



Somalia Hydro-met Operation and Maintenance Plan



August 2024

EXECUTIVE SUMMARY

This Operations and Maintenance (O&M) Plan outlines the strategies and procedures for the sustainable management of Somalia's National Hydromet System. Given the critical role of hydromet services in addressing the country's vulnerability to extreme weather events, such as droughts and floods, ensuring the optimal performance and longevity of hydromet infrastructure is paramount. This plan focuses on the effective operation and maintenance of meteorological and hydrological stations, data communication networks, and related equipment to guarantee the continuous collection, processing, and dissemination of high-quality hydromet data for informed decision-making in sectors such as agriculture, disaster management, water resources, management, humanitarian support services, and livelihood enhancement initiatives.

The plan prioritizes capacity building, technology enhancement, and robust quality control to improve data accuracy and timeliness. By establishing clear responsibilities, implementing effective monitoring and evaluation mechanisms, and fostering collaboration with stakeholders, this O&M plan contributes to building a resilient hydromet system capable of supporting Somalia's development goals.

The plan encompasses technical and institutional guidelines and measures for management of structures and procedures for operating, maintaining, and improving Somalia's Hydromet infrastructure. It also presents the necessary capacities to enhance the operational accuracy and precision in data gathering, compilation, analysis, manipulation, and dissemination of outputs. It provides guidance on the systematic upkeep, calibration, quality control and assurance, as well as the strategies to be implemented for emergency response, to ensure equipment's sustained functionality, accuracy of data, and enhanced reliability of operations.

As part of ongoing capacity building efforts, personnel competences will be enhanced, and service delivery will be maintained. The plan guides allocation of resources for either updating the technological systems or maintaining the equipment and personnel operation. Accountability mechanisms are established to monitor and improve the performance of hydromet service delivery over time. This will be achieved through the creation of monitoring and assessment and evaluation tools.

Compliance with national and international standards displays Hydroem's dedication to upholding integrity and ensuring operational safety. Implementing effective communication and outreach methods will enhance public confidence and engagement, ultimately contributing to the increased relevance of Hydromet services in Somalia. This, in turn, would promote resilience and sustainable development in the country.

The plan is therefore a strategic approach to enhance the reliability, responsiveness, and effectiveness of Somalia's Hydromet system in addressing the country's environmental, economic, and livelihood challenges.

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1.0 INTRODUCTION

1.1 Background

Hydrology and meteorology (Hydromet) are critical components of Somalia, which is heavily exposed to the adversities of extreme weather conditions. Hydromet services comprise all actions and tactics aimed at assessing, controlling, and predicting meteorological occurrences, water regimes, and climate change. These services are critical for promoting various sectors, including agriculture, water and mutual resources, disaster preparedness, and public security.

Federal State with six member states including Galmudug, Hirshabelle, Jubaland, Puntland, Somaliland and Southwest Somalia, strategically located in the Horn of Africa, which has an arid to semi-arid climate with minimal variations across regions.

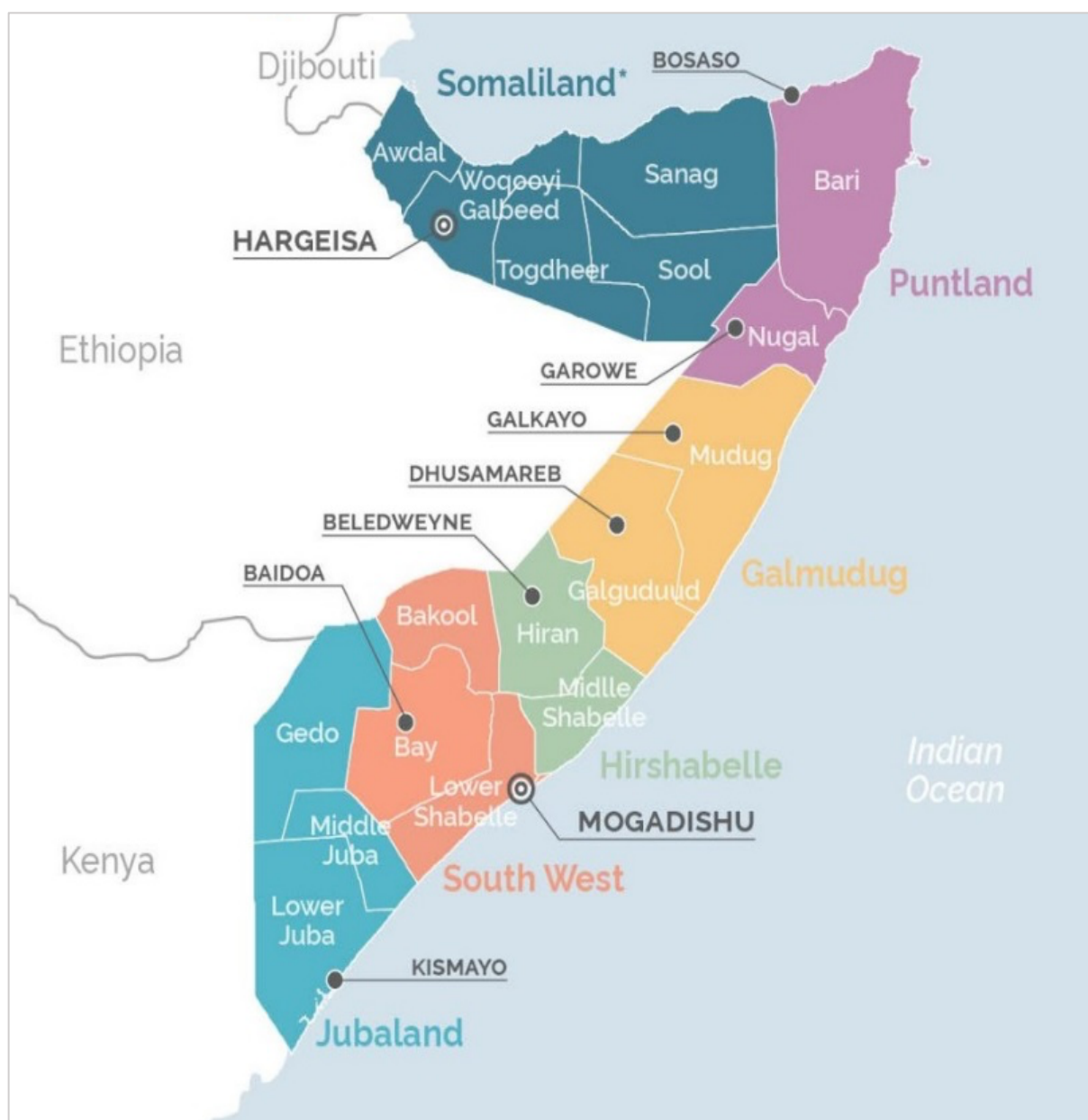


Figure 1.1: Somalia States and Regions map (Source: open aid)

From a climatic and geographical standpoint, this suggests that the country needs improved Hydromet services because weather variations are influenced by its coastlines and internal geographical features. These climate differences are critical for country's development and disaster management preparedness for natural disasters that occur frequently in the region, such as droughts, floods, and tropical storms.

Historically, Somalia's hydromet services were problematic, with concerns ranging from lack of enough infrastructure, inadequate technology, and ineffective institutionalization processes. These aspects have had a negative impact on the timeliness and accuracy of data collection, analysis, and reporting. However, in recent years, there has been some progress in Somalia's hydromet systems through the procurement of advanced equipment, capacity development, which includes human resource training, and the enhancement of forecast system.

Hydromet services are critical to Somalia's development strategy, climate change adaptation and risk reduction, and socioeconomic stability. Weather predictions and hydrological information are useful for agricultural purposes because they allow farmers to manage the timing of planting and watering to avoid huge losses caused by abnormally adverse climatic circumstances. Also, timely flood predictions and warning systems are critical for preventing loss of life and property in flood-affected areas.

Recently, advances in technology such as remote sensing, satellite imagery, and numerical weather prediction models, among others, have resulted in major improvements in hydromet services not only in Somalia, but around the world. These technologies open new options for enhancing prediction accuracy and the timely early warnings, all of which contribute to the improvement of disaster preparedness and response systems throughout the country. Another benefit of good hydromet services in Somalia is that the results are included into policy and decision-making processes. Continental and daily climate data improve decision making for policy formation in the country's strategic development areas such as water, infrastructure, and disaster risk reduction. It fosters synergies for the implementation of innovative approaches that improve Somalia's coping ability with climatic volatility and shocks.

Community engagement and public awareness are essential components of Hydromet services delivery. Capacity building campaigns and community engagement activities targeted at knowledge distribution play crucial roles in enhancing public understanding of weather and climate-related risks. Sharing information allows the populace to take preventive action in the face of climate-related calamities, increasing resilience at the individual, household, and group levels.

Achieving sustainable development objectives, lowering the risk of disasters, and creating communities that are climate resilient depend on the continuous improvement and fortification of Hydromet services. Somalia may further strengthen its ability to exploit meteorological and hydrological data by investing in infrastructure, development of technical capabilities, and promoting international collaborations.

1.2 Purpose of the Hydromet O&M Plan

The O&M plan serves the following primary goals:

1. The O&M strategy outlines how to sustain and improve the operational proficiency of Somalia's hydromet services. As a result, systematic maintenance methods ensure accurate consumption and status assessment of monitoring tools and gauges, data measuring devices, and communication systems. It ensures that meteorological and hydrological information is

provided on a timely and reliable basis, which is extremely valuable in decision making in a variety of areas.

2. The O&M plan includes budgets and constraints for personnel, equipment, and other financial aspects. The plan will be valuable in determining correct maintenance schedules and calibrations, so extending the lifespan of equipment, reducing downtime and the overall costs required to perform emergency repairs or obtain replacements.
3. In terms of quality management, the O&M strategy includes quality assurance and control procedures to ensure the delivery of reliable Hydromet services. Calibration, testing, and validation of equipment are essential for collecting meteorological and hydrological data and processes, which are the most critical parameters for end users and society.
4. The rules define how to respond to national legislative actions as well as international meteorological and hydrological service policies and procedures. Other aspects include risk control measures such as the use of helmets and other protective gears, adherence to environmental standards, and measures used while conducting research, which may include the use of protective gear to protect researchers and members of the public, all research instruments used during the study, and acceptable ethical practices in data collection and analysis.

1.3 Institutional Arrangements - Hydrometeorological Department

Somalia's hydromet service is multi-sectorial and involves several ministries and specialized agencies. Various organizations and government entities deliver hydrological, meteorological, and associated services including:

- Ministry of Energy and Water Resources (MoEWR) - Hydrometeorology Department
- Ministry of Agriculture (MoA) - Department of Irrigation and Agro-meteorology
- Ministry of Transport and Civil Aviation - Somali Civil Aviation Authority (SCAA)
- Ministry of Livestock, Forestry, and Range (MoLFR)
- Somalia Disaster Management Agency (SODMA)
- Puntland Information Management Centre (IMC)
- National Disaster Preparedness and Food Reserve Authority (NADFOR)
- Somaliland Information Management Centre
- Somalia Water and Land Information Management (SWALIM) Project
- IGAD Climate Prediction and Application Centre (ICPAC)
- United Nations Development Programme (UNDP)
- German Agency for International Cooperation (GIZ)
- The World Meteorological Organization (WMO)
- UNICEF - National WASH Cluster

The National Hydromet Policy stresses the importance of cross-sectoral cooperation in the Hydromet Services provision to support developmental and economic growth objectives across different sectors driven by social, environmental, and economic development objectives. This section takes an inventory of critical stakeholders in the hydromet sector and reports on their contribution towards Somalia's framework for providing hydromet services.

The Ministry of Energy and Water Resources (MoEWR), specifically the Hydrometeorology Department of Somalia, is the primary institution in charge of the country's hydromet activities. This department collaborates with other departments both domestically and globally, and it also receives

support from other organizations and partners to help it build technical competence and operational efficiency. It is also worth noting that, while improving meteorological and hydrological data and products, this strategy promotes collaboration, information transfer, and the exchange of best practices in forecasting and other services.

1.3.1 Vision of Hydrometeorological Department

The Hydro-Metrology Department's vision is to see Somalia achieve sustainable and effective assessment and use of water and climatic resources, allowing for equitable provision of the earth's benefits while avoiding environmental degradation and human suffering.

1.3.2 Mission of Hydrometeorological Department

To provide the Somali people and associated stakeholders with trustworthy and fast hydro-meteorological information to prevent loss of life, property, and the environment. For the formation and implementation of efficient policies aimed at rationally utilizing and conserving water resources, increasing climate stability, and the country's socioeconomic development.

1.3.3 Specific Tasks of of Hydrometeorological Department

Hydromet is one of the vital and significant departments within MoEWR, and its key activities include providing hydromet services for the entire country, providing information to decision-makers concerning the state of Somalia's water resources based on hydrological observation and assessment, including drought and flood monitoring and outlooks, forecasts, and warnings; weather and hydromet data monitoring; and issuance of forecasts and early warnings

The department assesses, monitors, and manages water resources, and plays an essential role in the forecast and early warning of hydromet disasters. The department contributes to national development by conducting hydrological and meteorology research, as well as improving health, the environment, agriculture and water resources, climate variability and change, technology, water security, disaster risk management, and climate proofing.

Overall, the department carries out the following functions:

1. Designing and implementing the country's hydrological and meteorological observation systems, including upper air temperature and groundwater monitoring systems.
2. Procurement and installation of hydromet-related infrastructure, such as the telemetry system, site office, regional offices, and hydraulic structure
3. Preparation and construction of connected hydromet infrastructure, such as telecommunication systems, work camps, regional stations, and intake structures.
4. Maintain and operate national hydro-meteorological observations, telemetry systems and related facilities
5. Establish and operate water quality and sediment sampling station networks including laboratories and related facilities
6. Operate and maintain communication and early warning facilities installed in different river basins
7. Modernize and upgrade hydro-meteorological network stations, telemetry systems, and hydrometric techniques in tandem with changing technologies.
8. Collection and transmission of hydrological and meteorological data from remote monitoring stations to the Central Database system headquarters.

9. Establishment of data collection and calibration facilities, development of proper technical specifications for hydro-met instrument and hydrometric technique.
10. Technical backstopping services to other specialized agencies in hydrometry and operational hydrology and meteorology services

1.3.4 Structure of Hydrometeorological Department

The Ministry of Energy and Water Resources' Hydrometeorological Department has four key sub-sections (Fig 1.2), each with distinct responsibilities:

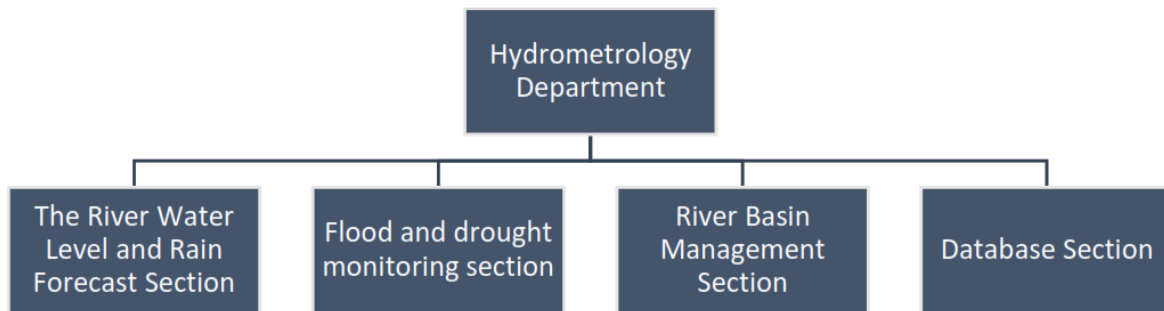


Figure 1.2: Four different sub-sections under the Hydro-metrological department of MoEWR

1. River Water Level and Rain Forecast Section:

- Provides timely river and flood forecasts.
- Issues hydrometeorological data for water resource planning, flood management, and operational programs.
- Conducts research to improve forecasts and warnings.
- Offers technical support to weather services and partners.

2. Flood & Drought Monitoring Section:

- Develops flood control and management plans for flood-prone basins.
- Provides flood protection measures like dams and dikes.
- Promotes non-structural flood mitigation strategies (forecasting, zoning).
- Optimizes water use and augments water supply through various methods.
- Improves national water resource assessment and management capabilities.

3. River Basin Management Section:

- Mediates disputes between water users.
- Manages and communicates water availability, demand, and quality data.
- Develops medium- to long-term water resource development and management plans.
- Monitors and regulates water quality and groundwater extraction.
- Develops flood/drought preparedness strategies and coping mechanisms.
- Promotes ecosystem protection and harmonizes land and water management policies.

4. Database Section:

- Maintains and updates the hydromet data management system.
- Provides technical support and troubleshooting for internal stakeholders.
- Manages data security and integrity policies.
- Collaborates with user departments to develop business applications.
- Ensures system changes are documented, tested, and approved.
- Optimizes departmental operations through software.

1.3.5 Coordination

1. National Hydromet Working Group

The Ministry of Energy and Water Resources (MoEWR) spearheads the National Hydromet Working Group, comprised of representatives from MoEWR, the Ministry of Agriculture (MoA), the Ministry of Health and Environment (MoHWE), and the Ministry of Environment. This group plays a vital role in:

- **Establishing the Hydromet Agency:** A key objective is to guide the creation of a dedicated Hydromet Agency for Somalia.
- **Facilitating Collaboration:** The Working Group serves as a platform for multi-sectoral collaboration among government stakeholders, fostering effective hydromet service development.
- **Improving Hydromet Services:** Their efforts contribute to the overall improvement of Somalia's Hydromet services.

Figure 3.2 illustrates the envisioned structure of the Working Group as a federal-level body, further solidifying its role in guiding collaborative efforts.

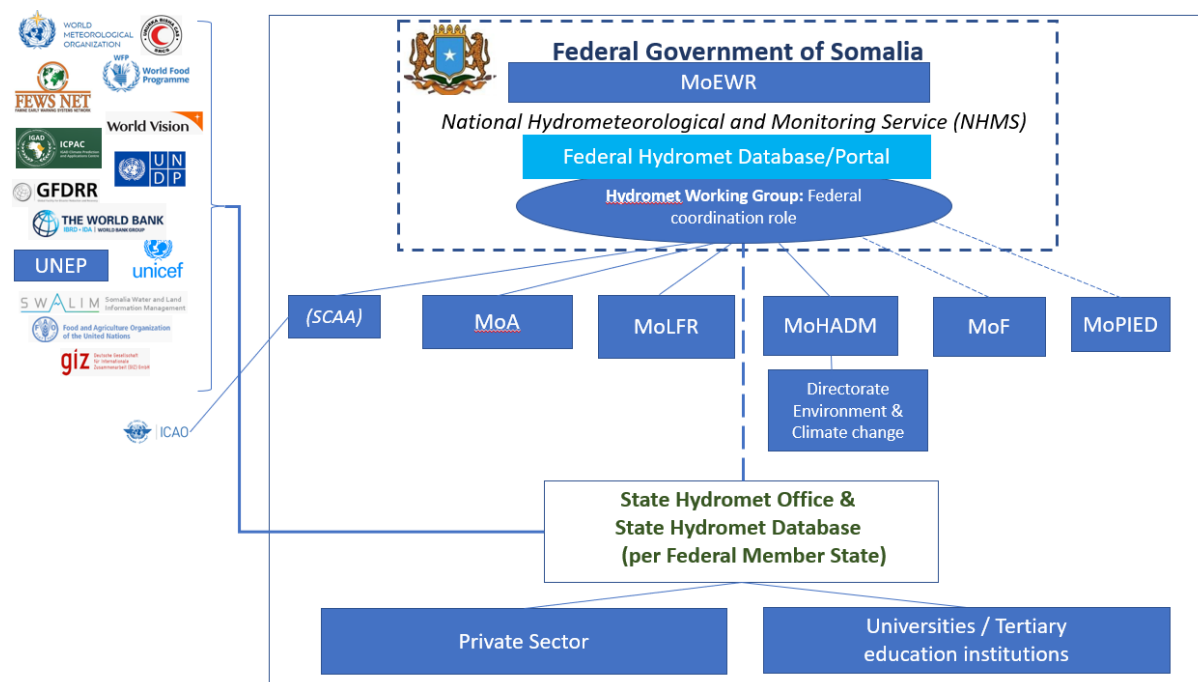


Figure 1.3: Composition & Role of the Hydromet Working Group (Source: hydromet policy)

2. Flood and Drought Task Force:

Established in 2021, the Task Force aimed to bridge the gap between international humanitarian agencies and the Somali government regarding flood and drought responses. However, a key distinction emerged:

- **Government's Focus:** The government prioritized long-term investments in flood and drought prevention (developmental agenda) led by the Ministry of Energy and Water Resources (MoEWR).
- **Humanitarian Agencies' Focus:** International agencies focused on coordinating emergency responses.

MoEWR recognized the importance of emergency response but emphasized the need for a separate entity to handle it (Ministry of Disaster Management and Humanitarian Affairs). MoEWR used the Task Force to:

- **Structure Water Sector Coordination:** Establish a framework for collaboration within the water sector.
- **Set Water Sector Priorities:** Define four key areas for coordinated action: rivers & canals, urban water, ground & reserved water, and soils & environment.

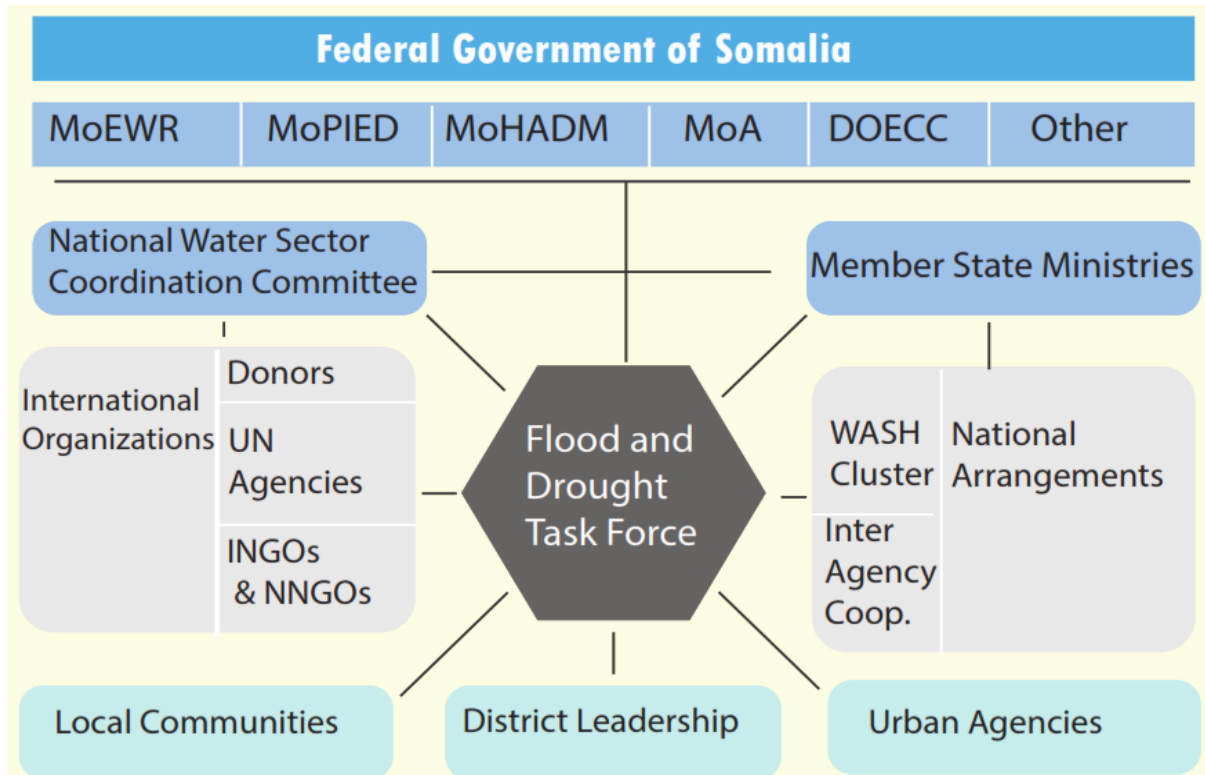


Figure 1.4: The structure of Flood and Drought Task Force (Source MoEWR)

3. Water Sector Coordination Facility

Somalia's Water Sector Coordination Facility (WSCF) was created to support the implementation of the National Water Resource Strategy (NWRs). It does this by coordinating important water sector projects and securing financing for them. The WSCF also helps strengthen the government's role in leading and coordinating water activities. An important part of the WSCF is the Hydromet Working Group, which oversees all hydromet services in Somalia. This group reports to a larger task force chaired by the Ministry of Energy and Water Resources. The WSCF was originally designed to support a World Bank project, but it also plays a vital role in coordinating between the government and other international organizations working on water issues in Somalia.

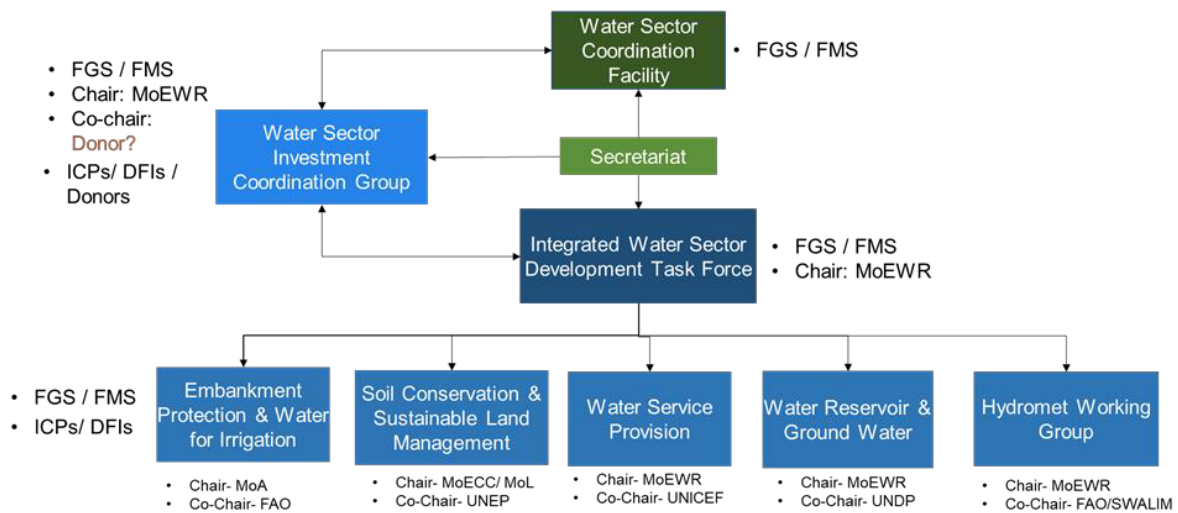


Figure 1.5: Structure of the Water Sector Coordination Facility. (Source MoEWR)

1.4 Target Audience of O&M Plan.

Effective hydromet services in Somalia require a collaborative effort from a diverse range of stakeholders. The following target audience have been identified:

1. Government Agencies:

- Ministry of Energy and Water Resources (MoEWR): Leads the National Hydromet Working Group and spearheads the establishment of a Hydromet Agency. They are responsible for developing national hydromet policies and regulations.
- Ministry of Planning Investment and Economic Development: Secures funding and coordinates development projects related to hydromet infrastructure and capacity building.
- Ministry of Environment and Climate Change: Oversees environmental policies and plays a role in integrating climate risk considerations into national planning.
- Somali Disaster Management Agency (SODMA): Relies on hydromet information for issuing early warnings for floods, droughts, and other weather-related hazards.
- National Environment Research and Disaster Preparedness and Management Authority (NERAD): Conducts research on environmental vulnerabilities and utilizes hydromet data for disaster risk reduction strategies.
- Humanitarian Disaster Management Authority (HADMA): Coordinates humanitarian responses to disasters, requiring access to accurate and timely hydromet data.
- Ministry of Transport and Civil Aviation: Relies on weather forecasts for safe air travel operations, potentially playing a more specific role in regulating air traffic based on weather conditions.
- Ministry of Agriculture and Irrigation: Needs hydromet data for agricultural planning, drought monitoring, and advising farmers on appropriate planting seasons.
- Ministry of Livestock Forestry and Range: Supports pastoral communities dependent on weather patterns for grazing land management.
- Ministry of Health: Utilizes hydromet data to prepare for heatwaves, floods, and other weather-related outbreaks of diseases.
- Ministry of Public Works and Reconstruction: Relies on weather forecasts for infrastructure maintenance and planning activities.

- Ministry of Labor and Social Affairs: Plays a role in ensuring the safety of workers during extreme weather events.
- Ministry of Interior, Federal Affairs and Reconciliation: Coordinates security responses during disasters and may require hydromet information for planning purposes.
- Ministry of Fisheries and Marine Resources: Needs weather forecasts for safe fishing operations and monitoring potential climate change impacts on fisheries.
- Ministry of Internal Security: May require hydromet data for security operations during extreme weather events.
- Ministry of Finance: Allocates resources for hydromet infrastructure development and operational costs.
- Educational Institutions (Ministry of Education, Regional Ministries): Play a crucial role in educating future generations on the importance of hydromet information and disaster preparedness.
- Ministry of Information, Culture and Tourism: Leverage its communication channels to disseminate weather forecasts and early warnings to the public, collaborating with hydromet agencies to tailor messaging based on weather patterns.

2. Non-State Actors:

- Non-Governmental Organizations (NGOs) and Community-Based Organizations (CBOs): Provide humanitarian assistance and development programs that often integrate hydromet data and early warnings.
- Academic Institutions: Contribute to hydromet research, data analysis, and development of early warning models tailored to the Somali context.

3. Communities:

- Traditional Leaders/elders and Religious Leaders: Hold significant influence within communities and can play a vital role in disseminating early warnings and mobilizing community action.
- Pastoralist Cooperatives, Farmers Associations, and Business Organizations: Utilize hydromet data for informed decision-making related to agriculture, livestock management, and business operations.
- Women and Youth Groups: Particularly vulnerable during disasters, these groups require targeted outreach and capacity building efforts related to hydromet information and disaster preparedness.
- District Disaster Management Committees: Coordinate local disaster response efforts and rely on hydromet information for decision-making.
- Vulnerable Groups: Women, elderly, youth, nomadic pastoralists, mobile populations, informal settlers, and people with disabilities require special considerations in terms of early warning dissemination and disaster preparedness due to potential access limitations or specific needs.

1.5 Scope of the Hydromet O&M Plan

The plan covers every aspect of Hydromet infrastructure and operations in Somalia. Key components of the plan include:

1. Infrastructure Inventory: Documentation of hydrometeorology including weather stations, instruments and communication systems installed in different parts of the country.

2. Maintenance Procedures: Specific schedules for regular and routine checks, tests, and overhauls intended for the sustained equipment functionality.
3. Data Management Protocols: The principles regarding the means of applying methods for data gathering, analysis, verification, archiving, sharing, and reporting that complies with the international standards.
4. Training and Capacity Development: Items that focus on improving the competence, training and knowledge of personnel working in Hydromet.
5. Risk Management Strategies: Risk assessment with regards to threats and opportunities affecting Hydromet, recommended measures to reduce the impact of risks that might prove hazardous to its operations.
6. Budget and Resource Allocation: Guidelines on budgetary allocation for the corporation, staff deployment, and procurement mechanisms
7. Monitoring and Evaluation Framework: Measures for establishing goals and objectives, how the success of O&M activities is to be evaluated, means of comparing the level of effectiveness with set targets, and other processes of performance enhancement.

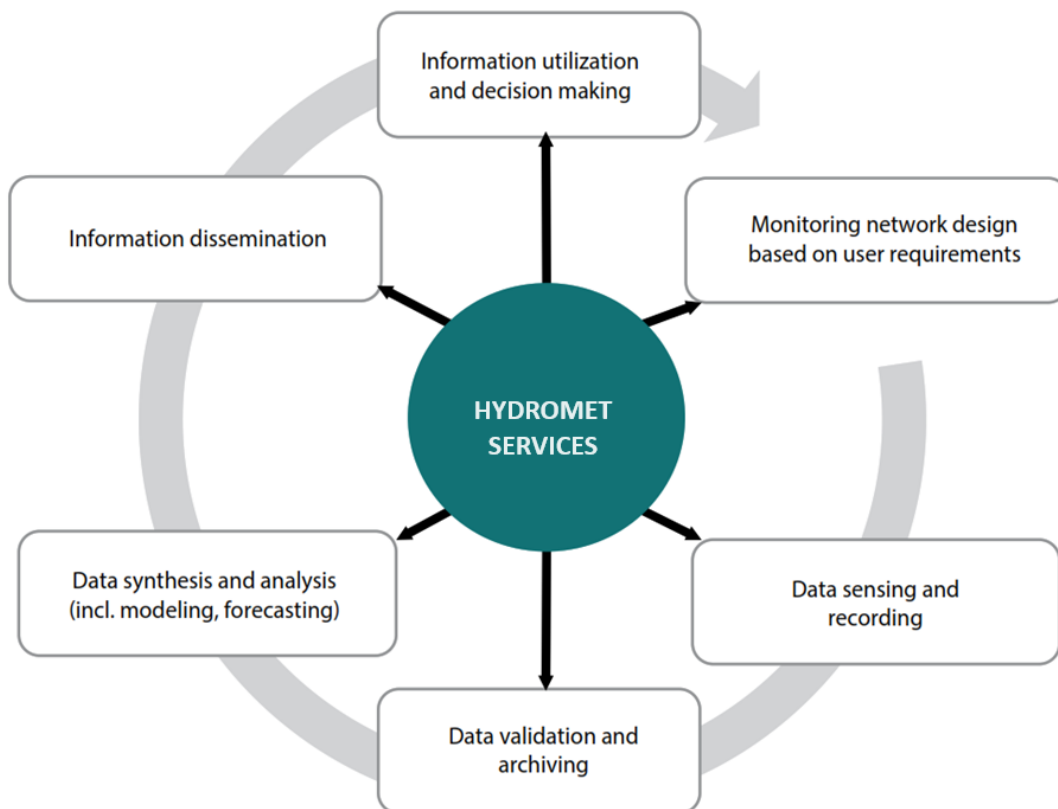


Figure 1.6: Schematic of inter-related elements of meteorological and hydrological monitoring networks

2.0 SYSTEM DESCRIPTION

A review of the existing network, database, and observation systems was carried out. The details of each of the systems, their functions, frequency of collection, parameters, network, storage system, bandwidth, etc. are also compiled and presented in subsequent sections and respective Appendices.

2.1 Surface Meteorological Observations Network

Currently, there are three types of surface meteorological monitoring stations some of them are not functional including 118 Manual Rainfall Stations (MRS), 5 manual Synoptic Stations (SS), and 44 Automatic Weather Stations (AWS) run by MoEWR-HD, FAO-SWALIM and IGAD-ICPAC (Fig 2.1 – See annex 1)

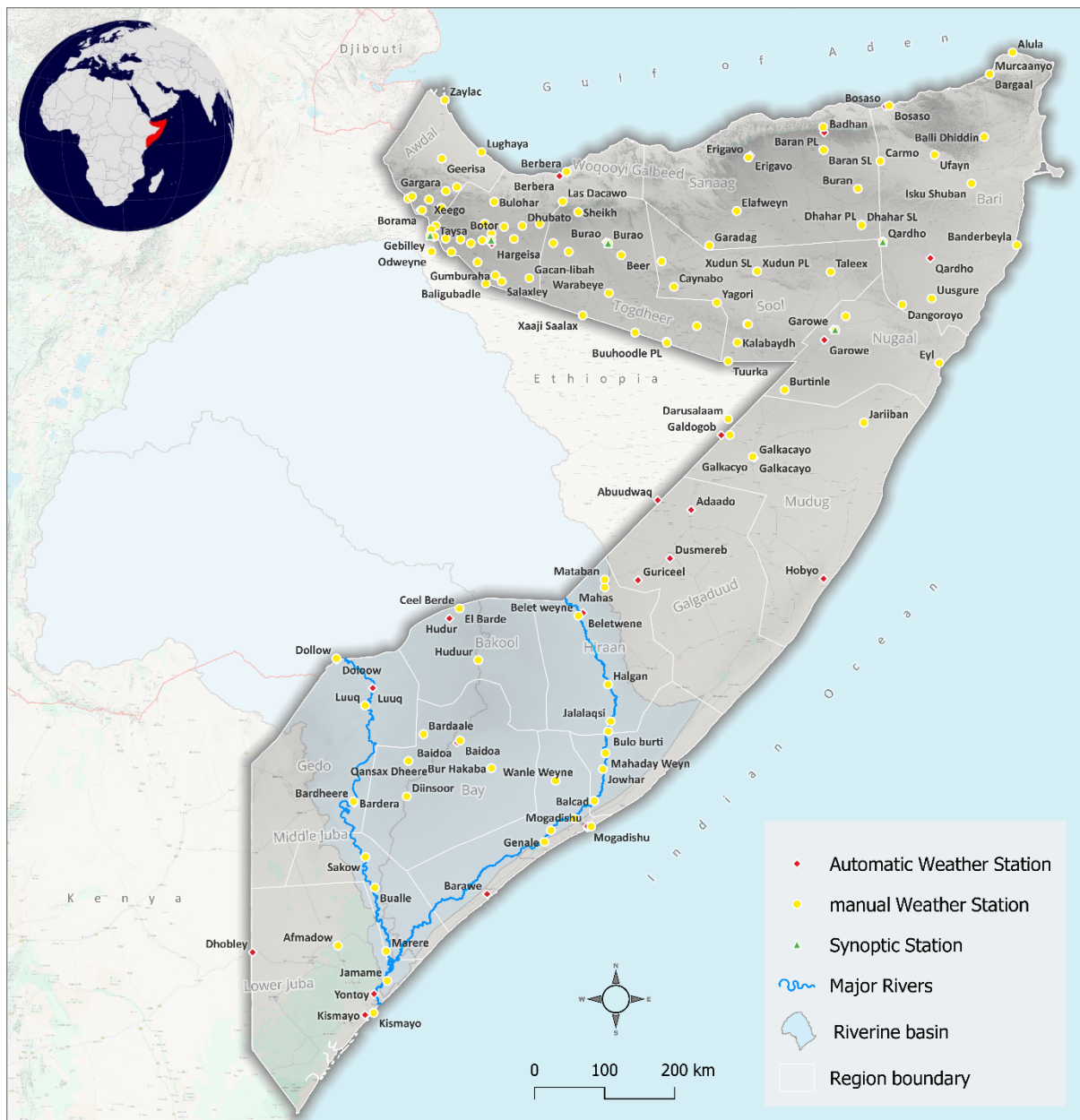


Figure 2.1: Locations of surface meteorological observations network

2.2 Surface Hydrological Observations Network

Currently, there are three types of hydrological observation stations monitors water levels and flow along Juba and the Shabelle Rivers, some of them are not functional run by MoEWR-HD, FAO-SWALIM, World Vision (Fig 2.2) including 17 River Gauging Stations (RGS) (including the pre-war and post-war) were re-established and maintained by SWALIM, 8 stations along the Shebelle and 9 stations along Juba Rivers. Only 1 Radar Water Level Sensor (RLS) installed recently in Beledweyne along the Shebelle River.

Many Groundwater Level Sensors have been installed in last 5 years by SWALIM, World Vision and other organization, but most of the technical information of these sensors are not available, for example, recently SWALIM through Puntland Water Agency installed many stations but no information is available. Recently World Vision have installed 22 sensors in production boreholes in Somaliland and Puntland.

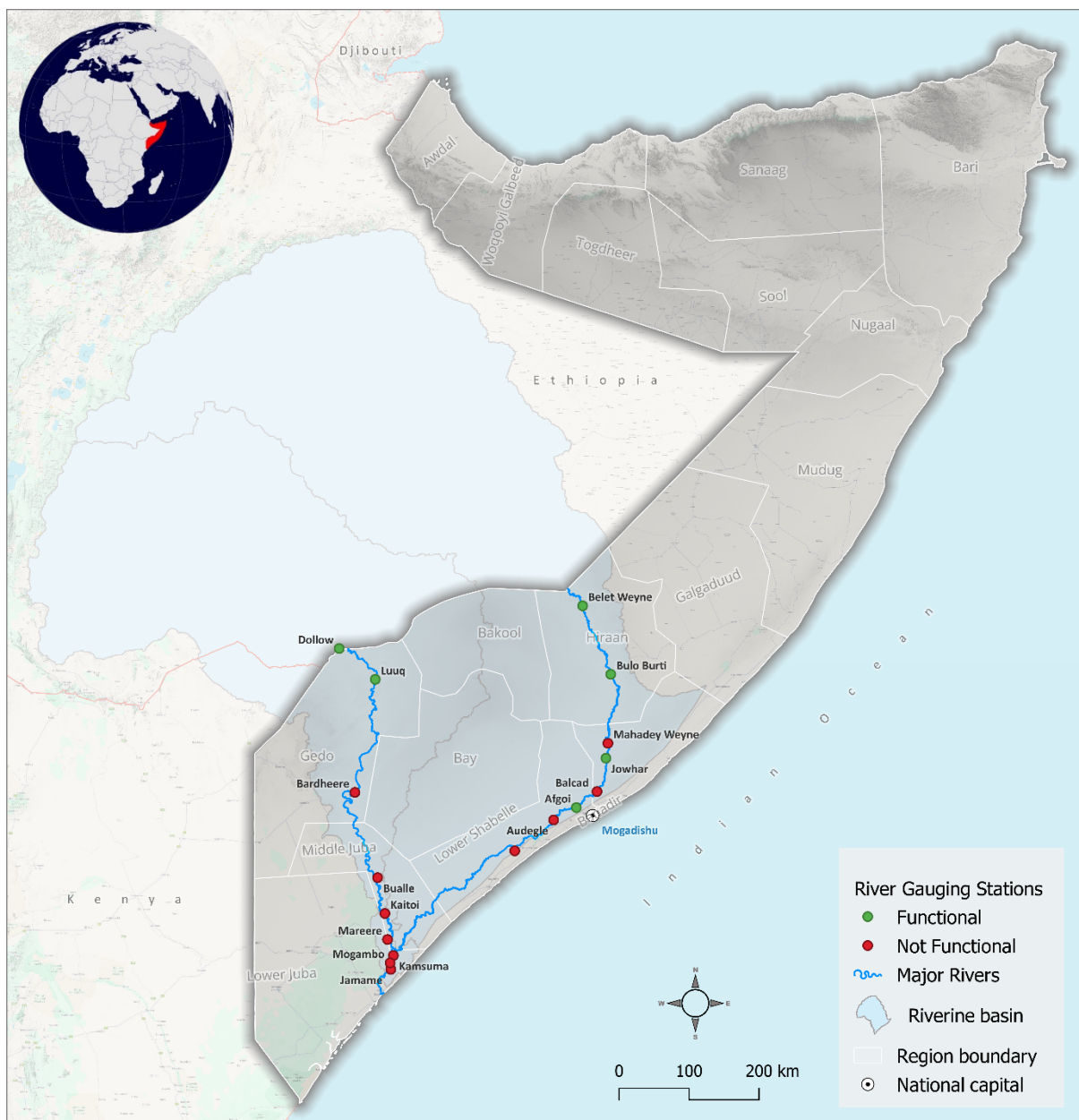


Figure 2.2: Locations of hydrological observation stations

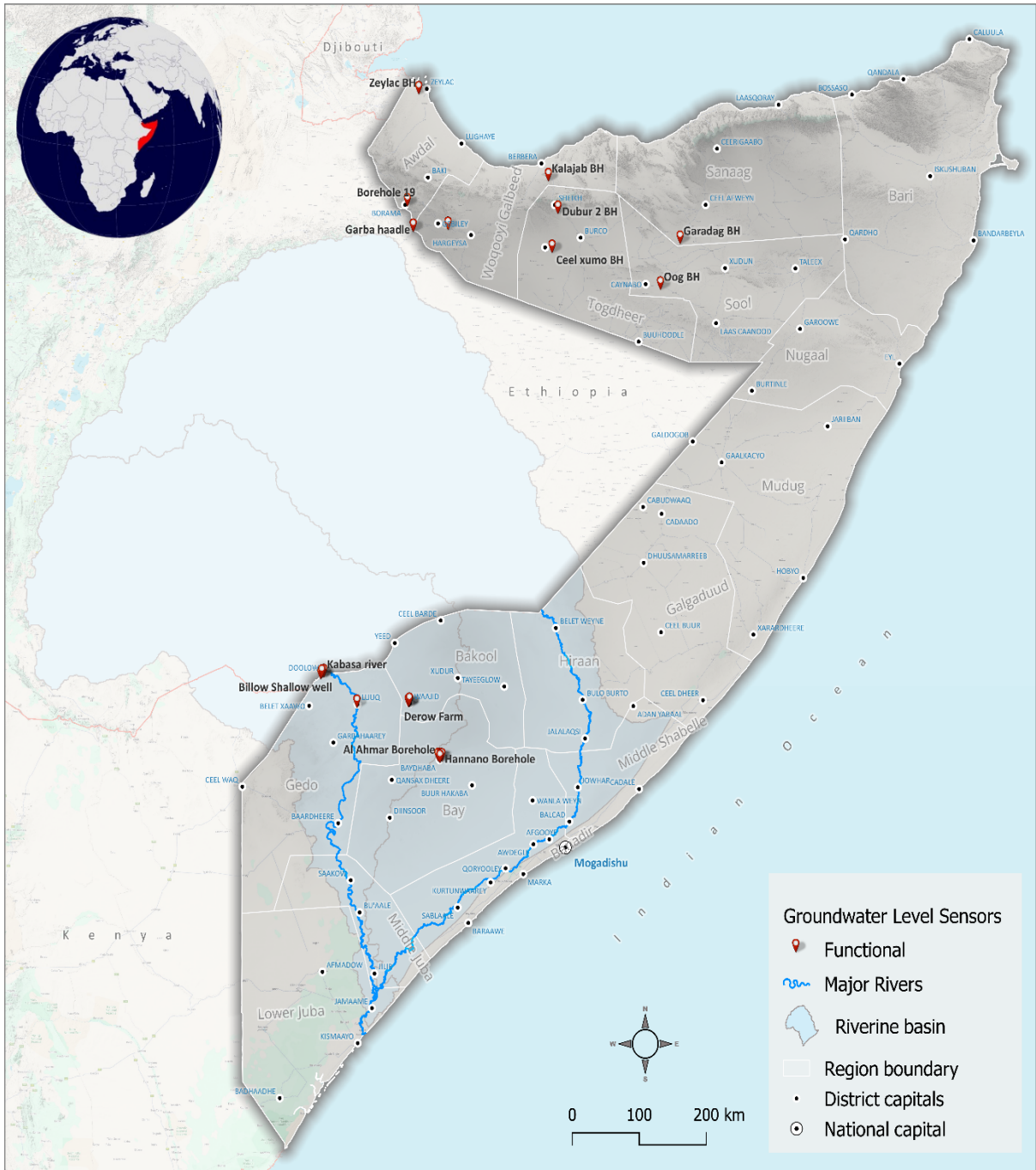


Figure 2.3: Location of the Groundwater Level Sensors

2.3 Communication and Storage Systems

All the stations across the country are connected in varied ways of communication, and have a different collection, transmission, and storage system. The end-use display is also isolated with standalone servers for each system. The following table explain each of the systems that are set up and used for the corresponding purpose.

Table 2.1: Hydromet Infrastructure

Type (Number)	Distribution	Operational functionality	Parameters measured	Communication
Automatic weather stations (AWS) (44)	Uneven with Mudug having the highest number (6) while Hiiran and lower Shabelle have the least (1 each).	24 are functional while 20 are non-functional	Air temperature, Relative humidity, Solar radiation, Precipitation, Wind speed, Wind direction and Air pressure	GSM, GPRS, various proprietary RF options, RF (WSN support)
Synoptic stations (5)	Uneven with stations concentrated in Puntland and Somaliland only.	4 are functional while 1 is non-functional	Air temperature and evaporation only	GSM/GPRS
Manual Rainfall Stations (MRS) (118)	Cover most parts of the country while a few gaps exist in Mudug, Galgaduud, Gedo and Lower Jubad Regions	108 are functional whereas 10 are non-functional	Rainfall	Telephone and email
River Gauging Stations (RGS) (17)	Evenly distributed along Shabelle (8) and Juba (9) rivers	6 functional and 11 non-functional	Daily water level, daily water flow and peak water flow.	Telephone and email
Radar water level sensors (RLS) (1)	Installed in Beledweyne along Shabelle River	Functional	Daily water level, daily water flow	GSM/GPRS
Groundwater Level Sensors (GLS) (22)	Uneven with all being concentrated in Puntland and Somaliland only.	Unknown	Water level, water temperature, electrical conductivity, salinity and total dissolved solids	GSM/GPRS/LTE modems

2.4 Data processing and management systems (software, hardware)

Isolated specific processing and data storage software's and display systems exist and used by Hydro-metrological department of MoEWR. All storage and services are independent and standalone with no security or automatic services. Below are the list software's used by the Department of Hydrometeorology, MoEWR:

No	Software	Specific Usage
1	Mike Hydro	Management, and planning of water resources
2	ArcGIS	Mapping
3	QGIS	Mapping
4	HEC-HMS	Hydrologic Analysis - Simulation
5	HEC-DSSvue	Scientific Data Storage Database
6	HEC RAS	Hydraulic Modelling
7	HydromRAM	Climate and Hydrology - Modelling
8	WEAP	Water Evaluation and Planning Systems - planning
9	GloFAS	Global Flood Awareness Systems - Flood Modeling
10	Python	Programming
11	R	Programming
12	Excel	Data Analysis
13	Server	Storing, securing, managing, and processing data on a network.

Mike Hydro

MIKE HYDRO, formerly known as MIKE BASIN, is an integrated water resources management program that incorporates allocation, management, and planning of water resources at a river basin scale. MIKE HYDRO is a network model that represents rivers and tributaries by a network of branches and nodes. The program consists of two modules: a basin module and a river module. The basin module allows the user to allocate, manage, and analyse water resources at a basin scale. The river module, a subset of MIKE 11, is a 1D river hydraulics model. MIKE HYDRO has been used for reservoir optimization, sediment transport, water quality, and streamflow forecasting.

Key features of the MIKE HYDRO model include GIS integration, rainfall-runoff modeling, ranking of water users, and scripting.

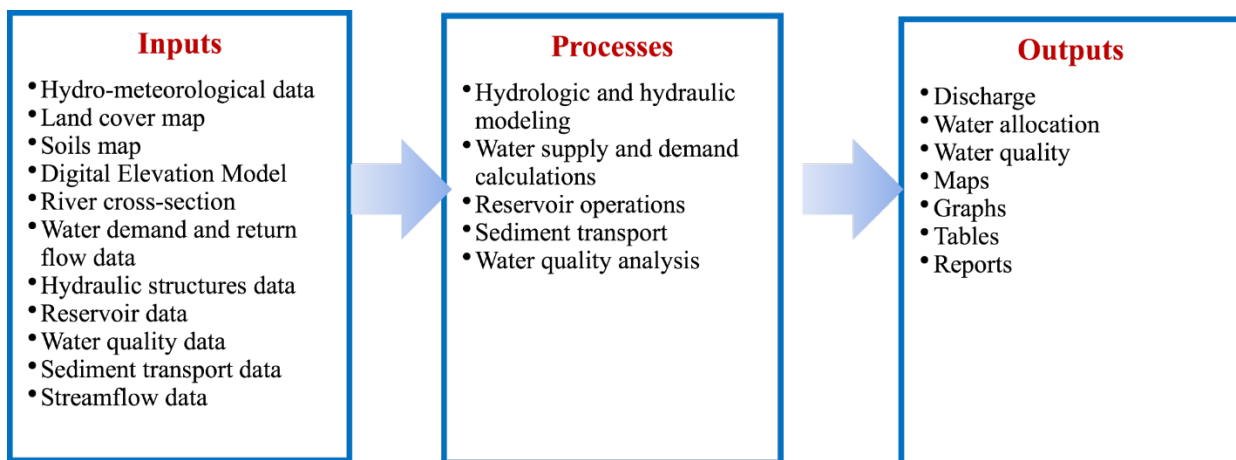


Figure 2.4: Key features of the MIKE HYDRO model

Overall condition and performance of the system.

All the stations need rehabilitations as result of the field assessment. Not all the stations are not connected to MIKE HYDRO. Some issues of the data collection, archival and sharing issues of automatic stations have been identified and listed below:

- Systems from different stakeholders are in different servers (managed by them) and with different applications. No record of maintenance or meta-data is in MoEWR system.
- No common database or front-end interface for all systems connected with MoEWR system. Many confusions and too many things to manage/handle for management.
- Mike Hydro seems to have broader applications that could be utilized to generate reports, QC, manage users, and combine besides regular station overviews.
- Data storage and backup are not optimal – hardware duplication
- No backup storage offsite
- No data transmission backup/ alternate link not there
- No proper archival system of data downloaded on USB

3.0 OPERATIONAL & MAINTENANCE RESPONSIBILITIES

3.1 Roles and responsibilities of key personnel and departments.

The specific roles and responsibilities within a Department of Hydrometeorology can vary depending on the size, structure, and focus of the organization. However, here's a general outline of key positions and their typical duties:

1. Director:

The Director leads the team. The department team is responsible for the actions and functions of the Department of Hydrometeorology. It also establishes and oversees the successful completion of the objectives set for each operational period. The management team sets objectives based on guidance from the Minister or the director general of MoEWR.

- Overall leadership and strategic direction of the department.
- Supports the Director-General in day-to-day operations.
- Oversees specific sections within the department.
- Resource allocation and budget management.
- Representation of the department at national and state levels.
- Policy development and implementation.
- Management Level

2. Section/Division Heads:

- Lead specific sections (e.g., river water level and rain forecast, flood & drought monitoring, river basin management and database section).
- Manage staff and resources within their sections.
- Develop and implement sections-specific plans and programs.
- Technical and Operational Level

3. Meteorologists:

- Collect, process, and analyze meteorological data.
- Prepare weather forecasts and warnings.
- Conduct research on meteorological phenomena.

4. Hydrologists:

- Collect, process, and analyze hydrological data.
- Develop hydrological models and forecasts.
- Conduct hydrological assessments and studies.

5. Climatologists:

- Analyze climate data and trends.
- Develop climate projections and scenarios.
- Provide climate information for various sectors.

6. Data Management Specialists:

- Manage and maintain meteorological and hydrological databases.
- Develop data quality control procedures.
- Ensure data accessibility and security.

7. IT Specialists:

- Manage the department's IT infrastructure.
- Develop and maintain meteorological and hydrological models.
- Support data communication and networking.

8. Observation Technicians:

- Operate and maintain meteorological and hydrological instruments.
- Collect and submit observational data.
- Conduct equipment calibration and maintenance.
- Support Staff

9. Administrative Staff:

- Handle administrative tasks, including human resources, finance, and procurement.
- Provide logistical support for field operations.

10. Communication Officers:

- Develop and implement communication strategies.
- Disseminate weather and climate information to the public.
- Manage public relations and media relations.

Note: This is a general overview, and specific roles and responsibilities may vary depending on the future planned staff.

3.2 Reporting Lines and Communication Channels

A well-defined reporting structure and effective communication channels are essential for the smooth functioning of a Department of Hydrometeorology, below are key considerations:

Reporting Lines

- **Hierarchical Structure:** Establish a clear chain of command, from the Director-General to the lowest level staff.
- **Matrix Structure:** Consider a matrix structure for complex projects or when expertise from multiple divisions is required.
- **Span of Control:** Determine the optimal number of subordinates a supervisor can effectively manage.
- **Delegation:** Clearly define responsibilities and authority levels for each position.
- **Regular Reviews:** Periodically assess and adjust reporting lines as needed to adapt to organizational changes.

Communication Channels

Formal Channels:

- Regular meetings (departmental, divisional, team)
- Written communication (memos, reports, emails)
- Information systems (Intranet, databases)

Informal Channels:

- Open-door policies

- Suggestion boxes
- Social gatherings

Communication Tools:

- Utilize technology (email, instant messaging, video conferencing)
- Develop a communication plan outlining preferred methods for different types of information.

Key Communication Principles

- **Clarity and Conciseness:** Ensure messages are clear and easy to understand.
- **Timeliness:** Deliver information promptly to avoid delays and misunderstandings.
- **Active Listening:** Encourage open communication and feedback.
- **Transparency:** Promote open and honest communication.
- **Consistency:** Maintain consistent messaging across all channels.

Additional Considerations:

- **Crisis Communication Plan:** Develop protocols for communicating during emergencies.
- **Cross-Functional Collaboration:** Facilitate communication and cooperation between different departments.
- **Performance Management:** Use communication channels to provide regular performance feedback.
- **Knowledge Sharing:** Encourage the sharing of information and best practices.

3.3 Roles and Responsibilities of Key Stakeholders

Government Agencies

- **Ministry of Energy and Water Resources (MoEWR):**
 - Overall leadership and coordination of hydromet activities.
 - Policy development, strategy formulation, and resource allocation.
 - Establishment and management of the national hydromet agency.
 - Partnership building with other government agencies and international organizations.
- **Ministry of Planning and Investment:**
 - Financial resource mobilization for hydromet infrastructure development.
 - Integration of hydromet information into national development plans.
 - Monitoring and evaluation of hydromet projects.
- **Ministry of Environment and Climate Change:**
 - Integration of climate change considerations into hydromet services.
 - Policy development for environmental protection and sustainable resource management.
- **Ministry of Agriculture:**
 - Application of hydromet information for agricultural planning, crop monitoring, and early warning systems.
 - Support to farmers and pastoralists.
- **Ministry of Health:**
 - Use of hydromet data for disease surveillance and early warning systems.

- Development of public health interventions related to weather and climate conditions.
- **Ministry of Transport and Civil Aviation:**
 - Integration of weather information into air traffic management and aviation safety.
- **Ministry of Finance:**
 - Financial resource allocation for hydromet activities.
 - Budgetary oversight and control.

Non-Governmental Organizations (NGOs) and International Organizations

- **Humanitarian NGOs:**
 - Provision of early warning and disaster response services.
 - Capacity building of local communities.
 - Advocacy for increased investment in hydromet services.
- **Development NGOs:**
 - Support to hydromet infrastructure development and capacity building.
 - Integration of hydromet information into development projects.
- **International Organizations:**
 - Technical assistance and capacity building.
 - Financial support for hydromet initiatives.
 - Knowledge sharing and technology transfer.

Academic Institutions and Research Organizations

- Conducting research and developing new methodologies for hydromet services.
- Providing technical expertise and support to government agencies.
- Training and capacity building of hydromet personnel.

Private Sector

- Developing and providing hydromet products and services.
- Investing in hydromet infrastructure.
- Collaborating with government agencies on data sharing and service delivery.

Communities

- Participation in data collection and dissemination.
- Utilization of hydromet information for decision-making.
- Early warning dissemination and response.

Key Considerations

- Effective communication and coordination: Regular meetings, information sharing platforms, and joint projects.
- Capacity building: Investing in human resources development across all stakeholder groups.

- Data sharing and standardization: Ensuring compatibility and accessibility of hydromet data.
- Resource mobilization: Identifying and securing funding for hydromet activities.
- Monitoring and evaluation: Tracking progress and impact of hydromet services.

4.0 STANDARD OPERATING PROCEDURES (SOPS)

Standard Operating Procedures (SOPs) are essential for the consistent and efficient operation of a hydromet department. They provide a clear framework for staff to follow, ensuring data quality, accuracy, and timely delivery of services. Key areas for developing SOPs include:

1. SOP for Daily hydromet operational checklist
2. SOP for Data collection and processing protocols
3. SOP for Data quality control and assurance procedures
4. SOP for Emergency response procedures
5. SOP for Equipment Calibration and Maintenance
6. SOP for Repair and Replacement Protocols
7. SOP for Data Management
 - Data collection procedures (manual and automated)
 - Data validation and quality control checks
 - Data storage and archiving
 - Data retrieval and dissemination
 - Data security and privacy protocols

4.1 Daily operation checklist

The daily operational checklist ensures systematic monitoring and maintenance of essential equipment and systems. This checklist helps maintain data accuracy, reliability, and operational readiness.

Table 1: Daily hydromet operational checklist

Type	Equipment	Action
Automatic Weather Stations (AWS)	AWS	<ul style="list-style-type: none"> • Check power supply (solar panels, batteries). • Verify functioning of sensors (temperature, humidity, wind speed/direction, precipitation). • Ensure data transmission to central database. • Clear debris or obstructions around station.
	Manual Rainfall Stations (MRS)	<ul style="list-style-type: none"> • Verify manual rainfall observations • Record data accurately in logbooks or electronic systems. • Check and empty rain gauges if necessary. • Ensure instruments are calibrated and functioning correctly
Synoptic stations	Visibility sensors	<ul style="list-style-type: none"> • Calibrate and verify functionality of visibility sensors • Clean sensors and lenses weekly to maintain data accuracy.
	Rain gauges	<ul style="list-style-type: none"> • Empty rain gauges before each rainfall measurement • Remove debris and unclog any blockages that may interfere measurements.
	Thermometers	<ul style="list-style-type: none"> • Calibrate sensors for accurate temperature measurement • Check for any damages or malfunctions.
	Anemometer	<ul style="list-style-type: none"> • Confirm the accuracy of wind speed and wind direction readings • Clear any obstructions which can interfere with measurements
	Hygrometer	<ul style="list-style-type: none"> • Calibrate for accurate humidity measurements • Ensure good ventilation for proper functioning of the sensor
River Gauging Stations (RGS)	RGS	<ul style="list-style-type: none"> • Check water level sensors and recording mechanisms. • Verify data transmission and ensure real-time monitoring. • Clear debris from sensors or river gauge structures.

Radar Water Level Sensors (RLS)		<ul style="list-style-type: none"> Record river discharge and water quality parameters as applicable
	RLS	<ul style="list-style-type: none"> Check power supply and communication systems for functionality Inspect for corruptions, damage or any structure or objects that can cause obstruction impeding the sensor performance
Ground water Level Sensors (GLS)	GLS	<ul style="list-style-type: none"> Verify water level measurements. Check groundwater quality sensors (pH, conductivity). Ensure proper functioning of data loggers or telemetry systems
Other daily operational procedures		
Data Transmission and Communication		<ul style="list-style-type: none"> Verify data transmission from remote stations to central database. Check satellite links, radios, or internet connections for reliability. Monitor data flow and troubleshoot any transmission issues
Data Quality Assurance		<ul style="list-style-type: none"> Conduct routine checks for data completeness and accuracy. Validate data against established standards and calibration records. Address any anomalies or discrepancies promptly
Preventive Maintenance		<ul style="list-style-type: none"> Perform scheduled maintenance tasks (cleaning, lubrication, inspection). Calibrate sensors and instruments according to maintenance schedule. Replace batteries or components as needed
Emergency Equipment Checks		<ul style="list-style-type: none"> Ensure availability and readiness of emergency response equipment (spare parts, backup power sources). Conduct test runs of emergency procedures (data backup, system recovery).
Daily Logs and Reports		<ul style="list-style-type: none"> Document all observations, maintenance activities, and operational issues in daily logs. Prepare daily reports summarizing data collection, station status, and any incidents or maintenance performed.
Monitor Weather Trends		<ul style="list-style-type: none"> Review meteorological data trends and patterns. Analyse forecast models and updates from regional or global forecasting centres. Prepare and disseminate weather forecasts and warnings as necessary
Safety Checks		<ul style="list-style-type: none"> Ensure compliance with safety protocols and regulations during operations. Conduct safety inspections of equipment and stations.

Feedback and Evaluation

- Address any safety hazards or concerns promptly.
- Gather feedback from field staff on operational challenges and observations.
- Evaluate checklist effectiveness and adjust as needed.
- Identify opportunities for process improvements or technological upgrades.

4.2 Data collection and processing protocols

The data collection and processing protocols is essential for ensuring the accuracy, reliability, and usability of meteorological and hydrological data in Somalia. These protocols establish standardized procedures for collecting, validating, storing, and disseminating data, thereby supporting informed decision-making across various sectors.

Table 2: Hydromet data collection protocol

Equipment	Actions
Automatic Weather Stations (AWS)	<ul style="list-style-type: none">• Parameters Monitored: Temperature, humidity, wind speed, wind direction, precipitation.• Frequency: Continuous monitoring with data logging at regular intervals (e.g., every 15 minutes).• Maintenance: Regular calibration and maintenance checks according to manufacturer guidelines.• Data Transmission: Automated transmission to central database via satellite, radio telemetry, or internet connection.• Backup: Implement data backup procedures to ensure data integrity during transmission disruptions.
Manual Rainfall Stations (MRS)	<ul style="list-style-type: none">• Parameters Observed: Rainfall.• Observation Schedule: Manual readings taken at hourly intervals.• Data Recording: Record observations accurately in logbooks or electronic data capture systems.• Quality Control: Conduct periodic audits to verify consistency and accuracy of manual observations.
Synoptic stations	<ul style="list-style-type: none">• Parameters measured: Humidity, temperature, atmospheric pressure, cloud cover, precipitation, visibility, wind speed and direction.• Instrumentation: The measurements are automated• Frequency: Routine observation at 6-hours intervals. Special observations at shorter time intervals may be made during extreme severe weather.

River Gauging Stations (RGS)

- Calibration: Regularly according to producer's guidelines and in line with both national and international (WMO) standards.
- Validation: Compare data from several stations within the same region and nearby stations for consistency and to eliminate outliers using statistical techniques.

Radar Level Water Sensors (RLS)

- Parameters Monitored: Water level, flow rate, water temperature.
- Instrumentation: Use of automated sensors and manual measurements for verification.
- Frequency: Continuous monitoring with real-time data transmission to central database.
- Calibration: Regular calibration of sensors and instruments to maintain accuracy.
- Validation: Compare automated and manual measurements to ensure data consistency.

Ground Water Level Sensors (GLS)

- Parameters monitored: water level and water flow
 - Instrumentation: Automated RADAR sensors
 - Frequency: Continuous real-time measurements every 30 minutes.
 - Calibration: Regularly calibrate between the radar signals and water level readings
 - Validation: To eliminate discrepancies and outliers, statistical hydrological models should be run on the data measurements.
- Parameters Monitored: Water level, groundwater quality (pH, conductivity, contaminants).
 - Monitoring Wells: Regular measurement of water level using calibrated instruments.
 - Sampling: Periodic sampling for water quality analysis, adhering to sampling protocols.
 - Data Transmission: Transmit data to central database for storage and analysis.

4.3 Quality control and assurance procedures

Quality control (QC) and quality assurance (QA) procedures are critical for guaranteeing the correctness, dependability, and integrity of meteorological and hydrological data collected and processed by Somalia's Hydromet services.

Table 3: Quality control and quality assurance procedures

Check	Action
Quality Control (QC) Procedures	<ul style="list-style-type: none"> • Data Validation: Implement automated checks to identify outliers, erroneous readings, and missing data points. • Range Checks: Set acceptable ranges for each monitored parameter (e.g., temperature, humidity, precipitation) based on sensor specifications and historical data. • Consistency Checks: Verify data consistency within a specific period and between different sensors or stations. • Flagging and Alerts: Flag data points that fall outside predefined thresholds and generate alerts for immediate review and corrective action. • Visual Inspection: Conduct visual inspections of data plots and time series to identify anomalies or trends. • Comparison: Compare automated data with manual observations to ensure agreement and consistency. • Quality Control Checks: Use standardized checklists and protocols to verify data completeness, accuracy, and adherence to measurement standards. • Regular Calibration: Schedule routine calibration of monitoring instruments and sensors according to manufacturer specifications and recommended intervals. • Maintenance Checks: Perform regular maintenance checks to ensure sensors are clean, aligned, and functioning correctly. • Documentation: Maintain detailed records of calibration and maintenance activities for audit trail and quality assurance purposes.

Quality Assurance (QA) Procedures

- **Data Storage:** Store collected data in a centralized database with robust backup and recovery procedures to prevent data loss.
- **Metadata Documentation:** Include comprehensive metadata such as station information, sensor characteristics, calibration history, and data processing procedures.
- **Access Control:** Implement strict access controls to protect data integrity and confidentiality, ensuring only authorized personnel can modify or access sensitive data.
- **Standard Operating Procedures (SOPs):** Develop and maintain SOPs for data collection, processing, and quality control procedures.
- **Audit Trails:** Maintain audit trails documenting changes made to data, ensuring transparency and traceability of data management practices.
- **Regular Reporting:** Generate regular QA/QC reports summarizing data quality assessments, findings, and corrective actions taken.
- **Staff Training:** Conduct regular training sessions for personnel involved in data collection, processing, and quality assurance to enhance technical skills and knowledge.
- **Knowledge Sharing:** Foster a culture of continuous improvement by sharing best practices, lessons learned, and emerging technologies in data quality management.

Continuous Improvement

- Establish mechanisms for receiving feedback from data users and stakeholders to identify areas for improvement in data quality and service delivery.
- Actively solicit input on data usability, relevance, and timeliness to enhance user satisfaction and stakeholder engagement.
- Conduct periodic evaluations of QC/QA procedures to assess their effectiveness in maintaining data quality standards and meeting operational objectives.
- Implement corrective actions and enhancements based on evaluation findings to address identified gaps or areas needing improvement.
- Ensure compliance with international standards and guidelines for meteorological and hydrological data quality, such as those set by the World Meteorological Organization (WMO) or regional regulatory bodies

4.4 Emergency response procedures

Emergency response procedures are critical for Somalia's Hydromet services to mitigate risks, protect personnel, and safeguard infrastructure during emergencies such as natural disasters or equipment failures.

Table 4: Emergency response procedures

Phase	Action	Activity
Preparedness	Risk Assessment	<ul style="list-style-type: none"> Identify potential hazards and risks specific to meteorological and hydrological operations in Somalia, such as floods, droughts, cyclones, and equipment failures. Conduct vulnerability assessments of monitoring stations, communication systems, and critical infrastructure.
	Emergency Response Plan Development	<ul style="list-style-type: none"> Develop an Emergency Response Plan (ERP) that outlines roles, responsibilities, and procedures for responding to emergencies. Define clear escalation procedures and communication protocols for alerting personnel and stakeholders.
	Training and Drills	<ul style="list-style-type: none"> Conduct regular training sessions and drills for staff on emergency procedures, including evacuation protocols, first aid, and use of emergency equipment. Ensure staff are familiar with ERP documentation and know their roles during emergencies.
	Emergency Contact Information	<ul style="list-style-type: none"> Maintain updated contact lists for key personnel, emergency response teams, local authorities, and relevant stakeholders. Ensure redundant communication channels (e.g., satellite phones, radio communication) are in place for emergency notifications.
Response	Immediate Actions	<ul style="list-style-type: none"> Activate the Emergency Response Team (ERT) and Incident Command System (ICS) if necessary. Initiate emergency communications to alert staff, stakeholders, and the public as appropriate. Implement initial response actions to mitigate immediate threats (e.g., shutting down equipment, evacuating personnel).
	Data Monitoring and Analysis	<ul style="list-style-type: none"> Monitor meteorological and hydrological data continuously to assess impacts and forecast conditions during the emergency.

Recovery		<ul style="list-style-type: none"> • Provide real-time updates and forecasts to relevant authorities and response teams to support decision-making.
	Infrastructure Protection	<ul style="list-style-type: none"> • Secure monitoring stations, equipment, and data storage facilities from damage or loss. • Implement measures to safeguard critical infrastructure against floodwaters, strong winds, or other environmental hazards
	Assessment and Evaluation	<ul style="list-style-type: none"> • Conduct damage assessments and evaluate the impact on monitoring stations, equipment, and data quality. • Document findings and lessons learned for post-event analysis and improvement of emergency response procedures
	Repair and Restoration	<ul style="list-style-type: none"> • Prioritize repairs and restoration of damaged equipment and infrastructure to resume normal operations. • Coordinate with suppliers and technical support teams for replacement parts and repair services.
	Review and Update	<ul style="list-style-type: none"> • Review the effectiveness of emergency response procedures and make necessary updates based on lessons learned. • Incorporate feedback from staff and stakeholders to enhance preparedness for future emergencies.
Communication and Coordination	Internal Communication	<ul style="list-style-type: none"> • Maintain open lines of communication within the Hydromet services team to ensure all staff are informed and updated during emergencies. • Use communication tools such as radios, mobile phones, and messaging systems for rapid dissemination of information
	External Communication	<ul style="list-style-type: none"> • Coordinate with national emergency response agencies, local authorities, and relevant stakeholders to ensure a coordinated response. • Provide timely updates and information to the public through official channels and media outlets

4.5 Maintenance Tasks for Common Hydromet Stations

A maintenance schedule ensures reliability, longevity, and optimal performance of equipment used in delivering Somalia's Hydromet services. It helps minimize downtime, reduce repair costs, and maintain data accuracy.

Table 5: Schedule for Maintenance Tasks for Common Hydromet Stations in Somalia

Station Type	Frequency	Cleaning and inspection	Calibration
Automatic Weather Stations	Monthly	<ul style="list-style-type: none"> Remove debris and dust from sensors, solar panels, and enclosures. Check for physical damage, ensure sensors function correctly, and verify data transmission 	-
	Quarterly	<ul style="list-style-type: none"> Detailed inspection of all components. 	Calibrate sensors according to manufacturer specifications.
	Annually	<ul style="list-style-type: none"> Comprehensive cleaning of all parts. Thorough system check 	Comprehensive maintenance including software updates.
Synoptic Stations	Monthly	<ul style="list-style-type: none"> Clean sensors, shelters, and other exposed equipment. Verify sensor accuracy and condition, ensure data logging and transmission systems function correctly. 	-
	Quarterly	<ul style="list-style-type: none"> In-depth inspection of all sensors. 	Calibrate temperature, humidity, and pressure sensors as per guidelines.
	Annually	<ul style="list-style-type: none"> Comprehensive cleaning of all parts. Full system review and overhaul if needed 	-
Manual Rainfall Stations	Monthly	<ul style="list-style-type: none"> Regularly clean the funnel and measurement cylinder to prevent blockages. Verify the integrity of measurement equipment, replace any damaged parts. 	-
	Quarterly	<ul style="list-style-type: none"> Ensure measurement accuracy 	-
	Annually	<ul style="list-style-type: none"> Comprehensive cleaning of all parts. Comprehensive inspection. 	Calibrate measurement cylinders.

River Gauging Stations	Monthly	<ul style="list-style-type: none"> Remove debris to ensure unobstructed water flow measurements. Inspect for siltation, erosion, and physical condition of gauging structures and measurement devices 	-
	Quarterly	<ul style="list-style-type: none"> Detailed inspection of structural components. 	-
	Annually	<ul style="list-style-type: none"> Comprehensive cleaning of all parts. Comprehensive review and maintenance of equipment. 	-
Radar Water Level Sensors	Monthly	<ul style="list-style-type: none"> Clean the radar sensor surface to ensure accurate readings. Check sensor alignment, mounting integrity, and data transmission. 	-
	Quarterly	<ul style="list-style-type: none"> Detailed inspection of all components. 	Calibrate radar sensors according to manufacturer specifications.
	Annually	<ul style="list-style-type: none"> Comprehensive cleaning of all parts. Full maintenance including software and hardware checks. 	-
Groundwater Level Sensors	Monthly	<ul style="list-style-type: none"> Clean the sensor housing, ensure the well is free from obstructions. Inspect for physical damage, verify data logging system. 	-
	Quarterly	<ul style="list-style-type: none"> Detailed inspection of all components. 	Calibrate sensors to ensure precision in water level measurements.
	Annually	<ul style="list-style-type: none"> Comprehensive cleaning of all parts. Comprehensive system checks and maintenance 	-

4.6 Calibration and Testing Procedures

Calibration and testing procedures are critical for ensuring the accuracy, reliability, and consistency of meteorological and hydrological instruments used in Somalia's Hydromet services. Proper calibration ensures that instruments provide accurate measurements, which are essential for effective weather forecasting, hydrological monitoring, and climate analysis.

Table 6: Calibration and Testing Procedures

Objective	Type	Action
Establishing Calibration Standards	Reference Standards	<ul style="list-style-type: none"> Identify and procure certified reference standards or instruments traceable to national or international metrological standards (e.g., World Meteorological Organization, WMO) for calibration purposes.
		<ul style="list-style-type: none"> Ensure the reference standards are regularly calibrated by accredited calibration laboratories to maintain accuracy.
	Calibration Intervals	<ul style="list-style-type: none"> Determine calibration intervals based on manufacturer recommendations, operational requirements, environmental conditions, and regulatory standards.
		<ul style="list-style-type: none"> Consider more frequent calibration for critical parameters or instruments operating in harsh environments.
Calibration Procedures	Preparation	<ul style="list-style-type: none"> Schedule calibration during periods of minimal operational impact to avoid disruptions to data collection.
		<ul style="list-style-type: none"> Prepare calibration procedures and checklists specific to each type of instrument and parameter being calibrated.
	Calibration Techniques	<ul style="list-style-type: none"> Use appropriate calibration techniques such as zero-point calibration, span calibration, and multi-point calibration depending on the instrument and measurement requirements.
		<ul style="list-style-type: none"> Follow detailed procedures outlined in manufacturer manuals or standard operating procedures (SOPs) developed for each instrument type.
	Documentation	<ul style="list-style-type: none"> Record all calibration activities in calibration logs or electronic databases, including date of calibration, instrument serial number, calibration results, deviations (if any), and personnel conducting the calibration.
		<ul style="list-style-type: none"> Label instruments with calibration stickers or tags indicating the date of last calibration and next due date.

Testing Procedures	Functional Testing	<ul style="list-style-type: none"> • Conduct functional tests to verify that instruments operate correctly and produce accurate measurements under normal operating conditions. • Test sensor response times, data transmission capabilities, and integration with data logging systems. 	
	Performance Testing	<ul style="list-style-type: none"> • Perform performance tests to validate instrument accuracy, precision, linearity, and stability over the operational range. • Compare instrument readings against reference standards or known values to assess measurement deviations and uncertainties. 	
	Environmental Testing	<ul style="list-style-type: none"> • Test instruments under simulated environmental conditions (e.g., temperature extremes, humidity levels) to evaluate their performance and accuracy in different operating environments. 	
		<ul style="list-style-type: none"> • Ensure instruments meet specified performance criteria and regulatory requirements for environmental conditions. 	
	Equipment Handling and Maintenance	Handling Procedures	<ul style="list-style-type: none"> • Handle instruments and calibration standards with care to prevent damage or contamination that could affect calibration results.
			<ul style="list-style-type: none"> • Follow manufacturer guidelines for proper storage, transportation, and handling of sensitive instruments.
Maintenance Checks		<ul style="list-style-type: none"> • Conduct routine maintenance checks before and after calibration to ensure instruments are clean, calibrated, and functioning optimally. 	
		<ul style="list-style-type: none"> • Replace worn-out components, recalibrate if necessary, and perform adjustments to maintain instrument performance. 	
Calibration Verification and Traceability	Verification Checks	<ul style="list-style-type: none"> • Periodically verify instrument calibration through spot checks or secondary verification against reference standards. 	
		<ul style="list-style-type: none"> • Compare current calibration results with historical data to identify trends or deviations that may indicate calibration drift. 	
	Traceability	<ul style="list-style-type: none"> • Maintain traceability of calibration records to national or international metrological standards to ensure the accuracy and reliability of measurement data. 	
		<ul style="list-style-type: none"> • Document calibration certificates and traceable calibration chains for audit and regulatory compliance purposes. 	
Training and Documentation	Training Programs	<ul style="list-style-type: none"> • Provide training for calibration technicians and operators on proper calibration procedures, techniques, and equipment handling practices. 	

		<ul style="list-style-type: none">• Ensure staff are knowledgeable about calibration standards, metrological principles, and compliance with quality assurance protocols.
	Documentation and Records	<ul style="list-style-type: none">• Establish a centralized database or record-keeping system to store calibration records, certificates, and documentation for easy access and retrieval.
		<ul style="list-style-type: none">• Maintain calibration schedules and reminders for timely recalibration of instruments based on established intervals.

4.7 Repair and Replacement Protocols

Repair and replacement protocols are essential for ensuring timely maintenance, efficient repairs, and effective management of equipment used in Somalia's Hydromet services. These protocols help minimize downtime, extend equipment lifespan, and maintain operational continuity.

Table 7: Repair and Replacement Protocols

Goal	Objective	Activity
Equipment Assessment and Evaluation	Routine Inspections	<ul style="list-style-type: none"> Conduct regular inspections of all equipment used in meteorological and hydrological monitoring, including Automatic Weather Stations (AWS), Manual Weather Stations (MWS), river gauges, groundwater monitoring wells, data loggers, and communication systems. Document inspection findings, noting any signs of wear, damage, or malfunction.
	Performance Monitoring	<ul style="list-style-type: none"> Monitor equipment performance through continuous data analysis and operational feedback. Establish performance thresholds and triggers for initiating repair or replacement actions based on predefined criteria (e.g., decreased accuracy, frequent breakdowns).
Repair Procedures	Troubleshooting and Diagnostics	<ul style="list-style-type: none"> Assign qualified technicians to conduct troubleshooting and diagnostics to identify the root cause of equipment malfunctions. Use diagnostic tools, testing equipment, and manufacturer guidelines to pinpoint issues accurately.
	Repair Plan Development	<ul style="list-style-type: none"> Develop a repair plan outlining specific action, resources required, and timelines for completing repairs. Prioritize repairs based on criticality to operations and data collection.
	Parts and Component Replacement	<ul style="list-style-type: none"> Source and procure replacement parts and components from approved suppliers or manufacturers. Ensure compatibility and quality assurance of replacement parts to maintain equipment performance.
	Repair Execution	<ul style="list-style-type: none"> Execute repairs according to established procedures and safety protocols. Document repair activities, including parts replaced, adjustments made, and testing conducted to verify functionality.
Replacement Procedures	End-of-Life Assessment	<ul style="list-style-type: none"> Assess equipment for signs of obsolescence, irreparable damage, or performance degradation beyond economical repair.
		<ul style="list-style-type: none"> Determine replacement criteria based on equipment lifespan, technological advancements, and operational needs.

Documentation and Reporting	Replacement Planning	<ul style="list-style-type: none"> • Develop a replacement plan outlining equipment specification, procurement process, budget considerations, and deployment timelines. • Coordinate with procurement teams to acquire new equipment and ensure seamless transition.
	Installation and Commissioning	<ul style="list-style-type: none"> • Install new equipment following manufacturer guidelines and technical specifications. • Conduct commissioning tests to verify proper functionality and integration with existing systems.
	Maintenance Records	<ul style="list-style-type: none"> • Maintain comprehensive records of all repair and replacement activities, including dates, equipment involved, repairs performed, and personnel responsible. • Use electronic systems or maintenance logs for systematic documentation and tracking.
	Performance Evaluation	<ul style="list-style-type: none"> • Evaluate repaired or replaced equipment to ensure it meets operational requirements and performance expectations. • Conduct post-repair testing and performance checks to validate effectiveness of repair actions.
Training and Capacity Building	Technical Training	<ul style="list-style-type: none"> • Provide ongoing training and certification programs for maintenance technicians on equipment repair, troubleshooting techniques, and safety procedures. • Foster a culture of continuous learning and skill development to enhance technical expertise.
	Knowledge Transfer	<ul style="list-style-type: none"> • Share best practices, lessons learned, and case studies from repair and replacement activities within the organization. • Facilitate knowledge transfer between experienced technicians and new recruits to strengthen maintenance capabilities.
Continuous Improvement	Root Cause Analysis	<ul style="list-style-type: none"> • Conduct root cause analysis for recurring equipment failures to identify underlying issues and implement corrective actions. • Implement preventive measures to minimize future breakdowns and enhance equipment reliability.
	Feedback Mechanisms	<ul style="list-style-type: none"> • Establish feedback loops with end-users, stakeholders, and equipment manufacturers to gather input on equipment performance and repair experiences. • Use feedback to refine repair and replacement protocols, optimize maintenance schedules, and improve service delivery.

4.8 Data Management

Proper management of data is indispensable if reliable data and useful information that will be collected from various hydromet stations in Somalia are to be realized. The frequency of collection and the format of data from each type of hydromet station are peculiar to the type. Equally, efficient data transmission methods are essential to ensure timely access to data from various hydromet stations. In this regard, standard practices regarding frequency, format of data collection and transmission for the various types of stations are shown in Table 9.

Furthermore, ensuring the quality and reliability of data collected from hydromet stations is critical for accurate weather forecasting and water resource management. The MoEWR System implements rigorous data quality control procedures, including automated and manual checks, to maintain data integrity (Table 10).

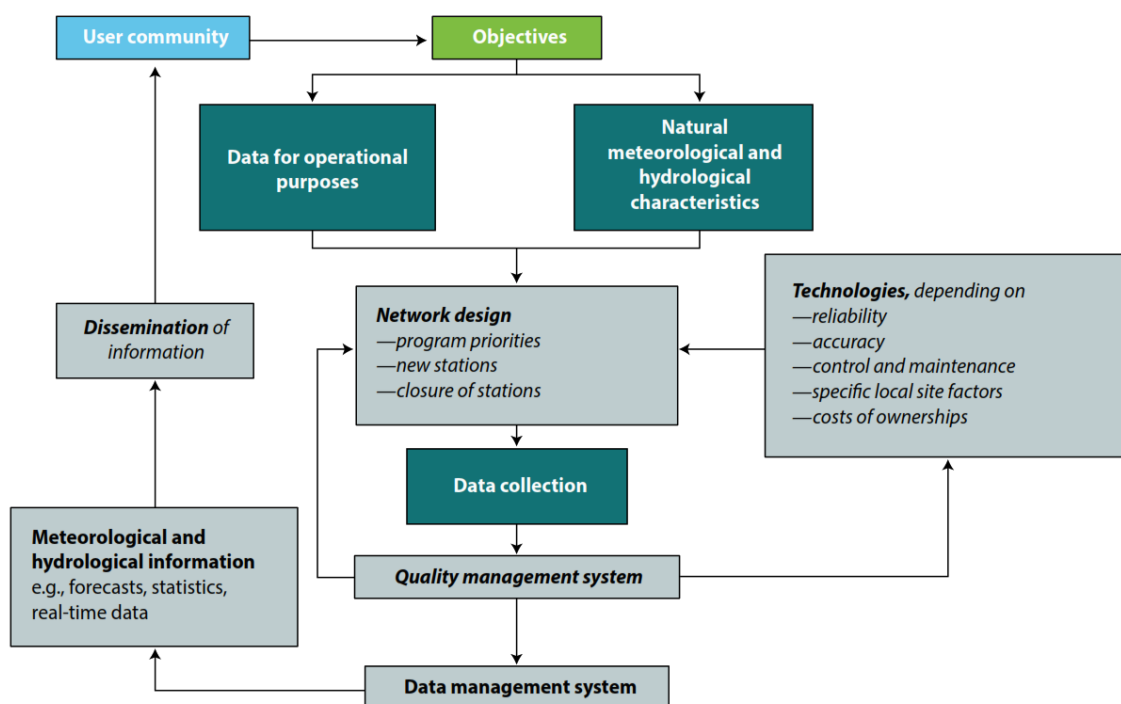


Figure 4.1: Data Flow in Hydrometeorological Services

4.8.1 Data Collection Methods and Transmission

- Gather meteorological and hydrological data from monitoring stations, satellite observations, and other sources.
- Ensure data collection methods (manual, automated) comply with standard protocols and quality assurance procedures.

Table 8: Data characteristics

Station Type	Frequency	Data Format	Data Transmission Method
Automatic Weather Stations	Continuous (real-time)	Digital (CSV, JSON, XML)	GSM/GPRS, Satellite, Internet

Synoptic Stations			Every 3 hours	Digital (CSV, JSON, XML)	GSM/GPRS, Satellite, Internet
Manual Rainfall Stations			Daily	Manual log, Digital (CSV)	Manual data entry, GSM/GPRS
River Gauging Stations			Hourly	Digital (CSV, JSON, XML)	GSM/GPRS, Satellite, Internet
Radar Sensors	Water Level		Continuous (real-time)	Digital (CSV, JSON, XML)	GSM/GPRS, Satellite, Internet
Groundwater Sensors	Level		Hourly	Digital (CSV, JSON, XML)	GSM/GPRS, Satellite, Internet

4.8.2 Data Quality Assurance

- Conduct quality control checks to validate data accuracy, completeness, and consistency.
- Identify and correct errors, outliers, or missing data points using automated algorithms or manual review.

Table 9: Quality control procedures

Procedure	Method	Purpose
Automated Checks	Outlier Detection	Identify and flag data anomalies.
	Consistency Checks	Ensure data consistency over time.
Manual Checks	Cross-Verification	Validate data accuracy from different sources.
	Validation Protocols	Periodic checks against known standards.
Real-time Monitoring	Alerts and Notifications	Immediate identification of data issues.

These checks are applicable to all sensors

4.8.3 Data Analysis Techniques

a) Statistical Analysis

- Apply statistical methods (e.g., mean, median, standard deviation) to analyse trends, variability, and relationships between meteorological variables (e.g., temperature, precipitation).
- Use regression analysis for both modelling and forecasting.

b) Spatial analysis

- Apply GIS software tools to investigate the spatial aspects of meteorological occurrences such as rainfall or temperature differences.
 - To determine the consequences on ecosystems or groups of people, superimpose weather data over geographic components.

c) Time-Series Analysis

- Time series analysis is used to investigate periodicity and emerging patterns, as well as monitor fluctuations in long-term values and rapid changes in meteorological data.
- Try using Fourier analysis or wavelet transforms to look for periodicity or oscillations.

d) Data Fusion and Integration

- Use data from weather stations, satellites, and other datasets to improve spatial and temporal analysis accuracy.
- Integrate meteorological and hydrological data to manage water resources more efficiently using flood forecasts.

4.8.4 Reporting and visualization

a) Dashboard and visualisation tools

- Create data analysis and representation tools such as graphs, maps, charts, and other visuals to display trends, unique data points, and projections.
- Improve the interfaces that assist users and other stakeholders in analysing the data collected.

b) Report Generation

- Prepare frequency reports with the results of the analysis, as well as the main findings and trends, for use by decision-makers, the government, and other stakeholders.
- To better data analysis, provide figures such as charts, tables, and additional remarks to increase clarity.

c) Forecasting and Early Warning Systems:

- Develop forecasting models based on historical data and predictive analytics to anticipate weather events (e.g., storms, droughts) and hydrological phenomena (e.g., river flow, groundwater levels).
- Issue timely alerts and warnings to relevant authorities and communities to mitigate risks and enhance preparedness.

4.8.5 Stakeholder Engagement

a) Communication Channels

- Establish effective communication channels to disseminate analysis results, reports, and forecasts to stakeholders.
- Ensure accessibility of information through websites, mobile applications, and public outreach programs.

b) Collaboration and Feedback

- Collaborate with government agencies, NGOs, and international organizations to share data, coordinate responses, and align strategies for disaster management and climate resilience.
- Solicit feedback from stakeholders to improve data analysis methodologies, reporting formats, and decision support tools.

4.8.6 Continuous Improvement:

1. Performance Monitoring:

- Monitor the effectiveness of data analysis and reporting procedures through performance metrics (e.g., accuracy of forecasts, timeliness of reports).
- Conduct periodic reviews and evaluations to identify opportunities for process optimization and enhancement.

2. Capacity Building

- Provide specialized corporate training, technical seminars, and workshops to help human resources improve their knowledge of data analysis, tools, and technology.
- Encourage employees and stakeholders to focus on change and knowledge.

5.0 CAPACITY BUILDING AND TRAINING

A comprehensive training needs assessment is the cornerstone for effective human resource development. This involves:

- **Job analysis:** Clearly defining the roles and responsibilities of each position within the department.
- **Skill gap analysis:** Identifying the difference between the required skills and the skills currently possessed by employees.
- **Performance appraisal:** Evaluating employee performance to identify areas for improvement.
- **Technology assessment:** Determining the level of technological proficiency required for different roles.
- **Stakeholder input:** Gathering feedback from employees, supervisors, and other stakeholders to identify training needs.

Training Programs for O&M Personnel

Based on the identified training needs, tailored training programs should be developed for O&M personnel. These programs may include:

- **Technical skills:**
 - Equipment operation and maintenance
 - Data collection and processing
 - Quality control procedures
 - Use of specialized software and tools
- **Soft skills:**
 - Communication and interpersonal skills
 - Problem-solving and decision-making
 - Teamwork and collaboration
 - Customer service

Training delivery methods can include:

- On-the-job training
- Classroom-based training
- E-learning
- Mentoring and coaching

Capacity Building Initiatives

To foster a culture of continuous learning and development, capacity building initiatives should be implemented. These may include:

- **Mentorship programs:** Pairing experienced staff with new employees.
- **Job rotation:** Providing opportunities for employees to gain experience in different roles.
- **Tuition reimbursement:** Supporting employees in pursuing higher education or professional certifications.
- **Knowledge sharing platforms:** Creating forums for employees to share knowledge and best practices.
- **Career development plans:** Assisting employees in setting career goals and developing a path to achieve them.

The following list is indicative of areas for which training is generally required by MoEWR-HD following a thorough assessment of the current capabilities and gaps in the knowledge of the relevant staff. Other areas may be added to this list as needed.

- Training on flood modelling, flood forecasting and flood risk management
- Training on flood forecasting using numerical models
- Training on maintenance and repair of hydro-met monitoring equipment.
- Training on weather forecasting using numerical models on all time scales from nowcasting to long-range forecasting
- Training on management, use and operations of Automatic Hydrological Stations and analysis of data generated.
- Training on management, use, and operations of automatic weather stations, and on analysis of data generated
- Training on management, operation and data collection
- Training on disseminate climate information and provide user-relevant climate risk management advice
- Training on Project management
- Training on Instruments and detectors maintenance
- Training on Database management
- Training on IT management skills
- Training on Public Weather Services and service delivery, including user/stakeholder consultation, communication, negotiation and feedback gathering

5.1 Training Needs Assessment

It is crucial to undertake a training needs assessment for Somalia's Hydromet services to identify the skills, knowledge, and competency gaps among the staff responsible for meteorological and hydrological observation.

Table 10: Training Needs Assessment

Step	Action	Details
Establish Objectives	Define Training Goals	<ul style="list-style-type: none"> Define explicit goals for assessing training needs, such as boosting data collection efficiency, improving data analysis, or implementing new technology.
	Identify stakeholders	<ul style="list-style-type: none"> Identify the individuals participating in hydromet activities, which include technicians, data analysts, researchers, and decision-makers.
Data collection	Surveys and interviews	<ul style="list-style-type: none"> Create questionnaires or interview questions to gather input from employees on their existing abilities, challenges, and potential training needs. Use questions related to specific technical competencies (for example, instrument preservation, data processing, hydromet methods), software applications, and general knowledge.
	Review of performance data	<ul style="list-style-type: none"> This comprises reviewing performance statistics on data quality, equipment maintenance records, and incidents to identify trends that point to recurring problems or a lack of required competencies.
Assess Training Needs	Skill Gap Identification	<ul style="list-style-type: none"> Surveys can then be compared to performance statistics, and the commonalities revealed can be used to identify desired abilities or areas of weakness. It is concerned with the priority of training in terms of its value to the overall functioning of the organization and the attainment of established goals and objectives
	Emerging Technology and Practices	<ul style="list-style-type: none"> Identify gaps in present hydromet monitoring systems to determine whether new instruments or procedures will require training.
Create a Training Plan	Training Objectives	<ul style="list-style-type: none"> When setting the specific training requirements, make sure to provide clear, quantifiable goals for acquiring knowledge in each of the categories.
	Training methods	<ul style="list-style-type: none"> Select an appropriate training technique and delivery method, such as face-to-face, at-work, computer-based, export training, and more. Make use of activity, the significance of situations, and demonstrations to reinforce what was learned.

Implementation	Resource Allocation	<ul style="list-style-type: none"> Organizational resource assignment entails allocating money and time resources for training activities, such as a training budget, a training calendar, and the availability of training aids or equipment.
	Training Delivery	<ul style="list-style-type: none"> Synchronize your training sessions with auspicious trainers or expert speakers to deliver training material that is appropriate for the demands. Create realistic assignments that allow employees to put their newly acquired knowledge into practice.
	Monitoring & Evaluation	<ul style="list-style-type: none"> Track the training process using feedback forms, quizzes, and participant activity assessments. Assess the training impact based on the outcomes of post-training exams and questionnaires, as well as the employees' performance in their field of work following training.
Continuous improvement	Feedback mechanisms	<ul style="list-style-type: none"> Create a method for collecting feedback from participants and supervisors to enhance training programs and be prepared to meet future requirements. Modify the training references and procedures based on the newly acquired and specific knowledge, as well as the most recent demands.
	Professional Development	<ul style="list-style-type: none"> Ensure that staff can receive additional training by providing the institution with access to certification courses and a mentorship program that will qualify them to rise to higher levels or positions within the institution.

5.2 Training Programs and Curriculum

Creating thorough training programs and a well-organized curriculum is crucial to improving the talents, know-how, and proficiency of staff members engaged in hydrological and meteorological monitoring.

Table 11: Training Programs and Curriculum

Aspect	Outcome	Action
Training Program Objectives	Skill Enhancement	<ul style="list-style-type: none"> Improve technical skills in data collection, instrument maintenance, and quality assurance procedures. Enhance data analysis capabilities for interpreting meteorological and hydrological data
	Technology Adoption	<ul style="list-style-type: none"> Introduce training on the use of modern equipment, automated systems, and remote sensing technologies. Foster proficiency in GIS applications for spatial analysis and data integration.
	Safety and Compliance	<ul style="list-style-type: none"> Ensure adherence to safety protocols and regulatory requirements during field operations and data handling. Promote awareness of ethical considerations, data privacy, and confidentiality in hydromet practices.
Curriculum development modules	Meteorological Concepts and Practices	<ul style="list-style-type: none"> Introduction to meteorological variables (e.g., temperature, humidity, precipitation) and their measurement techniques. Weather forecasting principles, including interpretation of synoptic charts and weather models.
	Hydrological Monitoring and Analysis	<ul style="list-style-type: none"> Fundamentals of hydrological cycle and water resource management. Techniques for measuring river discharge, groundwater levels, and water quality parameters.
	Instrumentation and Equipment Maintenance	<ul style="list-style-type: none"> Operation and maintenance of weather stations (manual and automated), river gauges, and data loggers. Troubleshooting common issues and performing routine maintenance tasks.
	Data Quality Assurance	<ul style="list-style-type: none"> Methods for data validation, quality control checks, and assurance procedures. Handling of metadata, calibration records, and documentation practices.
	Remote Sensing Applications	<ul style="list-style-type: none"> Utilization of satellite imagery and remote sensing data for monitoring weather patterns, vegetation indices, and climate trends.

Training Delivery Methods		<ul style="list-style-type: none"> • Mapping techniques for displaying meteorological and hydrological data and assessing spatial relationships.
	GIS and Spatial Analysis	<ul style="list-style-type: none"> • Integration of remote sensing data with ground-based observations for enhanced analysis. • Introduction to Geographic Information Systems (GIS) for spatial data visualization and analysis.
	Forecasting and Early Warning Systems	<ul style="list-style-type: none"> • Development of forecasting models using historical data, statistical methods, and numerical weather prediction techniques. • Implementation of early warning systems for floods, droughts, and extreme weather events.
	Workshops and Seminars	<ul style="list-style-type: none"> • Deliver case studies and brainstorming sessions with authorities in the respective subjects and professionals with extensive practice. • It is preferable to incorporate practical activities, illnesses and disease scenarios, as well as group discussions.
	On-the-Job Training (OJT)	<ul style="list-style-type: none"> • Establish a tutor and vocational training and internships for practical experience in the operations of the equipment and the analysis of data. • New employees mean new blood, but this comes with lack of skills and knowledge, the solution would be to assign the new employees to senior technicians or trainers.
Evaluation and Certification	E-Learning and Online Resources	<ul style="list-style-type: none"> • Offer web-based training materials in a format of e-learning courses or online classes available on LMS. • Create and provide courses that are available anytime which unlike traditional courses does not require the students to attend classes and involves elements such as videos, games, and documents for download.
	Assessment Criteria	<ul style="list-style-type: none"> • Assessment: It is crucial to set specific objectives/ learning outcomes in the training and easy measures definition for checking the participants' comprehending and application of training concepts. • Give quizzes, demonstrations, and group exercises to assess groups' knowledge and comprehension.
	Certification Programs	<ul style="list-style-type: none"> • Provide certificates or diplomas upon the end of training programs, and completion of all the respective assessment or examination. • Provide gifts to those who have the best performances as well as to those who take their time to learn more about the subject

Continuous Improvement	Feedback Mechanisms	<ul style="list-style-type: none"> Request participants/trainers and other stakeholders to complete an evaluation form to determine the effectiveness of the training and the need for future improvements. Utilize feedback as well as updates in the technologies and industry practices to modify curriculum and training materials.
	Professional Development Pathways	<ul style="list-style-type: none"> Provide advancement opportunities for the professionals, including options for additional training, professional designation, and joining occupational associations. It is possible to support continuous learning by taking refresher courses, workshops, or by attending conferences or seminars.

5.3 Knowledge Transfer and Succession

Knowledge transfer and succession protocols are essential factors for enhancing both the continuity and sustainability of Somalia’s Hydromet services, especially for the purpose of maintaining important information that needs to be passed from one individual to the other and the development of the future leadership.

Table 12: Knowledge Transfer and Succession

Objective	Action	Strategy
Knowledge Transfer Strategies	Documentation and Knowledge Management	<ul style="list-style-type: none"> Develop elaborate documentation policies that will facilitate writing of procedures, standards, and even experiences gained in meteorological and hydrological activities. Develop an informational datum of references that can be made available to the staff and efficiently updated from a central point.
	Mentorship and Shadowing	<ul style="list-style-type: none"> Provide experienced employees with an opportunity to mentor the new ones and help them as well as provide them with valuable insights and information. Promote on-job training where the staff follows the activities of their experienced counterparts during regular duties and operations.
	Training and Workshops	<ul style="list-style-type: none"> Conduct semi-annual refresher training and supplement with ‘spot’ training sessions and workshops on special skills, technologies, methodologies related to hydromet monitoring. Organize the content into practical problem-solving and application activities such as implementation of exercises, use of cases, and simulations.

Succession Planning Strategies	Cross-Training and Job Rotation	<ul style="list-style-type: none"> • Encourage staff exchange programmes that allow the staff to work in different functional areas of hydromet such as data acquisition, processing, and predicting. • Promote the practices of lateral movement of workers within departments or across departments to reduce on existent knowledge gaps.
	Knowledge Sharing Platforms	<ul style="list-style-type: none"> • Encourage staff to share ideas through daily or weekly meetings, weekly seminars and staff online forums where challenges, new innovations, and expertise are shared. • Promote the sharing of knowledge with other teams or with distant personnel by implementing technologies and instruments to support cohesion in a global collaborative work.
	Identify Key Positions and Roles	<ul style="list-style-type: none"> • List down positions in the Hydromet services where there is a need to apply succession planning including department managers, senior technologists, and specialised analysts. • Talent management surveys should also be conducted to determine who could best fill important organizational roles in a crisis.
	Talent Development and Career Planning	<ul style="list-style-type: none"> • Define training and experience activities with specific focus on succession plan for high performers in organization. • Promote the possibility to improve and enrich the knowledge at conferences or through receiving certain certificates or other types of further education.
	Leadership Training and Coaching	<ul style="list-style-type: none"> • For intending managers, establish management courses which enhances the abilities of leadership, critical thinking skills, and strategic outlook. • Assign a new generation of leaders with executive coaches or mentors particularly if there are changes in leadership.
	Succession Plan Implementation	<ul style="list-style-type: none"> • Conduct specific formal plans of succession that must point out the time frames, activities, and steps to move forward for the transfer of primary positions. • Continuity must be secured to achieve this overtraining of successors, conducting of overlap with the old leaders, and documentation of key processes and persons.
	Monitor and Evaluate Progress	<ul style="list-style-type: none"> • It is necessary to review and reconsider succession strategies constantly and update them according to changes in the organization, its employees' opinions, and trends in the field. • Address the efficacy of succession planning initiatives by key performance indicators, the survey of employees' satisfaction, and turnover figures.

Institutionalizing Knowledge and Succession Planning	Organizational Culture and Values	<ul style="list-style-type: none"> • Incorporate knowledge sharing and knowledge management as among the competencies of the organization. • Encourage those staffs who practice knowledge management and facilitate succession readiness on their relevant knowledge areas.
	Continuous Improvement and Adaptation	<ul style="list-style-type: none"> • Revised knowledge transfer and succession planning strategies consistently from the feedback, new lessons, and problems encountered so that new improvements are incorporated into the existing systems. • Identify the requirements of the future and the evolution of the types of skills the organisation will require as well as the technologies that can support talent acquisition.

6.0 MONITORING AND EVALUATION

Monitoring and evaluation (M&E) are essential for assessing the effectiveness of a hydromet O&M plan. It provides valuable insights into system performance, identifies areas for improvement, and informs decision-making. Key Components of M&E are:

- **Performance Indicators (KPIs):** Develop specific, measurable, achievable, relevant, and time-bound (SMART) indicators to assess the performance of the hydromet system. Examples include:
 - Data completeness and accuracy
 - Equipment uptime
 - Response time to equipment failures
 - Staff training and certification levels
 - Budget utilization
- **Data Collection:** Establish systems for collecting data on key performance indicators. This may involve using existing databases, conducting surveys, or implementing monitoring tools.
- **Data Analysis:** Analyse collected data to identify trends, patterns, and areas of strength or weakness.
- **Reporting:** Prepare regular reports on the performance of the hydromet system, including key findings and recommendations.
- **Feedback Mechanisms:** Establish channels for receiving feedback from staff, stakeholders, and end-users.
- **Corrective Actions:** Develop a process for addressing identified issues and implementing improvements.

Evaluation Methods

- **Regular reviews:** Conduct periodic reviews of the O&M plan to assess its effectiveness.
- **Impact assessment:** Evaluate the impact of the hydromet system on end-users and beneficiaries.
- **Cost-benefit analysis:** Assess the economic efficiency of the O&M plan.
- **Benchmarking:** Compare performance against similar hydromet systems.

Challenges and Considerations

- **Data quality:** Ensure data collected for monitoring and evaluation is accurate and reliable.
- **Resource constraints:** Allocate sufficient resources for M&E activities.
- **Stakeholder involvement:** Engage stakeholders in the M&E process.
- **Capacity building:** Build the capacity of staff to conduct M&E activities.
- **Use of technology:** Leverage technology for efficient data collection and analysis.

6.1 Performance Indicators

Performance indicators are essential for assessing the effectiveness, efficiency, and impact of Somalia's Hydromet services. These indicators help measure various aspects of operations, data quality, service delivery, and overall organizational performance.

Table 13: Performance Indicators

Aspect	Check	Indicator	Recommended
Data Collection and Quality	Data Availability:	<ul style="list-style-type: none"> Percentage of time data is available from weather stations, river gauges, and other monitoring instruments. 	<ul style="list-style-type: none"> Maintain data availability above 95% annually.
	Data Timeliness	<ul style="list-style-type: none"> Average duration, from the time it is collected, it takes before the data is prepared for analysis. 	<ul style="list-style-type: none"> Ensure the data are provided at specific times on the hourly, daily, monthly, and any other chosen sensor-specific time frame.
	Data Accuracy	<ul style="list-style-type: none"> Measured parameters of such as temperature and rainfall are measured using equipment vulnerable to damage and error and therefore the data is acceptable only when calibrated and checked against standard reference. 	<ul style="list-style-type: none"> Maintain data reliability at a predetermined level of error
Service Delivery	Response Time to Data Requests	<ul style="list-style-type: none"> Average time taken to respond to data requests from stakeholders (e.g., government agencies, researchers). 	<ul style="list-style-type: none"> Respond to data requests within agreed-upon time frames, preferably within 24 hours.
	Service Reliability	<ul style="list-style-type: none"> Percentage of uptime for data transmission systems (e.g., telemetry networks, satellite communication). 	<ul style="list-style-type: none"> Ensure high reliability with uptime exceeding 99% annually.
	Customer Satisfaction	<ul style="list-style-type: none"> Stakeholder feedback on the quality, usefulness, and accessibility of hydromet services. 	<ul style="list-style-type: none"> Achieve high satisfaction ratings through regular surveys or feedback mechanisms.
Operational Efficiency	Cost Efficiency	<ul style="list-style-type: none"> Operational costs per unit of data collected or service provided. 	<ul style="list-style-type: none"> Optimize operational costs while maintaining service quality and data integrity
	Resource Utilization	<ul style="list-style-type: none"> Utilization rates of equipment, personnel, and financial resources. 	<ul style="list-style-type: none"> Maximize resource utilization to support increased data collection and analysis demands.

Risk Management and Preparedness	Early Warning Response	<ul style="list-style-type: none"> • Timeliness and accuracy of issuing weather alerts and early warnings for natural hazards such as drought and floods 	<ul style="list-style-type: none"> • Improve early warning systems to enhance community preparedness and response.
	Disaster Response Effectiveness	<ul style="list-style-type: none"> • Evaluation of the effectiveness of hydromet data in supporting disaster response and recovery efforts. 	<ul style="list-style-type: none"> • Enhance coordination and communication to mitigate impacts of weather-related disasters.
Capacity Building and Sustainability	Staff Training and Development	<ul style="list-style-type: none"> • Participation rates in training programs and professional development opportunities 	<ul style="list-style-type: none"> • Increase staff competency and expertise in hydromet practices and technologies.
	Infrastructure Development	<ul style="list-style-type: none"> • Progress in infrastructure upgrades, expansion of monitoring networks, and adoption of new technologies. 	<ul style="list-style-type: none"> • Enhance infrastructure resilience and operational capabilities to meet evolving climate challenges.
Environmental and Social Impact	Environmental Compliance	<ul style="list-style-type: none"> • Adherence to environmental regulations and sustainable practices in hydromet operations. 	<ul style="list-style-type: none"> • Minimize environmental footprint and promote sustainability in data collection and management.
	Community Engagement	<ul style="list-style-type: none"> • Engagement levels with local communities, stakeholders, and decision-makers in utilizing hydromet information. 	<ul style="list-style-type: none"> • Foster partnerships for informed decision-making and community resilience building.

6.2 Regular Assessment and Reporting

Regular assessment and reporting are important in the governance and management of hydromet for improved service delivery in Somalia. These processes make it possible to check efficiency of the operations, data accuracy, as well as the awareness of the stakeholder on the performance of the service.

Table 14: Assessment and reporting protocol

Component	Action
Frequency of assessment	<ul style="list-style-type: none"> Regularly test and assess the functionality of the hydromet equipment at definite time intervals like quarterly, bi-annually, or annually to assess how well the operational performance is in line to the goals set.
Data quality assessment	<ul style="list-style-type: none"> Assess the reliability, promptness and thoroughness of hydromet data acquired basing on the monitoring stations and sensors.
Operational efficiency	<ul style="list-style-type: none"> Reflect on the effectiveness of the collected information, utilization rates of instruments, equipment, and other resources.
Service delivery	<ul style="list-style-type: none"> Evaluate the effectiveness in delivery of early warning systems and customer satisfaction by ensuring timely response to data requests by the end-users.
Risk management	<ul style="list-style-type: none"> Assess the capability in dissemination of weather alerts, participation in disasters response, and managing climate change risks.
Capacity building	<ul style="list-style-type: none"> Track the level of achievement towards staff training, skill enhancement, and construction of structures.
Environmental impact	<ul style="list-style-type: none"> Evaluate the social responsibility of the hydromet services with respect to environmental laws and compliance and engagement of various communities.
Methodology	<ul style="list-style-type: none"> Implement assessment tools and performance measurements to evaluate the hydromet's activities, utilizing KPIs and performance benchmarks aligned with standard assessment frameworks.
Stakeholder involvement	<ul style="list-style-type: none"> Engage the management, the technical staff and other internal staff to ensure that they contribute towards the assessment and the government agencies, the community and other external parties to ensure that they give their feedback on the assessment.
Report Components	<ul style="list-style-type: none"> Executive Summary: A summary of the assessment's outcome should be made inclusive of the assessment success, failures, and recommendations.

	<ul style="list-style-type: none"> • Data Analysis: Explain in detail the review of the results obtained for the following: Performance indicators, evaluation criteria, and trends identified during assessment. • Case Studies or Examples: Include specific examples of successful outcome of the initiatives, successful actions, and unsuccessful actions with recommendation for improvement respectively. • Recommendations: Give practical suggestions that will improve the overall efficiency of the operations, data quality, and the mentioned shortcomings. • Financial Summary: Summarize the expenses and spending and the hydromet services budget and draw the funding sources of hydromet services and its utilization.
Audience	<ul style="list-style-type: none"> • Tailor reports to different stakeholders, including government officials, funding agencies, technical experts, and the public, to ensure relevance and transparency.
Communication Channels	<ul style="list-style-type: none"> • Distribute reports through official channels, such as websites, newsletters, and stakeholder meetings, to reach a wide audience and facilitate feedback • Follow-up Actions: Implement a mechanism for monitoring progress on recommendations, addressing corrective actions, and updating stakeholders on developments between assessment periods.
Feedback Mechanisms	<ul style="list-style-type: none"> • Establish mechanisms for gathering feedback from stakeholders on assessment findings, report content, and service delivery experiences.
Learning and Adaptation	<ul style="list-style-type: none"> • Use assessment outcomes to inform strategic planning, policy development, and continuous improvement initiatives within the Hydromet services.
Capacity Building	<ul style="list-style-type: none"> • Invest in staff training, technology upgrades, and institutional strengthening based on assessment findings and evolving operational needs.

6.3 Continuous Improvement Plan

Continuous Improvement Plan (CIP) is required for improved services' operation, data quality, and service delivery.

Table 15: Continuous Improvement Plan

Objective	Strategy
Performance Evaluation	<ul style="list-style-type: none"> Take stock of daily practice, focusing on the data gathering, material and staff efficiency, as well as their competencies. Discuss main performance measures associated with data quality, service provision and delivery, working productivity and user/customer satisfaction.
SWOT Analysis	<ul style="list-style-type: none"> Analyse SWOT of hydromet services in Somalia. Analyse strengths or internal conditions, threats or external environment, and opportunities for change.
Set SMART Goals	<ul style="list-style-type: none"> By following the details of the SMART concept for goal setting, the department should set clear objectives for improvement of service delivery.
Prioritize Areas for Improvement	<ul style="list-style-type: none"> Identify other high-risk areas such as accuracy of collected data, performance of business processes, requirements for infrastructure, and staff development from the assessment results and stakeholders' comments.
Process Optimization	<ul style="list-style-type: none"> Generally, improve the existing methods of data collection, validation, and analysis to speed up their completion. To increase the validity and reliability of the data, the use of computers to process the data should be instituted together with quality control techniques.
Technology Upgrades	<ul style="list-style-type: none"> Spend in the latter concerning sensibly equipment modernization, telemetry, and put money in advanced forecasting models and digital geographic information system technologies. Adheres to compatibility with the international and acknowledgement of regional and world meteorological networks.
Training and Capacity Building	<ul style="list-style-type: none"> Establish an organizational training framework to improve on technical knowledge of the staff on meteorology, hydrology, statistics and information technology amongst others. Continuously learning by attending workshops, certification and knowledge enhancing programs in the organization.
Assign Responsibilities	<ul style="list-style-type: none"> Ensure there are specific people or groups of people who are responsible for the delivery of each improvement plan. In many cases, maps are used in a confusing manner since the roles, responsibilities, and schedules for the action plans defined are not clearly understood.
Allocate Resources	<ul style="list-style-type: none"> Acquire financial and other (human and technical) capital required for organization improvement activities.

Performance Metrics	<ul style="list-style-type: none"> • Closely follow the expenditure of the budget and dedicate necessary adjustments to make the implementation accurate. • Set up goals and objectives and assign specific targets that would indicate that there has been an improvement. • It is essential to track different performance indicators that are connected to data efficacy, performance of services, organization efficiency, and satisfaction of end users.
Feedback Mechanisms	<ul style="list-style-type: none"> • Survey internal users such as staff and external users including government, community members and non-governmental organizations on the repercussions of the improvement initiatives. • Feedback needs to be used to make changes and to counteract any difficulties and to fine-tune the improvement plan.
Continuous Review	<ul style="list-style-type: none"> • Assess effectiveness of the CIP on the regular bases, to determine which aspects require alterations. • Meeting the requirements of changing organizational objectives, technological developments and upcoming climate issues.
Adaptation to Change	<ul style="list-style-type: none"> • Be on the lookout for the emerging technologies, rules, and recommendations that will influence the organization and revise its strategies consequently. • Be able to foresee the future requirements and adapt the improvement plans to continue being promptly useful and efficient.

7.0 BUDGET AND RESOURCE ALLOCATION

A well-structured budget is essential for the successful implementation of a hydromet O&M plan. It ensures the availability of necessary resources to maintain and improve the hydromet system.

Key Budget Components

- Personnel Costs: Salaries, benefits, and training expenses for hydromet staff.
- Operational Costs: Expenditures for daily operations, including utilities, transportation, and communication.
- Maintenance Costs: Funds for equipment repair, calibration, and replacement.
- Capital Expenditures: Investments in new infrastructure, technology, and equipment.
- Training and Development: Allocations for staff training and capacity building.
- Contingency Funds: Reserves for unforeseen expenses or emergencies.

Resource Allocation

- Prioritize Needs: Identify critical areas requiring immediate attention based on the condition of the hydromet system and operational requirements.
- Cost-Benefit Analysis: Evaluate the potential return on investment for different budget options.
- Flexible Budgeting: Allow for adjustments based on changing priorities and circumstances.
- Resource Optimization: Maximize the utilization of available resources through efficient planning and management.

Funding Sources

- Government Allocation: Secure consistent funding from the government budget.
- Donor Support: Seek funding from international development partners.
- Cost Recovery: Explore opportunities to generate revenue through hydromet services.
- Public-Private Partnerships: Collaborate with private sector entities for resource sharing.

Financial Management

- Budget Monitoring: Track expenditures against the approved budget.
- Financial Reporting: Prepare regular financial reports for management and stakeholders.
- Auditing: Conduct periodic financial audits to ensure compliance and accountability.

Challenges and Considerations

- Limited Resources: Often, hydromet departments face budgetary constraints. Prioritization and cost-effective solutions are crucial.
- Inflation: Consider the impact of inflation on budget planning and execution.
- Currency Fluctuations: If applicable, manage the risks associated with foreign exchange rates.
- Sustainability: Develop strategies to ensure long-term financial sustainability of the hydromet system.

7.1 Resource Requirements (Personnel, Equipment, Supplies)

Resource specifics for Hydromet services in Somalia would mean determining the necessary human resources, tools, and materials to carry out meteorological and hydrological processes. It entails ascertaining the probable costs of continuing to provide the services without interruption or significant disruption, providing consistent maintenance services for the equipment used in delivering the hydromet services, and guaranteeing the quality and reliability of data gathered through the services.

Table 16: Hydromet Service Resource Requirement Budget Estimates

No	Personnel	Description	Monthly cost (USD)	Annual cost (USD)
1. Salaries and benefits				
1.1	Director	The Director leads the team and responsible for the actions and functions of the Department of Hydrometeorology.	4,500	54,000
1.2	Hydrologist	Hydrology data acquisition, processing, prognosis.	2,500	30,000
1.3	Meteorologist	Meteorology data acquisition, processing, prognosis.	2,500	30,000
1.4	Data analyst	Hydrometeorology data analysis	2,000	24,000
1.5	Technical advisor	National Water Resource Management Expert	2,500	30,000
1.6	Technical advisor	National Flood and Drought Forecasting and Modelling Expert	2,500	30,000
1.7	GIS/Remote Sensing Officer	In charge of remote sensing and GIS based data manipulation and projections	1,000	12,000
1.8	Communication and Graphics Design Officer	Ensures effective and efficient communication of hydromet information to the end users and even amongst staff.	8,00	9,600
1.9	Gender specialist	Ensures gender mainstreaming in all hydromet operations	8,00	9,600
1.10	Administrator	Handle administrative tasks, including human resources, finance, and procurement. Provide logistical support for field operations.	8,00	9,600
1.11	Finance Coordinator	Handle the financial part	8,00	9,600
Sub-total			20,700	248,400

2. Training and capacity building				
No	Item	Description	Units	Annual cost (USD)
2.1	Training modules	Development of hydromet training modules	1	5,000
2.2	Workshop venue	Cost of venue for the training and capacity building workshop	30 days	15,000
2.3	Trainers' fees	Cost of procuring consultant's to train and capacity build the technical staff.	30 days	15,000
2.4	Trainees allowance	Sitting allowances plus accommodations fees for the technical staff during training workshops	20 staff	10,000
2.5	Transport	Commuter facilitation for the technical staff to and from the training venue.	20 staff	10,000
	Exposure visits for staff	Bench marking by the technical staff on hydromet management in developed countries with well established hydro-meteorological department	Lumpsum	120,000
	Community capacity building	Training members of the community on the interpretation and response to the climate alerts	Lumpsum	120,000
	Establishment of higher level education program	Development of hydrology and meteorology related a curriculum to be introduced in institutions of higher learning	Lumpsum	500,000
		Sub-total		795,000
3. Procurement and installation of equipment and technology				
No	Item	Description	Unit cost (USD)	Annual cost (USD)
3.1	Automatic weather station	A few (32) for the regions not covered currently	10000	32,000
3.2	Satellite receivers	Six, one for each of the FMS	1000	6,000
3.3	Data loggers	For data storage and transmission to online platforms. Only for those stations without one (50).	300	15,000

3.4	Installation costs	Cost of installing the new equipment	5000	5,000
3.5	Logistics	Cost of mobilizing the equipment to site	1000	1,000
3.6	Training modules	Cost of developing training modules	1000	1,000
Sub-total				60,000
4. Maintenance and repair of equipment and technology				
No	Item	Description	Monthly cost (USD)	Annual cost (USD)
4.1	Preventive maintenance fees	For continuous maintenance of the stations (monthly)	500	6,000
4.2	Inspection fee	Cost of inspection services on all the components of the stations to ensure sustained functionality (Monthly)	500	6,000
4.3	Repair costs	Repair of impaired and worn-out components of weather stations (Monthly)	500	6,000
4.4	Technology upgrade costs	For system updates and purchase of new technologies (Annual)	5000	5,000
Sub-total				23,000
5. Operation and utilities costs				
No	Item	Description	Monthly cost (USD)	Annual cost (USD)
5.1	Electricity costs	Cost of electricity required to run weather stations (Monthly)	1000	12,000
5.2	Telecommunication	Media fees for dissemination of weather information to end users (Monthly)	1000	12,000
5.3	Field surveys and inspections	Cost of regular field visits (Monthly)	500	6,000
Sub-total				30,000
6. Data management and quality assurance				
No	Item	Description	Monthly cost (USD)	Annual cost (USD)

6.1	Software licensing	Annual license fees	10000	10,000
6.2	Cloud storage fees	Annual cloud storage subscription fees	1000	1000
Sub-total				11,000
7. Stakeholder engagement, contingency and monitoring and evaluation				
s/no	Item	Description	Unit cost (USD)	Annual cost (USD)
7.1	Stakeholder sensitization and awareness workshops	Quarterly stakeholder engagement workshops	1000	4000
7.2	Contingency fund	Emergency fund	10000	10,000
7.3	Monitoring and evaluation	Cost of quarterly monitoring and evaluation of hydromet services	5000	20,000
Sub total				34,000
Grand total				1,201,400

7.2 Funding Sources and Allocation

Securing adequate funding and strategically allocating resources are crucial for sustaining Somalia's Hydromet services encompassing meteorological and hydrological monitoring.

7.2.1 Sources of funding

1. Government Budget Allocation

- **National Budget:** Allocate funds through national budgets to support hydromet infrastructure, personnel salaries, and operational expenses.
- **Ministries and Agencies:** Coordinate funding through relevant ministries (e.g., Ministry of Water Resources, Ministry of Finance) responsible for water resource management and meteorological services.

2. International Aid and Development Assistance

- **Multilateral Organizations:** Source funds from the international financial institutions such as World bank, United Nations (UN) and the African Development Bank (AfDB) for infrastructural enhancement and training purposes.
- **Bilateral Aid:** Engage donor countries to supporting the funding of grants, loans or technical for improving hydromet and climate change.

3. Research Grants and Collaborative Projects

- **Research Institutions:** Gift funds from universities, research institutions and NGOs to make it easier to get allow for research on climate science, data analysis and modelling.
- **International Programs:** Support and be involved in contracts arising from the implementation of international programs concerning climate, natural disasters and sustainable development goals- SDGs.

4. Public-Private Partnerships (PPPs)

- **Private Sector Contributions:** Export private players in PPP arrangements for the financial commitment in strengthening hydromet infrastructure, technology, and data.
- **Corporate Social Responsibility (CSR):** Persuade corporate entities to provide funding or products or services towards the efforts of strengthening community readiness.

7.2.2. Allocation Considerations

1. Infrastructure Development

- Allocate funds for the procurement, installation, and maintenance of weather stations, river gauges, telemetry systems, and data management infrastructure.

- Prioritize upgrades to enhance data collection capabilities, reliability, and real-time data transmission.

2. Personnel and Capacity Building

- Budget for salaries, benefits, and training programs to develop and retain qualified staff in meteorology, hydrology, data analysis, and technical support roles.
- Invest in continuous professional development to keep pace with technological advancements and best practices.

3. Operational Expenses

- Allocate resources for day-to-day operational expenses, including utilities (electricity, water), office supplies, communication costs, and field operations logistics.
- Include provisions for emergency response preparedness, equipment maintenance, and contingency planning.

4. Research and Innovation

- Set aside funds for research initiatives, pilot projects, and innovation in climate modelling, forecasting techniques, and adaptation strategies.
- Support collaborations with academic institutions and research partners to leverage expertise and explore cutting-edge solutions.

5. Community Engagement and Outreach

- Dedicate resources for public awareness campaigns, stakeholder engagement activities, and capacity-building workshops to enhance community resilience and response to weather-related hazards.
- Foster partnerships with local communities, civil society organizations, and governmental agencies to promote data-driven decision-making and disaster preparedness.

8.0 RISK MANAGEMENT

8.1 Risk and Hazard Evaluation

Risk and hazard analysis is a vital process in assessing threats in the operations of Somali's Hydromet services to ensure the safety of its personnel and safeguard its services in case of adverse outcomes.

8.1.1 Types of Risks and Hazards

1. Environmental Risks

- Climate Extremes: Such as droughts, floods, cyclones, and extreme weather conditions which may affect machinery and equipment, interrupt business, or endanger staff.
- Natural Hazards: Challenges such as landslides, earthquake or tsunamis that may affect the stations or structures used in monitoring.

2. Operational Risks

- Equipment Failure: Damage to weather stations, river gauges or telemetry systems & equipment resulting into wrong results and interruption of service.
- Power Outages: Disruptions of power about the availability and reliability of electrical energy, needed for data transfer and organizational continuity.
- Communication Failures: Problems in getting timely data through satellite phones, internet, or radio affecting the timely data transfer.

3. Safety and Security Risks

- Field Operations: Hazards which can be likely to accompany the field surveys, site inspections as well as routine maintenance trips in tough or risky territory.
- Security Threats: New risks such as civil unrest or theft of some of the equipment and or harm to personnel.

4. Data Integrity and Cybersecurity Risks

- Data Breaches: illicit interface with personal meteorological or hydrological data, which inevitably leads to violation of the content confidentiality and its alteration.
- Cyberattacks: Involving ill-intentioned actions on IT systems or the computers that host data and information as well as the communication networks.

8.1.2 Risk Identification Process

1. Risk Assessment Methods

- Brainstorming Sessions: Involve the stakeholders to discuss and bring out some risks and hazards that they would see within the workplace by virtue of their position and knowledge.
- Risk Registers: It is necessary to keep an updated database or register where information about the identified risks, their probability, consequences, and possible preventive measures should be recorded.
- Scenario Analysis: Discuss with management hypothetical cases to predict risks and design measures to mitigate them.

2. Risk Mapping

- **Geographical Mapping:** Determine regions that are most at risk to specific dangers and target them for protective measures such as avoiding the construction.
- **Infrastructure Mapping:** Identify the places where the monitoring stations, equipment and communication nodes are to be sited to determine their exposure to environmental and operating risks.

8.1.3 Stakeholder Involvement

Internal Stakeholders

- Involve employees from various departments like meteorological, hydrological, and IT to bring ideas on the organizational operations' risks and how to avoid them.
- Promote cross-over between the technical teams that are involved in data gathering and processing as well as data base administrators.

External Stakeholders

- Meet with government departments, inhabitants and officials from the disaster management offices to gain an insight of risks in the region and to harmonise interventions.
- Develop cooperation with international organizations and research centres to learn from them, and to get technical assistance and recommendations in the sphere of risk management.

8.1.4 Risk Mitigation and Contingency Planning

Mitigation Strategies

- **Infrastructure Resilience:** Flood-proofing, seismic retrofitting and all other strategies aimed at enhancing the structure's resilience to environmental scourges must be addressed.
- **Backup Systems:** Natural and man-made disasters should have contingency solutions such as the duplicate storage systems for data, communication, and power.
- **Regular Maintenance:** Minimize or eliminate such risks by performing regular check-ups, and preventive measures, and acquire new better equipment

Contingency Plans

- **Emergency Response Protocols:** Establish and share guidelines on Disaster Management in cases of natural disasters, failure in equipment, and mishaps/ insecurity.
- **Business Continuity:** State guidelines for business continuity and keep vital operations, effective data transmission, and communication pathways during disasters.

8.1.5 Monitoring and Review

Continuous Monitoring

- Risk registers, incident reports and Key performance indicator reports should be reviewed periodically to know the extent of effectiveness of risks containment measures.

- Carry out an annual exercise of the response plan and train employees on performing response procedures.

Adaptation and Learning

- They should ensure that the process of managing risks involves appreciation of information obtained from previous accidents and close calls.
- Review and adapt the risk analysis and the mitigation plans according to the change in the environmental factors, new technologies, or changes in the organization structure.

8.2 Risk Mitigation Strategies

Developing robust risk mitigation strategies is essential for Somalia's Hydromet services to effectively manage and minimize potential threats to operations, personnel safety, data integrity, and service delivery.

Table 17: Hydromet Risk Mitigation Strategies

Risk	Hazard	Mitigation Strategy
Environmental Risks	Flooding and Extreme Weather Events	<ul style="list-style-type: none"> Protect the critical infrastructure and monitoring stations situated in the flood prone areas from floods by lifting equipment from the possibility of being flooded, placing barriers and designing good drainage system. Adequate power supplies should be put in place especially in cases of natural disasters like tornadoes, where there is a need for standby power such as generators or solar power.
	Drought and Water Scarcity	<ul style="list-style-type: none"> Save water to enhance the usage in the process of monitoring while utilizing rainwater during dry periods. This involves adopting water conservation measures such as rainwater harvesting, optimum irrigation and focusing on water's core uses.
Operational Risks	Equipment Failure	<ul style="list-style-type: none"> Adopt an effective preventive maintenance check point on weather stations, river gauges, telemetry systems and any other monitoring instruments. Effective troubleshooting should be performed regularly and ensure calibration, and timely service of the equipment. Store extra spare parts and appliances to overcome failure of devices and reduce the time to restore the functionality of the equipment.
	Power Outages	<ul style="list-style-type: none"> Have UPS systems or backup generators to provide power to the hydromet's essential items and data servers during blackouts. Adopt a conservative energy policy and replace machines to cut energy costs and increase accessibility during long blackouts.
Safety and Security Risks	Personnel Safety	<ul style="list-style-type: none"> Ensure that the field workers undertake an effective safety training on various general safety issues relevant to the specific weather monitoring activities including working at certain heights and working with hazardous materials. Ensure everybody engages in field operations uses the right personal protective equipment (PPE) including helmets, vests, boots, and gloves.

Data Integrity and Cybersecurity Risks	Security Threats	<ul style="list-style-type: none"> Enhance security measures for monitoring stations and equipment installations in remote or vulnerable areas. This includes installing security cameras, perimeter fencing, and employing security personnel or local community guards.
	Data Breaches and Cyberattacks	<ul style="list-style-type: none"> Encrypt data communication and procuring fire walls and IDSs to minimize the risk of vulnerability among its clients. Always update software and firmware to plug these and other possible points of weaknesses that arise with the ever-imminent cyber threats. Many types of protection should be put in place to make sure that only those people who are supposed to get access to lose information and other important systems get that access.
Continuity and Resilience Planning	Business Continuity Plan (BCP)	<ul style="list-style-type: none"> It is recommended to have and update a detailed BCP provided to offer step-by-step guidelines of how to sustain critical service, data, and communication processes in case of unforeseeable situations. Create procedural guidelines outlining how to address emergencies ranging from basic, such as a fire, tornado, blackout, etc, to more specific, like a system failure, cyber-attack, etc.
Training and Capacity Building	Staff Training and Development	<ul style="list-style-type: none"> Continued training is required to grow the understanding of the staff towards emergencies, risks, and new technologies. Cross-training of staff is very important to strengthen and develop versatility in dealing with a few activities and tasks involved in the hydromet service.
	Implementation and Monitoring	<ul style="list-style-type: none"> In the development of each of the above mitigation plans, it is important to indicate who is responsible for each of the plans, the resources that should be provided to execute these plans (finances, personnel, technology), and time frame for implementation. Conduct periodical evaluations and modifications of risk prevention measures by conducting renewal drills and simulations periodically to assess the applicability of the developed emergency plans.

8.3 Contingency Planning

Risk management is a great requirement to ensure that Somalia’s Hydromet services can efficiently counteract events or circumstances that are unforeseen or undesirable that may affect the operation, the information, and the services of the Hydromet.

Table 18: Hydromet Contingency Planning

Step	Objective	Strategy
Identify Potential Risks and Scenarios	Risk Assessment	<ul style="list-style-type: none"> Carry out a risk analysis to establish possibilities of risk and harm that pose a threat to hydromet operations. Check on environmental hazards (floods, droughts), operational hazards (equipment, power), safety hazards (during fieldwork) and cyber hazards (theft/loss of data, hacking).
	Scenario Planning	<ul style="list-style-type: none"> Construct threat profiles for each of the risks identified to be able to predict possible consequences on operations, the people that will be involved, data, and service delivery. Rank risks in a manner that results in their probability and expected impact being used to properly target contingency planning.
Develop Contingency Strategies	Response Strategies	<ul style="list-style-type: none"> Develop clear procedures or guidelines on how the organization will rectify adverse incidents for instance disasters, equipment breakdowns or cyber-attacks. Assign duties for the staff and other stakeholders who are involved in the emergency response plan’s implementation. Develop strategies to maintain essential services, data continuity, and communication channels during disruptions. This includes identifying backup systems, alternative data storage options, and alternative operational sites if primary facilities are compromised.
	Resource Allocation	<ul style="list-style-type: none"> Identify and allocate necessary resources (financial, human, and technological) to support contingency operations. Maintain contingency funds for emergency procurement, repairs, and operational continuity. Establish partnerships with suppliers and service providers for expedited access to critical resources during emergencies.

Communication and Coordination	Stakeholder Engagement	<ul style="list-style-type: none"> • Establish communication protocols with internal stakeholders (e.g., staff, management) and external stakeholders (e.g., government agencies, community partners) to ensure timely dissemination of information and coordinated response efforts. • Develop contact lists, communication channels (e.g., phone trees, email distribution lists), and protocols for activating communication during emergencies.
	Collaboration with Partners	<ul style="list-style-type: none"> • Foster partnerships with local authorities, disaster management agencies, and international organizations to enhance coordination and resource mobilization during crisis situations. • Participate in joint exercises, drills, and simulations with stakeholders to test and refine contingency plans and response strategies.
Training and Capacity Building	Staff Training	<ul style="list-style-type: none"> • Provide regular training sessions and workshops for staff on emergency response procedures, safety protocols, and the use of contingency resources. • Conduct cross-training initiatives to ensure personnel are equipped to perform multiple roles during emergencies and staff absences.
	Knowledge Sharing	<ul style="list-style-type: none"> • Document contingency plans, procedures, and lessons learned from past incidents to facilitate knowledge sharing and continuous improvement. • Update contingency plans based on feedback, emerging risks, and evolving organizational needs.
Testing and Evaluation	Drills and Exercises	<ul style="list-style-type: none"> • Conduct regular drills, tabletop exercises, or simulations to test the effectiveness of contingency plans and response strategies. • Evaluate staff performance, communication protocols, and operational readiness during simulated emergency scenarios.
	Feedback and Review	<ul style="list-style-type: none"> • Solicit feedback from participants and stakeholders involved in drills to identify strengths, weaknesses, and areas for improvement in contingency planning and response. • Review and update contingency plans based on feedback, new risk assessments, regulatory changes, and lessons learned from real-world incidents.

9.0 COMMUNICATION AND OUTREACH

9.1 Communication protocol

A comprehensive communication protocol for hydromet service delivery ensures effective communication among technical staff, the Ministry responsible for meteorological services, end users (such as farmers, fishermen, and local communities), and broader community stakeholders.

Communication Channels and Methods

1. Internal Communication (Technical Staff and Ministry)

- a) **Email:** For formal documentation, data sharing, and technical discussions.
- b) **Meetings:** Regular meetings (virtual or in-person) to discuss data analysis, forecasts, and operational updates.
- c) **Intranet or Shared Drive:** Centralized repository for technical reports, guidelines, and protocols.

2. External Communication (Ministry, End Users, Community)

Ministry to End Users

- **Weather Alerts:** SMS alerts, automated phone calls, or mobile app notifications for severe weather warnings.
- **Public Awareness Campaigns:** Workshops, community meetings, and radio broadcasts to educate on climate resilience and weather preparedness.

End Users to Ministry

- **Feedback Mechanisms:** Dedicated hotlines, community forums, or surveys to gather feedback on the usefulness of weather information and service delivery.
- **Data Collection:** Encourage end users to report local weather observations or impacts, fostering a participatory approach.

3. Emergency Response Protocol

- **Activation:** Define criteria and procedures for activating emergency response plans based on severe weather events (e.g., storms, floods).
- **Communication Flow:** Establish clear channels for rapid communication between technical staff, the Ministry, and community leaders during emergencies.
- **Public Alerts:** Ensure timely dissemination of emergency alerts to vulnerable communities through preferred communication channels.

4. Cultural and Contextual Considerations

- Tailor communication strategies to local languages and cultural norms to enhance accessibility and understanding.

- Consider the socio-economic context of different communities to ensure inclusivity and relevance of weather information.

5. Adherence and Compliance

- Ensure adherence to national regulations, international standards, and ethical guidelines in data collection, analysis, and dissemination.
- Uphold principles of transparency and accountability in service delivery.

9.2 Public Awareness Campaigns

Public awareness campaigns are crucial for educating and engaging the public, stakeholders, and communities on the importance of meteorological and hydrological information, safety measures, environmental conservation and disaster risk preparedness and mitigation.

Table 19: Public awareness campaigns strategy

Item	Category	Action
Objectives of Public Awareness Campaigns	Education and Outreach	<ul style="list-style-type: none"> • Raise awareness about the role of hydromet services in monitoring weather patterns, water resources, and climate change impacts. • Inform the public about the significance of accurate weather forecasts, flood warnings, and early warning systems in disaster preparedness and response.
	Safety and Risk Mitigation	<ul style="list-style-type: none"> • Promote safety guidelines, preparedness measures, and response protocols during extreme weather events, floods, droughts, and other natural hazards. • Educate communities on the importance of monitoring water levels, river flows, and weather conditions for mitigating risks and protecting lives and property.
	Environmental Conservation	<ul style="list-style-type: none"> • Advocate for environmental stewardship, sustainable water management practices, and conservation efforts based on hydromet data and insights. • Highlight the connection between climate variability, natural resource management, and community resilience to climate change impacts.
Target Audiences	General Public	<ul style="list-style-type: none"> • Reach out to the general population through mass media channels, including radio broadcasts, television programs, and social media platforms. • Tailor messages to resonate with diverse demographic groups, languages, and cultural contexts to maximize outreach and understanding.
	Community Leaders and Decision-makers	<ul style="list-style-type: none"> • Engage local government officials, community leaders, and policymakers through workshops, seminars, and briefings on utilizing hydromet information for data driven decision-making. • Foster partnerships to integrate climate resilience strategies into local development plans and disaster risk reduction initiatives.

Campaign and Tools	Strategies	Educational Institutions	<ul style="list-style-type: none"> • Collaborate with schools, colleges, and universities to incorporate meteorology, hydrology, and climate science into curricula, promoting environmental literacy and career awareness in STEM fields. • Organize student workshops, field trips, and educational competitions focused on weather monitoring, data analysis, and climate adaptation.
		Multimedia Content	<ul style="list-style-type: none"> • Develop visually appealing and informative materials such as infographics, brochures, posters, and videos explaining hydromet concepts, safety tips, and environmental impacts. • Distribute materials through local community centres, public libraries, health clinics, and government offices to reach diverse audiences.
		Community Engagement Events	<ul style="list-style-type: none"> • Organize public forums, town hall meetings, and community outreach events to facilitate dialogue, address concerns, and gather feedback on hydromet services and information needs. • Demonstrate the use of weather instruments, data collection techniques, and interpretation of weather forecasts to enhance public understanding and trust.
		Digital Platforms and social media	<ul style="list-style-type: none"> • Leverage social media platforms, websites, and mobile applications to disseminate real-time weather updates, hazard alerts, and educational content. • Encourage public participation through interactive quizzes, polls, and citizen science initiatives for monitoring local weather patterns and environmental changes.
Partnerships and Collaboration	and	Media Partnerships	<ul style="list-style-type: none"> • Collaborate with local media outlets, journalists, and influencers to amplify campaign messages through interviews, articles, and feature stories on climate resilience and disaster preparedness. • Utilize radio call-in shows, podcasts, and televised public service announcements (PSAs) to reach broad audiences with timely weather information and safety tips.
		Community-Based Organizations (CBOs)	<ul style="list-style-type: none"> • Partner with CBOs, non-governmental organizations (NGOs), and community-based groups to tailor outreach strategies to local needs, languages, and cultural practices. • Engage volunteers in conducting door-to-door outreach, hosting neighbourhood workshops, and distributing educational materials in underserved areas.
Monitoring and Evaluation	and	Impact Assessment	<ul style="list-style-type: none"> • Evaluate the effectiveness of public awareness campaigns through surveys, focus groups, and feedback mechanisms to gauge knowledge retention, behaviour change, and community resilience.

- Measure campaign reach, engagement metrics, and qualitative feedback to refine messaging, target audiences, and campaign strategies over time.

9.3 Stakeholder Engagement

Stakeholder engagement fosters collaboration, gathers feedback, and builds partnerships that enhance the effectiveness and relevance of meteorological and hydrological information.

Key Hydromet Stakeholders

1. Government Agencies

- Engage with national and local government entities responsible for environmental management, disaster risk reduction, water resources management, and climate change adaptation.
- Collaborate on policy development, regulatory compliance, and integrating hydromet data into decision-making processes

2. Communities and Civil Society Organizations

- Partner with community leaders, non-governmental organizations (NGOs), community-based organizations (CBOs), and grassroots networks representing vulnerable populations.
- Conduct outreach activities, participatory workshops, and capacity-building initiatives on weather awareness, disaster preparedness, and sustainable resource management.

3. Academic and Research Institutions

- Collaborate with universities, research institutes, and academic experts to advance scientific research, innovation in meteorology and hydrology, and climate change adaptation strategies.
- Facilitate joint research projects, data sharing agreements, and knowledge exchange platforms to strengthen technical capacity and data quality.

4. Private Sector and Industry Partners

- Engage with businesses, industries, and private sector stakeholders involved in sectors vulnerable to weather impacts (e.g., agriculture, fisheries, tourism)
- Explore opportunities for public-private partnerships, sponsorships for weather monitoring infrastructure, and value-added services based on meteorological data.

5. International Organizations and Donors

- Collaborate with bilateral and multilateral agencies, development partners, and international organizations supporting climate resilience, disaster risk reduction, and sustainable development goals.
- Access funding opportunities, technical expertise, and capacity-building initiatives to strengthen institutional capabilities and enhance service delivery.

Stakeholder engagement strategies

The following strategies should be adopted for effective and efficient stakeholder engagement in hydromet service delivery in Somalia.

Table 20: Stakeholder engagement strategies

Strategy	Action
Needs Assessment and Feedback Mechanisms	<ul style="list-style-type: none"> • Conduct stakeholder needs assessments, surveys, and focus group discussions to understand priorities, information requirements, and challenges related to weather and climate services. • Establish feedback mechanisms, such as stakeholder advisory groups or online portals, to solicit input on service quality, data usability, and emerging issues.
Capacity Building and Training	<ul style="list-style-type: none"> • Offer training workshops, seminars, and webinars on interpreting weather forecasts, using climate information for decision-making, and integrating meteorological data into sectoral planning. • Empower stakeholders with technical skills, data literacy, and tools for resilience-building, including disaster risk management and adaptation strategies.
Communication and Outreach Campaigns	<ul style="list-style-type: none"> • Develop tailored communication strategies and outreach campaigns to raise awareness about the importance of meteorological and hydrological information. • Utilize diverse communication channels, including social media, newsletters, radio broadcasts, and community events, to reach diverse audiences and promote engagement.
Participatory Decision-Making	<ul style="list-style-type: none"> • Foster participatory decision-making processes by involving stakeholders in consultations, policy dialogues, and collaborative projects. • Encourage inclusive approaches that prioritize local knowledge, cultural perspectives, and community priorities in designing and implementing weather and climate services.
Joint Projects and Partnerships	<ul style="list-style-type: none"> • Initiate joint initiatives, pilot projects, and partnerships with stakeholders to co-develop solutions for addressing shared challenges related to weather variability, water management, and climate resilience. • Establish formal agreements, Memoranda of Understanding (MoUs), or partnership frameworks to clarify roles, responsibilities, and mutual benefits of collaboration.

Monitoring and Evaluation

Performance Metrics

- Define key performance indicators (KPIs) to measure the effectiveness of stakeholder engagement efforts, such as participation rates, stakeholder satisfaction, and outcomes achieved.
- Regularly monitor progress, collect feedback, and conduct evaluations to assess impact, identify lessons learned, and make continuous improvements in engagement strategies.

9.4 Media and Public Relations

Media and public relations (PR) play a pivotal role in enhancing visibility, credibility, and public understanding of Somalia's Hydromet services.

Table 21: Media and public relations strategy

Item	Objective	Strategy
Objectives of Media and PR Strategies	Awareness and Education	<ul style="list-style-type: none"> • Increase public awareness about the role and importance of hydromet services in weather forecasting, climate monitoring, and disaster preparedness. • Educate stakeholders, including government agencies, communities, businesses, and media outlets, about the value of accurate meteorological data and its applications.
	Trust and Credibility	<ul style="list-style-type: none"> • Build trust and credibility by providing timely, accurate, and transparent information on weather forecasts, climate trends, and environmental impacts. • Enhance the reputation of Somalia's Hydromet services as a reliable source of weather information and a key partner in climate resilience efforts.
	Emergency Communication	<ul style="list-style-type: none"> • Improve communication during emergencies and natural disasters by disseminating early warnings, hazard alerts, and safety guidelines through media channels. • Ensure the public understands the risks posed by weather events and takes appropriate preparedness actions to mitigate impacts.
Media Engagement Strategies	Media Partnerships	<ul style="list-style-type: none"> • Cultivate relationships with local, national, and international media outlets, including newspapers, radio stations, television networks, and online platforms.

Public Campaigns	Relations		<ul style="list-style-type: none"> • Provide journalists with access to experts, data, and interviews to facilitate accurate reporting on weather-related topics and hydromet developments.
		Press Releases and Media Kits	<ul style="list-style-type: none"> • Issue press releases, media advisories, and fact sheets to announce significant weather events, service enhancements, research findings, and community outreach initiatives. • Distribute media kits containing background information, visuals, and contact details to facilitate media coverage and ensure consistent messaging.
		Media Interviews and Briefings	<ul style="list-style-type: none"> • Arrange interviews with hydromet experts, scientists, and spokespersons to discuss weather forecasts, climate research, and the impact of weather on local communities. • Conduct media briefings or press conferences to address emerging issues, respond to inquiries, and clarify misconceptions related to weather data and service capabilities.
		Social media and Digital Engagement	<ul style="list-style-type: none"> • Leverage social media platforms (e.g., Twitter, Facebook, Instagram) to share real-time weather updates, educational content, infographics, and interactive quizzes. • Engage with followers, respond to inquiries, and amplify key messages during weather emergencies to reach a broader audience and encourage public participation.
		Educational Campaigns	<ul style="list-style-type: none"> • Launch public awareness campaigns on weather safety, climate change adaptation, water conservation, and environmental stewardship. • Partner with influencers, community leaders, and educational institutions to amplify campaign messages and foster behavioural change among target audiences.
		Community Outreach Events	<ul style="list-style-type: none"> • Organize community events, workshops, and public forums to engage residents, businesses, and stakeholders on local weather impacts and adaptation strategies. • Demonstrate weather monitoring technologies, conduct hands-on activities, and distribute educational materials to enhance understanding and preparedness.
		Crisis Communication Planning	<ul style="list-style-type: none"> • Develop a crisis communication plan outlining protocols for responding to media inquiries, issuing emergency alerts, and coordinating with emergency management agencies. • Train spokespersons and staff on effective communication strategies during crises, emphasizing clarity, empathy, and actionable information for the public.
Evaluation and Feedback		Monitoring Media Coverage	<ul style="list-style-type: none"> • Monitor media coverage, sentiment analysis, and social media metrics to assess the reach, impact, and effectiveness of media and PR efforts.

- Evaluate stakeholder perceptions, media engagement levels, and audience feedback to refine communication strategies and improve outreach initiatives.

ANNEXES

- Detailed technical specifications
- Equipment manuals
- Maps and diagrams
- Data formats and standards
- Relevant data tables and statistics

