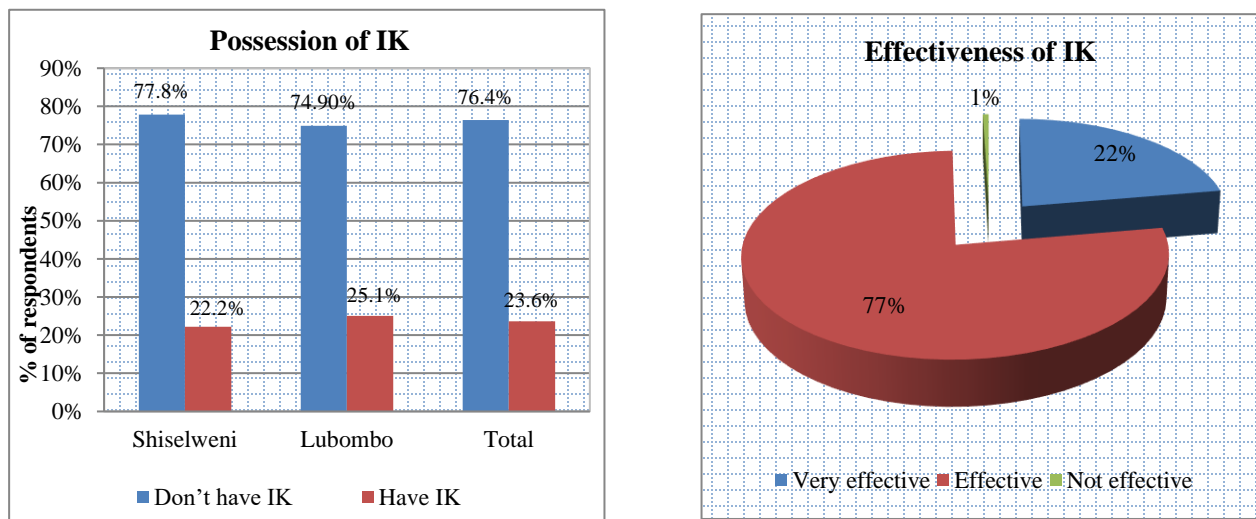
When respondents were asked what they think can be done to improve their understanding of early warning messages, the majority (71%) believed that education on weather-related issues would be key. About 19% suggested the simplification of disseminated early warning messages, while some noted that integrating indigenous knowledge systems with modern/scientific prediction tools could aid understanding (Figure 13).





**Figure 13:** Strategies to improve understanding of early warning messages

Further probing on the idea of integration of Indigenous knowledge was found necessary, particularly because it was also highlighted as a constraining factor to the utilization of early warning information. The researchers wanted to understand if the farming communities of Lubombo and Shiselweni possess any indigenous knowledge (IK) and the proportion of household heads who have knowledge of indigenous knowledge systems and whether they find this to be effective in predicting future climate-related events (early warning). It was discovered that a reasonable proportion of the surveyed households (23%) possess IK which they use to predict upcoming climate/weather events and this was particularly so in the Lubombo region where about 25.1% reported possession of such knowledge. Most interestingly was to note that almost all the households who use IK (99%) either noted that IKS are either effective (77%) or very effective (22%) in accurately predicting upcoming climate/weather events and is a very useful tool in early warning (Figure 14).



**Figure 14:** Possession and effectiveness of IK

Although the study did not focus on indigenous knowledge systems (IKS), the interest in integrating IKS in the drought-prone communities of the Lubombo and Shiselweni regions necessitated further exploration of the communities' experiences with IKS. This was done to understand the various indicators used by last-mile communities in Eswatini and the phenomena predicted by rural farmers in the study area. It was interesting to note that Swazis mostly use a combination of indicators to predict different upcoming events. These indicators include the shape and position of the moon (53%), the calling, behavior, or appearance of certain animals (53%), the appearance of certain clouds (66%), and the fruiting or flowering of certain plants (41%), among other important indicators.

Drought, on the other hand, is mainly predicted by the appearance of certain clouds (34%), the fruiting or flowering of certain plants (3%), and the calling, behavior, or appearance of certain animals, among other indicators. It is worth noting that the traditional IKS indicators used by farmers are related to rainfall prediction, as drought is largely associated with the amount of rainfall received. Additionally, IKS is used to predict seasonal crop performance (e.g., cloud appearance, calling of certain birds), hunger, and seasonal changes, among other variables (Figure 15).

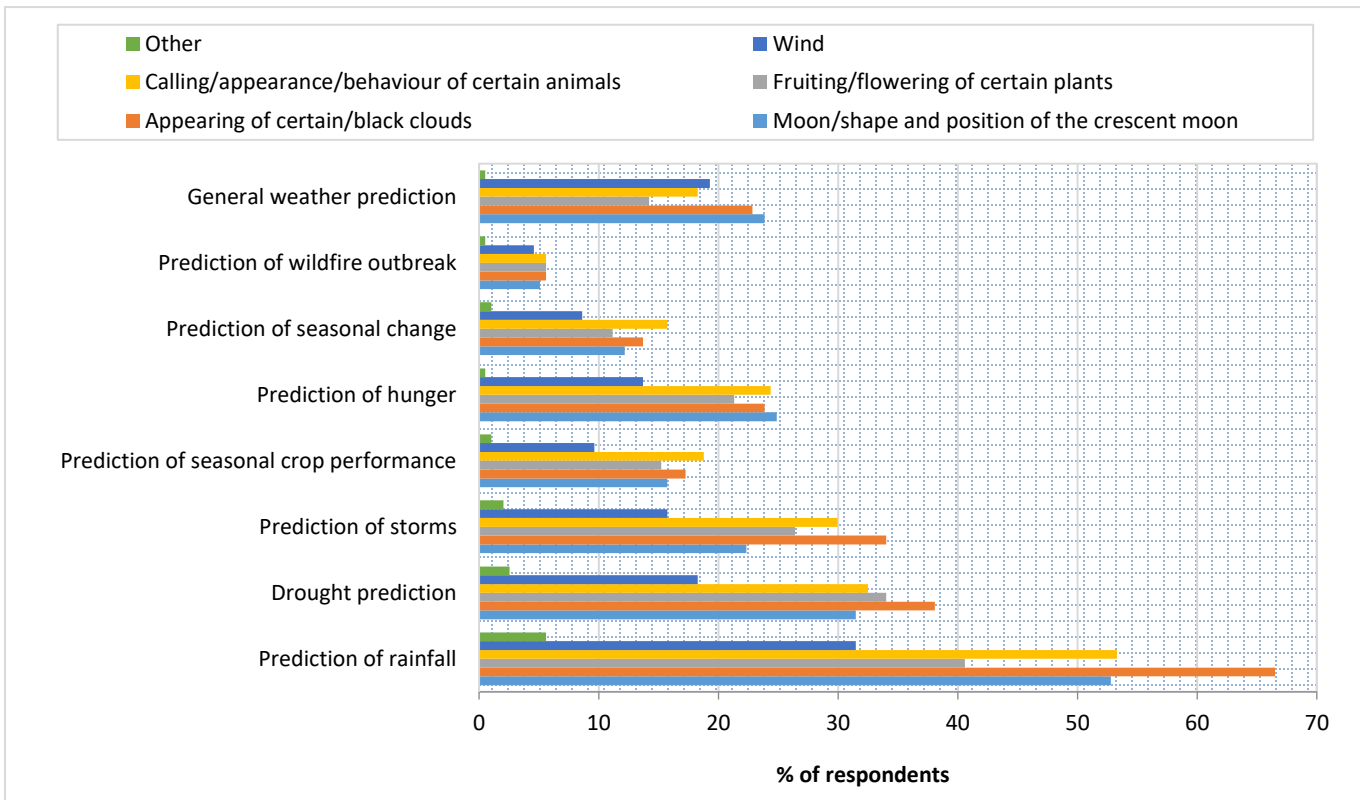


Figure 15: IKS indicators used and the predicted variables

The widespread use of IK for early warning was also highlighted by farmers during group discussions in the selected study area. The desire to see the government and its partners working towards integrating IK with scientific knowledge for an improved early warning system for disaster risk reduction was also highlighted. This is what some respondents in Lubombo had to say during FGD:

*We actually know and use traditional ways of weather prediction and early warning which we continue to use. It's very, very reliable and accurately predicts how the weather and year will look like for proper decision-making, especially for us as farmers. We learned this from our forefathers who have been relying on this traditional system due to its reliability and accuracy since it uses natural indicators. Nature will never go wrong in telling us what to expect. Through IK, we are able to predict different phenomena such as rainfall onset, drought, hunger/famine (poor harvest), and many other things, including a good year (bumper harvest) Male respondent, Lubombo).*

Similarly, the same view was shared by respondents in Shiselweni region during FGD who also noted that:

*As local people here in this region, we rely mostly on trees such as Siganganyane (Lannea discolor) to predict how the year or season will look. For example, if this tree fruited quite well, we know that we are heading for a drought; famine or hunger in that year or season and that is what usually happens. In 2015, for example, this tree had fruited so well and there was drought and hunger across the region and country, in general. This year, it has also fruited well and I am expecting a poor harvest. The trees are accurate (Male, lubombo).*

*I can also recall in 2014 (which was a good year) marula trees in this region had fruited quite well and that year, we had good rains and a good harvest, especially for maize. You can also recall in your area that in 2014 there was plenty of food in the country (Female respondent, Shiselweni).*

From the extracts above, it is clear that IKS is found to be a good prediction and early warning tool in the Lubombo and Shiselweni regions of Eswatini and is perceived to be a source of accurate early warning data as it accurately measures various weather/drought (and other) variables. This prediction system is mainly admired for its use of natural indicators which, according to the respondents, are what makes IKS accurate in its prediction as opposed to scientific and modern prediction technologies. It is the perceived accuracy and context specificity (allowing it to capture local conditions) that rural communities in the study area advocate for its integration into current modern systems to improve prediction accuracy, especially in the current climate change era. It

is, however, important to note that scientific skepticism surrounds the accuracy of IKS (in comparison to empirical scientific data) due to its reliance on traditional practices which may lack adaptability to the rapid pace of climate change. Hutton et al. (2026), for instance, argue that traditional ecological knowledge, in some instances, falls short in addressing new climate-related challenges (which raises questions about its reliability). Whyte (2017) also contends that while IK has been effective in stable environments, the unprecedented changes brought about by climate change may render some traditional practices ineffective. This debate emphasizes the urgent need for a critical examination of how IKS can evolve in response to new environmental conditions. Nonetheless, IK is believed by last-mile communities to be a good tool that cannot only complement modern early warning systems but can also compensate for early warning information gaps that tend to characterize remote communities in drought-prone areas of the Lubombo and Shiselweni regions in Eswatini, owing to accessibility issues and modes of information dissemination.

Several trees (flora indicators), animals (fauna indicators), and astrological/atmospheric indicators (e.g., moon and clouds) were identified as instrumental in early warning and prediction of future climatic patterns in remote rural societies in Lubombo and Shiselweni. Among the flora indicators are, but not limited to, the *Sclerocarya birrea* (Marula/umganu) tree (where high fruitage indicates above-normal rainfall and a good crop harvest for that season), *Mangifera indica* (Mango/Mangoza) (whose high fruitage also predicts a good year in terms of rain and harvest), and *Euphorbia ingens* (Umnhlonhlo) (whose fruiting/flowering predicts upcoming rain), among others. Conversely, high fruitage of other fruit trees such as the Dwarf Turkey-berry (*Umvutfwamini*) and *Lannea discolor* (Siganganyane) signifies an unfavorable year and predicts drought, famine, and hunger. Generally, tree species are primarily used to indicate two types of rainfall seasons: either a season with good rains or a drought season.

Astrological and/or atmospheric indicators include the shape and position of the crescent moon (indicative of imminent rain or lack thereof), the appearance of certain clouds, and wind direction, among others. The appearance (and calling) of certain animals (mainly birds) such as Blue Swallows (*Hirundo rustica*), Southern Ground-Hornbill (*Bucorvus leadbeateri*), and Burchell's Coucal (rainbird) predict normal to above-normal rainfall, while high infestation of locusts predicts an approaching drought condition. The latter was reported to have successfully predicted the 2015/16 drought condition, which was the worst drought experienced by Eswatini in history.



*Some of the respondents during the FGD in Shiselweni region*

## 5. Conclusion

Drought continues to be a persistent hydrological disaster that impacts the livelihoods of most households in remote rural communities in Eswatini, due to the overreliance of these communities on agriculture-related livelihoods practiced under rain-fed conditions. The devastating impacts of climate change are compounded by several factors, including poor access to and utilization of early warning information. Although a larger proportion of households in the country reports having access to early warning information, some households in Eswatini still find it hard to access this information, especially among last-mile communities in remote rural areas in the drought-prone regions of Lubombo and Shiselweni. The overreliance on radio as the main source of climate-related early warning information undermines the country's efforts towards resilience building in these communities through the dissemination of early warning messages for proactive response and action to minimize exposure to drought risks. With network coverage of about 99%, radio broadcasting is a medium that informs and educates people, and it is among the most important traditional electronic media used in the country. However, its accessibility is a very significant issue for persons with hearing disabilities and the younger age groups that do not listen to the radio as often. These are also a large and growing population group. With network coverage of about 99%, mobile phones have

the potential to improve access to early warning messages through cell broadcast text messages that can be sent to the screens of all mobile devices with such capability. People who are blind and have low vision can also access these warnings by using a screen reader.

Several factors account for the poorer utilization of early warning information in drought-prone areas in the Lubombo and Shiselweni regions. These include, but are not limited to, a lack of trust in the received early warning messages due to their alleged inaccuracy, reactions against a 'foreign prediction system' that lacks local relevance due to a lack of consultation on the most locally suitable prediction system, perception and awareness of climate change issues, high technicality of disseminated early warning information, lack of education on the proper interpretation of predicted messages, untimely information, and lack of practical application or relevance of predicted information to day-to-day household activities. Lack of decision-making authority also prevents marginalized communities from acting on received early warning information, particularly for women in highly patriarchal communities where the voices of women are rarely heard. The presentation of early warning messages in a foreign language (English) is also a contributing factor when early warning messages are not translated into the local language or interpreted to the level of understanding of the common farmer.

The study concluded that access to early warning information and the utilization of early warning messages are still low in remote rural areas in Eswatini, hindering resilience building and the protection of livelihoods for marginalized communities. Based on the findings of the study, the following recommendations are made:

## 5.1. Recommendations for Action

### **Simplify Early Warning Messages:**

#### *Use Plain Language:*

- The National Meteorological Service (MET), in partnership with the local disaster management authorities and community-based organizations, should develop early warning messages using simple, non-technical language that is easily understood by the target audience.
- NDMA and MET should ensure that early warning messages are clear, simple, and actionable (trigger response actions from citizens, regardless of their education level), ensuring accessibility and effectiveness for all citizens.

#### *Local Language Translation:*

- MET, in consultation with local language experts and community representatives, should ensure that critical messages are translated into SiSwati (local language and dialects) to enhance comprehension, and perhaps utilization, by all community members.

### **Improve Timeliness, Relevance and Actionability of Information**

#### *Contextual, Relevance and Actionable:*

- NDMA, in collaboration with local authorities and organizations representing diverse community groups, should ensure that early warning systems are inclusive and early warning messages are tailored to relate directly to the communities' daily activities and decision-making processes ((respond to the social and cultural needs of all users).

#### *Timely Updates:*

- Local authorities should prioritize the timely and effective dissemination of early warning messages to enable communities to take proactive measures that reduce the risk of impact from environmental, economic, and social shocks. This may include establishing information dissemination protocols to ensure the timeliness of early warning information, especially before farming seasons and critical periods.

### **Capacity Building and Training:**

#### *Education Programs:*

- Relevant government Ministries should secure funding for educational initiatives that aim to improve community understanding of climate risks and early warning systems.
- Relevant government Ministries such as the Ministry of Agriculture (through its agricultural extension services), in collaboration with community-based organizations and educational institutions, should implement training programs aimed at educating communities on interpreting early warning messages and understanding climate risks.

### **Empower Women:**

- Local disaster management authorities, in collaboration with community-based organizations and women's groups, should focus on empowering women in

decision-making processes related to disaster response and resource management to enhance community resilience.

- The MoA, with farmers and community-based organizations, should guide farmers in applying early warning information to their daily activities, ensuring the information is directly relevant and actionable, while the MET, with disaster management and research institutions, provide impact-based warnings with weather details, potential damages, and mitigation guidelines

### **Enhance Accessibility of Early Warning Information:**

#### *Technology Improvement:*

- Local government should invest in technology to improve mobile and connectivity in remote areas to ensure communities can receive timely early warning messages.
- The National Disaster Management Agency (NDMA), in coordination with MET and community-based communication networks, should ensure the prompt dissemination of early warning messages to enable communities to take proactive measures.

#### **Information Dissemination Channels:**

- It is recommended that the local disaster management authorities, in partnership with telecommunications providers and community-based organizations, should leverage diverse communication channels, including cell broadcasting, social media platforms, and mobile phones, to effectively disseminate early warning messages.
- Collaboration with local organizations to disseminate information through community meetings, and local leaders ensuring wider reach would improve access to early warning messages in remote rural areas where communication network is limited.

#### **Strengthen Community Engagement:**

- Local disaster management authorities, in partnership with community-based organizations and indigenous leaders, should involve communities in the design and dissemination of early warning systems to ensure the information meets their



specific needs, while also incorporating indigenous knowledge and practices to validate and complement scientific data.

### **Monitoring, Policy and Institutional Support:**

#### *Monitoring, Evaluation and Feedback Loops*

- The national disaster management authority, in collaboration with local government agencies, meteorological services, and community-based organizations, should establish robust feedback mechanisms that enable communities to regularly provide feedback on the effectiveness and clarity of early warning messages (enabling continuous improvement), while also conducting periodic evaluations of the early warning systems to identify gaps and implement evidence-based improvements, ensuring the continuous optimization and responsiveness of these critical systems to the evolving needs and capacities of vulnerable populations.

#### *Policy and Institutional Support*

- National Disaster Management Agency (NDMA) in collaboration with the Ministry of Agriculture, NGOs, and community-based organizations should advocate for policies that support the integration of early warning systems into local disaster risk reduction frameworks and agricultural planning.

## **5.2. Recommendations for Future Research**

- Future studies should include a wider range of communities across different regions of Eswatini to capture a more comprehensive understanding of early warning information utilization.
- Conducting longitudinal research would provide insights into how communities adapt to early warning messages over time and how their resilience evolves with repeated exposure to drought conditions.
- Further research should explore how indigenous knowledge systems can be systematically integrated into formal early warning systems to enhance community engagement and trust.

- Future research should delve into the socio-cultural dynamics that influence the reception and interpretation of early warning messages, particularly among vulnerable populations.
- A critical assessment of the existing policies related to drought preparedness and early warning systems should be conducted to identify gaps and propose necessary adjustments for effective implementation.
- The Lubombo region was found to utilize early warning information more effectively compared to the Shiselweni region. However, despite this increased utilization, the region continues to experience high vulnerability and exposure to drought impacts, highlighting its low level of resilience to drought. Further research is needed to explore the level of comprehension and implementation of early warning information in the Lubombo region.

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