COUNTRY HYDROMET DIAGNOSTICS

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July 2024

Peer Review Report – Comoros

Review agency: General Directorate of Meteorology, Morocco

AFRICAN DEVELOPMENT BANK GROUP
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SOFF Systematic Observations Financing Facility — Weather and climate data for resilience

WORLD METEOROLOGICAL ORGANIZATION

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Alliance for Hydromet Development

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General Director of Meteorology of Morocco and Permanent Representative of Morocco with WMO **Abdefetah SAHIBI**	
Director of Meteorology and Permanent Representative of COMOROS with WMO **Ahmed Youssouf ABDOU**	

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Content Table

List of acronyms and abbreviations

ACP	Africa, Caribbean, Pacific
ADRIFI	Africa Disaster Risk Financing Program
ANACM	National Agency of Civil Aviation and Meteorology
ASECNA	Agency for the Safety of Air Navigation in Africa and Madagascar
CHD	Country Hydromet Diagnostic
CMRS-La Réunion	Regional specialized meteorological center in Reunion
CREWS	Climate risks and early warning systems
DGSC	General Directorate of Civil Security of the Comoros
DTM	Technical Directorate of Meteorology of the Comoros
ECMWF	European Centre for Medium-Range Weather Forecasts
ER2C	Climate Resilient Water
WBG	World Bank Group
GBON	Global Basic Observing Network
GDM	General Directorate of Meteorology of Morocco
GFDRR	Global Facility for Disaster Reduction and Recovery
ICAO	International Civil Aviation Organization
WMO	World Meteorological Organization
NGO	Non-Governmental Organization
PANA	National Adaptation Action Plan
UNDP	United Nations Development Program
PUMA	Preparing for MSG use in Africa
QEP	Quantitative estimation of precipitation
RIMES	Regional Integrated Multi-Risk Early Warning System
DRR	Disaster Risk Reduction
NMHS	National Meteorological and Hydrological Service
QMS	Quality Management System
SNRRC	National Strategy for Disaster Reduction and Resilience
SOFF	Systematic Observations Financing Facility
SONEDE	National Company for the Exploitation and Distribution of Water in the Comoros
SOP	Standard operating procedure
EU	European Union
WDQMS	WIGOS Data Quality Monitoring System
WIGOS	WMO Integrated Global Observing System
WIS2	WMO Information System 2nd generation
WIS2Box	WIS2 In a Box

Executive summary

The Union of the Comoros is an archipelagic state consisting of four islands located in the western Indian Ocean approximately 200km east of the African continent and approximately 420km north of Madagascar. The country is subject to a range of hydrometeorological and geohazards, including tropical cyclones, heavy rainfall, river and flash floods, tsunamis, earthquakes and volcanic eruptions. The Comoros Islands are also highly vulnerable to the impacts of climate change.

The Directorate of Meteorology in the Union of the Comoros is a technical department of the National Agency for Civil Aviation and Meteorology (ANACM) created in 2017 by decree n°17-024/PR repealed and replaced by decree n°19-110/PR which sets the rules of organization and operation of the ANACM.

Known as the "Technical Directorate of Meteorology" (DTM), it comprises four technical departments covering the core activities of an NMHS (forecasting, warnings and research, climatology, environment and observation) and departments related to sectoral activities such as hydrology and agrometeorology. DTM operates in an environment characterized by significant challenges related to human and financial resources.

In this context, DTM faces significant challenges in maintaining its observation network and providing services to fulfill its core national missions and meets the needs of the Comorian community regarding service delivery. Not to mention the exchange of data as expected by the international meteorological community, which also represents a major challenge.

The ongoing development of DTM could be steered by a strategic plan that considers the broader national context, specifically the meteorological sector, and seeks to address the expectations of key stakeholders. These include the General Directorate of National Civil Security, which oversees the Disaster Risk Management platform, as well as the country's economic actors and decision-makers. The plan would aim to enhance DTM's role in protecting lives and property while aligning with national priorities.

The suggested priorities that could be considered in this context include:

- The development of the legislative framework governing the meteorological authority in the Comoros and the implementation of a national strategy for hydrometeorological forecasting and warning considering the recommendations of the "National Strategy for Disaster Reduction and Resilience" (SNRRC) and the guidelines of the "Multi-hazard Early Warning for All" Action Plan for Africa 2023-2027.
- Establishing an effective partnership-building process at the national level and adopting a proactive approach to participation in regional projects.
- The creation of a mechanism to promote and market DTM's weather and climate services, aimed at fostering the ongoing growth of public and private partnerships while developing innovative products and services.
- Enhancing meteorological observation systems and operationalizing oceanographic observations by upgrading or replacing aeronautical and automatic weather stations, installing marine observation systems (such as tide gauges, buoys, current meters, and marine radar), and upgrading or renewing the existing data concentration system to integrate all observation data
- Enhancing hydrological observation systems by implementing a range of automatic or manual systems to measure water levels in rivers and streams, as well as monitoring the level and quality of water in drinking wells
- Enhancing telecommunications infrastructure to consolidate all observation data, including the transmission of surface observations using technologies adapted to the national context, such as WIS2Box.
- Implementing a national maintenance program that covers both observation and processing systems, ensuring regular upkeep of equipment, performing diagnostics, and conducting first-level maintenance interventions.

- Establishing and operationalizing a database (meteorology, climatology, and hydrology) designed to meet the needs of DTM and its partners
- Establishing a system for receiving satellite products, outputs from global and regional models, and observation data from the area of interest, along with a data visualization system to integrate and process various data types.
- Strengthening capacities across all areas of DTM operations, including basic educational training and professional training.

Summary of assessed ratings for Country Hydromet Diagnostics elements

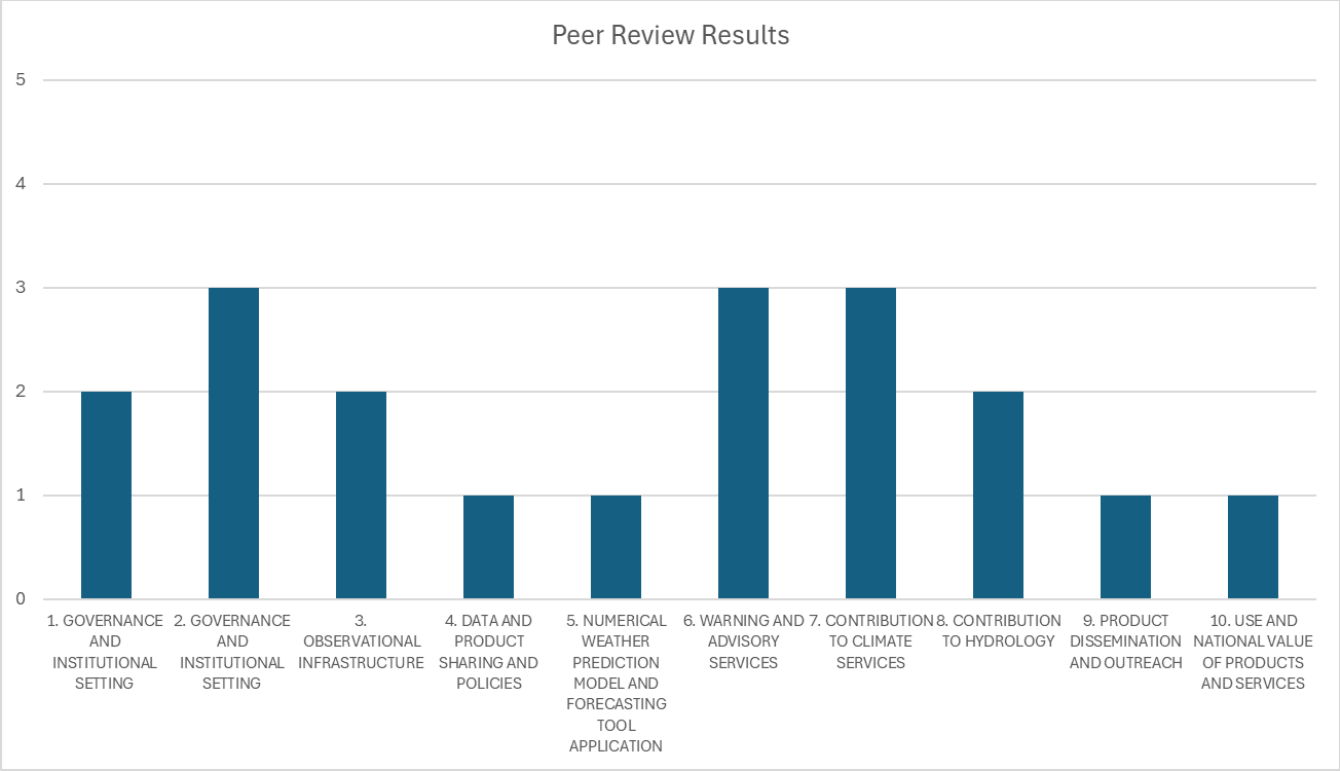

Figure 1. Maturity level scores of ANACM/DTM based on the CHD methodology.

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

Chapter 1: General information

Introduction

The Union of the Comoros is an archipelago in the western Indian Ocean located at the northern entrance to the Mozambique Channel, between 11°20' and 13°14' south latitude and 43°11' and 45°19' east longitude. The archipelago consists of three volcanic islands: Ngazidja (Grande Comore), Ndzouani (Anjouan), Mwali (Moheli). The Comoros are located equidistant between Madagascar and the east coast of Africa, covering an area of approximately 2,235 km^2. This unique geostrategic position places the islands on the main shipping route of the Indian Ocean, where 60% of international trade and 30% of world oil production, estimated at approximately 500 million tons of crude oil per day, transit. With nearly 5,000 oil tanker passages per year near the Comoros, the archipelago is exposed to very high risks of maritime pollution, especially during the cyclone season from December to April[1].

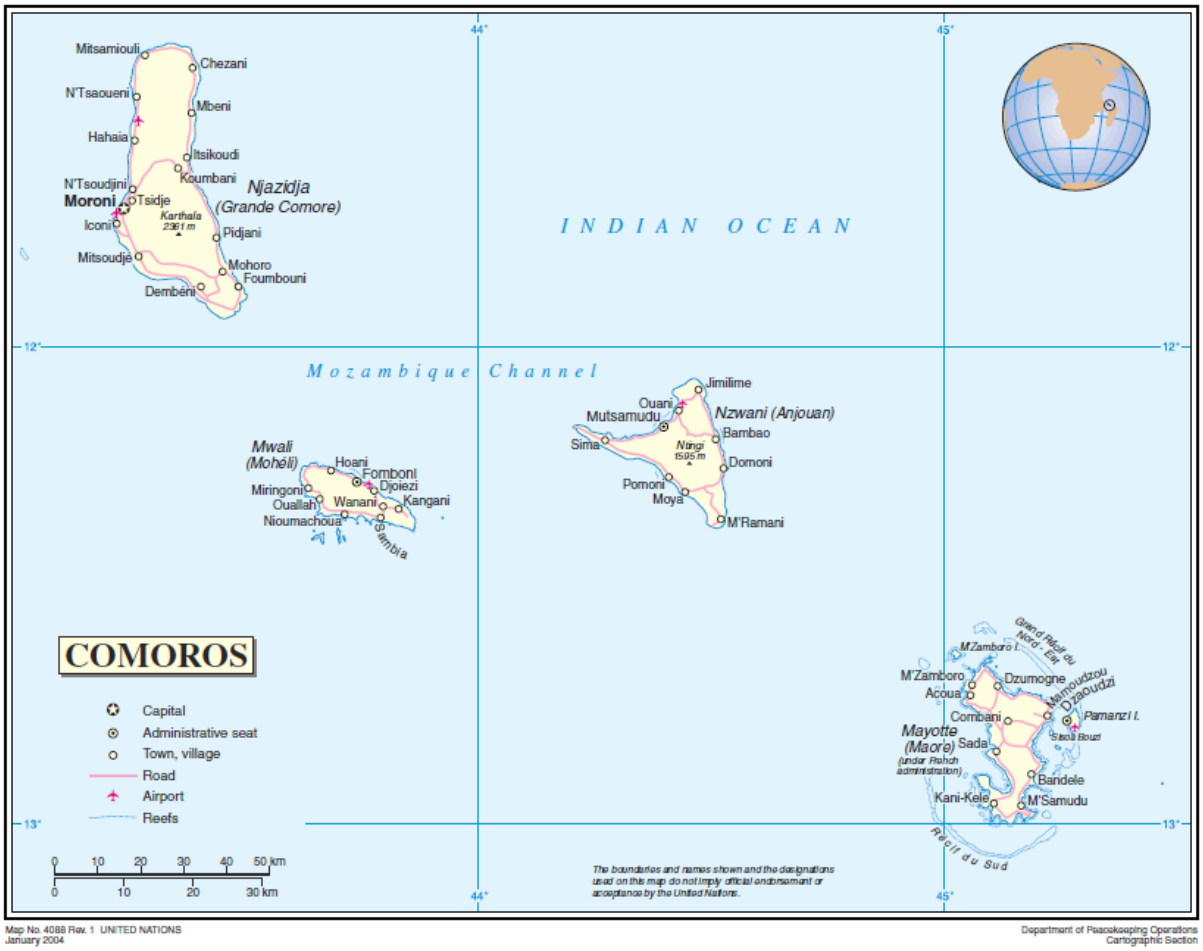

Figure 2. Geographical location of the Union of the Comoros [2]

Each island of the Comoros archipelago features diverse coastlines, ranging from fine sandy beaches to rocky cliffs, creating rich marine biodiversity and unique ecosystems.

- **Ngazidja (Grande Comore)** is the largest island and home to Mount Karthala, an active shield volcano and the highest point in the Comoros at 2,361 meters. The island's landscape is marked by volcanic-origin soils, including andosols, permeable brown soils, ferralitic, and black volcanic soils. Its coastlines vary from sandy beaches to rocky cliffs.

[1] https://unfccc.int/sites/default/files/resource/troisi%C3%A8me%20communication%20nationale%20des%20Comores.pdf
[2] https://www.un.org/geospatial/sites/www.un.org.geospatial/files/files/documents/2020/Apr/comoros_4088_r1_jan04.pdf

- **Mwali (Mohéli)**, known for its hilly terrain, hosts Mount Ntringui, peaking at 860 meters. The island is celebrated for its exceptional biodiversity and well-preserved coastal ecosystems, including mangroves and seagrass beds, which are vital habitats for numerous marine species.

- **Ndzouani (Anjouan)** features a rugged landscape, with Mount Ntingui reaching 1,595 meters. The island has a diverse range of soils, including ferralitic and hydromorphic varieties. Its coastlines are similarly varied, offering both sandy beaches and striking rock formations.

The Comoros Islands boast a diverse array of natural landscapes and an abundance of ecosystem, fauna, and flora biodiversity. The islands, situated approximately 40 kilometers apart, are separated by underwater abysses exceeding 3,500 meters in depth. This geographical isolation significantly heightens the islands' vulnerability to natural disasters and the pollution of marine and coastal ecosystems. This unique geographical setting not only endows the Comoros with exceptional biodiversity but also exposes it to significant environmental and climatic risks. As a result, the preservation of these ecosystems requires rigorous management and protection strategies to ensure their sustainability.

The climate of the Comoros is typically humid tropical, influenced by oceanic currents and marked by two distinct seasons: the southern summer season and the southern winter season. This climatic duality plays a decisive role in shaping the environmental conditions and economic activities of the archipelago. The delicate balance between the islands' rich biodiversity and their vulnerability to environmental hazards underscores the need for effective climate adaptation and environmental protection measures to safeguard the future of these ecosystems[3].

Southern Summer Season (mid-November to mid-April):

The southern summer season in the Comoros, also known as the hot and humid season, extends from mid-November to mid-April. During this period, the islands experience high temperatures and abundant rainfall. Average temperatures hover around 27°C at lower altitudes, with maximums ranging from 33°C to 35°C, and minimums varying between 21°C and 24°C. The months of January and February are especially rainy, with average monthly rainfall between 200 mm and 300 mm.

This intense rainfall is critical for the recharge of aquifers and helps maintain the islands' lush vegetation. The prevailing winds, known as "Kashkazi", blow from the north to northwest. These winds are generally weak but can occasionally reach gusts of up to 50 km/h. They play an essential role in moderating temperatures and dispersing moisture, influencing the microclimate across the islands.

The warm, humid conditions of this season support the islands' exceptional biodiversity, but they also bring challenges, such as increased flooding risks and the spread of humidity-related diseases. Agriculture, a key part of the local economy, relies heavily on these seasonal rains for the cultivation of rice, tropical fruits, and other important crops. The season's impact on both biodiversity and agriculture highlights the importance of managing the challenges posed by these intense climatic conditions to safeguard livelihoods and ecosystems in the Comoros.

[3] https://unfccc.int/sites/default/files/resource/troisi%C3%A8me%20communication%20nationale%20des%20Comores.pdf

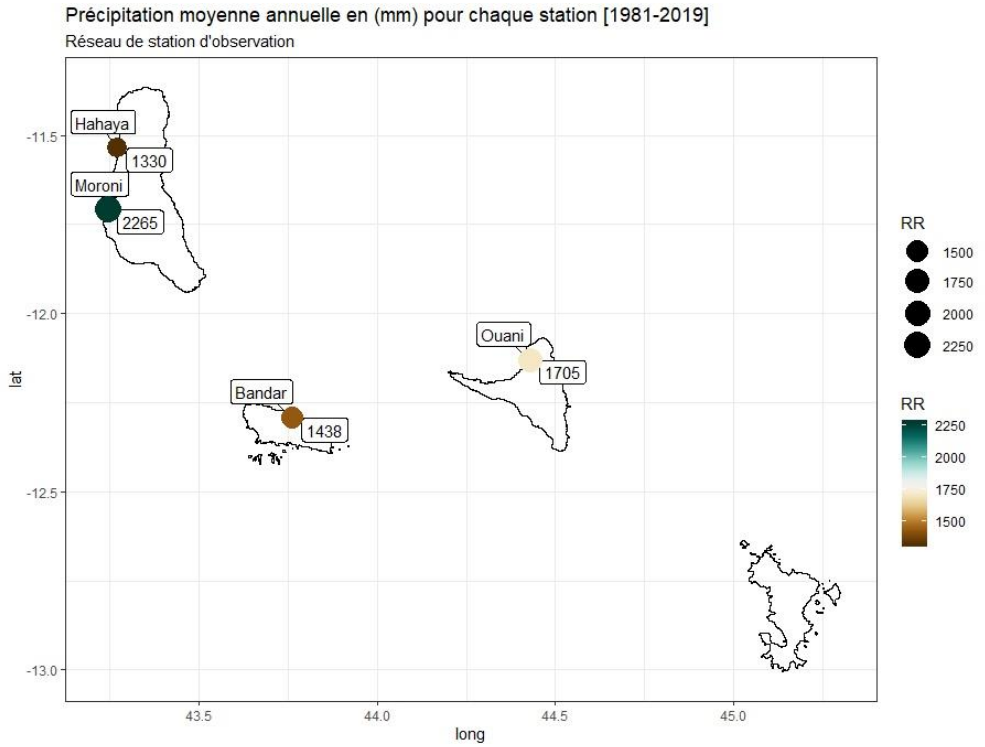

Figure 3 : Average annual distribution of rainfall at the country's 4 reference weather stations. Source: Third National Communication on Climate Change.

Southern Winter Season (mid-June to mid-October):

The southern winter season in the Comoros, from mid-June to mid-October, is characterized by drier and cooler conditions compared to the hot and humid summer. During this period, the average temperature at low altitudes is around 23°C, with maximums ranging between 27°C and 29°C, while minimums can drop to 13°C to 16°C at higher altitudes, providing significant cooling, particularly during the night.

Rainfall during the southern winter is minimal, and the months are often dry, creating a stark contrast to the rainy summer season. The "Kussi" trade winds, blowing from the southeast, gain intensity during this time, with gusts reaching up to 75 km/h. These dry winds help moderate temperatures and reduce humidity, making conditions more comfortable for people and certain crops. However, the dry season also presents challenges, especially regarding freshwater availability, as the reduced rainfall limits the recharge of water sources, impacting agricultural activities and water resource management.

The distinct seasonal cycles of the Comoros have a profound impact on the natural environment and economic activities. The summer season, with its abundant rainfall and high temperatures, is crucial for agriculture, groundwater recharge, and the maintenance of ecosystems. In contrast, the winter season, though cooler and drier, offers favorable conditions for some crops and boosts tourism activities, while also posing challenges in terms of water management.

These seasonal variations in temperature, rainfall, and wind patterns shape the biodiversity of the Comoros. Coastal ecosystems, forests, mangroves, and coral reefs rely on these climatic cycles for their survival and growth. Seasonal winds, whether the humid Kashkazi or the dry Kussi, play important roles in seed dispersal, pollination, and the modulation of local climatic conditions.

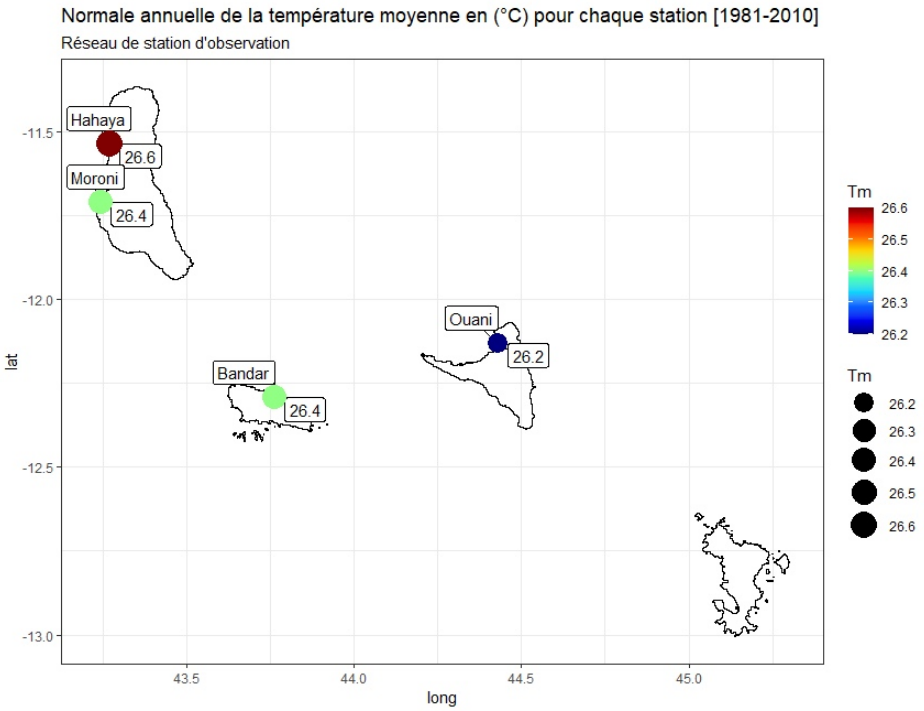

Figure 4 : Annual normal mean temperature (in °C) for each reference weather station in the country [1981-2010]. Source: Third National Communication on Climate Change.

In conclusion, the climate of the Comoros, with its two distinct seasons, creates a dynamic and diverse environment that supports rich biodiversity and various human activities. Effectively understanding and managing these climatic conditions is crucial for the sustainable development of the archipelago and the protection of its unique natural resources.

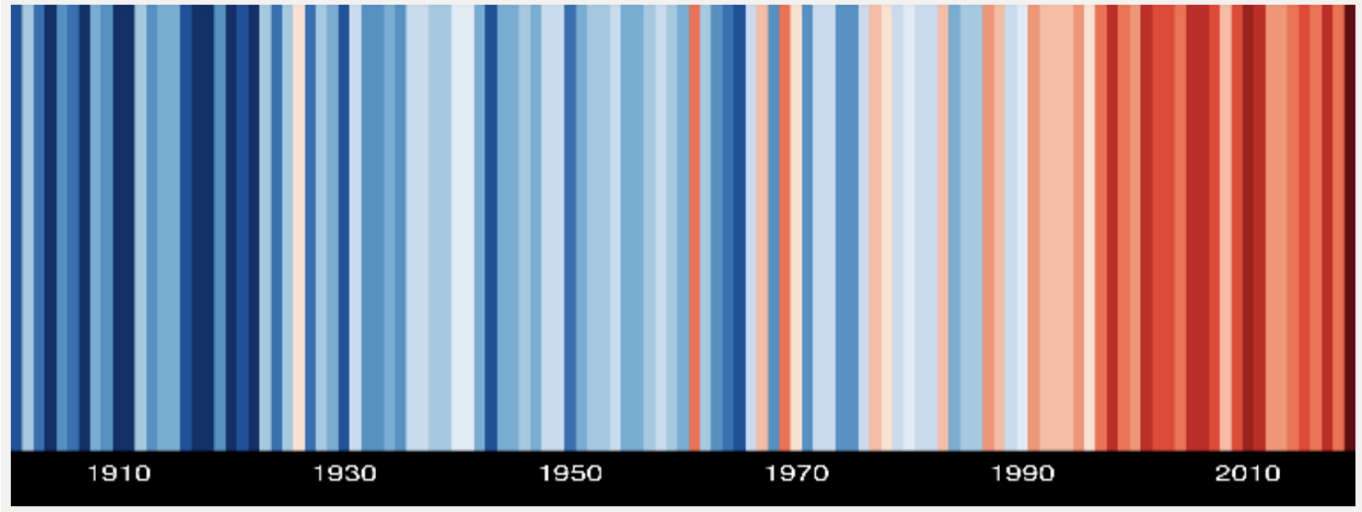

Figure 5. Temperature change in Comoros, 1901-2019. Source: Berkley Earth/#ShowYourStripes

The Union of the Comoros is recognized as one of the world's 25 global biodiversity hotspots, featuring an exceptional diversity of natural landscapes and rich ecosystems, fauna, and flora biodiversity. The country's ecosystems include tropical forests, mangroves, seagrass beds, and coral reefs. Forests, covering approximately 17,565 hectares, are home to endemic fauna and flora, providing critical habitats for many threatened species. The marine ecosystem is equally diverse, with iconic species such as the coelacanth, a prehistoric fish, and dugongs, marine mammals at risk of extinction. Additionally, Comorian waters are nesting grounds for green turtles and hawksbill turtles, which frequent the archipelago's beaches.

The population of the Comoros is estimated at 742,287 inhabitants, with 69% residing in rural areas. It is a young population, with 53.8% under the age of 20. The country's economy is primarily based on agriculture, fishing, and livestock farming, which together account for 57% of total employment and generate 90% of

operating revenues. The agricultural sector is particularly dominated by food crops and cash crops such as vanilla, cloves, and ylang-ylang.

The Union of the Comoros is particularly vulnerable to climate change. Over recent decades, the country has seen an average annual temperature increase of 0.28°C per decade, a sea level rise of 4 mm/year, and a decrease in annual cumulative rainfall by 63.3 mm per decade. These changes have been accompanied by an increase in extreme climate events such as cyclones, floods, and droughts, which negatively affect agriculture, biodiversity, water resources, and the country's economic and social infrastructure.

To confront these challenges, the Union of the Comoros has adopted climate-resilient and low-carbon strategies, aligning with global efforts to mitigate greenhouse gas emissions. The country has implemented rigorous adaptation measures aimed at limiting the impacts on vulnerable sectors. Key initiatives, such as the National Adaptation Action Plan (NAPA) and national climate change policies, are designed to strengthen Comoros' resilience to climate change and variability. In conclusion, the climate of the Comoros, with its two distinct seasons, creates a dynamic and diverse environment that sustains rich biodiversity and supports a variety of human activities. Understanding and managing these climatic conditions is critical for the sustainable development of the archipelago and the protection of its unique natural resources in the face of growing climate risks[4].

CHD Methodology

The "Country Hydromet Diagnostics" (CHD) report is a standardized peer-to-peer review of the operational environment of the Technical Directorate of Meteorology (DTM) in the Comoros, as well as its contributions to meteorological, climatic, hydrological, and alert services. This report has been prepared as part of the SOFF project in the Union of the Comoros.

The report follows a comprehensive review of DTM, which operates under the National Agency of Civil Aviation and Meteorology (ANACM). It also takes into account other entities within the agency that influence DTM's operations, such as human resources management, financial resources management, and quality management. This review has been conducted by the General Directorate of Meteorology of Morocco, serving as a peer advisor in the evaluation process.

The diagnostics carried out in this report complement the GBON National Gap Analysis Report for the Comoros and aim to identify areas that require special attention and additional support. These evaluations are based on the maturity levels defined for each of the ten critical elements of the Hydromet value cycle.

The CHD report will provide a strategic assessment based on these ten elements (as outlined in Figure 6), offering a foundation for guiding policy and investment decisions. In particular, it will inform investments related to the enhancement of hydrometeorological services in the Comoros, ensuring that the country's meteorological services are aligned with both national needs and international standards.

[4] All information relating to the geography and climatology of the Union of the Comoros included in this chapter is extracted from the Third National Communication on Climate Change – 2023 (French version) mentioned above.

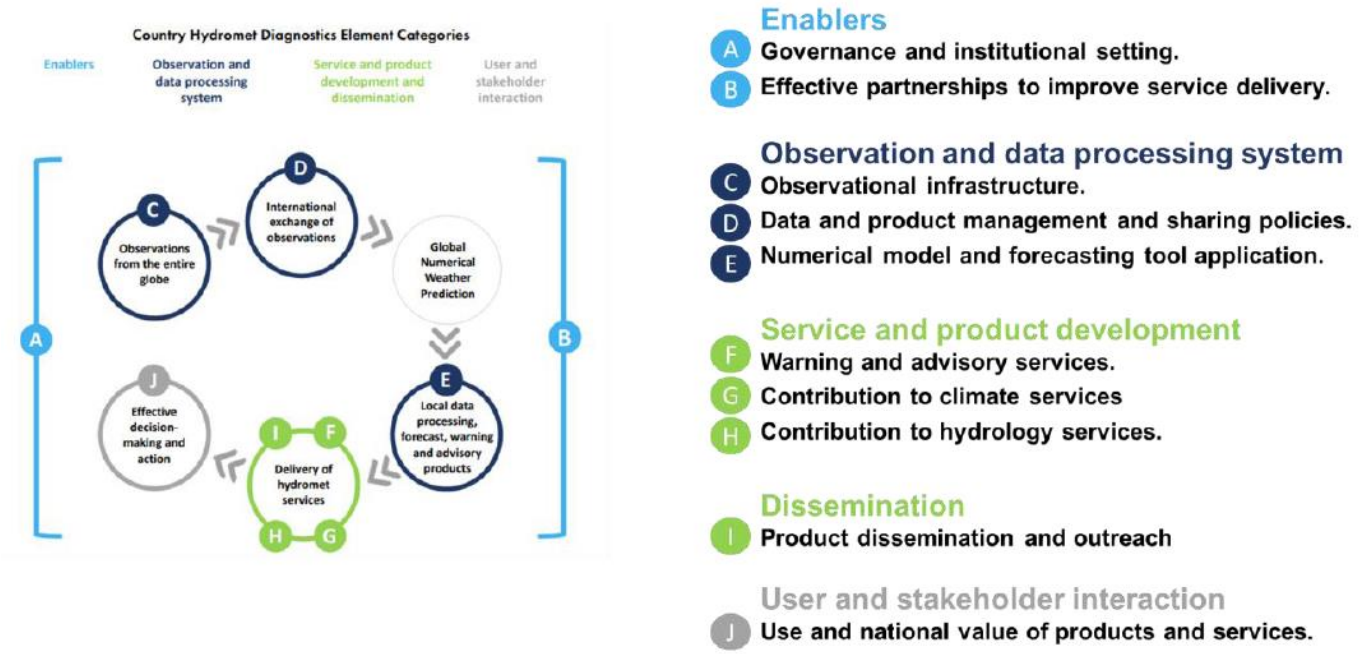

Figure 6. The10 CHD elements.

To carry out this diagnosis, the General Directorate of Meteorology of Morocco (GDM-Morocco) adopted a variety of methods:

- The process began with a preliminary stage, during which GDM-Morocco experts developed a questionnaire simplifying the ten elements of the Country Hydromet Diagnostics (CHD). This questionnaire was sent to the Technical Directorate of Meteorology (DTM) in the Comoros. Additionally, GDM-Morocco analyzed documents from the World Meteorological Organization (WMO) and other relevant organizations in the fields of meteorology, climate change, disaster reduction, and resilience. Documents related to the organization of the National Agency of Civil Aviation and Meteorology (ANACM), as well as various strategic studies conducted in the Comoros, were also reviewed.
- From April 12 to 27, GDM-Morocco experts visited the Comoros to organize workshops with DTM experts. These sessions included meetings with ASECNA (the Agency for the Safety of Air Navigation in Africa and Madagascar), and visits to observation sites on the three islands of the archipelago. This mission provided GDM-Morocco with a clear understanding of the observation and data processing infrastructures in the Comoros.

- Another visit took place from July 12 to 19, where GDM-Morocco experts finalized the information collected and engaged DTM experts in the CHD work:
    - The mission commenced with a meeting, during which the Director General of ANACM invited all DTM staff to actively participate and collaborate with the experts. This meeting served as an opportunity to clarify the project's objectives and explain the working methodology.
    - The work was organized into four workshops, allowing the participation of both Comorian experts and the technical staff of DTM.
    - To ensure agreement among stakeholders, the workshops were followed by a plenary session, where results were consolidated, and final contributions were gathered.

This methodological process allowed for an in-depth diagnosis of the capacities and gaps of hydrometeorological services in the Comoros. It also paved the way for developing strategic recommendations to enhance climate resilience and improve disaster risk management in the country.

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 National Meteorological and Hydrological Service (NMHS) of the Union of the Comoros is the Technical Directorate of Meteorology of the Comoros (DTM-Comoros). It operates as a technical directorate under the National Agency for Civil Aviation and Meteorology (ANACM). The legal framework for DTM-Comoros is outlined in Order No. 19-024/MTMA of the Minister of Maritime and Air Transport. This order specifies the terms for the implementation of Decree No. 19-110/PR[5], issued on September 16, 2019, which repealed and replaced Decree No. 17-024/PR of March 6, 2017, setting the organizational and operational rules for ANACM.

The decree defines the structure and organization of ANACM, including its sub-directorates. The ANACM organization chart comprises a safety and quality unit and seven directorates, one of which is the Technical Directorate of Meteorology. This structure ensures that DTM plays a central role in providing meteorological services within the framework of national civil aviation and meteorological operations in the Comoros.

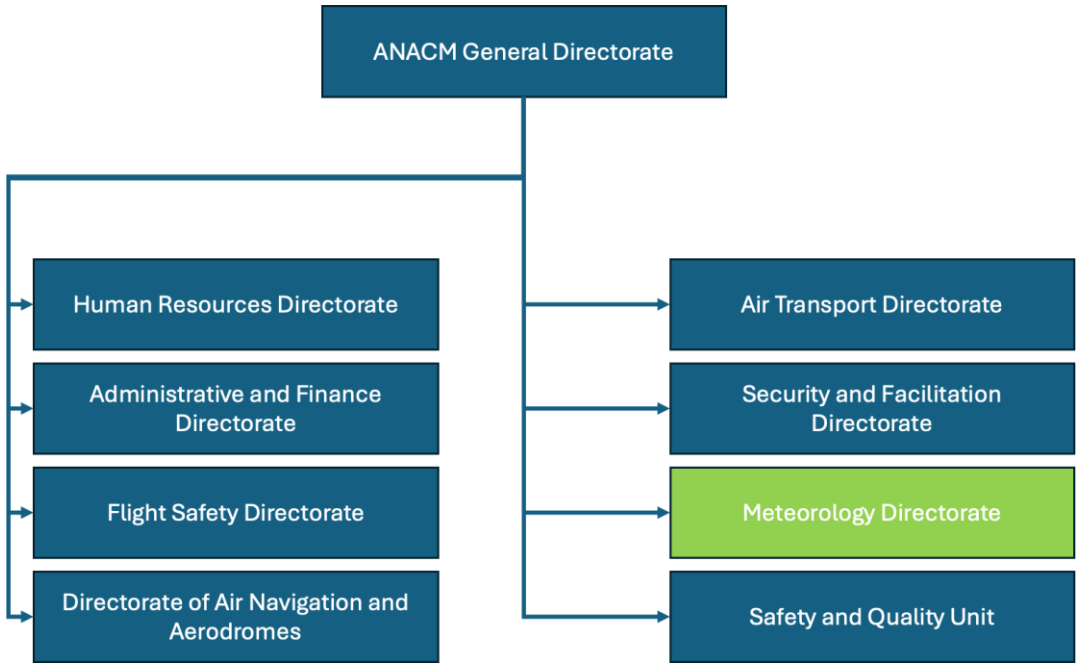

Figure 7. ANACM organization chart

The Technical Directorate of Meteorology is responsible for activities related to meteorological, climatic, and climate system evolution information and forecasts, essential for meeting the needs of users at the national level. It also ensures international data exchanges in accordance with agreements ratified by the Union of the Comoros. The Directorate implements the State's meteorological policy concerning the safety of people and property, following the laws and regulations in force in the Comoros, and adhering to WMO (World Meteorological Organization) and ICAO (International Civil Aviation Organization) standards when necessary. Additionally, it supports the Air Navigation Safety and Aerodromes Directorate in conducting safety supervision activities in the field of aeronautical meteorology. The Directorate comprises five services, each performing specific functions as outlined in Figure 8.

[5] the ANACM website still refers to decree No. 17-24/PR in "*Code de l'Aviation Civile*" section, and does not contain the new decree 19-110/PR. The document relating to the new decree was provided by the DTM in pdf format.

Meteorology Directorate

- Ensures activities relating to meteorological, climatic information and forecasts and changes in the climate system necessary to meet all the needs of users at the national level and ensure international exchanges of data in application of the agreements ratified by the Union of the Comoros.
- Implements the State meteorological policy regarding the safety of people and property in accordance with the laws and regulations in force in the Union of the Comoros in compliance with WMO and ICAO standards when necessary.
- Assists the Air Navigation and Aerodrome Safety Department in carrying out safety supervision activities in the field of aeronautical meteorology.

Activities common to all services

- Creation of the training plan and maintenance of skills,
- Participation in the implementation of the Agency's regulations and procedures and the improvement of their application.
- Participation in the implementation of the approach and the maintenance of the Agency's quality system.

Climatology, Environment and Observation Service

- Establishment of a system for observation, data processing, archiving and dissemination of data,
- Management and maintenance of the observation network,
- Monitoring of climatic and environmental variations,
- Monitoring of extreme weather phenomena responsible for major disasters and risks,
- Environmental monitoring and monitoring of polluting phenomena,
- Carrying out atmospheric and climatic research,

Agrometeorology Service

- Assistance to farmers by providing relevant professional information,
- Maintenance of collaboration and coordination between agricultural services and forestry services,

Hydrometeorology Service

- Assistance to stakeholders in the water sector by providing the necessary technical information,
- Carrying out hydrometeorological studies and research,

Forecasting and Research Service

- Production of general forecasts for public needs,
- Producing notices, alerts and bulletins of extreme weather conditions,

Maritime Meteorology and Oceanography Service

- Monitoring and study of ocean phenomena,
- Carrying out meteorological observations relating to the marine ecosystem,
- Assistance to maritime navigation and sea users by issuing warnings and bulletins of extreme weather conditions,
- Promoting sustainable development along the Comorian coasts and territorial waters,

** The Maritime Meteorology and Oceanography Service exists in the regulatory text, but it does not exist in the operational organization chart of DTM*

Figure 8. Structure of the Technical Directorate of Meteorology and functions of the services

The mandate and key responsibilities of the Technical Directorate of Meteorology (DTM) encompass a wide range of fields, including meteorology, climatology, hydrometeorology, agrometeorology, and maritime meteorology. DTM also plays a role in environmental monitoring and air quality. However, there are several critical observations related to the structure and functioning of DTM, as outlined in Order No. 19-024/MTMA:

- Many responsibilities are concentrated in DTM, despite its position within an agency (ANACM) whose primary focus is civil aviation.
- The Climatology Department handles a variety of tasks that are incompatible with climatology, leading to an inefficient division of labor.
- In the Forecasting and Research Department, there are no clear research activities, although such activities are found in other departments, particularly in Climatology and Hydrometeorology.
- Observation activities are spread across the Climatology, Hydrometeorology, and Maritime Forecasting departments, with no clear focus on managing and maintaining observation networks. These critical tasks are overshadowed by routine activities.
- There is no dedicated entity for information systems management, which is a significant gap. While ANACM has an IT department under its Security and Quality Unit, its role is limited to functions within ANACM's headquarters and does not extend to DTM's meteorological needs.

In addition to these organizational limitations, there are two major operational challenges hindering DTM's development:

1. Staff specialization: Despite having around sixty staff members (including doctors, engineers, technicians, and supervisors), only 11% of the staff are specialized in meteorology, and just 5% are specialized in IT and telecommunications. Most of the staff have backgrounds in geography (37%) or general science (16%), which limits the expertise needed for specialized meteorological services.
2. Budget constraints: The budget allocated to DTM by ANACM primarily covers staff salaries and office supplies, with no provision for infrastructure development. DTM is heavily reliant on aid from development agencies for infrastructure projects, and there is a total lack of subsidies. This creates an unfavorable working environment, limiting the sector's development and preventing DTM from fully realizing its potential in providing vital meteorological services.

These structural and financial challenges underline the need for reorganization and investment to strengthen DTM's capacity and ensure it can fulfill its broad mandate effectively.

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

Decree No. 12-181/PR of September 15, 2012, established the National Platform for Disaster Risk Prevention and Reduction in the Union of the Comoros. Following this, the National Disaster Risk Reduction Strategy (SNRRC) was developed in 2015 in partnership with the UNDP, World Bank Group, and GFDRR, with an updated version of the strategy completed in 2022.

The Action Plan for Disaster Risk Reduction (DRR) in the Union of the Comoros, created in 2014, defines the types of disasters, the actions to be taken for each, and the roles of various stakeholders, including the Directorate General of Civil Security (DGSC) and the Technical Directorate of Meteorology (DTM). The plan included several recommendations for upgrading the country's meteorological services[6]:

- Training engineers in meteorology through a structured development plan tailored to the nation's needs.

[6] Proposal for a National Disaster Risk Reduction Strategy in the Comoros– May 2015 (French version) : https://drmims.sadc.int/sites/default/files/document/2020-03/SNRRC_ComoresVF_2015.pdf

- Documenting hydrometeorological events that have caused fatalities or economic losses to enhance feedback.
- Setting up an alert system focused on highly vulnerable sites in the Comoros.
- Strengthening hydrometeorological research through dedicated researchers.
- Building a hydrometeorological risk database specific to the Comoros.
- Establishing a forum for networking among all stakeholders involved in hydrometeorological risks in the Comoros.

A 2023 study titled "Strengthening the Climate Resilience of Drinking Water Supply and Irrigation", focusing on 15 of the most vulnerable areas, laid the groundwork for water resource management and identified relevant stakeholders in the sector. However, it noted that DTM's role remains limited to providing precipitation data, without contributing to broader hydrometeorological research and studies[7].

In addition, a study conducted by the Southwest Indian Ocean Risk Assessment and Financing Initiative, funded by the World Bank Group (WBG), GFDRR, ACP, and the European Union (EU), has been instrumental in defining the risk profiles for disasters related to earthquakes, floods, and tropical cyclones in the Comoros[8].

While the operational plans for risk management are effectively managed by the civil security body, meteorological monitoring of extreme phenomena still requires special attention. There are significant weaknesses in both the organizational and functional aspects of the meteorological services, despite the numerous recommendations outlined in various strategic studies[9].

Moreover, there is a significant communication gap regarding these strategic studies and operational plans, as the majority of DTM staff are unaware of their existence. This lack of awareness hinders DTM's ability to effectively implement the recommendations and strategies designed to improve disaster risk management.

In conclusion, several key actions are strongly recommended to strengthen the Technical Directorate of Meteorology (DTM) in the Comoros. First, it is essential to review and update the regulatory frameworks governing the meteorology sector to better define its functions and allocate the necessary resources. Enhancing human capital is also critical, which can be achieved by recruiting personnel with the right profiles and skills aligned with DTM's mission and by providing ongoing training to address evolving challenges. Additionally, strengthening observation and data processing infrastructure is imperative to meet all weather and climate monitoring obligations, enabling DTM to innovate and provide products and services that cater to the needs of socio-economic sectors. An internal communication system should also be implemented to ensure that DTM staff are informed about relevant strategic studies and the country's broader orientations. By addressing these gaps, DTM will be better equipped to fulfill its mandate in monitoring extreme weather phenomena, enhancing its contributions to disaster risk reduction, and supporting the sustainable development of the Comoros.

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.

The ANACM budget is primarily funded by aeronautical taxes, which come from a limited number of internal, non-scheduled, and a few daily international flights. The portion of this budget allocated to the Technical Directorate of Meteorology (DTM) barely covers staff salaries and office supplies, with no additional subsidies. Consequently, DTM is heavily reliant on aid from development agencies for any project beyond basic operations.
This budget shortfall significantly affects DTM's operations and the quality of its services:

[7] https://www.eau-comores.com/sites/default/files/2023-06/livrable-5.4.-plans-daction-de-reduction-des-rc_vf_cam-21-nov.pdf
[8] https://www.gfdrr.org/sites/default/files/publication/dra_comores_fr.pdf
[9] As examples: https://drmims.sadc.int/sites/default/files/document/2020-03/Plan_Contingence_Comores_2017-2018.pdf, https://drmims.sadc.int/sites/default/files/document/2020-03/Plan%20d%27action%20RRC.pdf

- Maintenance and upkeep of observation and data processing systems are recurring issues. This lack of maintenance directly impacts the efficiency and lifespan of the systems. For instance, automatic weather stations installed through international projects typically break down within two to three years after installation. DTM lacks the logistical resources to conduct regular inspections and perform basic maintenance. As a result, plants and insects often invade sensors and processing units, leading to the gradual destruction of these systems.
- Observation systems are not calibrated at any point during their lifespan, further reducing the accuracy and effectiveness of data collected.
- Marine observation systems are virtually nonexistent, which severely limits DTM's ability to provide maritime assistance. This is a critical gap, given that small boat maritime transport is the dominant mode of fishing and transportation in the country.

In conclusion, DTM's limited budget and lack of resources have a direct and profound impact on its operational capabilities and the quality of meteorological services it provides, particularly in areas such as system maintenance, calibration, and maritime observation.

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 human resources structure of the Technical Directorate of Meteorology (DTM) does not align with the department's responsibilities[10]:

- As highlighted in Figure 9, there is a significant issue in the recruitment process: only 11% of the staff hold degrees in meteorology, and 5% have qualifications in IT and telecommunications. In contrast, most of the staff possess degrees in geography (37%) or science (16%), fields that do not directly correspond to the specialized needs of DTM. This imbalance in staff qualifications hinders the department's ability to effectively manage its meteorological, technological, and data-related functions.

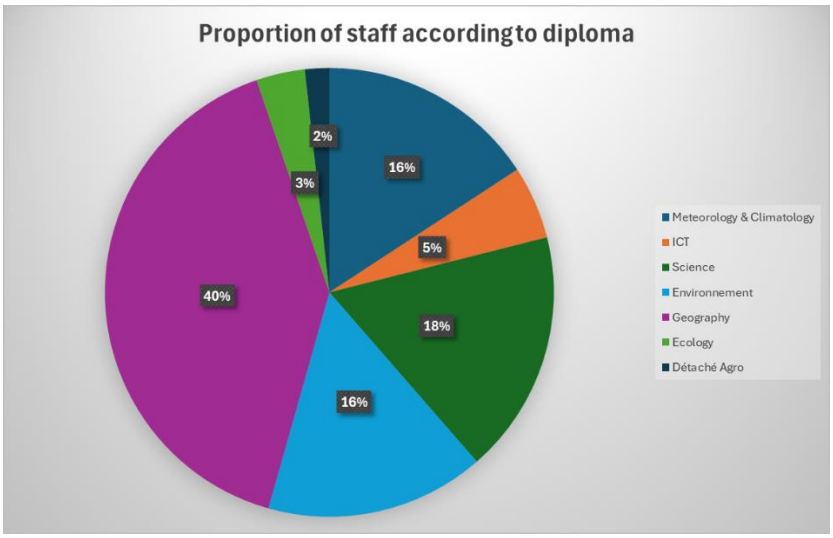

Figure 9. Structure of human resources of the Technical Directorate of Meteorology

- Figure 10 highlights significant gaps in the core specialties required for the proper functioning of a meteorological service. 74% of the personnel do not possess qualifications in meteorology or related fields, even though all five departments within DTM are technical services. This lack of alignment between staff expertise and the operational needs of the service undermines its ability to deliver accurate and reliable meteorological support, particularly in areas requiring specialized technical

[10] The study is based on the list of human resources provided by the ANACM Human Resources department

skills. Addressing these deficiencies is critical to enhancing the overall performance and capacity of the Comoros Meteorology Service.

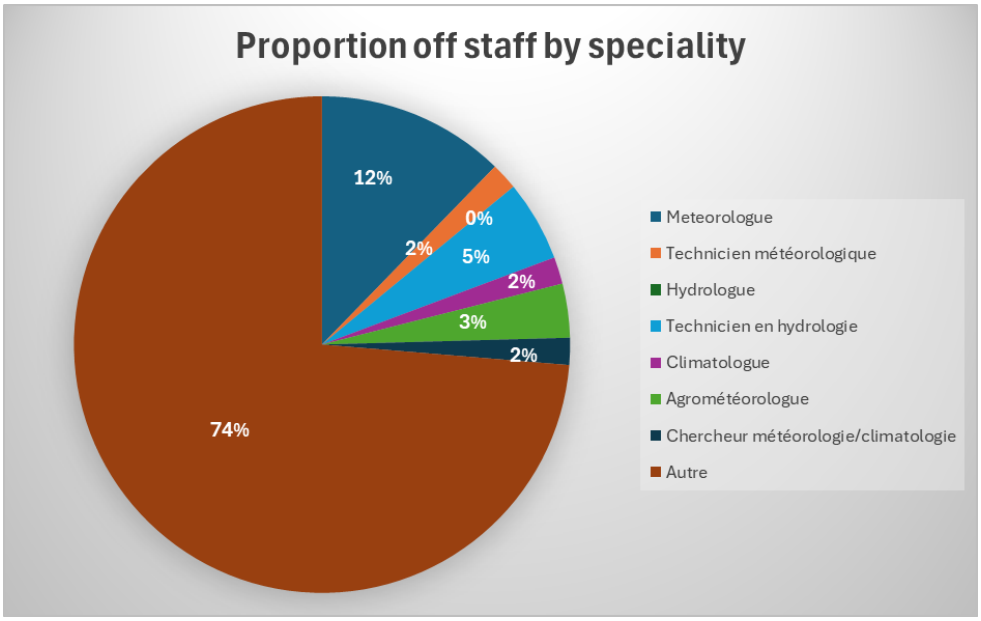

Figure 10. Proportion of staff by specialty

- Figure 11 shows that DTM has a relatively young workforce, with more than 60% of its staff under the age of 40.

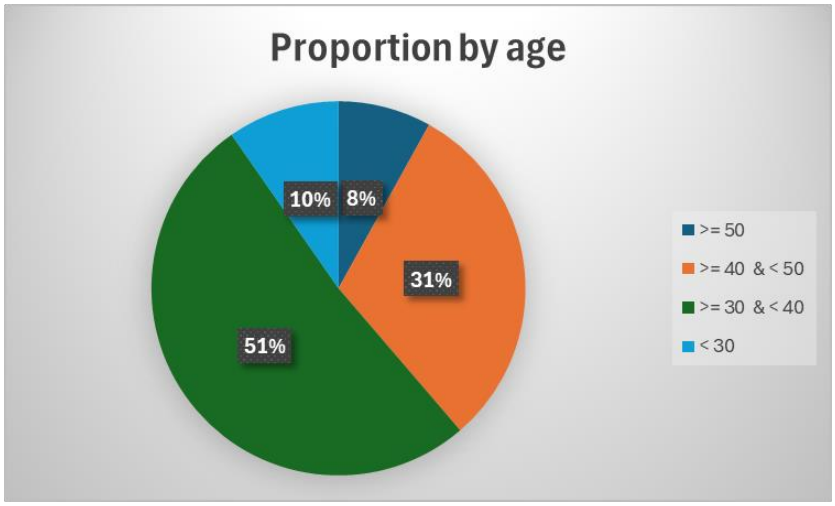

Figure 11. Proportions of staff by age

The factors that have led to this situation can be summarized as follows:

- The absence of a national strategy for the development of meteorology.
- The failure to operationalize the WMO National Strategic Plan.
- The lack of a human resource management plan outlining recruitment and career progression modalities, as well as planning for continuous training and technical supervision of staff.
- The failure to prioritize meteorology and its specific human resource requirements, resulting in a predominance of staff with backgrounds in geography and environmental studies rather than meteorology.
- The absence of a national institute or specialized center offering training in meteorology and climatology disciplines.
- A complete lack of a policy for the integration of technical personnel into DTM.

These issues collectively contribute to the challenges faced by DTM in fulfilling its responsibilities effectively.

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

DTM has participated in several international projects funded by various global organizations such as the World Bank Group, UNDP, Hydromet Alliance, CREWS, EU, ADRIFI, etc. Most of these projects are regional in nature and aim at disaster reduction and resilience (DRR).

Currently, several regional projects are in the implementation phase[11]:

- Climate Disaster Risk Management Project in Comoros (ADRIFI),
- Regional Climate Resilience Project (World Bank Group): This project includes components related to risk management, infrastructure and its sustainable management and social protection of resilient communities.
- Regional Hydromet Project: This project aims to strengthen regional resilience through improved meteorological, hydrological and climate services in the member countries of the Indian Ocean Commission.
- ER2C Project (UNDP): The objective of the project is to achieve a national paradigm shift in strengthening the climate change resilience of water supply by integrating systematic climate risk reduction approaches into the governance and provision of water resources, watersheds, water supply infrastructure and user management, including in planning, investment, design, operation and maintenance.

Regarding research and development, DTM's collaboration with universities is very limited. Joint research efforts are mostly reflected in a few master's or doctoral theses completed without any formal agreement between DTM and the universities. Improving these partnerships and formalizing collaborative agreements could significantly boost research output and innovation in meteorological services in Comoros.

Summary score and recommendations for Element 1:

The Union of the Comoros is assessed at **maturity level 2** on the CHD scale, reflecting "Ongoing efforts to formalize the mandate, introduce improved governance, management processes and address resource challenges."

This medium to low maturity level reflects the fact that DTM operates under a relatively weak legal mandate, positioned within an agency primarily focused on civil aviation and aviation safety through its seven functional directorates. It also reflects the absence of a strategic vision for the development of meteorology, the lack of adequate profile despite the large number of staff and specialized training in meteorological disciplines, the absence of a substantial budget to support the needs of the directorate, particularly in terms of maintaining its infrastructure and developing its information system.

To elevate the maturity level, finalizing the constitutive legislation for the meteorological authority must be an urgent priority. This could also be associated with the implementation of a national strategy for hydrometeorological forecasting and warning. Additionally, more formalized processes for budget and human resource management would be essential to enabling the Technical Directorate of Meteorology to effectively fulfil its legislative mandate and better serve national and regional needs.

[11] List provided by DTM

Element 2: Effective partnerships to improve service delivery.

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

The primary government partner of DTM is the General Directorate of Civil Security (DGSC), an entity responsible for handling both disaster response and prevention at the national level. In cases of disaster risk, a monitoring committee convenes to oversee the situation in real-time, operating 24/7. DTM is an integral member of the monitoring committee for cyclones and floods, providing meteorological monitoring of the phenomenon and regularly informing the committee on its developments.

DTM does not maintain a direct relationship with Comorian Radio and Television. However, in the event of a disaster risk (tsunami, cyclone or flood), Comorian Radio and Television broadcasts a news bulletin on the current phenomenon.

It is important to note that ANACM/DTM is not recognized as the meteorological authority according to ICAO (Annex 3), but it is partially involved in providing meteorological services for aviation through ASECNA. The aeronautical weather stations are managed by ASECNA; their data are transmitted to DTM for national use and dissemination to global systems.

The General Directorate of Water, Mines and Energy is an important partner of ANACM/DTM in the field of water resource management[12].

Other government partners frequently rely on DTM for its products and services, although these partnerships are not formalized through official agreements[13]:

- The Ministry of Agriculture has a partnership relationship with DTM, particularly with its agrometeorology department. In this context, an agricultural agent is attached to the agrometeorology department to participate in the implementation of specific products.
- The port authorities receive the daily bulletin summarizing the state of the sea to inform maritime navigation stakeholders and fishing boats.
- The National Water Exploitation and Distribution Company (SONEDE) benefits from the hydrometeorological services provided by DTM but does not contribute financially or otherwise to the management of hydrological measurement infrastructures.

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

DTM has few resources to create and maintain collaborative relationships with the private sector and research; but it does so occasionally, usually in the context of regional development projects.

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

There is strong evidence of international partnerships and support for DTM, particularly with organizations such as the Hydromet Alliance, CREWS/COI, and ADRIFI. These collaborations are generally focused on disaster risk reduction and enhancing resilience (see section 1.5).

[12] https://www.eau-comores.com/

[13] List provided by DTM

Regionally, DTM has established partnerships with several meteorological services, including Météo France (La Réunion), the General Directorate of Meteorology of Madagascar, and the South African Meteorological Service. Additionally, DTM collaborates with the wider Western Indian Ocean community and the World Meteorological Organization to maintain and enhance its meteorological services. These international and regional collaborations are vital in improving DTM's capacity to address meteorological challenges and contribute to global and regional efforts in climate and disaster resilience.

2.4. New or enhanced products, services, dissemination techniques, or new applications stemming from these relationships.

While DTM maintains an operational forecasting system, it faces significant challenges in developing new products or services that address the evolving needs of its partners and users. One major issue is the outdated data reception and processing system, installed under the PUMA project, which has been out of service for several years. As a result, forecasters rely on external weather websites that provide global forecasts for the western Indian Ocean region, particularly those from Météo France, the European Centre for Medium-Range Weather Forecasts (ECMWF), and regional platforms for southeast Africa.

Summary score, recommendations, and comments for Element 2:

The Union of the Comoros is assessed at **maturity level 3** on the CHD scale, which reflects "Moderately effective partnerships but generally considered the weakest partner in these relationships, with little influence on relevant funding initiatives."

This average maturity level is due to the absence of effective partnership agreements at the national level and the fact that most international funding for Comorian meteorology comes through regional projects, which often address regional needs rather than the specific local needs of the Comoros' meteorological services.

To further improve this level, it is recommended to:

- Implement a process for establishing effective partnerships at the national level.
- Adopt a more dynamic approach to participating in regional projects, ensuring that local needs are adequately addressed in these initiatives.

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.

The meteorological observation network of the Union of the Comoros includes[14]:

- **8 synoptic stations** measuring standard parameters (SLP, Temperature, Humidity, Wind, Precipitation), 3 of which are for aeronautical use.
- **6 agrometeorological stations** measuring, in addition to standard parameters, agrometeorology parameters such as the evapotranspiration rate,
- **19 rainfall stations** measuring standard parameters except for wind.

Except for the eight synoptic stations, all stations (agrometeorological and pluviometry) are of the same brand, with data collected and concentrated in a single data concentrator. However, the three surface stations declared for international data dissemination (Hahaya International Airport, Ouani, and Adda) frequently do not appear in the WIGOS Data Quality Monitoring System (WDQMS), indicating inconsistencies in data transmission. To address this, it is recommended to implement a transmission solution based on WIS2Box, which would enable the sharing of all observations with regional WIGOS centers, ensuring better integration and data quality monitoring within the global meteorological network.

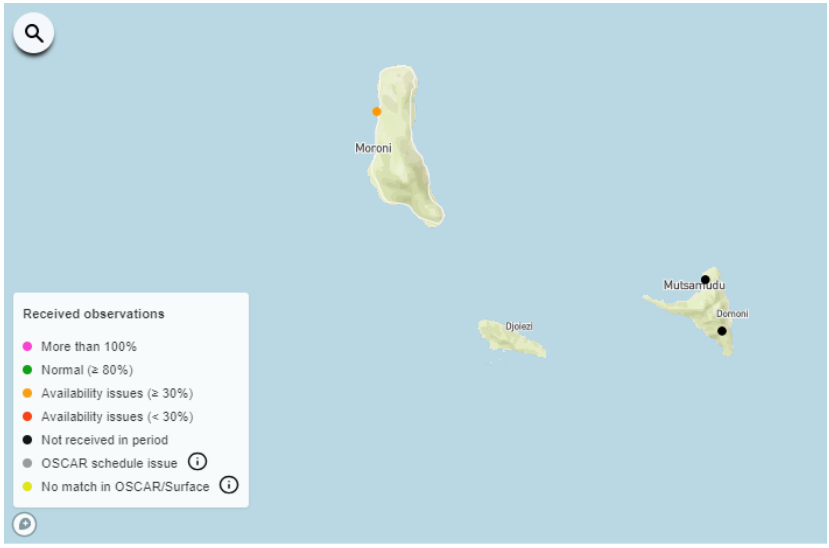

Figure 12. Surface observation availability check (source: WDQMS)

DTM does not have a high-altitude observation station. The nearest station is in Tananarive/Madagascar (about 500 km from Moroni)

3.2. Additional observations used for nowcasting and specialized purposes.

DTM currently lacks remote sensing infrastructure, including radar and lightning measurement systems, and, since the shutdown of its satellite reception system, it no longer has access to real-time satellite imagery.

Given its hydrological responsibilities, DTM has a set of piezometric sensors for measuring the height of the water in the wells operated by the water exploitation and distribution company (SNEDE). However, it does not have a sensor for measuring river levels or flow rates, which are critical for effective hydrological monitoring.

[14] Comoros - GBON-National-Gap-Analysis-Report

In terms of maritime responsibilities, DTM previously had a buoy and tide gauges for monitoring ocean conditions, but these instruments were either lost to the ocean or destroyed by cyclonic forces.

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

Given the lack of human and material resources, the maintenance and upkeep of observation and data processing systems is a recurring issue that directly affects the efficiency and lifespan of these systems. For example, automatic stations installed as part of international projects tend to break down two to three years after installation. DTM lacks the logistical resources to conduct regular visits and perform basic maintenance, which leads to the gradual degradation of the systems. Additionally, the observation systems are not calibrated at any point during their lifespan, from installation to the end of their use, further compromising their accuracy and functionality.

3.4 Implementation of sustainable newer approaches to observations.

To implement new sustainable approaches to meteorological and hydrological observations, the following components are recommended to be integrated into the project financing plan:

- **Maintenance Component**: This includes the recruitment of qualified human resources and systematic training on the newly acquired systems. Additionally, sustainable financial and logistical support should be ensured to enable travel to installation sites, along with the acquisition of the necessary tools and spare parts for ongoing maintenance.
- **Calibration Component**: Calibration should be conducted according to the sensor's frequency. This requires the recruitment and training of qualified personnel and may involve acquiring a mobile calibration laboratory or establishing service contracts with a qualified organization to ensure the sensors remain accurate and reliable.
- **Master Plan for Observation Development**: A comprehensive development plan should be established, including a policy for selecting observation sites. This policy should prioritize accessibility and the availability of necessary amenities to facilitate ongoing operation and maintenance.

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

The surface observation park consists exclusively of automatic stations.

Summary score, recommendations, and comments for Element 3:

The Union of the Comoros is assessed at **maturity level 2** on the CHD scale, reflecting "basic network, large gaps, mainly manual observations with serious challenges and data quality issues."

While the surface observation network consists exclusively of automatic stations, the challenges arise from inadequate maintenance, the absence of calibration, major issues with data concentration, and the complete lack of Comoros data within the WIGOS system. Moreover, the country lacks upper-air observations, marine observations, and remote sensing capabilities like radar or lightning detection systems.

The ambitions of DTM of the Union of the Comoros to expand and modernize its network reflect a strong commitment to improving climate resilience and enhancing the accuracy of national meteorological observations. Achieving a higher maturity level will not only help address existing deficiencies but also position DTM as a key player in regional weather forecasting and climate risk management. To realize this, the following key actions are recommended:

1. **Infrastructures modernization:**

- Upgrading of old stations and installation of marine observation systems (tide gauges, buoys, marine radars, etc.),
- Upgrading or renewing the existing observation data concentration system to effectively integrate all observation data.

2. Development of New Observation Systems:

- Implementation of a set of automatic or manual systems for measuring the water level in rivers, watercourses, the level and quality of water in drinking water wells;

3. Improvement of telecommunications infrastructures:

- The implementation of telecommunications solutions to concentrate all observation data, including the transmission of surface observations to WIGOS, taking advantage of technologies adapted to the country's context such as WIS2Box.

4. Care and Maintenance:

- Implementation of national maintenance covering both observation systems and processing systems and capable of ensuring regular maintenance of equipment, carrying out diagnostics and first-level interventions.

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 WMO Integrated Global Observing System (WIGOS) Regional Centers.

The Hahaya station, which is already affiliated with GBON, is in good condition but requires an upgrade to restore the regularity of its data transmission. Currently, DTMET has not yet taken advantage of the services offered by the WIGOS regional centers, particularly the data concentration capabilities through WIS2Box. Implementing this system would significantly improve data transmission and integration into the global network.

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

There is no formal data sharing policy in place.

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

The data reception and processing system, which was installed as part of the PUMA project, has been non-operational for several years. As a result, DTM forecasters rely on external sources for meteorological data. These include global weather websites that provide forecasts for the western Indian Ocean region, with key sources being Météo France and the European Centre for Medium-Range Weather Forecasts (ECMWF). Additionally, forecasters use regional platforms focused on southeast Africa.

Summary score, recommendations, and comments for Element 4:

The Union of the Comoros is assessed at **maturity level 1** on the CHD scale, reflecting "No observational data are shared internationally, either because they are not available to be shared, or because of the lack of data sharing policies or practices, or because the existing infrastructure does not allow data sharing."

This low maturity level is explained by the absence of Comorian data in international systems and the lack of capability to receive and process international data, including satellite imagery and model outputs.

To address these deficiencies and improve this maturity level, it is essential to implement technical solutions that allow for the reception and dissemination of data at the international level. The first step is to install a data reception and processing system capable of receiving and integrating satellite data and outputs from global and regional models. This system would enhance the analysis and utilization of critical information for weather forecasting and climate assessment.

Additionally, it is crucial to develop an effective telecommunications infrastructure to enable the transmission of surface observation data to WIGOS. The adoption of appropriate technologies, such as WIS2Box, could be particularly beneficial in ensuring that Comoros' meteorological data are shared effectively at the international level. This includes establishing data-sharing protocols that adhere to international standards, ensuring the availability and accessibility of data to partners and researchers worldwide.

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.

Since the shutdown of its PUMA system, DTM has been developing all its forecasts using maps provided by free websites. The forecasting relies on digital models generated by partner centers, including:

- RSMC, Pretoria
- CMRS, La Réunion – Météo France
- RIMES, Bangkok
- ECMWF (European Centre for Medium-Range Weather Forecasts)
- Regional Centers in Australia, Indonesia, and India, specifically for tsunami warnings.

Similarly, the satellite data are monitored directly via the EUMETSAT website, reflecting DTM's reliance on external sources for its meteorological and forecasting needs. This situation highlights the need for enhanced internal capacity to process and utilize data locally.

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

DTM has neither the capacity nor the resources to launch a local atmospheric model. Consideration is being given to launching a swell forecasting model project based on an Opensource.

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

DTM forecasters use the ensemble forecast outputs from the European Centre for Medium-Range Weather Forecasts (ECMWF) irregularly. To properly interpret these products, they require additional training and practical internships to enhance their understanding and usage of these advanced forecasting tools.

Summary score, recommendations, and comments for Element 5:

The Union of the Comoros is assessed at **maturity level 1** on the CHD scale, reflecting "Forecasts are based on conventional forecasting techniques without model guidance and cover only a limited forecast period."

This low maturity level is largely due to the lack of a system for receiving and processing international meteorological data, such as satellite imagery and model outputs. Although DTM benefits from weather maps available on various agencies' websites, this is no substitute for a dedicated visualization system capable of zooming in and interpolating data to address the specific needs of the small islands within the Comorian archipelago. To elevate the maturity level of hydrometeorological services in the Comoros, it is crucial to implement a system for receiving and visualizing international meteorological data, including satellite and numerical model outputs. This system will allow for more detailed, accurate forecasts tailored to the archipelago's unique geographic characteristics.

Additionally, training forecasters in the use of these new digital tools and satellite data is vital to improving the efficiency and precision of forecasts. This training will strengthen local capacity and enhance the use of numerical models in weather prediction. Moreover, it is essential to encourage the development of new hydrometeorological products and services that address the specific needs of various socio-economic sectors, such as agriculture, fisheries, maritime transport, and water resources management.

Finally, establishing partnerships with international organizations and meteorological agencies will be key to leveraging their expertise and securing the necessary support for the implementation and operation of the new systems. These steps will contribute to enhancing the Comoros' ability to provide high-quality meteorological services and bolster the country's resilience to climate impacts.

Element 6: Warning and advisory services

6.1. Warning and alert service cover 24/7.

DTM plays a crucial role in the management of weather alerts in the Comoros; it is responsible for producing short, medium and long-term weather forecasts. Although DTM does not have a 24/7 alert service, the forecast service provides a monitoring protocol for the production and monitoring of alerts in the event of extreme weather phenomena such as tropical storms, cyclones and heavy rain. This monitoring protocol is triggered if an extreme weather phenomenon is forecast in the next 72 hours. This protocol begins with the production of a descriptive note of the phenomenon and makes it available to the DGSC, which is ready to trigger the holding of the vigilance cell. If the phenomenon becomes more likely, the forecast service issues an alert, and the vigilance cell begins its work[15].

The DGSC is the sole recipient of the weather alert and is the only one authorized to communicate via Radio and Television about the phenomenon and its impact on the country. The warnings issued cover a wide range of phenomena: tropical storms, cyclones, heavy rains, and strong winds. Marine warnings cover strong swells, exceptional high tides and dangerous conditions for navigation, as well as tsunami warnings[16].

The alert process within DTM has traditionally relied on an observation network to monitor weather phenomena by measuring key meteorological parameters, alongside a system for receiving and visualizing satellite data and outputs from numerical models. However, the data reception and processing system, initially installed through the PUMA project, has been non-operational for several years. As a result, forecasters must rely on external meteorological websites, such as Météo France and the European Centre for Medium-Range Weather Forecasts (ECMWF), which provide global forecasts for the western Indian Ocean region, as well as on regional platforms.

The quality of the alerts issued by DTM is further impacted by the absence of essential remote sensing systems (such as radar and lightning detection), which play a critical role in enhancing short-term forecasting capabilities.

Moreover, the lack of qualified human resources and the ongoing need for training to keep pace with technological advancements and new climate challenges remain significant barriers. These challenges impede DTM's ability to develop more effective and timely alerts for natural risks.

In conclusion, while DTM plays a crucial role in managing natural hazards and issuing alerts, it faces several structural challenges that limit its development. To enhance its effectiveness, continuous investment in technological infrastructure, comprehensive training and supervision of personnel, and stronger regional and international cooperation are essential. These improvements will be crucial for strengthening the efficiency and accuracy of DTM's services, ultimately enabling it to better protect the Comorian population from weather-related risks.

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

The Union of the Comoros is particularly vulnerable to various hydrometeorological hazards, necessitating a robust disaster risk management system to minimize the impacts on both the population and the environment. Decree No. 12-18/PR, which established the National Platform for Disaster Risk Prevention and Reduction (PNPRRC), provided a solid framework for managing risks and coordinating related actions among

[15] https://drmims.sadc.int/sites/default/files/document/2020-03/Plan_Contingence_Comores_2017-2018.pdf
[16] https://drmims.sadc.int/sites/default/files/document/2020-03/Plan_Contingence_Comores_2017-2018.pdf

the various stakeholders. This platform includes national, regional, and local authorities to ensure monitoring and action at all levels.

Moreover, the Union of the Comoros has benefited from multiple international funding initiatives as part of global efforts for disaster risk reduction and resilience. These include funding for the development of the **National Disaster Risk Reduction Strategy in 2014,** its update in 2022, and financing for the creation of **disaster risk profiles for the Comoros**, particularly focusing on the three main hazards: floods, tropical cyclones, and earthquakes. These efforts underscore the need for continuous support in enhancing the country's disaster management capabilities and resilience.

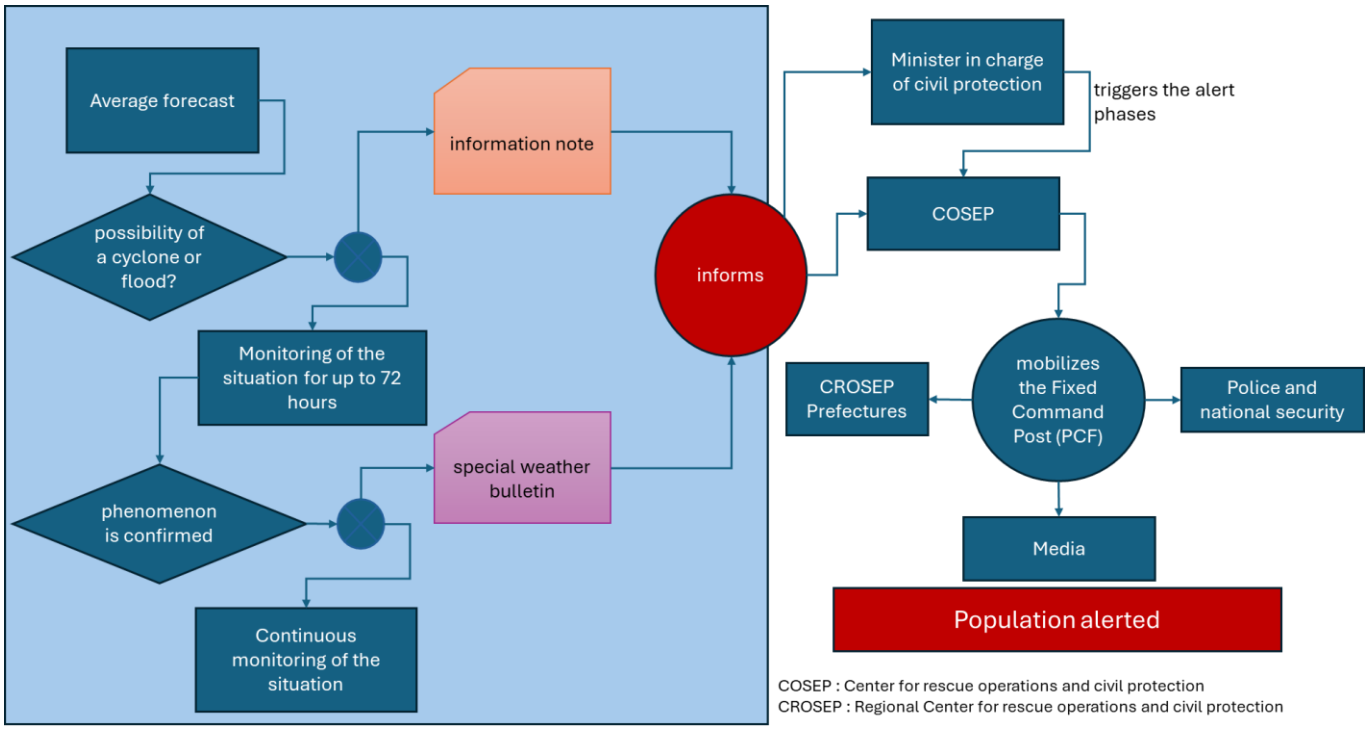

Figure 13. Hydrometeorological disaster risk management device

The legislative framework and strategic studies outline the roles and responsibilities of each stakeholder. The Technical Directorate of Meteorology (DTM) plays a crucial role in forecasting risks related to floods and tropical cyclones, describing the extent, intensity, and duration of the phenomenon from its onset to its dissipation. The responsibility for information and communication, however, is exclusively handled by the Directorate General of Civil Security (DGSC). The DGSC collects information from various stakeholders and disseminates it in the form of official communications, then gathers feedback from stakeholders, NGOs, and the public[17].

[17] https://www.facebook.com/DGS2Comores

UNION DES COMORES

Unité - Solidarité – Développement

MINISTERE DE L'INTERIEUR, DE L'INFORMATION, DE LA DECENTRALISATION, ET DE L'ADMINISTRATION TERRITORIALE, CHARGE DES RELATIONS AVEC LES INSTITUTIONS

DIRECTION GENERALE DE LA SECURITE CIVILE

Le Directeur Général,
N° 24-89/DGSC-DG

Moroni, le 04 Mai 2024

COMMUNIQUE N°06

L'Union des Comores a levé son alerte vigilance cyclonique. Malgré cela, la tempête tropicale HIDAYA continue de gagner en intensité, devenant une forte tempête tropicale, située à plus de 600 km au nord-ouest des Comores et se dirigeant vers la Tanzanie à moins de 50 km.

La DGSC demande à la population d'être à l'écoute des annonces officielles et la remercie pour sa disponibilité et son soutien communautaire.

UNION DES COMORES

Unité - Solidarité – Développement

MINISTERE DE L'INTERIEUR, DE L'INFORMATION, DE LA DECENTRALISATION, ET DE L'ADMINISTRATION TERRITORIALE, CHARGE DES RELATIONS AVEC LES INSTITUTIONS

DIRECTION GENERALE DE LA SECURITE CIVILE

Moroni, le 04 mai 2024

Le Directeur Général,
N°-24-89/DGSC-DG

COMMUNIQUE N°5

Les prévisions météorologiques annoncent qu' à partir du 04 Mai 2024 à 03h00 locale, le pays sentira une forte tempête tropicale à une distance de 490 km au Nord Nord-Ouest de Ngazidja.

Les prévisions du 04 Mai 2024 à15h00 locale annonce une Tempête tropicale Modérée à 603 km au Nord-Ouest de Ngazidja (près de la Tanzanie).

Les impacts HIDAYA se sentiront de moins en moins le 04 Mai 2024 dans l'ensemble de l'archipel. Cette nuit sera pluvieuse dans l'ensemble de l'archipel. Nous appelons la population à être vigilante et à réduire tout déplacement inutile et restez à l'écoute des annonces des services météorologiques.

La Direction Générale de la Sécurité Civile recommande la Vigilance cyclonique.

UNION DES COMORES

Unité - Solidarité - Développement

MINISTERE DE L'INTERIEUR, DE L'INFORMATION, DE LA DECENTRALISATION, ET DE L'ADMINISTRATION TERRITORIALE, CHARGE DES RELATIONS AVEC LES INSTITUTIONS

DIRECTION GENERALE DE LA SECURITE CIVILE

Le Directeur Général,
N° 24-[illegible]DGSC-DG

Moroni, le 23 Mai 2024

COMMUNIQUE

Un vent fort de Sud-Est souffle sur l'archipel avec des vitesses dépassant 30 km/h et des rafales atteignant 46 km/h, compliquant l'atterrissage des avions à l'AIMPSI le 22 mai 2024. Pour le 23 mai, des vents similaires sont prévus avec des rafales de plus de 40 km/h, surtout le matin. La chance de pluie est faible et la température maximale atteindra 30°C. Le temps sera venteux avec peu de nuages et une bonne visibilité, mais une attention particulière est recommandée pour les vols inter Îles Anjouan et Mohéli. Suivez les mises à jour pour garantir la sécurité des vols.

Pour toute information, restez à l'écoute des annonces officielles de la Direction Générale de la Sécurité Civile.

Figure 14. Examples of Early and End Alert Notice

The disaster risk management cycle, as defined in the national strategy, provides a comprehensive framework for planning and responding to extreme events.

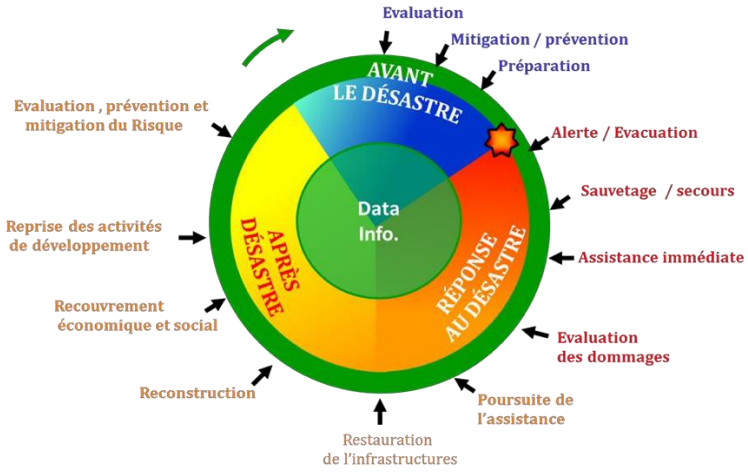

Figure 15. Disaster Risk Management Cycle. Source: SNRRC

Disaster Risk Management Cycle[18]:

The disaster risk management cycle, depicted in Figure 15, is an integrated framework that encompasses several key phases: pre-disaster, disaster response, and post-disaster. The goal of this cycle is to minimize the impacts of natural disasters through coordinated actions in prevention, preparedness, response, and recovery.

- **Pre-Disaster**: This phase focuses on risk assessment, prevention, and mitigation. Vulnerable areas are identified, and risk reduction strategies are implemented. Preparedness efforts include developing contingency plans and raising awareness within communities about potential risks and responses.
- **Disaster Response**: When a disaster occurs, this phase involves rapid warning, evacuation, followed by rescue, relief, and immediate assistance. Damage assessments are carried out to determine the most urgent needs for affected populations.
- **Post-Disaster**: After the disaster, the focus shifts to recovery, including the resumption of development activities, economic and social recovery, and the rebuilding of infrastructure. This phase

[18] https://drmims.sadc.int/sites/default/files/document/2020-03/Plan_Contingence_Comores_2017-2018.pdf

also involves continuous evaluation and improvement of risk management strategies to enhance future resilience.

In conclusion, while hydrometeorological disaster risk management has been recognized in Comorian legislation and supported through international investment projects, and although strategic studies have identified and highlighted the weak points in Comorian meteorology, the Technical Directorate of Meteorology (DTM) has not received the special attention or funding needed for major structural improvements. There is a lack of the necessary legal framework and financial support to address critical challenges such as:

- **Human resources**: Recruitment of suitable personnel, ongoing training, and professional development.
- **Financial resources**: Proper functioning of services, including infrastructure maintenance and calibration of measurement systems.

To fully realize the potential of the disaster risk management cycle, it is crucial that DTM is prioritized for funding and capacity-building efforts to enhance its ability to safeguard the population and support long-term climate resilience.

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.

The risk profiling study conducted as part of the Southwest Indian Ocean Risk Assessment and Financing Initiative has mapped the risks and their impacts on the population and the country's wealth and defined the areas most exposed to floods and tropical cyclones[19].

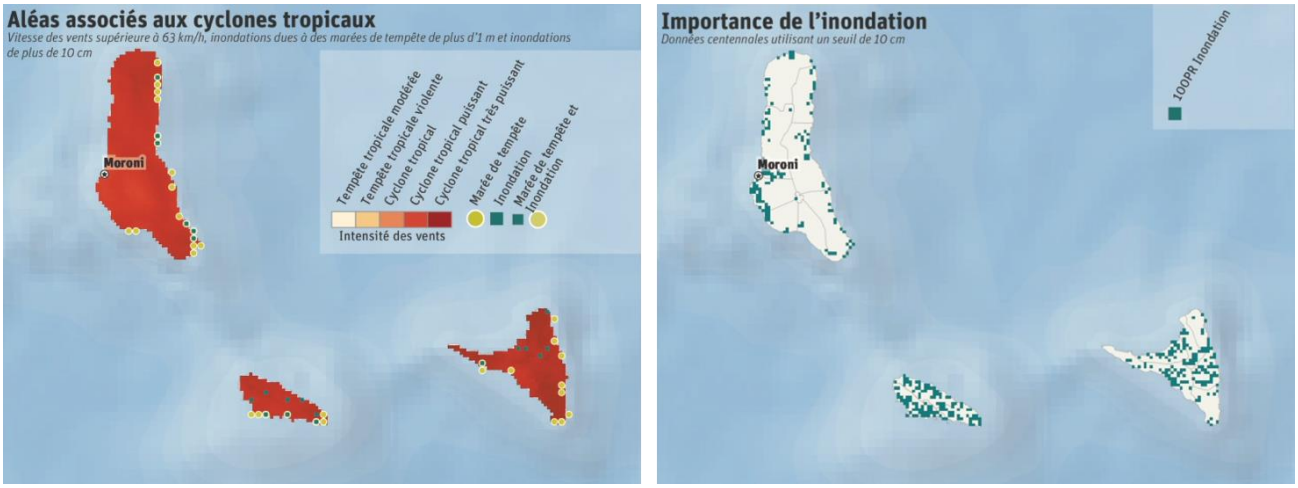

Figure 16. Tropical Cyclone and Flood Impact Maps

[19] https://www.gfdrr.org/sites/default/files/publication/dra_comores_fr.pdf

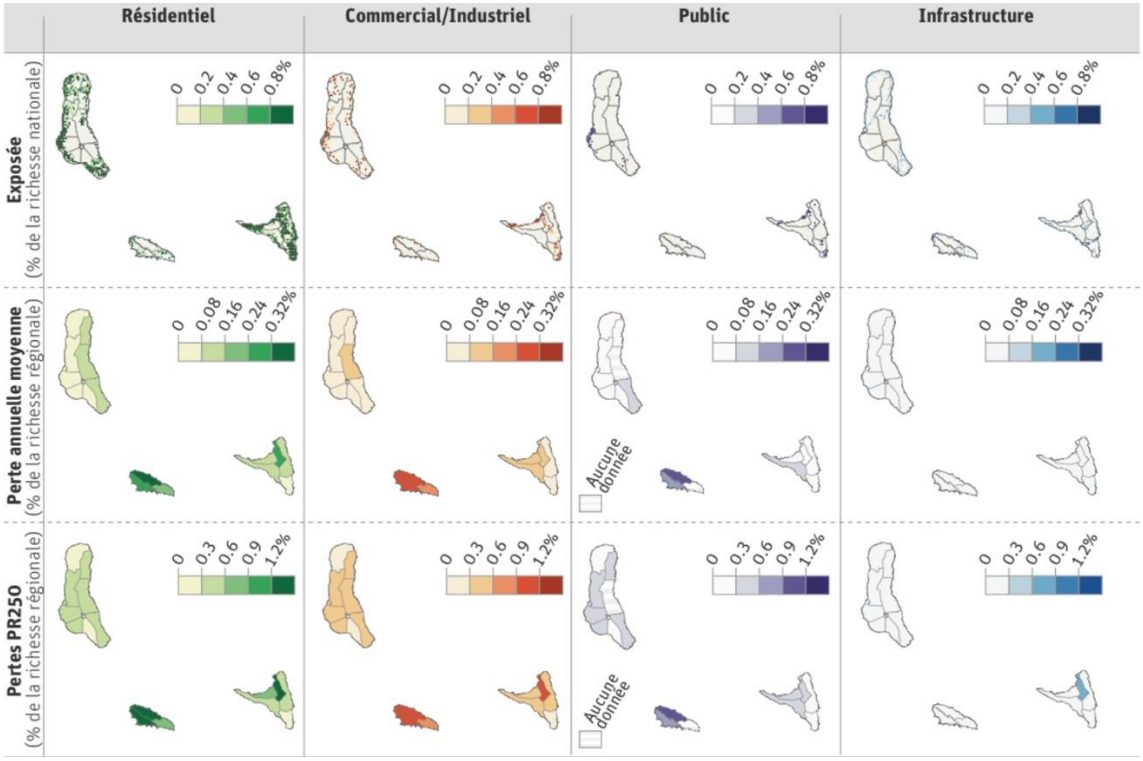

Figure 17. Tropical cyclone impact zones (source: Comoros Disaster Profile)

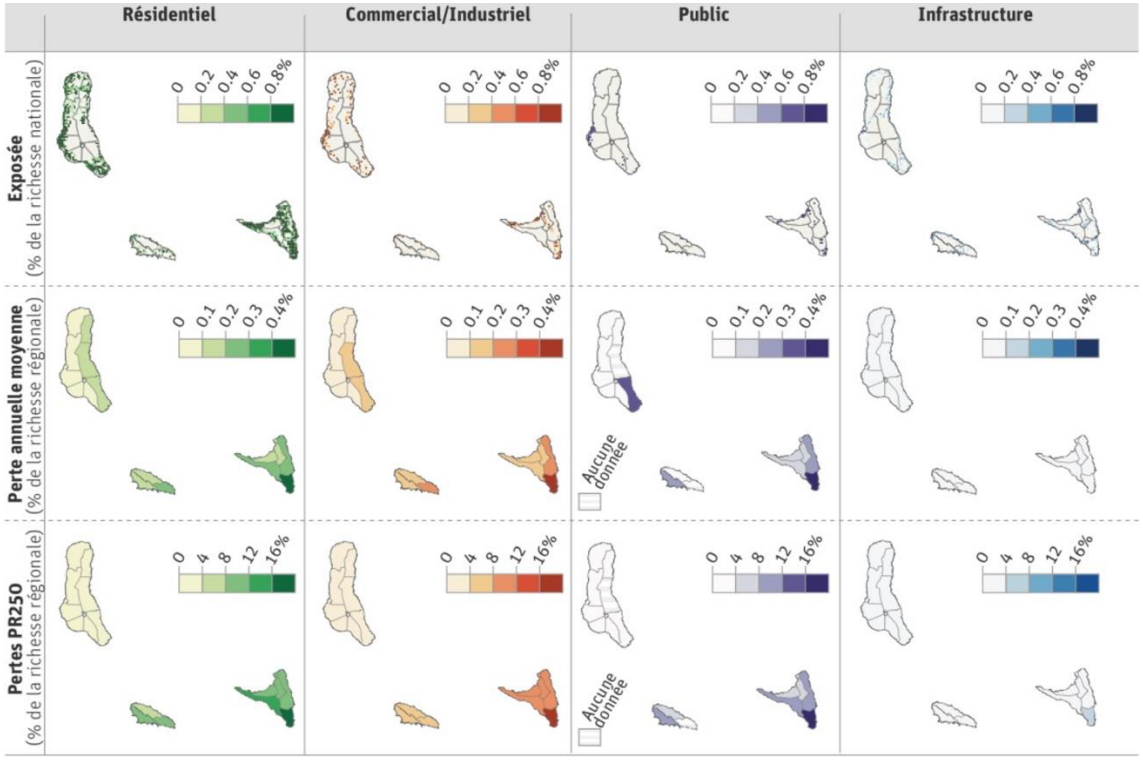

Figure 18. Flood impact zones (source: Comoros Disaster Profile)

In conclusion, despite efforts to enhance disaster risk management through the organization of processes and the identification of disaster risk profiles, the Technical Directorate of Meteorology (DTM) remains significantly behind in adopting an impact-based alert preparation approach. Many technicians, including department heads, are not familiar with the findings of these strategic studies and continue to develop their products independently, without aligning them with the outcomes of these studies. However, the vigilance committee within the national risk management platform does conduct thorough analyses of disaster risks and their probable impacts. Based on this information, the committee develops alert bulletins, integrating

appropriate instructions for the population and economic actors. This disconnect highlights the need for stronger integration between DTM's forecasting efforts and the broader impact-based disaster preparedness strategies led by the vigilance committee to ensure a more cohesive and effective risk management system in the Comoros.

Summary score, recommendations, and comments for Element 6:

The Union of the Comoros is assessed at **maturity level 3** on the CHD scale, reflecting "Weather warning service with modest public outreach and informal engagement with relevant institutions, including disaster management agencies." While the Technical Directorate of Meteorology (DTM) is an integral member of the Disaster Risk Management Platform, this intermediate maturity level reflects certain limitations. DTM is not highly visible in the public sphere, as the Directorate General of Civil Security (DGSC) is responsible for monitoring disasters and communicating about related phenomena through official press releases. This situation reduces DTM's direct engagement with the public regarding hazardous weather events.

Additionally, the lack of budget and qualified human resources further limits DTM's capacity to play a leading role in decision-making regarding impacts or in communicating directly about dangerous phenomena. These challenges prevent DTM from being at the forefront of disaster communication, both in terms of informing the public and coordinating with other agencies to minimize risks. To improve its maturity level, DTM would require enhanced funding, capacity building, and a more defined role in public and institutional outreach.

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.

Climate change governance in the Union of the Comoros falls under the responsibility of the Ministry of the Environment, which implements the guidelines of the United Nations Framework Convention on Climate Change (UNFCCC). The administrative body for environmental management is the General Directorate of the Environment and Forests. It works closely with other state institutions including the Ministry of Finance, the General Planning Commission, the Technical Directorate of Meteorology, the General Directorate of Health, the General Directorate of Civil Security, the General Directorate of Water, Mines and Energy, the National Directorate of Agriculture and Livestock, the General Directorate of Fisheries Resources, the National Center for Documentation and Scientific Research, the National Research Institute for Agriculture, Fisheries and the Environment, NGOs, civil society and the private sector[20].

Although the Technical Directorate of Meteorology is a key player in this governance due to its responsibility for collecting and processing climatological data and safeguarding them as national heritage and due to its participation in the implementation of the directives of the United Nations Framework Convention, the lack of vision and resources does not allow it to live up to its responsibilities for safeguarding climatological heritage. The climatological database suffers from multiple issues that undermine the reliability and continuity of data series:

- DTM does not maintain a structured climatological database. Instead, data are dispersed across Excel files stored on various personal computers within the Climatology Service.
- Old data were destroyed due to adverse weather conditions, and the small amount of data that has been recovered is unreliable, making it impossible to accurately calculate the climatological statistical normals for different measurement stations.

Summary score, recommendations, and comments for Element 7:

The Union of the Comoros is assessed at **maturity level 3** on the CHD scale, reflecting "Essential capacities for the provision of climate services."

Although the Technical Directorate of Meteorology in the Comoros has implemented basic systems for delivering climate services, significant improvements are needed in several critical areas to enhance the effectiveness and impact of these services. One of the most urgent needs is the establishment of a structured and reliable climatological database. Strengthening this area is crucial to ensuring that climate data is well-organized, accurate, and accessible for informed decision-making.

[20] Excerpt from the third national communication on climate change to the Union of the Comoros

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.

The water sector in the Union of the Comoros is managed by various government stakeholders, including the Ministry of Agriculture, Fisheries, Environment, Tourism, and Handicrafts and the Ministry of Energy, Water, and Hydrocarbons through the General Directorate of Water, Mines, and Energy.

A study conducted in 2023, titled "Strengthening the Climate Resilience of Drinking Water Supply and Irrigation in 15 of the Areas Most Exposed to Climate Change Risks in the Union of the Comoros," was overseen by the Ministry of Agriculture. This study laid the groundwork for water resource management and identified key stakeholders within the sector. However, it limited the role of the Technical Directorate of Meteorology (DTM) to providing precipitation observations, excluding its involvement in hydrometeorological studies and research.

The platform https://www.eau-comores.com/, managed by the Ministry of Energy, Water, and Hydrocarbons through the General Directorate of Water, serves as a space for discussions on water management in the context of climate change. It recognizes the Technical Directorate of Meteorology and SONEDE as the primary partners in the water sector[21].

It is evident that the water sector would benefit from the establishment of a national water resources planning commission. This commission, under the aegis of the Ministry responsible for water, would ensure the coordination of all stakeholders, clearly defining their roles and contributions to integrated water resources management[22]. Furthermore, the contribution of the Technical Directorate of Meteorology of Comoros to hydrology is essential for water resources management and flood risk forecasting, particularly in arid areas subject to heavy rainfall. Meteorological services play a crucial role in providing products such as quantitative precipitation estimation (QPE) and hydrological forecasts. These products are generated to meet specific needs of the hydrological community; however, their quality is constrained by the unavailability of model outputs with appropriate resolution. Currently, the estimates provided are mainly qualitative, which limits their accuracy for detailed hydrological applications. Additionally, the absence of a weather radar significantly hampers the precision of precipitation estimates, which could otherwise benefit from improved spatial coverage and finer resolution.

Moreover, the lack of a system for monitoring the impacts of heavy rainfall on river and stream flows limits the authorities' ability to anticipate and effectively manage potential floods. The Technical Directorate of Meteorology currently does not provide standardized hydrological data in a systematic manner to the hydrological community. This is mainly due to the lack of formal structures for the collection and sharing of hydrological data. The future of meteorological and hydrological services in Comoros will largely depend on the ability to strengthen observation infrastructure, improve hydrological forecasting systems, and establish strong partnerships with water sector stakeholders such as the Ministry of Agriculture and the Ministry of Energy, Water and Hydrocarbons.

[21] https://www.eau-comores.com/

[22] Excerpt from the study on “strengthening the climate resilience of drinking water supply and irrigation” in 15 of the areas most exposed to risks related to climate change in the Union of the Comoros.

In conclusion, the current contribution of meteorological services to hydrology requires significant improvements to fully meet the needs of the hydrological community. Increasing technical capacities, improving observation infrastructures, and strengthening inter-institutional collaboration are crucial steps to ensure effective water resources management and improving flood risk forecasting in the Union of the Comoros.

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

There is currently no Standard Operating Procedure (SOP) that formalizes the relationship between the Technical Directorate of Meteorology and stakeholders in the water sector.

While the relationship with SONEDE could be formalized through an SOP, the core issue in the water sector lies in the absence of a national body that organizes and unifies the sector.

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

DTM has yet to establish a formal agreement with stakeholders in the water sector or with international entities for the sharing of hydrological data. The implementation of such agreements is essential to ensure that critical data is available and accessible to relevant stakeholders, particularly for the purposes of water resource planning and management.

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

The 2023 study on "Strengthening the Climate Resilience of Drinking Water Supply and Irrigation in 15 Areas Most Exposed to Climate Change Risks in the Union of the Comoros", carried out under the supervision of the Ministry of Agriculture, alongside the https://www.eau-comores.com/ platform administered by the Ministry of Energy, Water, and Hydrocarbons, demonstrates significant dynamism in the water sector.

However, the role of the Technical Directorate of Meteorology in this sector remains limited to the provision of precipitation observations, without extending to broader hydrometeorological studies or research. This narrow scope means that DTM's full potential in supporting water resource management and climate resilience efforts remains untapped, especially in key areas like hydrological forecasting, flood risk assessment, and integrated water resource management.

Summary score, recommendations, and comments for Element 8:

The Union of the Comoros is assessed at **maturity level 2** on the CHD scale, reflecting "Meteorological inputs to hydrology and water resources management are provided on an ad hoc and/or disaster basis."

One of the most critical steps in improving this sector is the formalization of a national body that can organize and unify the various stakeholders in water resources management. Such a body would enable better coordination and preparedness for extreme weather events by ensuring a more integrated approach to hydrometeorological services. Establishing data sharing agreements, developing joint projects, and increasing technical and financial capacity are essential measures to build robust and resilient hydrometeorological cooperation. These actions will significantly strengthen the ability of the Comoros to manage its water resources effectively, ensuring better preparedness and response to extreme weather events while improving the overall resilience of its hydrometeorological services.

Element 9: Product dissemination and outreach

9.1. Channels used for user-centered communication and capacity to support these channels (e.g., does the NMHS operate its own television, video, or audio production facilities? Does it effectively use advanced techniques?).

DTM previously had its own video recording equipment for the national television, but due to a lack of maintenance, this equipment is no longer operational.

Currently, the daily weather bulletin is not broadcast on Comorian Radio or Television. However, in the event of a disaster risk (such as a tsunami, cyclone, or flood), Comorian Radio and Television broadcast information bulletins issued by the National Disaster Risk Management Platform. At present, the only channel for disseminating meteorological information to the public is the Facebook page of the Technical Directorate of Meteorology.

9.2. Education and awareness initiatives in place.

Educational resources exist and DTM engages, as far as possible, in relevant projects and initiatives.
Irregular school visits are organized on DTM site in Moroni. However, due to lack of resources, DTM does not have didactic resources that serve to introduce students to key ideas on weather and climate and show the importance of the role of national meteorology. Additionally, public education is conducted through DTM's Facebook page, which serves as the primary platform for disseminating information about weather, climate, and the importance of meteorological services.

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

DTM is not directly responsible for informing the population during disasters. This responsibility lies with the DGSC, the entity in charge of both disaster response and prevention at the national level. The DGSC takes measures, to the extent possible, to reach marginalized communities and indigenous populations, ensuring that crucial information is communicated effectively.
Furthermore, the "Communication and Awareness Strategy for Disaster Risk Reduction for Comoros, Madagascar, Mauritius, Seychelles"[23], developed by UNDRR, serves as a regional strategic framework. This strategy outlines the communication styles and tools required for effective disaster risk reduction (DRR) communication across the region.
The "Action Plan for Disaster Risk Reduction (DRR) in the Union of the Comoros"[24] further defines the specific types of disasters and the corresponding actions that must be taken for each. It also specifies the awareness-raising roles of key stakeholders, including the DGSC and the Technical Directorate of Meteorology, highlighting the importance of collaboration in educating the public and ensuring preparedness for various disaster scenarios.

Summary score, recommendations, and comments for Element 9:

The Union of the Comoros is assessed at **maturity level 1** on the CHD scale, reflecting "Dissemination using only limited traditional channels such as daily newspapers and the national channel and with little control over the message and/or format."

This low maturity level highlights the significant challenges faced by DTM in communicating weather-related information to the public. DTM does not have a dedicated website to share its data, nor does it have regular access to national media outlets. Meteorological information is only broadcast on Comorian Radio and Television when there is a risk of a hydrometeorological disaster. Even in these cases, the information is included as part of a DGSC press release, which combines meteorological details with information on probable impacts and instructions for the population.

[23] https://www.undrr.org/media/95466/download
[24] https://drmims.sadc.int/sites/default/files/document/2020-03/Plan%20d%27action%20RRC.pdf

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.

DTM currently lacks a formalized platform for interacting with users to co-design and improve its services. While there is an internal project aimed at developing an interactive website to facilitate engagement, this initiative is still in the reflection phase. The project faces significant challenges, primarily due to a lack of budget and specialized human resources. These constraints hold DTM's ability to move forward with the development and implementation of a user-centric platform, which is essential for enhancing service delivery and ensuring that user needs are met effectively.

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

At present, DTM does not conduct any independent user satisfaction surveys. The only existing feedback mechanism relies on comments collected through DTM's Facebook account, but these comments are not systematically processed or analyzed to inform service improvements. This lack of formal feedback collection and analysis limits DTM's ability to gauge user satisfaction effectively or to use such insights to enhance its services.

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

The ANACM organization chart includes a Safety and Quality Unit that reports directly to the Director General and is responsible for managing the Agency's Quality Management System (QMS). This unit primarily focuses on activities related to air transport and air safety. However, meteorological services provided by the Technical Directorate of Meteorology are not yet integrated into this QMS, and the process-based approach to quality management has not been implemented within DTM.

Despite this, the presence of a well-established Quality Unit within ANACM and its experience in applying and controlling quality standards in the aeronautics sector will be a significant advantage for the future integration of DTM into the QMS. Leveraging this experience will support the development of quality management processes for meteorology, ensuring that DTM can meet key user needs and promote continuous improvement in its services.

Summary score, recommendations, and comments for Element 10:

The Union of the Comoros is assessed at **maturity level 1** on the CHD scale, reflecting "Service development relies on informal input and feedback from stakeholders."

Currently, the Technical Directorate of Meteorology (DTM) lacks a formal communication mechanism to engage with users, and no independent user satisfaction surveys are conducted. The only feedback mechanism in place is informal, based on comments collected through DTM's Facebook page, with no systematic processing or analysis of this input.

Annex 1: Consultations (including experts and stakeholder consultations)

The following stakeholders were consulted, directly or indirectly:

- Ministry of Maritime and Air Transport, Ministry of Agriculture, Ministry of National Education,
- National Company responsible for the Exploitation and Distribution of Water (*SONEDE-Comores*)
- Indian Ocean Commission and CREWS East Africa project was consulted on planned activities and investment planning in the Comoros.
- WMO was consulted on WISBOX-WIS2.0 and WDQMS.
- ASECNA
- ANACM (Aviation)

Annex 2: Urgent Needs reported

The ongoing development of DTM could be steered by a strategic plan that considers the broader national context, specifically the meteorological sector, and seeks to address the expectations of key stakeholders. These include the General Directorate of National Civil Security, which oversees the Disaster Risk Management platform, as well as the country's economic actors and decision-makers. The plan would aim to enhance DTM's role in protecting lives and property while aligning with national priorities.

The suggested priorities that could be considered in this context include:

- The development of the legislative framework governing the meteorological authority in the Comoros and the implementation of a national strategy for hydrometeorological forecasting and warning considering the recommendations of the "National Strategy for Disaster Reduction and Resilience" (SNRRC) and the guidelines of the "Multi-hazard Early Warning for All" Action Plan for Africa 2023-2027.
- Enhance the DTM team by adding qualified personnel in meteorology, climatology, and information technology, as well as in software and hardware maintenance (both engineers and technicians).
- Establishing an effective partnership-building process at the national level and adopting a proactive approach to participation in regional projects.
- The creation of a mechanism to promote and market DTM's weather and climate services, aimed at fostering the ongoing growth of public and private partnerships while developing innovative products and services.
- Enhancing meteorological observation systems and operationalizing oceanographic observations by upgrading or replacing aeronautical and automatic weather stations, installing marine observation systems (such as tide gauges, buoys, current meters, and marine radar), and upgrading or renewing the existing data concentration system to integrate all observation data
- Enhancing hydrological observation systems by implementing a range of automatic or manual systems to measure water levels in rivers and streams, as well as monitoring the level and quality of water in drinking wells
- Enhancing telecommunications infrastructure to consolidate all observation data, including the transmission of surface observations using technologies adapted to the national context, such as WIS2Box.
- Implementing a national maintenance program that covers both observation and processing systems, ensuring regular upkeep of equipment, performing diagnostics, and conducting first-level maintenance interventions.
- Establishing and operationalizing a database (meteorological, climatological, and hydrological) designed to meet the needs of DTM and its partners
- Establishing a system for receiving satellite products, outputs from global and regional models, and observation data from the area of interest, along with a data visualization system to integrate and process various data types.

- Strengthening capacities across all areas of DTM operations, including basic educational training and professional training.

The General Directorate of Meteorology of Morocco (GDM), as SOFF peer advisor to the ANACM/DTM, is committed to supporting the ANACM/DTM in strategic and operational development and the modernization of its systems.

Annex 3 Information supplied through WMO

The GDM peer advisor recognizes the reference lists provided by the SOFF in the orientation guides and models. These documents served well throughout the preparation phase of this mission and particularly the information and advice given in the CHD data inventory and in the review sheet for the Union of the Comoros:

- SOFF Operational Guidance Handbook
- WMO Community Platform country profile information (for Union of Comoros)
- WIGOS Data Quality Monitoring System: https://wdqms.wmo.int/
- CHD -Early Warning for All - Datasheet for Comoros

Annex 4 List of materials used

The peer adviser GDM utilized the following materials:

- Materials and documents provided by ANACM/DTM or downloaded directly from web site:
  - Civile Aviation Code: order N°19-024/MTMA of the Minister of Maritime and Air Transport
  - Water Code: Law n°94-037 of December 21, 1994 - relating to the Water Code
- Online material included as references to this document and Web pages of different departments related to meteorology, hydrology and civile security.
- Reflections and contributions to resilience and disaster reduction projects such as:
  - Proposal for a National Disaster Risk Reduction Strategy in the Comoros,
  - Third National Communication on Climate Change – 2023
  - National Determined Contribution – Summary Report 2021-2023
- Results and data from the workshops and interviews with the various actors of the ANACM (including DTM staff) and personal communication and reflections provided during the drafting of this report.

Photos : GDM's experts meeting and working sessions with DTM's personnel in Moroni - Comoros