

COUNTRY HYDROMET DIAGNOSTICS

Informing policy and investment decisions for high-quality weather forecasts, early warning systems, and climate information in developing countries.



November 2023

MOZAMBIQUE NMHS Peer Review Report

Reviewing Agency: SOUTH AFRICAN WEATHER SERVICE

Authors: Francis Moseelho & Samantha Linnerts



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DocuSigned by:
Ishaam Abader/11/2024 | 9:51 AM SAST
86EA2275F10408...

WMO PR of the South African Weather Service: Mr Ishaam Abader
1263 Heuvel road Centurion Central, Centurion, South Africa
with a copy to:




WMO PR of the National Institute of Meteorology: Dr Aderito Aramuge
Mukumbura Street 164
PO Box 256, Maputo, Mozambique

The findings, interpretations and conclusions expressed are those of the named authors alone and do not necessarily reflect those of the agencies involved.

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List of Abbreviations



AWS – Automatic Weather Station
BUFR - Binary Universal Form for the Representation of meteorological data
CHD – Country Hydromet Diagnostic
DRR – Disaster Risk Reduction
ECMWF – European Centre for Medium-Range Weather Forecast
EWS – Early Warning Services
FTP – File Transfer Protocol
GBON – Global Basic Observation Network
GTS – Global Telecommunication System
ICT - Information and Communication Technologies
INAM- National Institute of Meteorology
MQTT – Message queuing Telemetry Transport
NGO – Non-Governmental Organization
NMHS – National Meteorological and Hydrological Service
NMME – North America Multi-Moddle Ensemble
NWP – Numerical Weather Prediction
QA/QC – Quality Assurance/Quality Control
RADAR- Radio Detection and Ranging
RSMC – Regional Specialised Meteorological Centre
SAWS - South African Weather Service
SOFF – Systemic Observation Financing Facility
SWFP – Severe Weather Forecasting Programme
UNDP – United Nations Development Programme
WFP – World Food Programme
WIGOS - WMO Integrated Global Observing System
WIS – WMO Information System
WMO – World Meteorological Organization



Executive Summary

National infrastructure in Mozambique was severely impacted in early 2000 by a cyclone. This cyclone caused widespread flooding in the country, resulting in devastation of the already precarious infrastructure. Weather and climate monitoring systems were not spared.

The National Institute of Meteorology, abbreviated to INAM, which is a public institution of a scientific technical nature mandated with the responsibility to ensure inspection and supervision of agrometeorological, climate and air quality monitoring stations, in collaboration with other state and private entities that operate similar observation networks except hydrology, continued to ensure availability of weather and climate information for decision making.

To ensure availability of weather and climate information for the country, INAM developed the "One District One Weather Station strategy" covering the period 2020 to 2024, which aims at the expansion and modernization of the meteorological observation network in Mozambique. Through the implementation of this strategy, a weather RADAR installation in Beira and several automatic weather stations occurred.

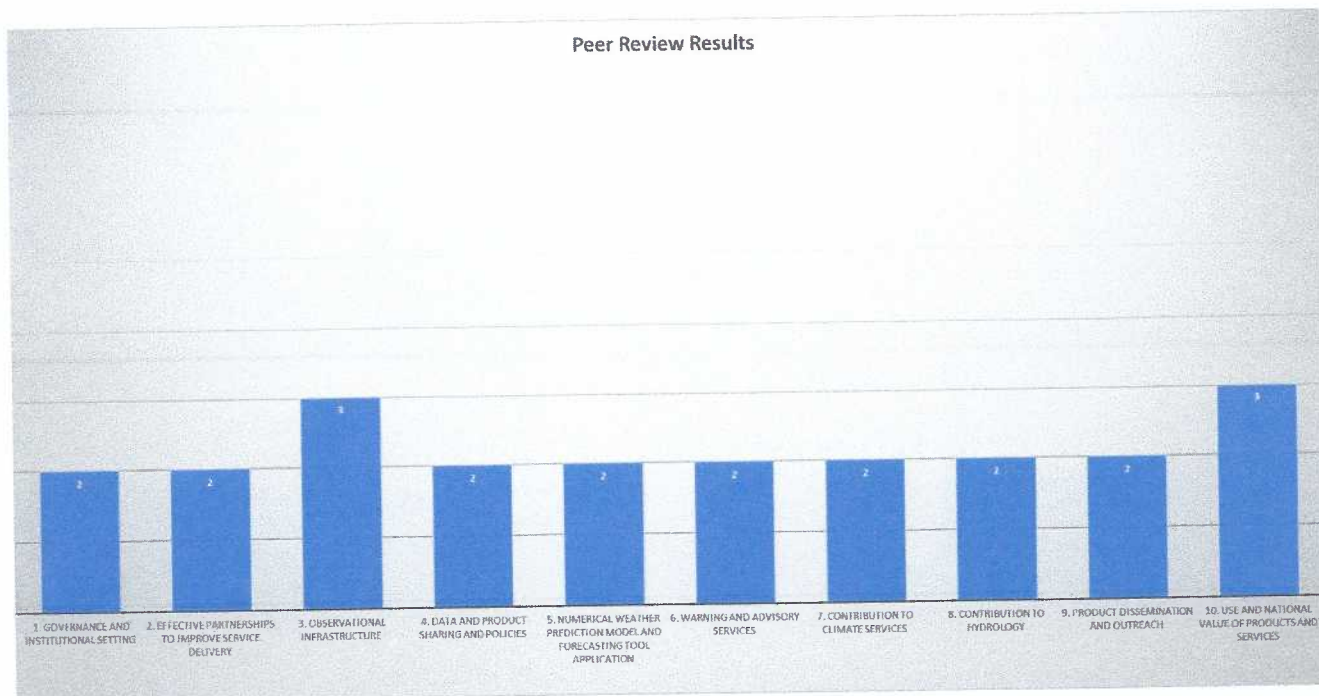
The implementation of this strategy is however limited due to insufficient government budget allocation, which does not fully cover the needs of the NMHS in terms of its national, regional, and global responsibilities. Only 17% of the government annual budget allocation¹ to INAM can be used to resource its operations to fulfil its national, regional, and global responsibilities, while 78% is allocated to staff costs. There is a need to increase INAM's allocation so as to enable the NMHS to employ additional professional staff, and to procure suitable equipment, and to ensure the provision of National Meteorological Service functions. There have been interventions through international development projects to rebuild the national observation infrastructure, but these efforts were only focused on provision of the infrastructure and not on the sustainability thereof.

The hydrological services within Mozambique are hosted by the National Directorate of Water Resource Management under the Ministry of Public Works and Housing there is an MoU in place between this Directorate and INAM for data sharing and maintenance of observation infrastructure. Through the coordination platform provided through the Institute for Disaster Risk Management, the two entities provide all required technical information together with hydrology and other relevant sectors.

The graph below presents INAM's capacity level across the 10 elements of the hydromet value chain: with maturity scores ranging from 2 to 3, INAM provides mainly basic services, which have the potential to be further enhanced with additional capacity building efforts and resources.

¹ In 2023, INAM's government budget allocation totalled 165 682 460 MZM.





Element	Maturity level score
1. Governance and institutional setting	2
2. Effective partnerships to improve service delivery	2
3. Observational infrastructure	3
4. Data and product sharing and policies	2
5. Numerical weather prediction model and forecasting tool application	2
6. Warning and advisory services	2
7. Contribution to climate services	2
8. Contribution to hydrology	2
9. Product dissemination and outreach	2
10. Use and national value of products and services	3

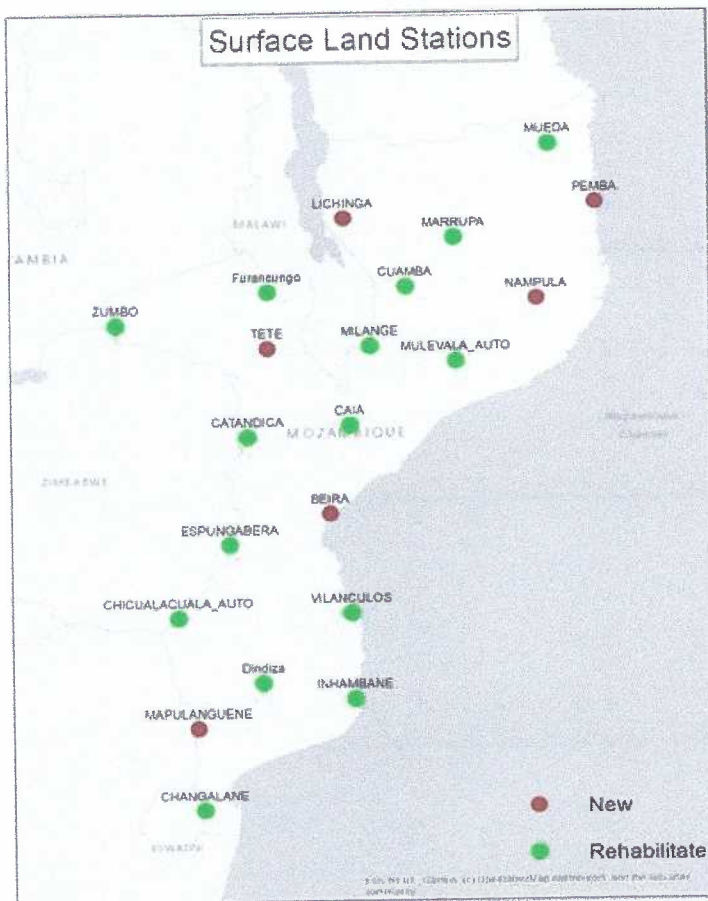


Chapter 1: General information

Introduction

INAM operates and maintains 106 Automatic Weather Stations and 46 manual climate stations deployed nationally across the nine provinces of Mozambique. There are no operational upper air observing network. The INAM's current weather observation infrastructure is funded through Mozambique's national government budget allocation. This budget is used to covers the entire INAM financial requirement of INAN which include but not limited to personnel salaries, maintenance of buildings, communication, travel and accommodation, logistics, maintenance of Weather Observation and Forecasting systems as well as repairs and maintenance of the Information and Technology systems of INAM.

A technical assessment of the 21 surface land stations identified for GBON indicated that 20 of the stations are Automatic Weather Stations and 1 station, Tete, is a manual climate station. It was also found that 7 stations have data loggers with the FTP data transfer protocol whereas 13 stations have the FTP, MQTT and SFTP data transfer protocol respectively. MQTT and SFTP data transfer protocol are required for the implementation of WIS 2.0.



CHD methodology

This report has been prepared using the methodology described in the 28 February 2023 update of the Country Hydromet Diagnostics (CHD) Operational Guidance for SOFF. An initial desktop review was performed, using information supplied by National Institute of National Meteorology (INAM), the World Meteorological Organization (WMO), other international organizations (FAO, WFP, UNDP, etc.) and other partners. An in-country visit was then undertaken by the peer advisor delegation for the assessment of the observation infrastructure for data collection required for development of the GBON National Gap Analysis and well as the GBON National Contribution plan. This data was also relevant for development of this report.

This document will provide crucial information for the SOFF initiative implementation phase, which in Mozambique is coordinated by South African Weather Service (SAWS) together with World Food Program (WFP), as well as informing the ambitious EW4All initiative. This assessment by SAWS has been facilitated by an on-site visit as well as various remote consultations. Following the CHD structure, this report is presented along the ten most critical elements of the hydromet value cycles, with an indication of their respective maturity level and some high-level recommendations to help increase that maturity level, with a special emphasis on monitoring, forecasting, climate projection and warning systems for climate-related hazards, across all timescales.



Chapter 2: Country Hydromet Diagnostics

Element 1: Governance and institutional setting

1.1 Existence of Act or Policy describing the NMHS legal mandate and its scope

The legal mandate of the National Institute of Meteorology in Mozambique and its scope is regulated and described by the Ministerial Diploma no. 67/2016². The National Institute of Meteorology, abbreviated to INAM, is a public institution of a scientific technical nature, endowed with legal personality and autonomy administrative responsibility.

This mandate, under article 3 (b), describes one of the roles of INAM as the institute that is endowed with the responsibility to ensure inspection and supervision of Agrometeorological, Climate and Air Quality monitoring stations, in collaboration with other State and private entities that operate similar observation networks except Hydrology. Furthermore, under article 3 (e) of this mandate, INAM must ensure the provision of quality analysis and weather forecasting services for the public, aviation, navy and other interested parties. This policy also places responsibility of ensuring the availability of scientific and technical information necessary for the definition of national policies related to the risks of natural disasters in meteorological origin on INAM.

1.2 Existence of Strategic, Operational and Risk Management plans and their reporting as part of oversight and management.

INAM developed the "One District One Weather Station" [strategy](#) covering the period of 2020 to 2024, which aims at the expansion and modernization of the meteorological observation network in Mozambique. Through the implementation of this strategy, a weather [RADAR was installed in Beira](#), as well as new several automatic weather stations across the country.

There is however no clear evidence of the existence of operational and risk management plans, and as such no report as part of oversight and management are available. It is hereby recommended that a Strategic plan and related Operational and Risk Management plans be developed for INAM.

1.3 Government budget allocation consistently covers the needs of the NMHS in terms of its national, regional, and global responsibilities and based, among others, on cost-benefit analysis of the service. Evidence of sufficient staffing to cover core functions.

INAM's government budget allocation does not cover the needs of the NMHS in terms of its national, regional, and global responsibilities. It amounted to 165 682 460 MZM in 2023, of which only 17% could be used for covering the NMHS's operations, while 78% of the budget was allocated to staff costs. There is no clear indication of any cost recovery income, even though the mandate under article (d) suggests INAM must ensure the provision of quality analysis and weather forecasting services for aviation.

² The Ministerial Diploma No. 67/2016 is available at: <https://archive.gazettes.africa/archive/mz/2016/mz-government-gazette-series-i- dated-2016-10-05-no-119.pdf>



1.4 Proportion of staff (availability of in-house, seconded, contracted- out) with adequate training in relevant disciplines, including scientific, technical, and information and communication technologies (ICT). Institutional and policy arrangements in-country to support training needs of NMHS.

The staff base of INAM comprises approximately 406 employees, of which 245 are trained in relevant disciplines, including scientific, technical, information and communication technologies (ICT) as well as data management. 267 employees are male and 119 are female, which suggest the gender representativity is skewed towards male dominance.

The table below is a representation of the demographics with the country. However, it should be noted that some of the staff members roles are cross cutting, example being within the management level there are meteorologists and researchers.

Number of Staff (Management)	117
Meteorologist	24
Meteorological Technician	153
Hydrologist	0
Hydrological Technician	0
Climate Services	3
Researcher	4
Other	105
Total Staff number M:F	287:119

1.5 Experience and track record in implementing internationally funded hydromet projects as well as research and development projects in general.

INAM does have an experience and track record in implementing internationally funded hydromet projects, such the weather RADAR installation in Beira, several automatic weather stations rolled out as part of the one district one weather station strategy, establishment of the flood and drought forecasting and early warning system for the Limpopo, Save, Búzi and Pungué river basins, which will be based in Maputo in collaboration with the National Directorate of Water Resource Management under the Ministry of Public Works and Housing under the theme "building strong communities that are resilient to climate and economic shocks in the Zambezi Watercourse, through the promotion of inclusive transformative investments." The four river basin commissions are the platforms through which Mozambique stands out in the establishment of early warning systems, which have Strategic Action Plans, as well as Data and Information Sharing Protocols.

Summary score and recommendations for Element 1

The CHD Element 1 score for the "Governance and Institutional Setting" assessed as Maturity Level 2 on the CHD scale, reflecting "Effort ongoing to formalize mandate, introduce improved governance, management processes and address resource challenges."



Recommendations:

- a) To develop the strategy covering the period of 2025 to 2030, which must aim at sustainability of the meteorological observation network in Mozambique in ensuring the availability of scientific and technical information necessary for the definition of national policies related to the risks of natural disasters of meteorological origin.
- b) The government of Mozambique to increase the budget for sustainability of the hydro-meteorological infrastructure, capacity development for current personnel operating and maintaining and recruitment additional staff in the information and technology section to facilitate uninterrupted operation of the organization. Furthermore, to equip INAM with required test equipment for maintenance of its infrastructure.



Element 2: Effective partnerships to improve service delivery.

2.1. Effective partnerships for service delivery in place with other government institutions.

INAM have MoUs with the public sector, such as with National Directorate of Water Resource Management under the Ministry of Public Works and Housing, as well as with the Ministry of Agriculture, which allows for operation and maintenance of their observation infrastructure monitoring the weather conditions required for agricultural purposes nationally. The observation infrastructure for the Ministry of agriculture is compatible to the INAM observation infrastructure. The MoU makes provisions for maintenance of this infrastructure and for data sharing across the two institutions.

Furthermore, INAM as the Met Authority has close working relationship with the Civil Aviation Institute of Mozambique (ICAM) for provision of aviation related weather forecasting. INAM is a standing member of the National Disaster Management Service 's disaster management advisory forum, which is the platform for multi sector consultation and discussion around service delivery linked to impact of extreme weather events and other extreme events with negative impact to the country, where deliberation takes place aimed at disaster mitigation and reduction.

2.2. Effective partnerships in place at the national and international level with the private sector, research centres and academia, including joint research and innovation projects.

INAM has in place Memorandum of Understandings with private sector companies, such as Cahora Bassa hydropower, Açucareira de Mafambisse and Açucareira de Marromeu Sugar factories, who operate and manage weather observations stations, to provide support on maintenance of their infrastructure. Furthermore, INAM has partnerships with local institutions of higher learning and academia such as Eduardo Mondlane University and Universidade Pedagógica de Maputo which are the local institute of higher learning, University of Cape Town, University of Reading, University of Bristo and University of Exeter which are international institutes for joint research and innovation projects.

2.3. Effective partnerships in place with international climate and development finance partners.

There is a MoU in place with the World Food Programme to support INAM with capacity development in programmes that are geared towards food security in the country. Furthermore, several weather observation infrastructures nationally were rolled out with the support of external funders such the World Bank (WB), Food and Agriculture Organization (FAO), Nordic Development Fund (NDF), African Development Bank (AfDB), United Nations Development Programme (UNDP) respectively.

2.4. New or enhanced products, services or dissemination techniques or new uses or applications of existing products and services that culminated from these relationships.

No evidence of enhanced products and services could be found during the assessment, however INAM issues 10-day forecasts for the country based on the existing web-based



numerical weather prediction models and publish these on the INAM website. Furthermore, INAM supports the issuance of aviation related weather forecasts for all national airports.

Summary score, recommendations, and comments for Element 2

The INAM has some existing MoU's with governmental departments for maintenance and operation of weather observation networks as well as data sharing. Furthermore, there are also partnership in place with national and international institutions of higher learning for research and for capacity development activities.

The Effectiveness of partnerships to improve service delivery for the INAM was assessed being at level 2 "Limited partnerships and mostly excluded from relevant finance opportunities" based on existence of the MoUs.

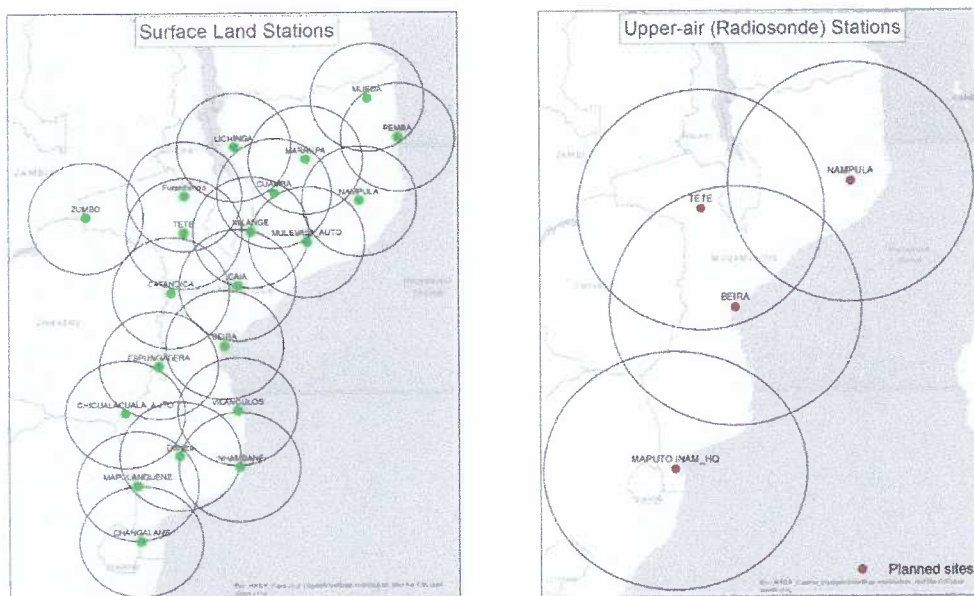


Element 3: Observational infrastructure

3.1. Average horizontal resolution in km of both synoptic surface and upper-air observations, including compliance with the Global Basic Observing Network (GBON) regulations.

INAM operates and maintains 106 Automatic Weather Stations and 46 manual climate stations deployed nationally across the nine provinces of Mozambique. There are no operational upper air observing network.

Based on the Global Basic Observing Network (GBON) horizontal resolution requirements, INAM should assign 21 surface synoptic stations at average horizontal resolution of 200km and 4 upper air stations at the horizontal resolution of 500 KM to the GBON.



A technical assessment of the 21 surface land stations identified for GBON indicated that 20 of the stations are Automatic Weather Stations and 1 station, Tete, is a manual climate station. At the time of this assessment, all of these GBON allocated station were not in compliance with the Global Basic Observing Network (GBON) regulations based on sensor requirements and data transmission.

Of these 21 surface stations, it was found that 7 stations have data loggers with the FTP data transfer protocol whereas 13 stations have the FTP, MQTT and SFTP data transfer protocol respectively. MQTT and SFTP data transfer protocol are required for the implementation of WIS 2.0.

3.2. Additional observations used for nowcasting and specialized purposes.

INAM recently installed a weather RADAR in Beira as an additional tool to support nowcasting services in the country. The Hydrology department’s information on stream/river flow gauges is also used to monitor downstream flooding warning.



3.3. Standard Operating Practices in place for the deployment, maintenance, calibrations, and quality assurance of the observational network.

The Manual on WMO Integrated Global Observing System (WIGOS), calls on Members to ensure that observations are traceable to the International System of Units standard. Furthermore, Members are called upon to ensure that measurement systems and instruments are calibrated regularly in accordance with adequate procedures for each type of system and instrument. There are currently no Standard Operating Practices (SOP) in place for INAM to guide personnel in the deployment, maintenance, calibrations, and quality assurance of the observational network. Lack of these guiding documents impact on sustainable operation of the observation network and reliability of the collected data. These needs to be developed.

There are other entities within Mozambique, operating and managing observation infrastructure. WMO calls for development of the National WMO Integrated Global Observing system for the country where all stakeholders operating and managing weather observation networks can work together towards developing the national observation infrastructure to minimise duplication of national efforts in deployment of infrastructure. This is one of the activities to be conducted with Mozambique to address the global requirement for WIGOS implementation.

3.4 Implementation of sustainable newer approaches to observations.

The INAM is in the process of upgrading its surface observation station to meet the GBON requirements, and to implement automatic technology for the transmission of data from remote sites to the server at INAM and further to the Global Telecommunication System (GTS). Furthermore, migration of data to BUFR for ingestion into the numerical Weather prediction models is in progress. As GTS is reaching its end of life, countries as call to implement WMO Information System latest technologies, WIS2.0. This is one of the considerations to be implemented to support INAM in effective and efficient data transmission, locally, regionally, and globally.

There are however limitations in human resources to support instrumentations to perform calibration, as well as difficulties in accessibility of remote sites.

3.5. Percentage of the surface observations that depend on automatic techniques.

All GBON allocated surface Synoptic Stations depend on automatic data transfer techniques. 93% of the current infrastructure has been converted from manual to automatic weather station, with 36% of this automation having been performed during the last 5 years. There are however some stations that transmit data through other modes of communication to INAM head offices for capturing and transmission to the GTS.

Summary score, recommendations, and comments for Element 3

Observation Infrastructure for the INAM is assessed at **level three (3)** "Moderate network with some gaps with respect to WMO regulations and guidance and with some data quality issues". There is a process being followed, based on the national strategy, to have an observation station in every district of the country. Through this programme several surface weather observation infrastructures were rolled out which includes deployment of



the weather RADAR in Beira. Furthermore, INAM is one of the LDCs being supported through the SOFF for meeting GBON compliance.

It is hereby recommended that: -

1. All surface weather observation stations be upgraded to automate data transmission for the remote observation network to meet the hourly data transmission as per GBON requirements.
2. Upgrade all sensors and data loggers to meet the GBON minimum requirements.
3. Standard Operating Practices (SOP) for the deployment, maintenance, calibrations, and quality assurance of the observational network be developed.
4. Furthermore, the "One district One weather station" plan be implemented to improve on data availability nationally.
5. The institution was recently involved on the rollout of observation infrastructure such as weather RADAR and AWS. There is however a need to build technological capacity and provide financial resources for INAM to be able to ensure sustainable operation of the rolled-out infrastructure.

Element 4: Data and product sharing and policies

4.1. Percentage of GBON compliance – for how many prescribed surface and upper-air stations are observations exchanged internationally. Usage of regional WIGOS centres.

Mozambique is one of the countries allocated to the Regional WIGOS Centre-Southern Africa (RWC-SA) for monitoring of data availability and quality. Currently all the 21 stations allocated to GBON do not meet the requirements of hourly data transmission and hereby are not meeting the minimum requirement of 80% monthly synoptic data availability. WIS 2.0 box has not yet been implemented. Data availability for the GBON allocated synoptic station is below 33%. Data transmission to the GTS is done on a three hourly basis, but not for all stations.

4.2. A formal policy and practice for the free and open sharing of observational data.

No formal data policy in place but there is a provisions in the INAM mandate, article 1 "(g) Guarantee the observation, transmission, monitoring, archiving and publication of the results of national meteorological and climate observations; (i) Coordinate, at national level, matters concerning the execution of international treaties, conventions and agreements relating to meteorology; (j) Issuing opinions in the field of meteorology, with regard to cooperation agreements and international conventions." that addresses the role that INAM must play in relation to data collection and dissemination.

4.3. Main data and products received from external sources in a national, regional and global context, such as model and satellite data.

The forecasting section as well the research section at INAM have access to various Numerical weather prediction models (NWP) such as ECMWF as well as satellite products (EUMETSAT) through the internet, utilising Vodacom as the primary link, at 20 Mbps and MoRENet as the secondary/ backup link at 50 Mbps.

Some of the products been accessed by INAM include but not limited to the following:

INAM uses products from several global and regional weather models to generate its forecasts, as follows:

- ECMWF (rainfall accumulation, wind direction and speed at various pressure levels, maximum and minimum temperature, sea level pressure, geopotential height, vorticity, relative humidity at various levels, instability indices, cloud cover, waves);
- GFS (rainfall accumulation, wind direction and speed at various pressure levels, maximum and minimum temperature, sea level pressure, geopotential height, vorticity, instability indices, cloud cover, wave height and direction, sea surface temperature, visibility);
- UK MET OFFICE (rainfall accumulation, wind direction and speed at various pressure levels, maximum and minimum temperature, sea level pressure, geopotential height, relative humidity, divergence, vorticity, instability indices);
- GSM (rainfall accumulation, wind direction and speed at various pressure levels, maximum and minimum temperature, sea level pressure, geopotential height, vorticity, instability indices);



- UM 4km (rainfall accumulation, wind direction and speed at various pressure levels, maximum and minimum temperature, sea level pressure, geopotential height, relative humidity, divergence, vorticity, instability indices);
- ALPERJE (rainfall accumulation, wind direction and speed at various pressure levels, maximum and minimum temperature, sea level pressure, geopotential height, relative humidity, vorticity, instability indices, cloud cover);
- WRF (rainfall accumulation, wind direction and speed at various pressure levels, maximum and minimum temperature, sea level pressure, geopotential height, relative humidity, vorticity, instability indices, cloud cover);
- FEWS-INAM (tides, wave height ad direction, wind at surface, currents, visibility, rainfall accumulation, sea level pressure);
- EUMETSAT (cloud cover and type, fog, solar radiation);
- FENGYUN (cloud cover and type, fog, solar radiation).

Summary score, recommendations, and comments for Element 4

This element is hereby assessed at level two (2) "A limited amount of GBON compliant data is shared internationally. The existing data sharing policies or practices or the existing infrastructure severely hamper two-way data sharing". There is however some MoUs with government departments which include agreements for data sharing. Furthermore, a limited amount of GBON compliant data is shared internationally due to the communication infrastructure limitations.

It is hereby recommended that:

1. the INAM develop a data policy for the country aligned with the WMO Unified data policy.
2. Automate data collection/ transmission for all the INAM weather observations infrastructure including the Non GBON Stations for national and international use.
3. Develop a National WIGOS Implementation plan for the country.

Element 5: Numerical model and forecasting tool application.

5.1. Model and remote sensed products form the primary source for products across the different forecasting timescales.

INAM utilises forecast products such as ECMWF products such as rainfall accumulation, wind direction and speed at various pressure levels, maximum and minimum temperature, sea level pressure, geopotential height, vorticity, relative humidity at various levels, instability indices, cloud cover, waves, The SWAN and the WRF model from World Meteorological Centres (WMCs) which also cover similar products as ECMWF, Regional Specialized Meteorological Centres (RSMCs) including Regional Climate Centres (RCCs) to assist with for forecasting of waves along the coast of Mozambique and related services.

5.2. a) Models run internally (and sustainably), b) Data assimilation and verification performed, c) appropriateness of horizontal and vertical resolution.

There are no models run internal to INAM for data assimilation and verification. They utilise web-based models such as the WRF, JMA model to perform their routine forecasting activities. Service effectiveness is at times impacted by internet connectivity.

5.3. Probabilistic forecasts produced and, if so, based on ensemble predictions.

INAM produces probabilistic seasonal forecasts for a 3-month rolling period predicting precipitation and maximum temperature this is based on statistical downscaling of global models such as North American Multi-Model Ensemble (NMME) and ECMWF, DWD, UK-Met Office or Meteo-France.

Summary score, recommendations, and comments for Element 5

The CHD Element 5 'Numerical Model and forecasting tool application' of INAM is hereby assessed at level two (2) "Basic use of external model output and remote sensed products in the form of maps and figures, covering only a limited forecast time range.". The NMHS does not have capabilities such as supercomputing to assimilate data from the national observations infrastructure or to run its own model(s). Currently, INAM on the use of NWP products from RSMCs is rated at level 1³.

It is therefore recommended that: -

1. Enhancement of the current computing capabilities for the NMHS be considered to allow for delivery on forecasting of extreme events at a local level, whereby the global models are not able to fully address. This will need to be linked with personnel capacity development to build inhouse capabilities for downscaling regional models to address local forecasting requirements. Unstable internet connectivity impacts negatively on ensuring reliable and timely forecast products. Enhanced computing power and personnel capacity development will allow for the downscaling of the outputs meet the national requirements. The two requirements must be addressed concurrently.

³ Classification as per WMO-No. 1311 (2023) [Guidelines on High-resolution Numerical Weather Prediction](#)

2. Capacitate the INAM forecasting personnel to be able to effectively utilise the existing web-based forecasting tool.
3. Strengthen working relationships with RSMC, especially around the Severe Weather Forecasting Programme, to continue to improve the applicability of global and regional models.

Element 6: Warning and advisory services

6.1. Warning and alert service cover 24/7.

INAM provides 24/7 forecasting services, which include warning and alert services. The office utilises the RSMC Pretoria issued guidance maps for the provision of warning services for the country. The coordination of Multi-Early Warning Service is through the Disaster Management centre.

Standard operating procedure for issuance of warnings are in place. They are developed by responsible sectors, since INAM is only responsible for meteorological related hazards and other sectors, such as Hydrology, are responsible for hydrological warnings.

6.2. Hydrometeorological hazards for which forecasting and warning capacity is available and whether feedback and lessons learned are included to improve warnings.

Mozambique is prone to hydrometeorological hazards for which forecasting and warning capacity is available even though there is limited capacities and access to reliable and appropriate NWP products. The later can be attributed to internet connectivity and computing capabilities.

The hydrometeorological hazards which affect Mozambique are heat wave; drought/dry spell; wind; tropical cyclone; thunderstorms/squall lines; rain/wet spell, lightning; riverine floods; flash floods and cold wave. However, INAM is only responsible for meteorological hazards, while other departments are responsible for the hazards related to their respective sectors. There are defined platforms for collection of information to perform hazard impact assessment, except utilisation of media platforms such as electronic and social media to gather evidence of impact at local level. Furthermore, Local Disaster Risk Management Committees feedback sessions are used to further validate social media reports and also disseminates severe weather to the local communities.

6.3. Common alerting procedures in place based on impact-based services and scenarios taking hazard, exposure and vulnerability information into account and with registered alerting authorities.

None.

Summary score, recommendations, and comments for Element 6

The CHD Element 6, (Warning and advisory services) is assessed at level 2 "Basic warning service is in place and operational but with limited public reach and lacking integration with other relevant institutions and services."

It is hereby recommended that:

1. SOP for Multi-Hazard Early Warning System (MHEWS) be developed for the country.
2. Capacity development be conducted for assessment of the early warning issued as well as incorporation of these outcomes into the improvement of the early warning services.

Element 7: Contribution to Climate Services

7.1. Where relevant, contribution to climate services according to the established capacity for the provision of climate services.

The basic weather observations network operated and maintained by INAM as well as other sector departments contribute towards the provision of weather forecasting as well as national climate statistics for the country.

Scientists from INAM contribute towards capacity development of emerging farmers in understanding the use of climate information for decision making. The manual climate statistics of the country are being digitised to improve access for future use in assessing climate variation of the country.

Summary score, recommendations, and comments for Element 7

The CHD Element 7, Contribution to Climate services, is assessed at level 2 "Basic Capacity for Climate Services Provision". The scientists in INAM are involved in development of the climatic outlook for the country and furthermore capacitate the public in the use of climate information for decision making.

Element 8: Contribution to hydrology

8.1. Where relevant, standard products such as quantitative precipitation estimation and forecasts are produced on a routine basis according to the requirements of the hydrological community.

Hydrology in Mozambique is not part of the INAM. It is a under the National Directorate of Water Resources Management within Ministry of Public Works, Tourism and Water Resources. This Ministry has its own mandate for governance of Hydrological services nationally.

To comply with the provisions of the Water Policy, National Water Resources Management Strategies and Strategic Development Plan of the National Institute of Meteorology, regarding actions to improve the early warning system, it was deem essential that institutions that have hydrometeorological networks , such as the National Institute of Meteorology (INAM), an institution supervised by the Minister of Transport and Communications and the National Directorate of Water Resources Management (DNGRH) of the Ministry of Public Works, Housing and Water Resources have clear mechanisms for sharing data and information for the prevention and mitigation of natural disasters, benefiting stakeholders and the general public.

8.2. SOPs in place to formalize the relation between Met Service and Hydrology Agency, showing evidence that the whole value chain is addressed.

The MoU between INAM and the National Directorate of Water Resources Management within Ministry of Public Works, Tourism and Water Resources established the mechanisms for sharing hydrometeorological data and information between those two institutions, the Minister of Transport and Communications and the Minister of Public Works, Housing and Water Resources determines through:

Article 1. The National Institute of Meteorology and the National Directorate of Water Resources Management, hereinafter referred to as institutions, must share hydrometeorological data and information with each other.

Art. 2. The sharing of information between institutions has with a view to preventing and mitigating natural disasters.

Art. 3. When sharing information, institutions have the following responsibilities:

- a) Share hydrometeorological data and information continuously;
- b) Collect data according to the standards of the World Meteorological Organization and the respective quality control, until national standards are established;
- c) Use the data and information shared only for the purposes set out in this diploma

Art. 4. Institutions must share the following data and hydrometeorological information:

- a) Hydrometeorological data:
 - i. Daily precipitation from the national meteorological network;
 - ii. Daily precipitation from stations located in the river basins of the Southern African region available on the global telecommunications system;

- iii. Evaporation;
- iv. Average, maximum and minimum daily temperatures
- v. Water temperature;
- vi. Relative humidity;
- vii. Wind (Direction and speed);
- viii. Other parameters as might be deemed necessary.

b) Hydrometeorological information

- i. Daily and medium-term forecasts
- ii. Warnings of the occurrence of extreme events
- iii. Seasonal climate forecasts
- iv. National hydrological forecast
- v. National Hydrological Bulletin
- vi. Reports and Warnings of Flood Occurrences
- vii. Other information, when requested

The data and information referred to above are used to produce the Hydrometeorological forecasts; Seasonal forecasts; Water balance of reservoirs; Hydrological bulletins; Studies for the sizing of infrastructures; Strategic studies on the development of water resources; Climatic and other relevant studies; Weather monitoring report; National contingency plan; Hydrological yearbooks of river basins; National rainy season assessment report; on any other relevant report as might be deemed necessary.

The developed product and services must be disseminated to interested parties.

8.3. Data sharing agreements (between local and national agencies, and across international borders as required) on hydrological data in place or under development.

Data sharing for hydrological services is a legislative requirement nationally as per article 7 which states "Institutions must disseminate to interested parties the information produced by them under the terms of this diploma. There is currently information available on international data sharing agreements.

8.4 Joint projects/initiatives with hydrological community designed to build hydrometeorological cooperation.

The Mozambique climate resilience project that focused on the Cabo Delgado, Ribaué, Cuamba, Niassa and Nampula provinces during 2017 to 2021, aimed at risk reduction of the farmers' livelihood from the threats associated to rainfall and climate change through maximizing all the possible and existing assets that one holds to mitigate impact. The program seeks to increase the resilience of the farmers and knowledge starting at the household and community level.

Summary score, recommendations, and comments for Element 8

CHD element 8 is assessed at level 2 where "Meteorological input in hydrology and water resource management happens on an ad hoc basis and or during times of disaster". Hydrology is hosted by National Directorate of Water Resource Management under the Ministry of Public Works and Housing which is regulated through the legislative mandate of the Ministry. INAM's role is mainly supportive to Hydrology.

It is hereby recommended that:

1. Enhancement of the existing MoU with Hydrology to improve on institutional support and build a common platform to discuss the problems and implement solutions.
2. Concept of Operations or SOPs to be established between INAM and National Directorate of Water Resource Management for effective cooperation.

Element 9: Product dissemination and outreach

9.1. Channels used for user-centred communication and ability to support those channels (for example, does the NMHS operate its own television, video or audio production facilities? Does it effectively use cutting-edge techniques?).

INAM does have a studio for video production to share with media houses for broadcasting, even though some technical challenges currently exist to fully perform the required functions.

The communication channels being used to disseminate products and services include TV, radio, printed media, INAM's website, e-mail, social media, and a mobile phone application.

9.2. Education and awareness initiatives in place.

Local radio stations, local disaster risk management committees' forums (Local Leader taking the leading role during local disaster risk management committees) as well as agriculture extension officers are being used for education and building awareness related to products and services available for hydromet services.

9.3. Special measures in place to reach marginalized communities and indigenous people.

Outreach for marginalized communities, indigenous people, the youth and the elderly in the country is mainly conducted through local radio stations utilizing indigenous languages, local disaster risk management committees' forums where local leaders are used to convey information, agriculture extension officers who works with local communities.

Summary score, recommendations, and comments for Element 9

CHD element 9 is assessed at level 2 where "Traditional communication channels and a basic dedicated website is used to disseminate forecasts and basic information." Well-coordinated response during disaster is in place. Furthermore, existing local disaster risk community forums are used to ensure communication reaches all levels of the society.

It is hereby recommended that:

1. The existing challenges in studio facilities are addressed to enhance information dissemination.

Element 10: Use and national value of products and services

10.1. Formalized platform to engage with users in order to co-design improved services.

INAM is not responsible for Hydrology since Hydrology is hosted by the National Directorate of Water Resource Management under the Ministry of Public Works and Housing which is regulated through the legislative mandate of the Ministry. Institute for Disaster Risk management is mandated to coordinate all disaster activities, INAM provide all required technical information together with Hydrology and other relevant sectors.

INAM distribute questionnaire to end users for information gathering as part of the input for the products and services that are rendered in order to include their requirements in the product that will be released.

10.2. Independent user satisfaction surveys are conducted, and the results used to inform service improvement.

No independent user satisfaction surveys are conducted, however internal assessment is done internal in INAM.

10.3. Quality management processes that satisfy key user needs and support continuous improvement.

INAM provides aviation related products and services such as Terminal Aeronautical Forecasts (TAF), Meteorological Aviation Report (METAR), Special Meteorological Aviation Report (SPECI), and aerodrome warnings. The QMS certification ISO 9001/2015 was attained by INAM for aviation services, however, no evidence could be found of the implementation of a Quality Management System for climate services.

Summary score, recommendations, and comments for Element 10

CHD element 10 is assessed at level 3 where "Services development draws on regular dialogue with major stakeholders." INAM and Hydrology share the early warning platform during disaster and the Institute for Disaster Risk management is mandated to coordinate all disaster activities, INAM provides all required technical information together with Hydrology and other relevant sectors.

Annex 1 Consultations (including experts and stakeholder consultations)

- (1. Dr Aderito Aramuge, Director-General & Permanent Representative of Mozambique to the World Meteorological Organization – WMO, Vice-Presidente of WMO Regional Meteorological Association for Africa.
- (2. Bernardino João Nhantumbo (Ph.D.) INAM
- (3. Francisco Nostado (INAM)
- (4. Lena Schubmann (Programme & Policy Officer - World Food Programme Maputo, Mozambique



Annex 2 Urgent needs reported

The following need to be addressed to realise significant improvement: -

1. To increase the budget of ANAM in order to enhance its capacity to employ additional professional staff, and to procure suitable equipment and ensure its basic maintenance.
2. Enhancement of the current computing capabilities for the NMHS be considered to allow for delivery on forecasting of extreme events at a local level, whereby the global models are not able to fully address.
3. Full automation of data collection/ transmission processes for all the INAM weather observations infrastructure (towards the implementation of WIS 2.0).
4. Implement WIGOS nationally.



Annex 3 Information supplied through WMO

1. WMO Monitoring System Data
2. WMO EW4All Rapid Assessment for Pillar-2
3. WMO Hydrology Survey



Annex 4 List of materials used

1. Country Hydromet Diagnostics, published by WMO, 2023
2. CHD Operational Guidance for SOFF, 2023
3. [One District One Weather Station strategy for INAM 2022-2023](#)
4. INAM [Mandate](#) (Internal Regulation of the National Institute of Meteorology)
5. [Memorandum of Understanding between National Institute of Meteorology and National Directorate of Water Resource Management under the Ministry of Public Works and Housing.](#)
6. [Memorandum of Understanding between National Institute of Meteorology and World Food Programme](#)
7. [Law No. 10.2020-Disaster Risk Management and Reduction Law](#)

