Scoping report of the state of institutional linkages between agencies

July 2023

WISER
Weather and Climate Information Services

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REPORT

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Introduction

The WISER Early Warnings for Southern Africa (EWSA) project is working in three countries – South Africa, Mozambique and Zambia, to support provision of nowcasting for use in early warning alerts for storms. Each country has a different institutional framework and legal mandates that determine which agencies have responsibility for the provision and communication of severe weather warnings. This scoping report presents what the information flows look like in each country. It has largely been compiled on secondary information as an input to the project team's work. Further information on the functioning of the linkages will become clear as the project progresses.

Weather and climate services value cycles

Weather and climate information services (WCIS) are concerned with delivering weather and climate information that is useful to and useable by decision-makers to reduce risk. Providing WCIS climate services requires involvement of number of different actors, often with fluid boundaries separating them, depending on the service in question. Producers of WCIS are the agencies that generate weather and climate information, and are typically the National Meteorological and Hydrological Services but also sometimes water management agencies. Intermediary organisations receive this weather and climate information and typically either translate or transform it into specific products and services – for example in the form of advisories. End users receive weather and climate information and translated products for us. However they also play a key role in closing the circle by providing feedback and insights on their needs which helps to inform the design and format of useable products and information.

The WCIS value chain shows the relationships and linkages between these different actors (Figure 1). Generating WCIS requires data from observation and monitoring, then the development delivery of particular products. Against the backdrop of a predominant flow of information from producers to end users, there are intermediate flows between producers and intermediary users, producers and end users, and intermediary users and end users. The red arrow shows the closed loop of evaluation and feedback, which is an essential part of WCIS compared to a more traditional supply-based approach led by producers of information (Webber and Donner, 2017).

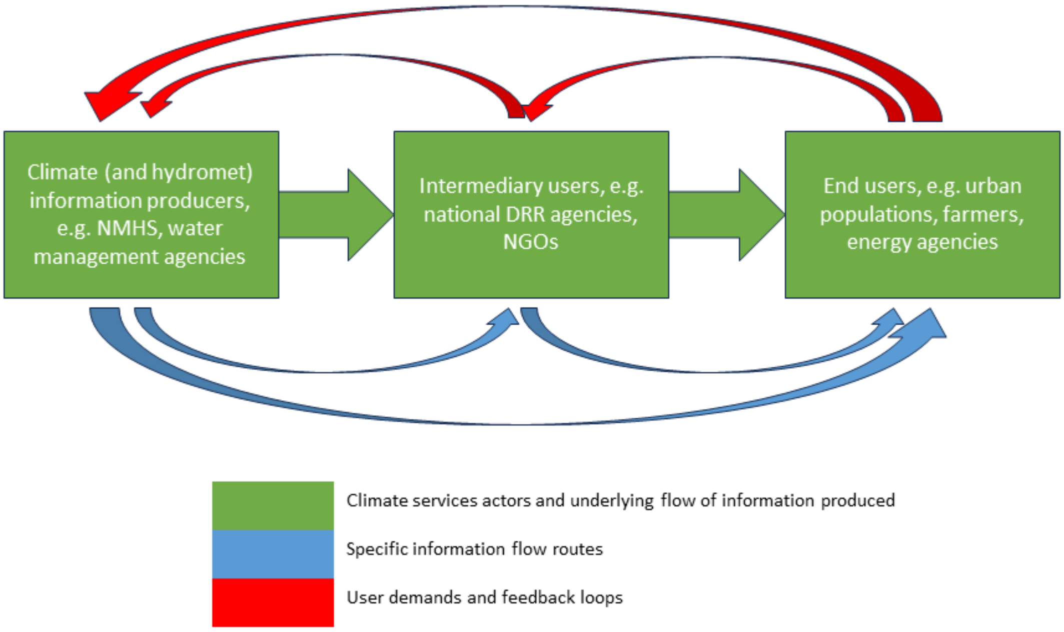

Figure 1: Schematic of the institutional architecture of the climate services value cycle

Early warnings

There is some overlap of WCIS and early warnings, in the sense that both are intended to provide targeted and tailored information that meets decision contexts. Early warnings are typically short timeframe alerts of impeding events. Successful early warnings typically comprise disaster risk knowledge based on the systematic collection of data and disaster risk assessment; detection, monitoring, analysis and forecasting of hazards and possible consequences; dissemination of authoritative, timely, accurate and actionable warnings and associated information on potential impacts by an officially designated source; and preparedness at all levels to respond to the warnings issued and to build back better in recovery, rehabilitation and reconstruction (UNDRR, n.d.). These 4 elements must be underpinned by: effective governance and institutional arrangements, including effective coordination and collaboration of the key institutions and stakeholders; a multihazard approach to early warnings; involvement of concerned communities and stakeholders, including local communities and appropriate consideration of gender, age, disability and cultural issues.

In 2023 the UN announced a global initiative to ensure that everyone is protected by early warnings by 2027 – Early Warnings for All. Mozambique is among the countries that have been prioritised for this initiative.

Institutional architecture in Mozambique

Figure 2 illustrates the nature of the institutional architecture of the WCIS value cycle in Mozambique, two agencies are responsible for producing WCIS: the National Institute of Meteorology (INAM) and the National Directorate for Water Resources Management (DNGRH).

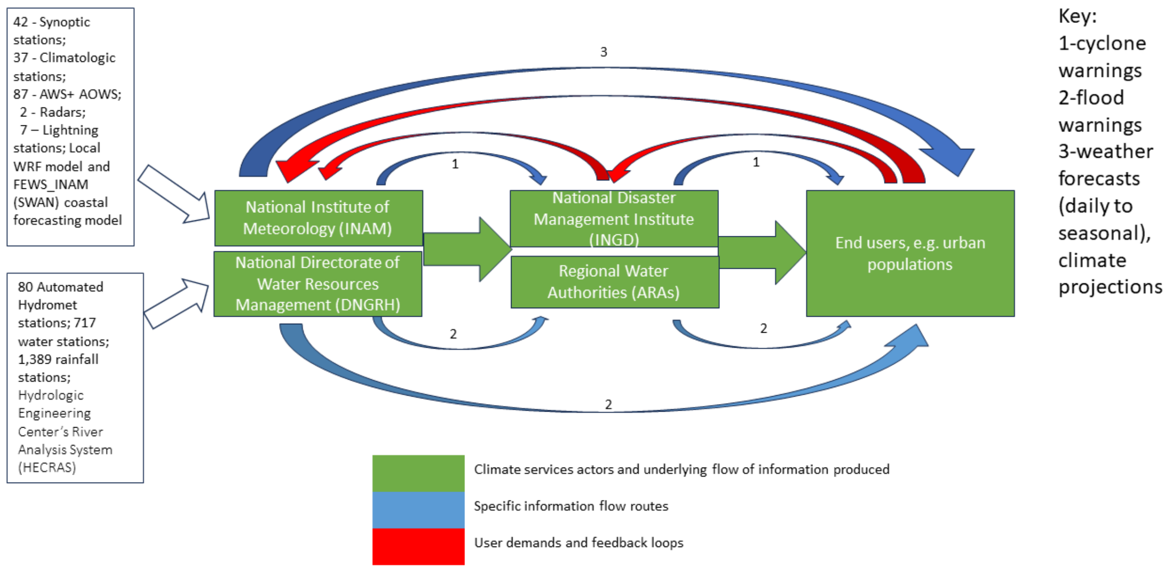

Figure 2: Institutional architecture of the WCIS value cycle in Mozambique

INAM issues daily to seasonal forecasts, including targeting particular sectors (e.g. aeronautical, marine and agriculture) and 41 points (cities and districts), and national meteorological and climatological warnings (see annex for an example). It generates these using data from its observational network, which comprises 42 synoptic stations, 37 climatological stations, 87 Automated Weather Stations and Automated Weather Observing Systems, 2 radars and 7 lightning stations. INAM uses a variety of Numerical Weather Prediction models. This includes international models, such as the UK Met Office Unified Model, NOAA/NCEP GFS model, INAM/JICA GSM model, and the European Centre WCMWF model and regional models, such as UM from the RSMC in South Africa and Aladin from La Reunion (Júnior, pers.comm). INAM also runs its own WRF and FEWS_INAM (SWAN) coastal forecasting system. DNGRH issues flood warnings. It generates these using data from its observational network of 80 Automated Hydromet stations, 717 water stations, 1389 rainfall stations, which are typically managed under the five regional water administrations (ARAs). DNGRH uses the Engineering Center's River Analysis System (HECRAS).

There are a variety of communication mechanisms from information producers. General weather forecasts are communicated from INAM direct to end users using a variety of channels, including radio, website and social media. There are a number of challenges with this communication. Television weather forecast broadcasts were paused for several years due to lack of equipment; and there is insufficient resourcing to counter dis- and mis-information that circulates on social media (WMO, 2019).

Similarly DNGRH communicates flood forecasts direct to the public. There are also intermediary organisations. The National Disaster Management Institute (INGD) receives and then issues response measures to these weather and water warnings. INGD works from regions to provinces to districts, where it has four multiple use and resources centres (CERUMs), as well as local committees for disaster risk management that focus on the prevailing hazards in any one location (Figure 3). Regional water authorities (ARAs) also communicate to end users. In some places at high risk of flooding, community-based warning systems are in place – for example in Búzi (Global Disaster Preparedness Centre, n.d.). This involves local community members taking river level readings and raising the alarm if there are rapid river level changes.

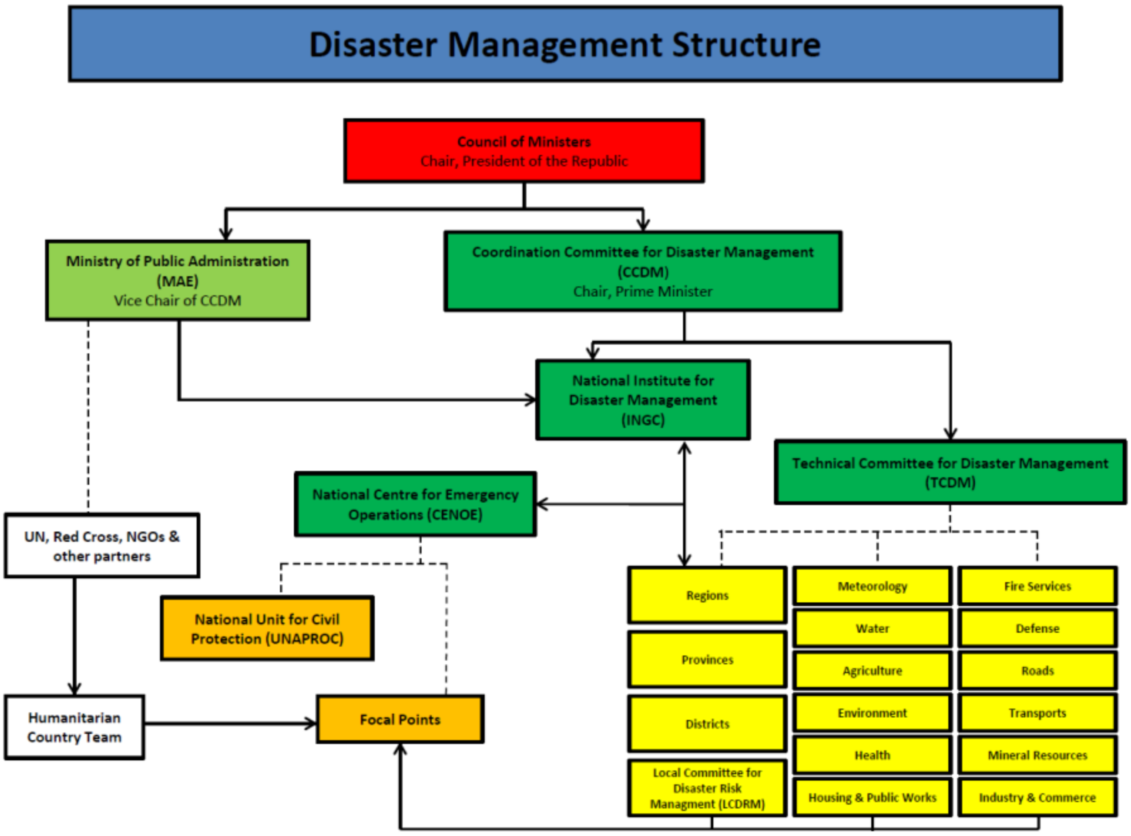

Figure 3: Disaster risk management institutional architecture in Mozambique (source WMO, 2019)

A variety of communication mechanisms are used between intermediary users and end users. Through its network, INGD and DNGRH both have colour coded alert levels linked to traffic lights. These are distributed through this network using a variety of mechanisms, including radio, social media, and direct communication using loudspeakers and by messengers wearing clothing that corresponds to the alert level.

As with any system of moving parts, the multiple actors and mechanism in play can lead to attrition of the messaging. Although feedback loops are in place, they are rather ad hoc and informal – with INAM noting that the majority of their feedback comes from interactions with INGD, as opposed to direct communication with members of the public.

In particular the nature of the complementarity of INAM and DNGRH's mandate and responsibilities has caused some problems in the past. Both organisations are collecting and curating their own data, with no common platform for storage and analysis, although there is now a Memorandum of Understanding in place to facilitate data sharing (Vincent et al, 2022). The fact that both institutions issue early warnings also creates confusion – not least because they both use colour coded warning alerts, as does INAM to indicate the time until landfall of tropical cyclones. In the future, there are plans to develop Standard Operating Procedures for the communications of alerts, watches and early warning messages to improve clarity (WMO, 2019).

The disaster management institutional framework is otherwise well developed in Mozambique, led by INGD. The Disaster Management Policy was adopted in 1999, and 2004 saw the establishment of an early warning system that includes both flood and cyclone warnings. The National Emergency Operations Centre (CENOE) was established in 2006, the same year that the Master Plan for Prevention and Mitigation of Natural Disasters was approved. The Disaster Management Law came into force in 2014, and the country is currently under the Master Plan for Disaster Risk Reduction 2017-30. The 5-year government plan (PDQ) 2015-20 made specific mention of the need to strengthen early warning systems to reduce disaster risk. In 2023, Mozambique was named among early countries for implementation of the WMO's Early Warnings For All campaign.

Institutional architecture in South Africa

In comparison with Mozambique, the actors within the WCIS value cycle in South Africa are simplified, at least where urban populations are concerned (Figure 4). The South African Weather Service (SAWS) holds the legal mandate as the only authority to provide weather, aeronautical, marine meteorological and air quality services, under the South African Weather Service Act no 8 of 2001, as amended Act no 48.

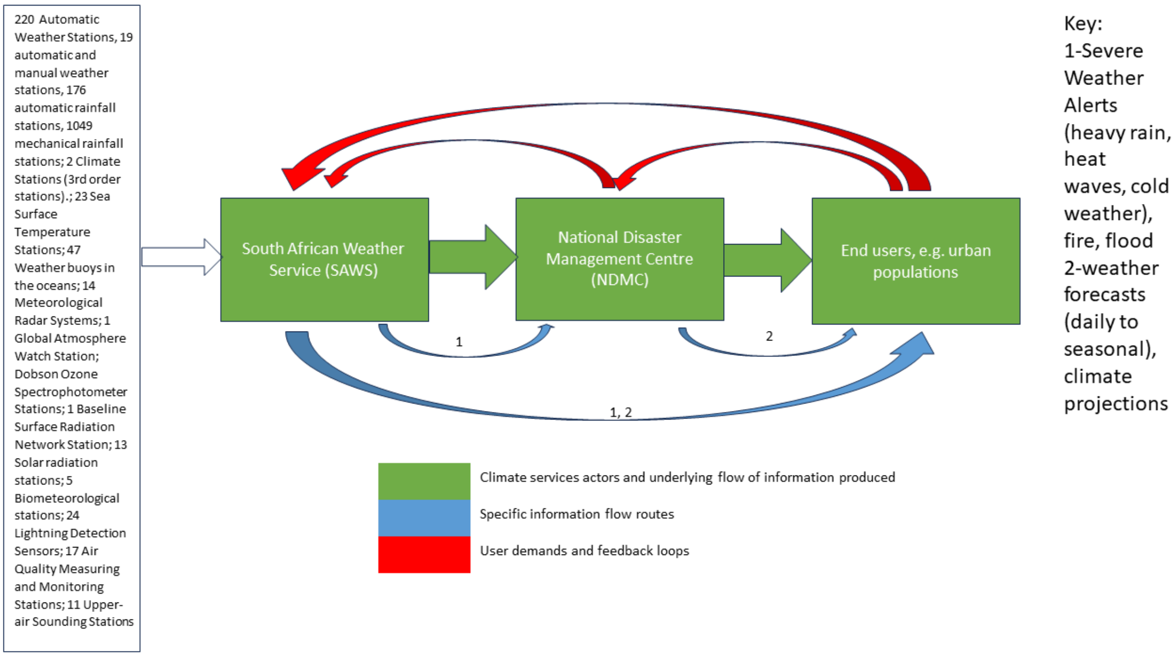

Figure 4: Institutional architecture of the WCIS value cycle in South Africa

SAWS issues a variety of forecast products, from sub-daily to seasonal, including targeting particular sector (e.g. aeronautical and marine), as well as climate projections. It also has a specialised range of forecasting products aimed at enhancing decision making, for example the South African Flash Flood Guidance System (SAFFG), South African Regional Flood

Guidance System (SARFFG) and the Severe Weather Warning System (SWWS)(see annex for an example of impact-based forecasting for waves). It generates these products using data from its extensive observational network, which comprises 226 Automated Weather Stations, 19 Automated and manual Weather Stations, 176 Automated Rainfall Stations and 1049 Mechanical Rainfall Stations. In addition SAWS has access to data from a variety of other sources, including 2 Climate Stations (3rd order stations), 23 Sea Surface Temperature Stations, 47 Weather buoys in the South Atlantic and South Indian Ocean, 14 Meteorological Radar Systems, 1 Global Atmosphere Watch Station at Cape Point, 2 Dobson Ozone Spectrophotometer Stations in Irene and Springbok, 1 Baseline Surface Radiation Network Station in De Aar, 13 Solar radiation stations (UVB Biometer network), 5 Biometeorological stations, 24 Lightning Detection Sensors, 17 Air Quality Measuring and Monitoring Stations and 11 Upper-air Sounding Stations with Irene also conducting ozone soundings (Midgley et al, n.d.). In addition to international models, SAWS acts as the Regional Specialised Meteorological Centre under the WMO. There are other agencies involved in data collection in South Africa, notably the Agricultural Research Council, which hosts its own network of 600 observation stations which it uses to inform agrometeorological advisories. Since these are not expressly targeted to urban populations, they are not further elaborated here.

SAWS issues its own severe weather alerts, which comprise impact-based warnings, fire danger warnings, and advisories, through television, radio, website, social media and its own app. In addition they provide information to the National Disaster Management Centre, whose responsibilities include the management of an early warning system that enables dissemination of early warnings to vulnerable communities, as well as risk assessment. Such dissemination typically happens through a cascade mechanism from national to provincial to municipal level, and is highly reliant on ICT, including a recently-introduced API platform for weather data, GIS, and the hosting of third-party applications (Pillay, pers.comm).

Among the challenges faced so far with regards to coordination between SAWS and NDMC has been the fact that both organisations have developed processes and procedures separately. To address this, current activities focus on developing joint response procedures based on impact-based warnings so that the activation levels are consistent. As with Mozambique, there are feedback mechanisms in place to close the loop, but they are stronger from end users back to NDMC, and then NDMC to SAWS, as opposed to end users to SAWS directly.

The disaster management institutional framework is also well developed in South Africa. It is guided by the Disaster Management Act (DMA) No 57 of 2002 and the National Disaster Management Framework (which acts as the policy) that promotes reduction, prevention and mitigation. Figure 5 shows national level coordination. The DMA allows for provision for Disaster Management Centres in each province and district municipality – with the option for municipalities to apply to their district municipality if they would like to have one in addition. Their responsibilities include providing disaster management plans and managing local situations as they arise.

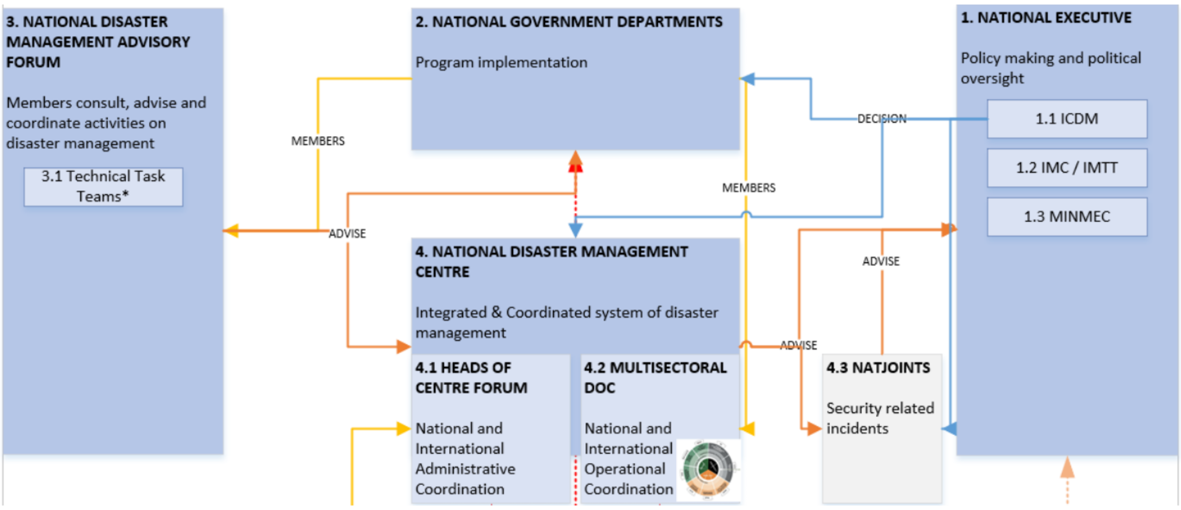

Figure 5: National level coordination structure for disaster risk management in South Africa (Source: Sithole, 2023)

Institutional architecture in Zambia

Figure 3 illustrates the nature of the institutional architecture of the WCIS value cycle in Zambia, where two agencies are responsible for producing WCIS: the Zambia Meteorological Department (ZMD) and the Water Resources Management Authority (WARMA).

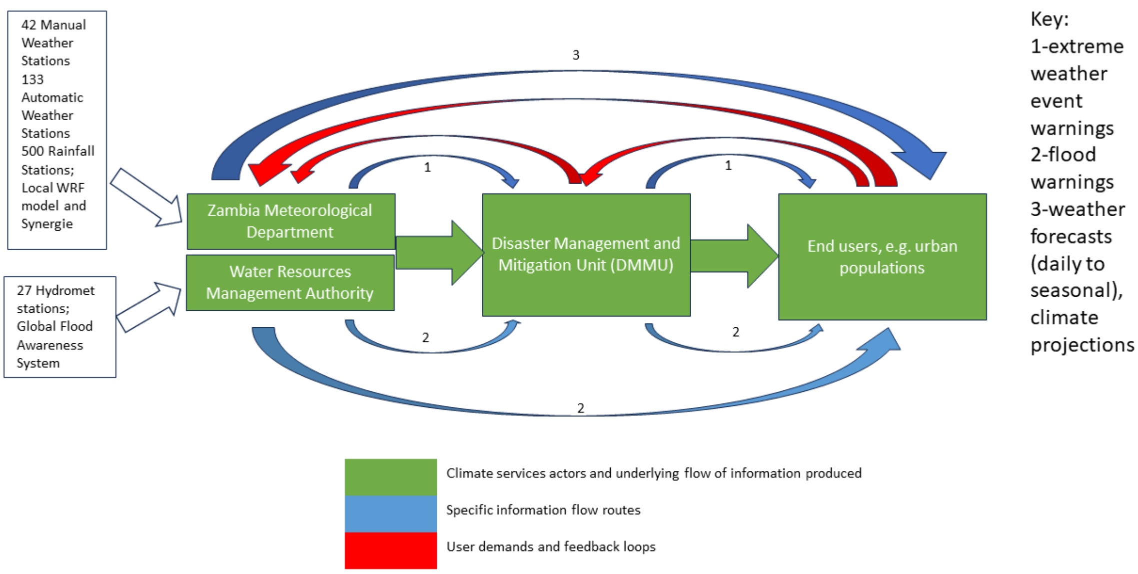

Figure 6: Institutional architecture of the WCIS value cycle in Zambia

ZMD issues daily to seasonal forecasts, including targeting particular sectors (e.g. aeronautical, and agriculture), agro-meteorological bulletins, and flash flood warnings, and also had a climate map room. It generates these using data from its observational network, which comprises 42 Manual Weather Stations, 133 Automated Weather Stations and 500 Rainfall Stations. ZMD uses a variety of Numerical Weather Prediction models. This includes international models, such as the UK Met Office Unified Model, NOAA National Centers for Environmental Prediction (NCEP), the European Centre ECMWF model, WRF and regional models, such as from the RSMC in South Africa. ZMD also runs the Synergie Puma System and has its own Flash Flood Guidance System (Imbwae, pers.comm).

WARMA has the legal mandate to manage, develop and protect water resources, which covers flood and drought management. As a result, WARMA issues flood forecasts using the Global Flood Awareness System (GloFAS); a flood awareness software or early warning tool derived from the European Flood Awareness System (EFAS). The tool provides daily ensemble forecasts with a horizon of 30 days across global river networks. This system is fed by data collected through WARMA's 27 hydrometric stations across the country.
There are a variety of communication mechanisms from information producers. Both ZMD and WARMA issue alerts direct to the public. General weather forecasts are communicated from ZMD direct to end users using a variety of channels, including television, radio and social media. WARMA issues flood alerts as needed during the rainy season when severe flood conditions are anticipated, highlighting the likely peak flows, locations and affected areas by district (giving sub-district explanations, for example referring to villages and other public facilities (see annex for an example).

Both organisations also issue information to the Disaster Management and Mitigation Unit (DMMU) as an intermediary organisation. DMMU passes on alerts from ZMD and WARMA, and supports development of disaster risk management plans and response efforts where required. The disaster management institutional framework in Zambia is underpinned by the Disaster Management Act no 13 of 2010 and the National Disaster Management Policy (2015). Figure 7 outlines the disaster management institutional architecture in Zambia from national to local level.

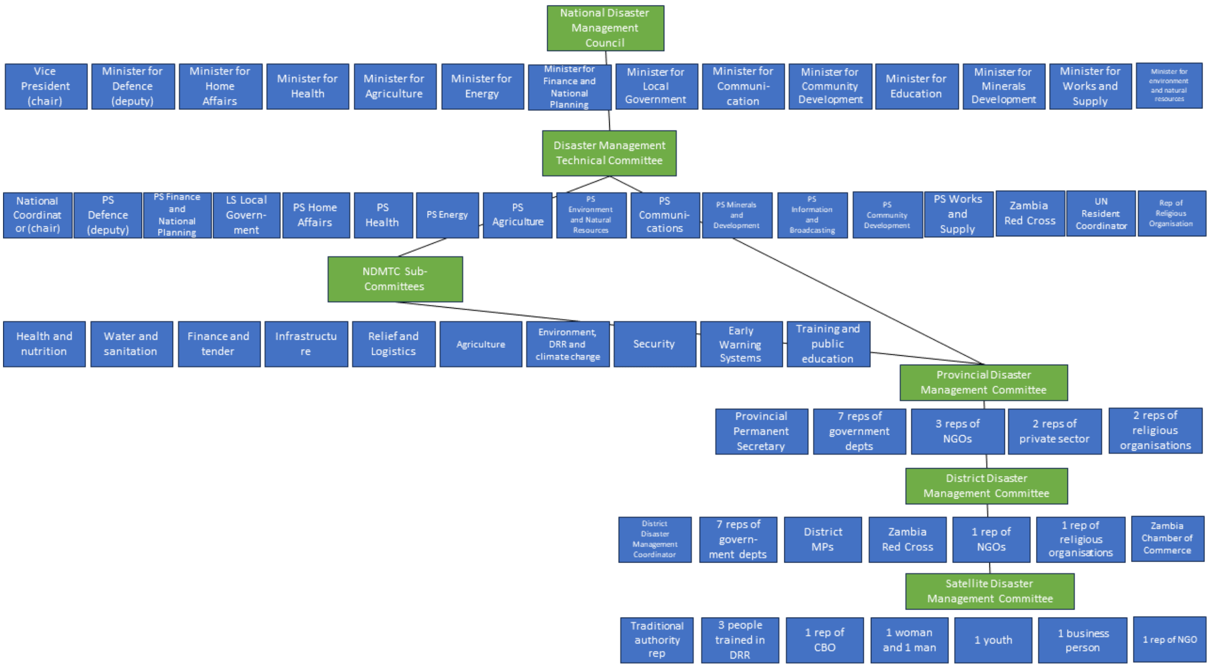

Figure 7: Disaster management institutional architecture in Zambia

Conclusion

Each country has its own particular institutional set up for the delivery and communication of weather and climate information and early warning alerts. They all follow the typical WCIS value chain, with roles as producers for national meteorological and hydrological agencies (and in Mozambique and Zambia's case, also water management authorities) and as intermediary organisations for the disaster management agencies, who are responsible for cascading warnings and contextualising them into alerts based on their own analysis of vulnerability and disaster risk. Various challenges have been identified with regards to mandate and coordination in all three countries. Subsequent direct engagement will further elaborate these challenges and opportunities for improvement.

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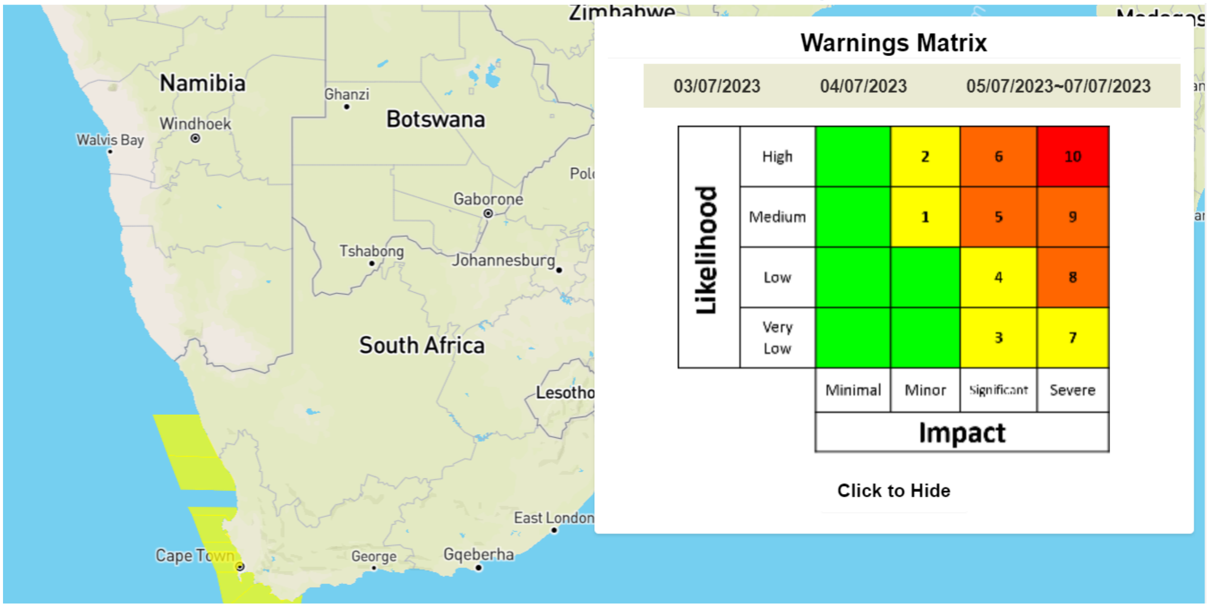
Annex: Examples of INAM warnings (Mozambique)

Date	**04/03/19**	**05/03/19**	**06/03/19**	**07/03/19**	**08/03/19**	**09/03/19**
Warning	Heavy rain, severe thunderstorm and strong wind	Tropical depression	Heavy rain, severe thunderstorm and strong wind	Heavy rain, severe thunderstorm and strong wind	Heavy rain, severe thunderstorm and strong wind	Tropical depression
Target Area	Zambézia, sofala and Tete	Zambézia, Sofala, Manica, Tete and Niassa	Zambézia, Sofala, Manica, Tete and Niassa	Zambézia, Sofala, Manica, Tete Nampula and Niassa	Zambézia, Sofala, Manica, Tete and Niassa	Zambézia, Sofala, Manica, and Tete
Alert color code	Yellow	Red	Red	Red	Orange	Orange
Observed data	Wind: 56km/h gust 74km/h Precip (mm): Quelimane - 63.6; Mocuba - 187.0	Wind: 37 km/h Gust 56 km/h Precip(mm): Mocuba -88; tsangano - 103.1; Milange - 224.1 ; Caia - 53.1	Wind: 37 km/h Gust 56 km/h Precip(mm): Mocuba - 98.9 Furacungo: - 134.4; Tsangano - 166.4; Ulongue – 139.2; Songo – 65.7; Tete – 69.9; Cuamba – 64.7; Milange – 66.2 ;Luia – 65.4 Moatize – 75.3 Zobwe – 110.7	Wind: 36km/h Precip(mm): Furancungo – 135.4; Tsangano – 168.7; Ulongue – 309.5; Caia – 86.4 Milange - 66.5; Pebane – 78.2 ;Zobwe - 147	Wind:34km/h Precip(mm): Lumbo – 47.8 ;Milange 37.0	Wind: 56km/h Gust 83km/h Precip(mm): Angoche 30.8
Date	**10/03/19**	**11/03/19**	**12/03/19**	**13/03/19**	**14/03/19**	**15/03/19**
Warning	Moderate tropical Storm IDAI	Intense Tropical Cyclone IDAI	Intense Tropical Cyclone IDAI	Tropical Cyclone IDAI	Intense Tropical Cyclone IDAI	EX- Tropical Cyclone IDAI
Target Area	Mozambique Channel, Zambezia , Sofala, Manica and Tete	Mozambique Channel, Zambézia, Sofala, Manica, and Tete	Mozambique Channel Zambézia and Sofala	Mozambique Channel, Sofala, Manica, Zambezia and Inhambane	Sofala, Manica, Tete, Zambezia and Inhambane	Sofala, Manica, Tete and Inhambane
Alert color code	Orange	Orange	Red	Red	Red	Orange
Observed data	Wind: 120 km/h Gust 167 km/h Precip(mm): below 30	Wind: 176 km/h Gust 250 km/h Precip(mm): Pemba – 55.7 ; Montepuez – 32.6	Wind: 158 km/h Gust 213 km/h Precip(mm): below 30	Wind: 185km/h Gust 259 Precip(mm): Quelimane – 47.4	Wind: 194 km/h Gust 278 km/h Precip(mm): Above 250 (Satellite estimate)	Wind: 167 km/h Gust 231 km/h Precip(mm): Chimoio – 233.3 Espungabera – 220.6

Annex: Example of DNGRH warnings (Mozambique)

Date	08/03/19 (warning 1)	09/03/2019 (Warning 2)	10/03/19 (Warning 3)	13/03/2019 (warning 4)	17/03/2019 (warning 5)
Warning	Water levels in the Licungo river 1.85 m above alert levels. Water levels rising rapidly in the rivers Revubuè, Liua and Chire. People and instititutions in the along the Licungo and Zambeze rivers to evacuate immediately from at risk zones to higher ground.	Zambeze river under maximum alert. Water levels at 10meters in the Revúbue sub-basisn at Chingodzi. Peoplle and institutions along the river to evacuate immediately from at risk areas to higher ground	Risk of urban floods in the cities of Beira and outskirts and Qualimane and outskirts dur to a propical depression in the Mozambique channel. People to evacuate immediately from at risk zones to higher ground	Probability of heavy rains due to tropical cyclone IDAI with the risk of moderate to big floods in the citiy of Beira and outskirts, Dondo and outskirts, Quelimane and outskirts. People to evacuate to higher ground	Duee to intense rainfall in the rpovinces of Sofala, manica and neighbouring Zimbabwe, Chicamba dam might release water flows of the order of 500 m3/s.Increased risk of flooding in the districts of Búzi, Nmamatanda, Donmdo, Muanza and Chibabava. People to evacuate from at risk areas to high ground
Target Area	Districts of maganja da Costa, Namacurra, Chemba, Mutarara, Cais, Luabo, Marromeu and Chinde	Districts of Chemba, Tambara, Caia, Chinde, Luabo, Mopeia and Marromeu	Cities of Beira, Quelimane and Donndo and in the basisn of Licungo, Zambeze, Púnguè and Búzi	Cities of Beira, Quelimane and Dondo and in the basins of Licungo, Zambeze, Púnguè and Buzi	Districts of Búzi, Nmamatanda, Donmdo, Muanza and Chibabava

Annex: Example of wave alert (impact-based forecasting) (South Africa)



Annex: Example of flood alert (Zambia)

WARMA

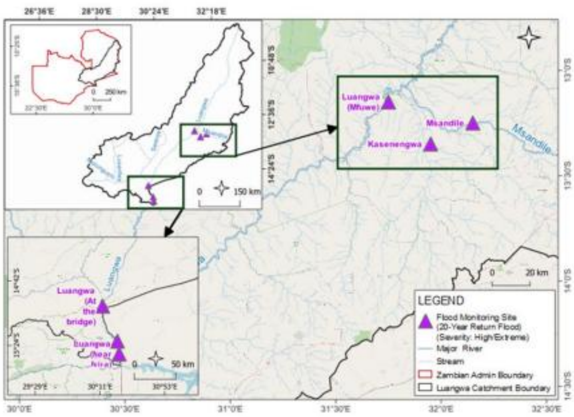
FLOOD ALERT BY WARMA TO THE GENERAL PUBLIC

ISSUED: 10th February 2023

In line with Section 8 (2) (i) of the Water Resources Management Act No. 21 of 2011, the Authority wishes to inform the general public of an imminent emergency relating to flooding events in the following areas:

SUMMARY REPORT	
River Name: Luangwa **Tributary of:** Zambezi **District:** Luangwa **Peak Forecasted:** 20/02/2023 **Magnitude:** Severe	**River Name:** Msandile River **Tributary of:** Luangwa River **District:** Mambwe **Peak forecasted:** 12/02/2023 **Magnitude:** Severe
River Name: Kasenengwa **Tributary of:** Lutembwe **District:** Kasenengwa **Peak forecasted:** 12/02/2023 **Magnitude:** Severe **Affected Areas:** Nyamandela village, Chisenga School and the bridge near the River.	**River Name:** Luangwa **Tributary of:** Zambezi **District:** Mambwe **Peak forecasted:** 16/02/2023 **Magnitude:** Severe **Affected Areas:** Department of National Parks & Wildlife offices and the lodges close to the River bank.

MAP SHOWING THE TRIGGERS AND AFFECTED AREAS



MEMBERS OF THE PUBLIC IN THE AFFECTED AREAS ARE URGED TO TAKE PRECAUTIONARY MEASURES TO AVOID THE ADVERSE EFFECTS OF THESE FLOOD EVENTS!!!!