Assessment of non-urban user needs for weather and climate information – Mozambique and Zambia

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REPORT

Assessment of non-urban user needs for weather and climate information – Mozambique and Zambia

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Table of Contents

List of Tables

Summary

This report presents findings on the current use and potential needs for weather and climate information from 17 interviews with representatives of key sectors in Mozambique (agriculture, coasts, infrastructure/communications) and Zambia (agriculture, fisheries and infrastructure/communications). Participants were selected purposefully and through snowballing. They disproportionately represent agriculture and fisheries as these are bigger sectors overall, but, in practice, some interviewees covered more than one sector (e.g. coastal and infrastructure/communications, and coastal and fisheries).

Findings show that these sectors all variously view weather and climate information as important to different decisions. Longer-term information is more useful for planning and shorter-term information is more useful for operational decisions. However, the seasonal forecast is the longest timeframe of weather information that is used across all sectors. None of the participants used climate projections.

Most people access information from the national meteorological agencies and remarked on improvements in availability and quality over time. However, these sectors in Mozambique and Zambia also noted several persistent barriers to the use of weather and climate information services that are well known from the literature. This includes issues of accessibility, language, credibility, and the mismatch between what information is provided and what would be optimal to inform particular decisions. At the same time, comments from some participants indicated a lack of awareness of weather products and services already issued by the national meteorological services. This indicates a need to better publicise and communicate those products and services for optimum accessibility, which is a prerequisite for utility.

Participants view some potential for nowcasts. These have a more obvious need for reduction in risk in saving lives, for example for coasts and fishermen in deciding whether to venture out to sea/to the water. However, they may also be useful as part of a suite of weather and climate information services across different timeframes to support operational decisions.

1. Introduction

Weather and Climate Information Services (WISER) Early Warnings for Southern Africa (EWSA) is a project implemented by the University of Leeds in conjunction with South African Weather Services, Kulima Integrated Development Solutions, World Meteorological Organisation, Finnish Meteorological Institute, UK Centre for Ecology and Hydrology, Tyrsky Consulting, Mozambique's National Institute of Meteorology and Zambia Meteorological Department from March 2023 to June 2025. The project will work with disaster risk management agencies and non-governmental organisations, focusing on women and people with disabilities, to reduce disaster risk through the co-production of new weather information services and early warnings targeting urban areas.

In the initial stages of the project, a baseline user needs assessment was conducted in the project's urban case study locations in Mozambique (Vincent et al, 2024a), South Africa (Vincent et al, 2024b) and Zambia (Vincent et al, 2024c). As part of the motivation to ultimately expand early warnings to other sectors beyond urban areas, there was also the intention to explore user needs for weather information services and early warnings with a broader range of sectors.

This report presents the findings of an exploratory study to assess current and potential future use of weather and climate information services and early warnings in Mozambique and Zambia. The team selected these sectors on the basis of their weather exposure. In Mozambique, the priority sectors were identified to be agriculture, coasts and infrastructure/communications; while in Zambia, the priority sectors were identified to be agriculture, fisheries and infrastructure/communications. An assessment of non-urban user needs was not conducted in South Africa as a similar study was conducted last year as part of the Weather and Climate Science for Services Partnership (Lumbroso et al, 2024). The approach adopted in Mozambique and Zambia was informed by the South African study in order to maximise opportunities for comparison.

The report is structured as follows. Section 2 presents the method. Section 3 presents the results, with sub-sections outlining how weather and climate influence the operations of the various sectors, the current sources of weather and climate information that are used, the suitability of current weather and climate information for sector contexts and the level of interest in the nowcast timescale of weather information. Section 4 discusses the result in the context of the literature on weather and climate information services. Section 5 provides a conclusion.

2. Method

Given the exploratory aim of this study, a qualitative methodology was employed. An interview protocol was developed, based on that used for the Weather and Climate Science for Services Partnership study in South Africa (Lumbroso et al, 2024; Vincent, 2023) and in alignment with the baseline user needs quantitative survey conducted in urban areas in Mozambique (Vincent et al, 2024a), South Africa (Vincent et al, 2024b) and Zambia (Vincent et al, 2024c). The interview protocol had several themes. These included: how weather affects the sector, what weather and climate information is currently used, where it is sourced and how this use and sources have changed over time; the extent to which weather and climate information is suitable for current needs and what could make it more useful; and the level of interest in the nowcast timeframe of weather information services (see annex A for the full interview protocol).

The sampling strategy for identifying interviewees was purposive and used snowballing. With a target of five interviewees per sector per country, the intention was to proactively invite interviewees with sufficient experience to be able to speak on behalf of their sector and cover both the public and private sector as appropriate.

A total of 17 interviews were conducted. Ten interviews were conducted with Zambian stakeholders, comprising five from the agriculture sector and five from the fisheries sector (Table 1). Seven interviews were conducted with Mozambican stakeholders, comprising five from agriculture, one from the coastal sector, and one from infrastructure and communications (Table 2).

In practice, there was some overlap between some of the sectors: for example, the participant in Mozambique who was targeted as a representative of infrastructure and communications is the provincial director for infrastructure of a coastal province, and thus also had many insights that were relevant for a coastal stakeholder; and another one was targeted as an agriculture stakeholder but is from a provincial directorate of agriculture and fisheries, so gave comments reflecting both sectors.

Table 1: Zambian participant sample profile

Participant	Sector	Organisation type	Role within organisation
Participant A	Agriculture	Membership organisation	Executive director
Participant B	Agriculture	Government	Senior IT technician
Participant C	Agriculture	NGO	Head of Agricultural Development
Participant D	Agriculture	Private company	Farm manager
Participant E	Agriculture	NGO	Director of organisation
Participant F	Fisheries	University (ex-NGO)	Currently PhD candidate, with long-standing history in fisheries in Zambia
Participant G	Fisheries	Government	Principle aquaculture research officer
Participant H	Fisheries	Independent	Freelance fisheries ecologist
Participant I	Fisheries	FAO	National Project Officer
Participant J	Fisheries	NGO	Fisheries officer

Table 2: Mozambican participant profile

Participant	Sector	Organisation type	Role within organisation
Participant 1	Agriculture	Private sector	Commercial director/agronomist
Participant	Agriculture	Government	Programme coordinator
Participant 3	Agriculture	Multilateral development bank (ex-government)	Impact evaluation field coordinator
Participant 4	Agriculture	Government	Provincial director
Participant 5	Agriculture	Private sector	Sales manager
Participant 6	Infrastructure and communication	Government	Provincial director of infrastructure
Participant 7	Coastal	Government	Head of technical department responsible for transport and registering fishermen and boats

The total number of interviews conducted and the sector representation was less extensive than intended. In practice, exploration through known contacts and secondary research could identify potential interviewees, but response rates and willingness to participate were low. In Zambia, having overcome the initial hurdle of successfully contacting the right people and arranging the interviews, many appointments were broken, some multiple times. In the case of Mozambique, the presidential election on 9th October meant that many government representatives were preoccupied in advance of the election. The ensuing civil unrest caused additional difficulties in arranging interviews, not least due to the disruption to internet and cellphone services. The infrastructure and communications sector was particularly difficult to access. Not only is this sector smaller than the others, but it also has a higher proportion of private sector stakeholders who are typically more guarded with their time and opinions. This challenge mirrors the experience of the South Africa Weather and Climate Science for Services Partnership study, where the infrastructure insights typically came from people targeted through other sectors, for example, water and human settlements (Lumbroso et al, 2024).

Interviewees were contacted by phone or email with a brief introduction to the study and a request to participate. They were also provided with an information sheet and consent form that they were asked to sign and return to indicate their consent to participate. Interviews were conducted online (for Zambia and Mozambique) and in person (in Zambia, given the high failure rate of remote communications) in the language of the interviewee's choice. For Mozambican interviews conducted in Portuguese, WISER EWSA team members provided simultaneous interpretation given their familiarity with the content matter and technical terminology. Interviews were recorded (with permission) and transcribed, or comprehensive verbatim notes were taken. These transcripts and notes were analysed by hand in terms of themes.

3. Results

3.1 How weather and climate affect sectors and information that is used

3.1.1 Agriculture

Zambia

Participants interviewed from the agricultural sector in Zambia all stated that weather and climate are important to their sector and a key element in determining production levels. Rainfall (too much or too little) was mentioned consistently as having the most critical effect on agricultural practices.

“*I think maybe we can say, first of all, weather is maybe the predominant determinant of, you know, production, agricultural production in Zambia, you can almost see correlation between the total production of the staple maize and, you know, the rainfall in a particular year...*" - Participant C

“*The agricultural sector basically depends on weather. The weather, and most of our farmers, they depend on rain with the agriculture. Yes. So ,the way it affects agriculture is basically when they when there are no rains, then very few farmers will farm...”* - Participant E

Many referenced the recent (2023–2024) drought and how it resulted in crop failures and livestock emaciation. Also important, but typically mentioned secondarily to rainfall, was temperature. One participant highlighted that moderate temperatures are crucial for the success of maize (a Zambian staple) while another stated that temperatures and evaporation levels are also critical factors.

Weather and climate information from different timeframes are used for various planning and operational purposes. As shown in

Table 3, in the short term, daily to weekly weather forecasts help inform operational decisions such as when to apply fertilisers or when to harvest. Seasonal forecasts, on the other hand, are primarily used for broader farm management decisions, such as determining the types of crops to plant, the likely timing of planting, and optimal locations. Seasonal forecasts also influence budget planning, guiding decisions on how much to invest in seeds, infrastructure (e.g. building fences to protect against frost during colder periods), and other critical resources.

All of the participants focused specifically on the uses of short-term weather information in discussion, with the seasonal forecast forming the longest-term service that is used. When asked if they used longer-term climate projections, no one indicated that they did.

Table 3: Summary of decisions that are informed by weather and climate information in the agriculture sector

	Short-term operational decisions	**Longer-term planning decisions**	
	Forecasts (days to weeks)	**Outlooks/Seasonal forecasts (month to six months)**	**Climate outlooks (10 years plus)**
Zambia: agriculture	Planting, harvesting, disease prevention (e.g. what insecticides	General management (i.e. type of crops to be planted, when and location), budgets (how much to invest in seeds and infrastructure (e.g. Fences during cold periods to mitigate against frost), estimation of grass availability for	Not used

	fungicides need to be sprayed)	livestock, disease prevention (e.g. what insecticides/fungicides need to be sprayed)	
Mozambique: agriculture	- Daily weather forecasts for planning agricultural inputs and activities (e.g. irrigation, fertilisation) - Adjusting short-term operations based on immediate conditions (e.g. changes in temperature or humidity affecting livestock)	Generally stated that these were not available, but were crucial for planning: - Seasonal forecasts for planning crop selection and planting schedules as well as livestock management - Planning for product distribution based on expected seasonal conditions	Not used

Mozambique

In the agricultural sector of Mozambique, weather and climate play a crucial role in shaping activities and outcomes. Rainfall is a vital component for both crop and livestock management. Participants emphasised the need for accurate rainfall forecasts to plan agricultural inputs and activities effectively. For instance, Participant 1, who works with agricultural inputs like seeds, fertilisers, and pesticides, indicated that understanding expected rainfall patterns is essential as it informs the optimum timings for distributing inputs to shops and training farmers. This is important as planting is typically linked with the onset of rains, and agrochemicals either need to be timed with rains or to avoid rains, depending on the type of chemical. Participant 2 described the delicate balance of harnessing the rainy season for crops that thrive in wet conditions while managing crops during dry periods.

For a livestock farmer, the challenges take a different form but are no less critical. Rainfall affects animal health in many ways, from disease prevalence to pasture availability. Knowing what to expect from the weather helps livestock farmers plan for critical tasks such as administering drugs, managing reproduction cycles, and preparing for birthing seasons. One participant pointed out that seasonal forecasts help to inform when to conduct tasks such as horning and castrations. Temperature and humidity also influence daily tasks like milking and managing heat-sensitive animals like chickens. In livestock farming, reducing stress in animals through informed planning leads to better productivity and health. Participant 4 explained the importance of humidity:

"*Humidity influences the wellbeing of the animal – for the animal to be in a good mood cooler temperatures are better, as the air humidity influences thermal sensation in the animal. So the temperature feeling is linked to the humidity just as much as the temperature. Reducing stress in the animals is key for optimum performance – so the humidity on a daily basis would be really helpful for planning for reproduction and for milking.*" – Participant 4.

Weather information that affects planning for agricultural support services for crops is also relevant for planning for livestock services. Participant 5, a sales manager, highlighted the financial and logistical implications of seasonal variability. As someone who supplies products to farmers, he must anticipate changes in demand based on seasonal conditions. In addition, this also affects the nature of products and support that may be required. During droughts, there is a greater need for supplements and specialised products, while rainy seasons require different stock. He noted how extreme weather, such as floods, disrupts deliveries, adding logistical challenges to an already complex situation.

Participants highlighted the significance of various timescales in informing both planning and operational activities. Agricultural sector stakeholders often depend on short-term forecasts, which focus on immediate conditions and limit their capacity to prepare for broader climatic impacts. As in Zambia, no one from the agricultural sector in Mozambique mentioned the use of climate timescales of information. Reliance on short-term information has been highlighted in other studies of climate information use in agriculture in Mozambique. Novela et al (2021) found that farmers rely more heavily on daily forecasts than seasonal forecasts.

3.1.2 Coasts

Weather and climate information is crucial in this sector because it directly impacts the safety and navigation of boats, particularly in instances of rainfall or strong winds. During extreme weather events, such as cyclones, it becomes critical to prevent fishermen from going to sea to ensure their safety. Representatives of the coastal sector indicated that accurate information on tides and wave conditions is essential for making informed decisions about whether it is safe for fishermen to venture out. This has also been shown to be important in other studies focusing on coastal fisheries (Ouedraogo et al, 2018). The two interviewees covering coasts focused on the importance of short-term (1-10 day forecasts and warnings) timeframes of information, and did not mention seasonal or climate timeframes.

3.1.3 Fisheries

Weather and climate play critical roles in the fisheries and aquaculture sectors, impacting fish populations, aquatic ecosystems, and the livelihoods of fishing communities. Participants highlighted various challenges linked to weather, emphasising its influence on fish physiology, reproduction, and productivity. One participant noted, "*fish are quite dependent on environmental changes. So, any change in the environment... affects the physiology, performance of the fish, reproduction, and even productivity*" (Participant H). Rising temperatures, while beneficial for some warm-water species, can lead to stress if thresholds are exceeded. Another participant mentioned, "*when temperatures suddenly drop... it stresses the fish*" (Participant H).

Rainfall variability is another major concern. Decreased rainfall leads to reduced water levels, which also affects food productivity in the water resources, while excessive rain can cause floods that wash away ponds and infrastructure. Similarly, droughts, such as those experienced in 2023–24 in Zambia, were said to affect production and productivity of fisheries due to receding water bodies and loss of critical habitats.

Extreme weather events also pose direct threats to the safety of fishers and the sustainability of fishing activities. Participants mentioned how strong winds and waves during certain months increase accidents on lakes, while one described flood events as disrupting fish migrations and spawning patterns. Storms and high winds, particularly in large lakes like Tanganyika, can remove fish cages from their anchors, compounding the risks for aquaculture operations.

Water quality deterioration due to extreme weather was also emphasised. Flooding events, for example, promote the proliferation of diseases, such as fungal infections, and disrupt the aquatic environment. One participant noted, "*extreme weathers affect water quality... which is a very important parameter for fish farming*" (Participant G).

Participants highlight that both short-term and long-term weather information is used to inform operational and planning decisions (Table 4). Short-term forecasts are essential for day-to-day activities, helping fishers assess immediate safety risks and weather conditions. Short-term forecasts are also used to inform fish farmers as to potential damaging flood events which will require quick action, such as harvesting or raising embankments, to avoid losses.

Long-term seasonal forecasts were identified as being critical for broader planning and investment decisions. For example, a participant highlighted that "*seasonal information is important… we know when it starts the season for fishing, and we need to know, for example, how much we expect the production to be*" (Participant H). Long-term data also informs infrastructure decisions, such as reinforcing embankments or determining where to situate ponds. Another participant explained, "*For long-term planning… you may have to look at where those ponds are situated*." (Participant G).

While short-term information addresses immediate operational concerns, long-term data supports strategic planning and resource allocation. A participant emphasised the need for both, stating, "*There are both long- and short-term requirements for information… short term tells you whether it's safe to go, and long term helps plan investments*" (Participant H). That said, as in the case of agriculture, "long term" when used by representatives of the fisheries sector also tended to refer to an annual timeframe. No one in the fisheries sector reported using climate projections to inform decision-making.

Table 4: Summary of decisions that are informed by weather and climate information in the fisheries sector

	Short-term operational decisions	**Longer-term planning decisions**	
	Forecasts (days to weeks)	**Outlooks/Seasonal forecasts (month to six months)**	**Climate outlooks (10 years plus)**
Zambia: Fisheries	Fishing activity, cover pond/raise embankments, harvest, fish stocking, catch viability, safety	Budgeting/investment – e.g. infrastructure purchases (e.g. water storage facilities, pond production), situation and construction of ponds, implement biosecurity measures, fish stocking	Not used
Mozambique: Coastal	Assessment of fishermen safety	Not used	Not used

3.1.4 Infrastructure

Weather and climate affect a range of infrastructure and communications, including water and sanitation, water resource management, transport, mining and energy. Mozambique's geographical location on the coast, and with the mouth of several major rivers from the continent, means that its infrastructure is at risk of flooding, and so weather information from upstream countries can also be relevant. Flood risk information issued by the National Directorate of Water Resources Management is thus a key relevant source of weather and climate information. Coastal provinces are exposed to tropical cyclones. Thus, they also pay attention to early warning information. As Participant 6 explains, "*Better to warn and anticipate than to stay and cope with its effects*."

Despite recognising that climate is critical for infrastructural decisions, and although the government has growing awareness of and commitment to addressing climate change, climate projections are not used to design infrastructure. Instead observational data are considered. Participant 6 recalled that historical observational data relating to rain and winds were used to inform the planning and construction of the airport in Gaza. Although they are not necessarily using weather and climate information, infrastructural design decisions increasingly consider climate-resilient design principles. For example, drainage was not ordinarily considered in the construction and rehabilitation of roads, which meant that heavy rainfall and flooding led to damage. Now it is standard practice to build drainage at the side of roads. From an agricultural infrastructure perspective, Participant 4 explained that historical observational data are also the main source of information in the design of irrigation systems. However, knowing that climate is changing relative to the past, they typically add a small margin (e.g. 10%) to compensate.

3.2 Sources of information

3.2.1 Agriculture

Representatives of the agriculture sector in Zambia unanimously noted that their primary source of weather and climate information is the Zambia Meteorological Department (ZMD). A couple of participants mentioned Google and smartphone apps such as AccuWeather.

Similarly in Mozambique, everyone from agriculture mentioned the National Meteorology Institute (INAM) as their source of information, which they, reportedly, receive via radio and television. Regional water bodies, such as ARA-Sul and ARA-Norte, were noted for offering specialised insights into water basins, complementing general forecasts. Some participants use online sources such as Google, though this is more common in urban areas where internet access and smartphone penetration are higher.

3.2.2 Coasts

The representative of the coastal sector also rely on INAM for daily forecasts, which they receive via email or WhatsApp. In the event of any delays from INAM, Participant 7 noted that he would use cellphone applications to independently research and gather weather forecasts for the current and upcoming days, extending up to a week, so that he can fulfil his role of promptly advising fishermen and boat owners.

3.2.3 Fisheries

The representatives of the fisheries sector in Zambia also reported receiving their information primarily from ZMD, with some also mentioning Google or smartphone apps such as AccuWeather.

Given that the national meteorological agencies are the primary source across all sectors in both countries, it is not surprising that no one pays directly for weather information. However, several participants noted that, although the information is provided at no cost, their access to it often comes at a cost, particularly if they are using email or WhatsApp, which causes them to incur data charges.

3.2.4 Infrastructure

The National Institute of Meteorology is the main source of weather information for the infrastructure sector. The National Directorate of Water Resources Management is also a critical source of flood information.

3.3 Suitability of information

3.3.1 Agriculture

Zambia

Accessibility was identified as a major challenge, particularly for small-scale farmers who often lack access to smartphones and televisions. Radios were cited as a more widely available medium for disseminating weather information.

"The modern system, I can tell you that it has not yet started reaching out to the smallholder farmers by and large, because it's being disseminated mostly using smartphones and using television stations.

These are not accessible to the smallholder farmers. There are very few of the farmers who have access to those things." – Participant A

In the absence of access to scientific forecasts, traditional knowledge is often used as a fallback.

"...*the forecasting system that is done by the modern technology rarely reaches the majority of the smallholder farmers. And in in in some cases, they are just using their traditional knowledge to say, "this is how the sun has risen today and these are the clouds that are there we expect rainfall*" - Participant A

Voice-based dissemination through mobile phones was suggested as an effective method, leveraging existing communication practices and offering access even in areas with limited network connectivity. Customised systems for delivering weather information on mobile devices were also proposed to bridge accessibility gaps.

Language barriers also play a significant role; some participants stressed the need to provide weather forecasts in local languages to ensure comprehension, particularly among smallholder farmers who may not be fluent in English. Participant A noted that the current season was the first time that he had seen seasonal forecasts disseminated in Zambia's seven major language groups, which he believed would increase accessibility.

Participants highlighted issues with the **accuracy** of accessed weather forecasts, noting that inaccurate predictions, such as promised rainfall that did not occur, disrupt their planting and harvesting schedules. In some cases, a lack of trust in scientific information can lead to a preference among farmers for traditional knowledge. That said, one participant indicated that trust in scientific data is gradually improving. Television broadcasts, with their visual representation of weather data, were noted as particularly effective in building trust and enhancing comprehension.

There were also problems cited with the current **content** of weather information not meeting the needs of the agricultural sector. Broad probabilistic categories in seasonal forecasts were seen as not useful, with participants suggesting that what would be more useful would be the inclusion of specific rainfall quantities, such as millimetres, or at least an indication of the likely timing of onset and distribution of rainfall within the season. At least one person recognised the tension in being able to provide desired content, noting that "*Weather being chaotic it is difficult to say which is why the forecasters have to be a bit general*" (Participant C).

A recurring theme was the need for highly localised weather information. Participants indicated that current forecasts, which often cover broad regions, fail to meet the needs of farmers. They called for data specific to individual farms or smaller agricultural zones. While provincial forecasts are currently available, many participants advocated for district- or subdistrict-level seasonal forecasts to better align with their requirements. This higher resolution is not limited to spatial information but also includes temporal, with one participant emphasising the value of hourly weather updates to respond to sudden changes, particularly rainfall.

Several participants highlighted that there would be a use for a wider range of weather information than is currently available. In addition to temperature, wind speed and humidity would be helpful information to inform operational decisions like pest control and spraying. Other variables have also been cited in other studies in Zambia looking at the need for weather and climate information in the agricultural sector (Clarkson et al, 2021).

Greater use of advisory information with actionable recommendations was also widely demanded by the agricultural sector representatives. This has also been noted in other Zambian studies (Kokwe et al, 2022). One participant also expressed a desire for enhanced modelling that links weather conditions to actionable crop management recommendations:

We need to go a little bit more scientific into this thing. It's, it's, it's okay for the MET people to give us this, but it's also good if they went further and say, "Look, with this weather, expect to see these changes in your crops. For example, you should expect these kind of pests, insect pests, they move along with this kind of weather. You should expect these diseases. They also come when you are experiencing this weather…" – Participant D.

Mozambique

In Mozambique, participants widely recognised **improvements in the reliability and accuracy** of weather forecasts in recent years, particularly for short-term predictions. However, there are still also issues.

Despite the improvements in the quality of information, **accessibility** of weather and climate information is a persistent challenge, particularly for smallholder farmers. While many recognised the critical role of seasonal forecasts for strategic planning, a notable gap in their availability was evident. Participant 5 stated, "*They do not broadcast the seasonal forecast, so they don't know what the weather will be like in the longer term*." The predominant communication channels for weather information are now electronic and through television. This often excludes those in rural areas who face barriers such as power constraints and limited access to digital technologies. Accessibility is also impeded by the use of technical languages in weather forecasts which can make them difficult for farmers to interpret.

In addition to the challenge of technical presentation, the **content** of weather information in Mozambique is also often unsuited to the needs of the agricultural sector. Many participants mentioned the lack of spatial resolution in the information provided. For example, rainfall forecasts were cited as being too generic, covering large areas such as entire provinces, which makes them unsuitable for localised farming decisions. This mismatch between the scale of available data and the needs of farmers highlights the urgent need for more granular information. Participants noted that local weather stations could address this gap by providing data to inform information tailored to specific districts and farming communities, which would enhance both accuracy and relevance.

The temporal resolution of information was also seen to be a poor match for needs. Short-term forecasts, while helpful for daily decisions, often leave farmers in a reactive position. Participants underscored the need for longer-term forecast information, particularly mentioning seasonal forecasts covering the entire year. Such forecasts would enable farmers to prepare for extreme weather events and adapt their practices to mitigate risks. One participant bemoaned the lack of availability of climate projections, feeling they would be useful.

"*Climate projections are not available…it would 100% be better if they were because they talk about sustainability and it's gold to have that to plan better to sustain business and the sector…but we are reactive by culture*" – Participant 1.

Another participant noted the gaps in information at the other end of the timeframe, highlighting that recent floods exposed a lack of preparedness and highlighted the importance of early warnings.

The variables that are presented are also not always suitable for needs. Representatives of the agricultural sector highlighted that basic temperature data, such as maximum and minimum temperatures, are often insufficient for making informed agricultural decisions. Variables that would be useful for the agricultural sector include forecasts of rainfall quantity in millimetres, timing of rains, and humidity levels. One participant suggested that combining soil moisture data with weather forecasts could provide farmers with a clearer understanding of how weather conditions affect crop growth and water needs. Training extension agents to interpret and translate weather data into practical advice for farmers was also highlighted as an important step toward improving its applicability.

A common thread throughout the Mozambique interviews was data availability. Many participants remarked on the potential for localised forecasting being realised through the installation of weather stations that could provide more relevant data.

3.3.2 Coasts

Participant 7 highlighted the significant improvements in the suitability of weather information over the past three years, which has resulted in a notable reduction in sea accidents. Participant 7 said:

"*Information provided by INAM has been trustworthy in recent times due to better technology which means they provide accurate weather bulletins…in the last 3 years we are having fewer accidents*" – Participant 7.

Previously, many accidents occurred due to sudden weather changes while fishermen were already at sea. However, with the introduction of early warnings from INAM, these incidents have decreased. The enhanced accuracy of these warnings is attributed to technological advancements and a shift from locally produced forecasts at the provincial level to more reliable national-level forecasts. The provincial weather stations, which were previously responsible for generating early warnings, were inadequately equipped, leading to inaccurate and rapidly changing information. The transition to national-level forecasts has provided more precise and dependable data, enabling better preparation and preventive measures for maritime activities.

They emphasised the need for a broader spectrum of weather and climate information, extending beyond the typical one or two days in advance, to provide better warnings for fishermen and boat owners. While the forecasts from INAM have improved safety at sea, they often provide forecasts with only 24 hours' notice.

3.3.3 Fisheries

Participants acknowledged that while weather and climate information is generally helpful and relevant to the fisheries sector, there are a few areas which could be improved.

Accessibility to weather information is a significant barrier for many within the fisheries sector, particularly in rural and remote areas. Urban stakeholders and management-level personnel often have better access, with one noting that "*information has become much more accessible in remote areas where we work because of access to internet by phone and computer"* (Participant J). However, rural fishers struggle due to limited network coverage and insufficient resources (e.g. lack of smartphones or televisions). Participants also highlighted that even radios, which are generally used, sometimes lack coverage:

"*Well, sometimes it was the limitation of the reach of the community radios. In some cases, the radio would not reach as far as you would think…*" – Participant H.

Establishing interactive platforms for real-time communication and extending community radio coverage were further proposed to improve the accessibility of weather information.

Language was also viewed as a barrier, and many participants suggested that weather and climate information should be translated into regional dialects. Communication in local languages and with graphical representation would improve this situation.

Accessibility is also impeded by delays in the receipt of information. **Timeliness** emerged as another critical issue. These delays reduce the utility of the information, particularly in time-sensitive situations. Having an interactive platform where fishers, extension officers, and meteorological experts could collaborate and exchange real-time alerts would ensure that vital information reaches all stakeholders promptly.

"*This also feeds into what we were saying earlier, which is that if we had a platform that the fish farmers are there, the fishers, our MET officers and ourselves we are on one platform that information is issued, meaning that it can get to our people in good time. And like to wait for the general information which comes on national television or the website it is maybe too late*." – Participant G

A recurring concern was the **unsuitability of spatial scales** in current forecasts. Broad regional predictions often fail to address the specific needs of fishers and aquaculture practitioners, who require highly localised information tailored to particular lakes or ponds. Participants pointed out the need for tools designed for small-scale inland fisheries, similar to systems used for commercial deep-sea fishing. Expanding weather station networks and strategically placing monitoring systems were seen as necessary steps to provide more granular and accurate data.

3.4 Interest in nowcasts

3.4.1 Agriculture

Zambia

The majority of farmers felt that there is limited usefulness of short-term warnings. Three participants from the agricultural sector in Zambia felt that a 0–6 hour warning is impractical for farmers to mitigate damages effectively. Participant A emphasised that smallholder farmers, being resource-poor, cannot make substantial preparations within such a short timeframe:

"*If information is just coming abruptly, how are they going to make necessary arrangements so that they can forestall the damage that will come to occur, or they can lessen that damage that may occur. It becomes very difficult for them to take steps against any natural calamity that will occur, if the information is just given them within a day, two days, three days…*" – Participant A.

Similarly, Participant B stated that short-term warnings provide no realistic opportunity to prevent crop damage:

"*It's impossible to prevent when you say this will damage your crop within six hours or so. Then you just accept that, unless maybe you are told way in advance.*" – Participant B.

While they may not be useful for crops directly, two participants indicated that they would have a place in informing operational decisions. Participant C and Participant D highlighted that knowing about impending weather in a 0–6 hour parameter could help in relocating livestock, removing equipment from the field or optimising the timing of field operations, such as applying fertilisers which may be washed away by rainfall.

Mozambique

Participants' responses revealed a range of perspectives on the utility of receiving short-term (0–6 hours) nowcasts for thunderstorms. While some found such information valuable for immediate operational adjustments, others felt the timeframe was too limited for significant action, especially in agricultural contexts where preparation often requires more time. For some, the short timeframe was particularly impractical due to geographical or logistical constraints. One participant shared an example involving their mother, who must walk several kilometres to reach her farm. In such cases, the immediacy of a nowcast would not allow sufficient time to move equipment or take protective actions.

Several participants highlighted how nowcasts would only be useful as part of a suite of information, pointing out that for tasks like spreading fertiliser, nowcasts could provide guidance within a day but that would be reliant on having a decent seasonal forecast which had allowed preparation to have the fertiliser available. From a livestock perspective, Participant 5 noted the value of these warnings for securing livestock, as well as making the most of water management systems (e.g. to capitalise on rainwater harvesting).

As in Zambia, the agricultural representatives from Mozambique also highlighted that there would be limitations to the utility of nowcasts. For example, Participant 2 also echoed these sentiments, highlighting that while the information will allow for quick action tasks such as draining water channels, the 0–6 hour time frame wouldn't allow them to do anything substantial like saving their crops.

3.4.2 Coasts

For the coastal sector, which already relies heavily on very short-term information, nowcasts would be useful. This would particularly be the case in potential nowcasts of wave levels, as waves are the biggest risk to coastal operations.

3.4.3 Fisheries

All interviewees agreed that 0–6 hour thunderstorm warnings would be useful to the fisheries sector. Several participants highlighted that having this information would allow them to protect their fish from harm:

"*So a six hour period is long enough to secure whatever you have… instead of a complete loss there is someone who can at least organise protection of their fish*" – Participant G.

"*There are options that you can do. Is one, either you remove your fish from the ponds, and if you have an alternative site where you can put them to reduce on losses*" – Participant H.

In addition to safeguarding the loss of fish, interviewees emphasised the role of short-term warnings in preventing the loss of human lives and protecting equipment. Participant I highlighted the importance of timely dissemination, suggesting that short-term warnings could stop fishers from heading out to potentially dangerous waters and help those already on the water to find shelter. Participant H echoed this, explaining how avoiding hazardous conditions on lakes could reduce risks to fishers and their boats.

However, while all agreed on the usefulness, some participants did highlight potential challenges associated with the brevity and reliability of such warnings. For instance, Participant F noted that while short-term warnings can be helpful, they are limited by the short preparation window, making it difficult to decide what actions to prioritise. They emphasised that having more time to prepare would increase the ability to mitigate potential damages. Participant H echoed this sentiment, emphasising that the feasibility of taking preventive measures varies based on the nature of operations and the available time.

Some participants also provided suggestions to ensure that short-term forecasts would be useful. These included the need for area-specific forecasts to enhance relevance and applicability (Participant J). Additionally, a participant emphasised using multiple communication channels, such as radios, mobile phones, and community networks, to ensure warnings reach all stakeholders in a timely manner (Participant I). Participant G proposed creating a dedicated platform that connects fishers, meteorological officers, and other relevant parties to facilitate swift and targeted dissemination of warnings.

4. Discussion

Weather and climate information is important to the agriculture, coasts and fisheries sectors. As shown in other studies in southern Africa, weather information is far more widely used than longer-term climate information, and the longest timeframe of interest tends to be one year. Longer-term weather information, such as seasonal forecasts, is typically used for planning decisions, for example including what to plant, while the shorter-term forecasts are used more for operational day-to-day decisions, for example how to practice agriculture or fishing. The shortest-term information is useful for fisheries and coasts, where operational risk management is key.

The use of climate and weather information among farmers has evolved, shaped by individual preferences, technological advancements, and the increasing unpredictability of weather patterns. While some farmers rely heavily on intuition and traditional practices, others consistently integrate the use of weather and climate information into their decision-making.

In earlier times, limited access to such information posed a significant barrier, but the proliferation of tools like mobile apps and improved updates from meteorological offices has made it more readily available, encouraging greater engagement. The growing unpredictability of weather and experiences with climate change impacts, particularly the recent drought, have heightened the importance of this information, prompting many farmers to take it more seriously. Seasonal variations also play a role, with heightened interest following critical events like dry periods, even as traditional practices, such as observing the sky or relying on seasonal forecasts, remain ingrained.

Across all sectors and both countries, the national meteorological agencies are the most common source of information. Also across both countries, participants reported improvements in the quality and reliability of information that is made available. Among participants in Mozambique in particular, there was a common thread around data availability, and the belief that more observation stations would enable more localised and tailored forecasts. This likely is linked to the promotion of the “one district, one weather station” presidential campaign which has put a focus on data availability.

Despite the improvements, there remain some persistent challenges that impede the success of weather information services across these sectors in Mozambique and Zambia. As summarised in Table 5, there are still issues with accessibility, language, credibility and the mismatch of information with needs. These challenges are all well recorded in the climate services literature, with many suggestions having been made to improve them (e.g. Lemos et al, 2012; Vincent et al, 2020).

There are several international and national efforts to address the challenges identified in the utility of weather information services. This includes, for example, the Global Framework for Climate Services and other World Meteorological Organisation initiatives to improve weather forecasting and early warning (e.g. Hewitt et al, 2012; WMO, 2024). Several participants recognised that there are limitations to their wishes – for example with the spatial resolution information, one or two participants recognised that it is unlikely to capture the resolution that would ideally be desired accurately. However, some of the responses also highlighted that improvements in information availability by the meteorological services are not optimally communicated and understood by users. For example, a common request across both countries, for both the agriculture and fisheries sectors, was for actionable recommendations of what to do with the weather forecast. Zambia issues an agrometeorological bulletin and a weekly weather bulletin, both of which contain agricultural advisory information, yet these products were not reported to be used. Similarly, both countries are experimenting with impact-based forecasting which provides more advisory information, but this was not acknowledged (other than the general widespread comments that information quality had greatly improved). Likewise in Mozambique, some participants requested information contained in the seasonal forecast. This either indicates that the seasonal forecast is not as widely communicated as it could be – or it reflects the timing of the interviews which took place around the time of the seasonal forecast being issued.

On the nowcasts, there are differences between the sectors in perceptions of utility. As already outlined, the shorter-term information is useful for operational decisions while the longer-term information is useful for planning. Since 0–6 hour weather warnings are a shorter timeframe than what is currently available, it is not surprising that their utility is mainly for immediate, tactical decisions rather than broader strategic planning.

Table 5: Summary of challenges that impede use of weather information services

Issue	Explanation
Accessibility	Not everyone is receiving information due to variable access to communication channels.
Language	Not everyone is understanding information, either because it is not communicated in a language that they can understand, or because the terminology used is too technical.
Credibility	Inaccurate forecasts undermine trust in the information and can drive reliance on traditional forecasts.
Mismatch of presented information with needs	The variables presented are not useful, the information is not presented at the appropriate spatial or temporal scale, and/or there is a lack of actionable recommendations of what to do with the information

Within the agriculture sector, they are not perceived as a transformative tool for the sector. Many highlighted the constraints of limited options to act on such information – for example, the inability to move a planted crop. However, others recognised that short-term information could practically be used to inform some decisions to manage risk. Thus their role in the agriculture sector is as a complement to the existing varied timescales of information that are available.

For the coastal and fisheries sectors, there is already greater reliance on very short-term information, and thus a greater perceived utility for nowcasts. For fisheries, there is greater potential to move fish than there is crops, for example. There is also the potential to save fishermen's lives by informing them when it is too dangerous to fish. A previous WISER project in East Africa, HIGHWAY, has been successful in reducing deaths of fishermen by providing fishing-specific forecasts (Watkiss et al, 2020) – and this approach was even known and recognised by one of the participants (Participant J). The life-saving aspect of nowcasts was also strongly highlighted in the urban user needs assessment, where very high proportions of the sample in Mozambique, South Africa and Zambia recognised they would have a life-saving role (Vincent et al, 2024a, b, c).

In being life-saving, the short-range weather information of nowcasts aligns well with early warning systems, and perhaps more so than the efforts that focus on improving climate services. The UN Secretary General's Early Warning for All initiative recognises that early warning systems comprise four components. One is detection, observation, monitoring, analysis and forecasting, and another is warning dissemination and communication. These two pillars have complementarities with climate service initiatives and focus on information availability. However, the other two pillars are disaster risk knowledge and management, and preparedness and response capabilities. These two are firmly in the realm of disaster risk reduction and require that people are able to act upon the information that they receive. One of the biggest sets of barriers cited in the urban user needs assessment to not using early warning information related to not being able to act upon it, due to not having the capacity or access to the resources necessary to act upon it (Vincent, 2024a, b, c). This exploration with wider sectors highlights that short-range information can be used to save lives, but such barriers prevent it from being able to reduce all the potential dimensions of risk unproblematically.

5. Conclusion

This report has outlined the findings of a study conducted within the context of the WISER EWSA project to assess the current and potential future use of weather and climate information services and early warnings in key sectors in Mozambique (agriculture, coasts, infrastructure/communications) and Zambia (agriculture, fisheries and infrastructure/communications).

Based on 17 interviews across those sectors, the most robust findings come from agriculture and fisheries, with only indicative insights on infrastructure/communications. Findings show that these sectors all variously view weather and climate information as important to different planning and operational decisions. Longer-term information is more useful for planning and shorter-term information is more useful for operational decisions. However, the seasonal forecast is the longest timeframe of weather information that is used across all sectors. None of the participants used climate projections.

These findings mirror those from other studies across Africa that focus on the current use of weather and climate information. The reliance on shorter-term weather information is understandable in the context of immediate needs, but failing to consider climate information and long-term trends means that countries will always be in a position of reactivity, as was bemoaned by one interviewee in Mozambique.

Most people access information from the national meteorological agencies and remarked on improvements in availability and quality over time. However, these sectors in Mozambique and Zambia also noted several persistent barriers to the use of weather and climate information services that are well known from the literature. This includes issues of accessibility, language, credibility, and the mismatch between what information is provided and what would be optimal to inform particular decisions. At the same time, comments from some participants indicated a lack of awareness of weather products and services already issued by the national meteorological services. This indicates a need to better publicise and communicate those products and services for optimum accessibility, which is a prerequisite for utility.

Participants view some potential for nowcasts. These have a more obvious need for reduction in risk in saving lives, for example for coasts and fishermen in deciding whether to venture out to sea/to the water. However, they may also be useful as part of a suite of weather and climate information services across different timeframes to support operational decisions.

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Annex A – Interview protocol

PLEASE ENSURE YOU HAVE RECEIVED BACK THE SIGNED CONSENT FORM BEFORE PROCEEDING WITH THE INTERVIEW

Introduction (read to your respondent)

I am working as part of a team to investigate the ways in which people in your sector are currently accessing and using weather forecasts and early warning, and would like to ask you a few questions. This should take no more than 30 minutes.

The information gathered will be used by project team that includes researchers and the South African Weather Service/INAM/ZMD (delete as appropriate) and other partners to inform the future development of useful weather forecasts and early warnings.

Your answers will remain confidential (and nothing you say will be identifiable to you), and securely stored only for the purposes of this study. Leaving your contact details is optional if you would like us to follow up with you (to share findings).

Name:
Date:
Organisation/location:
Email address (optional):
Cellphone number (optional):

Gender:

Age category:
18-30
31-40
41-50
51-60
61-70
71-80
over 80

Highest level of education? (choose one of the below)
Secondary
Tertiary (technical or vocational training, university)
Postgraduate

(Note questions 1 and 2 ask people to talk on behalf of their sector. If they talk about themselves personally, when moving to question 3 you can ask what they individually use, but if they talk about their sector, then you can ask generally for the sector)
1. In what ways does weather affect your sector?
-prompts for types of weather and the characteristics of that weather e.g. rainfall (amounts, intensity, timing, duration), temperature (min and max), extremes (drought, flood, extreme heat)
-prompts for types of decisions, e.g. planning (over what timeframes?), operational decisions

2. (Referring back to the planning and operational decisions mentioned in the previous question) What weather and climate information is used in your sector in planning and operational decisions (referring back to the planning and operational decisions mentioned in the previous question)?

– Timeframes: check historical observational data, weather (1 to 10 day), sub-seasonal, seasonal (e.g. seasonal forecasts), climate (projections – check timescales)

3.a. What sources of weather and climate information is used in your sector, and where do people get it from? (For each of the different timescales mentioned in question 2)?
(note some people might say where they get it from but not be aware of the source of the information, i.e. say they get from TV but not know the source of the info on TV

– TV, radio, app, other social media (Facebook, LinkedIn, WhatsApp), from a particular organisation – as the medium
– ZMD/INAM, AccuWeather, yr.no, others – to specify (as the source*)*

3.b. Are any of the above paid services/do people pay for any of the sources of weather and climate information that you mentioned?

4.a. Has there been a noticeable change over time in the sources of weather and climate information that people in your sector use?

-If so, why? (e.g. cost, availability, accessibility/ease of use…)

4.b. Has there been a noticeable change over time in the frequency with which people in your sector use weather and climate information?

-If so, why? (e.g. weather becoming a more important issue to us, more availability…)

5. To what extent is available weather and climate information suitable for your purposes/the purposes in your sector?
Potential issues that people raise/you could prompt for include:

– Accuracy/precision/reliable (and probe to see what they mean when using this term)
– Accessible/understandable
– Credible/trustworthy
– Suitable (spatial/temporal) scale
– Available in a timely fashion etc?

6. (building on 5) What could make weather and climate information more useful to your sector?

– Different information types/products
– More accessible to a wider range of people (if so, who?)
– Presented in different ways etc.

7. If it were possible to tell you with a 0-6 hours' notice that a thunderstorm is coming and the level of damage that it might cause, how would you use this information? (they might say they wouldn't!)