Assessment of Hydromet Monitoring Network Status of Somalia and Gap Analysis – Draft

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Contents

Abbreviations

AWS	Automatic Weather Station
CBEWS	Community-based Early Warning System
CDI	Combined Drought Index
CORDEX	Coordinated Regional Downscaling Experiment
DRM	Disaster Risk Management
DSS	Decision Support System
ENSO	The El Niño Southern Oscillation
EWS	Early Warning Systems
FAO	Food and Agricultural Organization
FEWS NET	Famine Early Warning System Network
FRRMIS	Flood Risk and Response Management Information System
FSNAU	Food Security and Nutrition Analysis Unit
GDACS	Global Disaster Alerts and Coordination System
GIEWS	Global Information and Early Warning System
GIS	Geographic Information System
HADMA	Humanitarian Affairs and Disaster Management Authority (Puntland)
ICPAC	IGAD Climate Prediction and Applications Centre
IGAD	Intergovernmental Authority on Development
INDC	Intended National Determined Contribution
IOD	Indian Ocean Dipole
ITCZ	Inter-Tropical Convergence Zone
MoEWR	Ministry of Energy and Water Resources
MoHADM	Humanitarian Affairs and Disaster Management
MoU	Memorandum of Understanding
NADFOR	National Disaster Preparedness and Food Reserve Authority
NAPA	National Program of Action
NDP	National Development Plan
NDRMP	National Disaster Risk Management Policy
NDSS	Somalia National Durable Solutions Strategy
NDVI	Normalized Difference Vegetation Index
NGO	Nongovernmental Organization
NHMS	National Hydro-Meteorological and Monitoring service
NOAA	National Oceanic and Atmospheric Administration
NWRS	National Water Resource Strategy
PET	Potential evapotranspiration
RCP	Representative Concentration Pathway
SDGs	Sustainable Development Goals
SOP	Standard Operating Procedure
SPI	Standardized Precipitation Index
SWALIM	Somalia Water and Land Information Management
UN	United Nations
UNDP	United Nations Development Program
UNFCCC	United Nations Framework Convention on Climate Change
UNISDR	United Nations International Strategy on Disaster Reduction
UNOCHA	United Nations Office for the Coordination of Humanitarian Affairs
UNSPIDER	United Nations Platform for Space-based information for Disaster Management
USAID	United States Agency for International Development
USGS	United States Geological Survey
WASH	Water, Sanitation and Hygiene
WHO	World Health Organization
WMO	World Meteorological Organization

Executive Summary

Somalia previously boasted a functional Hydromet monitoring network. Prior to the civil war's outbreak in 1991, the Ministry of Agriculture successfully managed a network monitoring the Juba and Shabelle Rivers. This network provided valuable data that fed into a flow forecasting model. Tragically, the war led to the network's neglect and abandonment. Monitoring stations fell into disrepair, and data collection and management ceased entirely. However, some hope emerged in 2001 and 2002 with the partial restoration of the pre-war network.

This assessment examined the current state of Somalia's Hydromet monitoring network and identified critical gaps that hinder its effectiveness. The network suffers from uneven distribution, with many stations concentrated in specific regions, leaving vast areas lacking data collection capabilities. A significant portion of existing stations are also non-functional due to equipment failure, lack of maintenance, or incomplete handover procedures.

The assessment also revealed limitations in human resources. A shortage of skilled personnel hinders effective station operation, maintenance, and data analysis. Additionally, harsh environmental conditions, unreliable power supplies, and sensor vulnerability can compromise data quality and station functionality. Furthermore, some stations might not be registered with the central data collection agency, limiting data accessibility and utilization. Outdated technology poses another challenge, with older stations potentially using inefficient equipment incompatible with modern data processing systems.

Implementing effective Hydromet services faces challenges as well. Limited budgets restrict investments in modern technologies, maintenance, and personnel training. Unreliable communication infrastructure hinders timely dissemination of weather information. Communicating weather data to local communities can be difficult due to potential misunderstandings or lack of engagement. Finally, project-specific station deployment by international organizations creates a network that doesn't fulfill broader national needs.

The report recommends a multi-pronged approach to address these gaps and improve the network. This includes expanding station coverage for a more representative network, investing in maintenance and building the capacity of staff of service providers in technical and management aspects including modern observing networks; use of modern observation networks; innovative tools for weather and hydrological forecasting; application of downscaling methods for long-range forecasting and climate prediction. Developing a national institutional framework for hydromet services in Somalia that clarifies the roles and responsibilities for each of the institutions involved in observation, data management, modeling, forecasting, and service delivery of hydromet events. Establishing an institutional mechanism between the hydromet service providers, as well as between these services and the users for sharing, data, information, joint product development, and shared capacity enhancement; introducing a Quality Management System (QMS) to strengthen the internal management and operational system of the MoEWR-HD, including human resources planning, project and contract management, and financial and procurement capacity.

Designing new, if necessary, and rehabilitating existing, meteorological and hydrological observation networks and establishing an operational maintenance program, along with advocating for increased funding to support network development and maintenance. Establishing data management systems and strengthening the ICT infrastructure.

Introducing modern forecasting tools and methodologies, including Ensemble Prediction Systems (EPS) and probabilistic forecasting for weather and hydrological forecasting to produce accurate forecasts with required lead time and spatial resolution depending on end-user requirements, including those for aviation and agriculture pest and disease monitoring; introducing and operationalizing forecast verification methods; introducing downscaling techniques for long-range forecasts and climate prediction and introducing impact-based forecasting to cover severe hazards (e.g., floods, droughts…etc);

Additionally, developing strategies for better communication and outreach to local communities is essential. Finally, implementing a strategic plan for station deployment that considers both national and local needs is critical for an all-inclusive and more robust Hydromet network in Somalia.

1. Introduction

Somalia is in the Horn of Africa, with both arid and desert climates and the longest coastline of any mainland African country. The landscape is characterized by plains in the south, highlands and plateaus in the north, and a mountain range along the northern coast. Somalia experiences two rainy seasons, one in April-June and one in October-December[1], and the Juba and Shabelle Rivers bring water through southern Somalia into the Indian Ocean[2]. Somalia is one of the poorest countries in Africa, with seven out of ten Somalis living in poverty[3]. The country is in the process of reconciliation and reconstruction following a long spell of political instability after the 1991 civil war. The Federal Government of Somalia was established in 2012 with the current government duly elected and formed in 2022. Somalia is a Federal State with six member states including Galmudug, Hirshabelle, Jubaland, Puntland, Somaliland and Southwest Somalia. However, Somaliland and Puntland operate as autonomous states.

Somalia has been devastated not only with the long-lasting civil war but also by hydro-meteorological hazards[4] including drought, floods, cyclones, and other climate-related disasters that have adversely affected the lives, property, and livelihoods of the Somali people for centuries. Thus, the country is ranked among the most vulnerable countries in the world to climate change and has a low capacity to adapt to climate change because of its poor socioeconomic development[5]. In recent years, climate-related shocks, mainly drought and flooding, have increased in frequency and intensity over the past 25 years, exacerbating the needs and undermining resilience to climate change and its shocks at the household and community levels[6].

The country's low level of socioeconomic development makes it extremely vulnerable to disaster, with several notable contributing factors. Decades of disasters have undermined the country's coping mechanisms and protective capacity thus increasing the likelihood that hazards turn into disasters with large humanitarian and economic consequences. A considerable amount of the loss and damage could be avoided if the people to be affected are warned early enough for adequate disaster preparedness. The absence of a warning system that uses modern forecasting and dissemination systems is a major hindrance in building climate resilience in Somalia.

Somalia faces significant challenges due to a lack of a systematic hydro-met network. Fragmented institutional responsibility and limited technical capacity hinder the collection, dissemination, and utilization of accurate hydro-met data. This deficiency restricts effective water resource management, hinders disaster preparedness, and impedes development efforts. Timely Hydromet information is crucial for:

- **Early Warning Systems:** Responding effectively to droughts, floods, and other hazards to minimize social and economic impacts.

[1] Somalia Climate Change Analysis.docx (climatelinks.org)
[2] docs.wfp.org/api/documents/WFP-0000138262/download/?_ga=2.255784655.659630207.1690576625-1308116390.1689688509, page 9
[3] https://www.usaid.gov/sites/default/files/2022-05/Somalia_CDCS_External-2025.pdf
[4] Somalia Climate Change Analysis.docx (climatelinks.org)
[5] RCO_FACTSHEETS_CLIMATE.pdf (un.org)
[6] NUPI. (2021). Climate, Peace, and Security Fact Sheet: Somalia. NUPI. https://www.nupi.no/en/news/climate-peace-and-security-fact-sheet-somalia#_edn2

- **Infrastructure Development:** Building resilient bridges, culverts, and other infrastructure that can withstand extreme weather.
- **Agriculture and Food Security:** Choosing appropriate farming techniques and adapting to climate change.
- **Private Sector Decisions:** Mitigating climate risks for business operations.

Therefore, a strong Hydromet Policy is needed to:

- Encourage data sharing and user involvement.
- Deliver user-friendly information in a timely manner.
- Coordinate efforts across different stakeholders.

The Federal Government of Somalia (FGS) through the Ministry of Energy and Water Resources (MoEWR) with support from World Bank, is leading efforts to strengthen climate resilience and early warning systems in Somalia. A key component of these efforts is the development of an integrated Hydromet data system, focusing on:

- Improving data collection, analysis, and dissemination to support informed decision-making for water resource management, disaster preparedness, and climate change adaptation.
- Reducing risks associated with climate variability and extreme events.
- Enhancing capacity to cope with hydro-meteorological events.

In response to the need of enhancing data management, integration, visualization, and analysis capabilities for MoEWR's hydro-meteorological data, MoEWR has contracted Optimal Development & Performance Limited (OPD) to extend the consideration of hydromet monitoring and applications to a much broader scope of operation and maintenance plan as well function of hydro-met service in the country – to support developmental growth and stability in the country. This will ultimately lead to improved decision-making in water resource management within Somalia.

This report summarizes our initial understanding of the project scope, objectives, methodology, timeframe, and key stakeholders for the project "Strengthening Hydro-Met and Hazard Monitoring in Somalia" commissioned by the Ministry of Energy and Water Resources (MoEWR) of Somalia. This report is presented to establish a shared understanding between OPD (the consultant) and MoEWR before proceeding further with the project.

1.1 Objectives of the Assessment

The primary objective of this project as outlined in the Terms of Reference (ToR), is to review the hydromet network requirements, design the optimized hydromet network, develop detailed specifications for the required equipment and develop the long-term institutional capacity and O&M plan for the optimized network that facilitates efficient data collection, management, visualization, and analysis for MoEWR, through a comprehensive assessment of technical, financial, institutional, and legal factors, that will guide the development and implementation of a sustainable solution. This will be achieved through the following specific objectives:

- Assess monitoring equipment and maintenance needed for hydromet infrastructure in Somalia (operational and maintenance needs).

- Develop the technical network design and prepare technical specifications for procurement of equipment.
- Develop Hydromet network operation and maintenance (O&M) plan.
- Evaluate current and future quality assurance/control processes for data collection.
- Identify long-term training needs as part of the institutional capacity development plan.
- Design an effective monitoring network for:
    - Strategic hazard risk management
    - Forecasting (weather, floods)
    - Agro-meteorological monitoring
    - Water quality monitoring
- Provide training for hydrometeorological staff in the O&M of Hydromet stations.

This consultancy shall focus on the following key activities:

- **Reviewing existing MoEWR hydro-meteorological systems and infrastructure.** This involves assessing data availability, quality, accessibility, and institutional capacity for data collection and management.
- **Developing a comprehensive plan for the integrated HMDS.** This encompasses designing an interoperable IT solution to gather data from various MoEWR institutions, including river gauging stations and Automatic Weather Stations (AWS). It also includes identifying essential hardware, software, and quality control/assurance (QC/QA) mechanisms.
- **Exploring options for data management and forecast visualization systems.** This involves analyzing the feasibility of integrating these functionalities within the core platform or evaluating suitability of the commercially available visualization tools.
- **Providing technical guidance on system implementation, operation, and maintenance.** This includes procurement advice, installation/commissioning of software, training for Somali personnel, and user manual development.
- **Developing guidelines for monitoring and evaluating system performance.** This focuses on assessing data quality, timeliness, and the system's effectiveness in supporting decision-making for water resource management.
- **Preparing a final report summarizing the project and recommendations for future improvement.**

1.2 Methodology and Overall Approach

The assessment was conducted using a mixed-methods approach, which combined quantitative and qualitative data collection, analysis, and stakeholder engagement. These methods were chosen to ensure a comprehensive understanding of the situation and were utilized strategically according to the specific characteristics of each district. The project itself was designed in three distinct phases:

- Phase I: Inception Phase
- Phase II: Data Collection and Analysis
- Phase III: Data Reporting

A summary of the activities, methods, and deliverables for each phase can be found in Figure 1.1

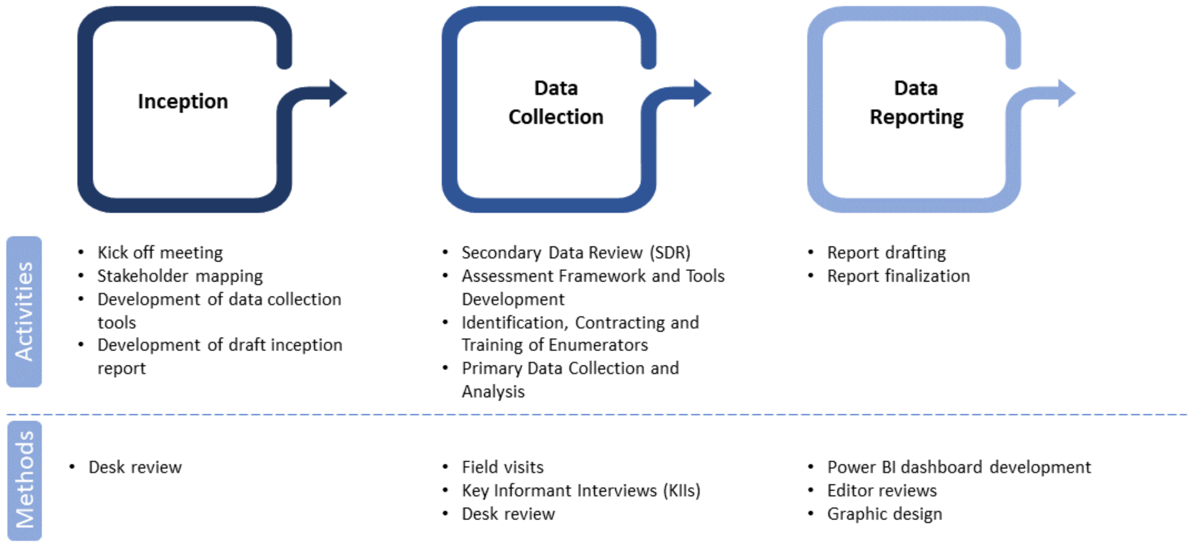

Figure 1.1: Assessment Approach

1.3 What are Hydrometeorological Services?

Hydrological and meteorological services, often shortened to hydromet services, play a critical role in understanding our planet's water resources and weather patterns. These services involve the collection, analysis, and dissemination of information from two key scientific disciplines:

- **Hydrology:** This branch of science delves into the world of water on Earth, encompassing its movement, distribution, and properties. It examines aspects like rainfall, groundwater, surface water (rivers, lakes), and evaporation.
- **Meteorology:** This field focuses on the atmosphere and weather phenomena. It involves observing and predicting weather patterns, atmospheric pressure, temperature, humidity, wind speed and direction, and other atmospheric conditions.

In essence, hydrometeorological services provide a unified view of both water resources and weather conditions. This comprehensive understanding is crucial for various applications, including:

- **Water Resource Management:** Effective planning and allocation of water resources for agriculture, drinking water needs, and industrial use.
- **Disaster Preparedness:** By monitoring weather patterns and predicting potential floods, droughts, or other weather-related disasters, early warnings and mitigation strategies can be implemented.
- **Climate Change Adaptation:** Understanding long-term weather trends and their impact on water resources allows for the development of adaptation plans.
- **Agriculture:** Monitoring weather conditions and soil moisture levels optimizes crop yields and irrigation practices.
- **Ensuring Aviation and Maritime Safety:** Providing weather forecasts and real-time data ensures safe navigation.

Hydrological and meteorological data and services are recognized as the foundation for actions that:

1. Safeguard life and property from extreme weather and climate events.
2. Build resilience to the consequences of natural disasters.

3. Support effective planning, preparedness, and robustness for economic development.
4. Underpin responsible climate action.

Measurement data is the cornerstone of the hydromet value chain (Fig 1.2). Routine, long-term monitoring of meteorological and hydrological conditions forms the basis for predicting changes over time, from short-term moments to entire seasons. This data is also vital for projecting and understanding the impacts of long-term climate change.

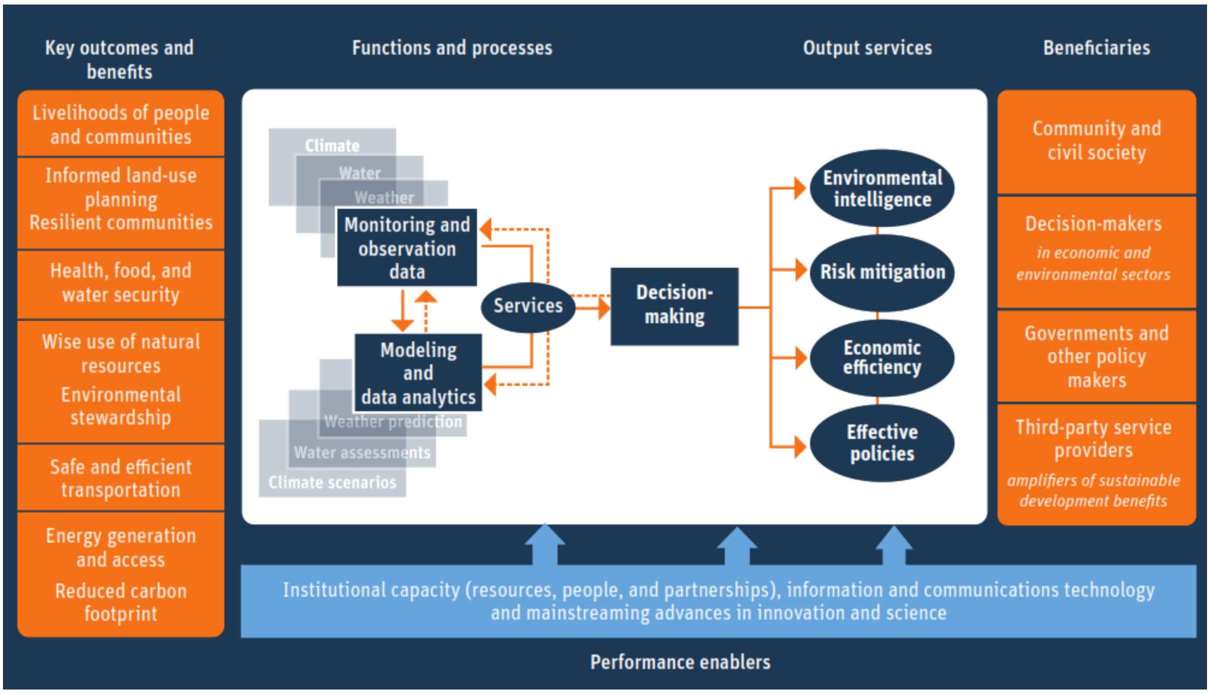

Figure 1.2: Hydrometeorological Value Chain

Since weather, climate, and water resource patterns transcend political boundaries, international cooperation in data exchange, access, and use plays a significant role in improving the predictability of these conditions at national and local levels.

With improved access to global hydrological and meteorological data and forecasts, all national economies can reap the benefits of:

- More timely early warnings
- More efficient economic decision-making
- Adapting to climate-smart built infrastructure
- Developing more environmentally sensitive policies

2. Country Overview

Federal Republic of Somalia is an arid and semi-arid land located in the Horn of Africa. Its 637,700 km^2 are bordered by Ethiopia to the west, Djibouti to the northwest, the Gulf of Aden to the north, the Indian Ocean to the east, and Kenya to the southwest. The country is divided into seven states Somaliland, Puntland, Galmudug, Hiirsabelle, Jubaland, Southwest and Banadir each subdivided into districts, and the largest city, Mogadishu, is the country's capital. Somalia's terrain consists mainly of arid and semi-arid plateaus, plains, and highlands[7] (Fig 2.1).

Within such an arid environment, the most prevalent livelihood of livestock rearing is constrained by the increasingly limited resource base. With average rainfall of <500mm and high evapotranspiration, rain-fed forage production is limited. Somalia's predominant natural resource-based livelihoods are extremely vulnerable to the impacts of climate change, particularly high mean surface temperatures, floods, and droughts. Recurrent devastating droughts and irregular rainfalls that vary according to location and season pose a serious and growing threat to Somalia's sustainable development.

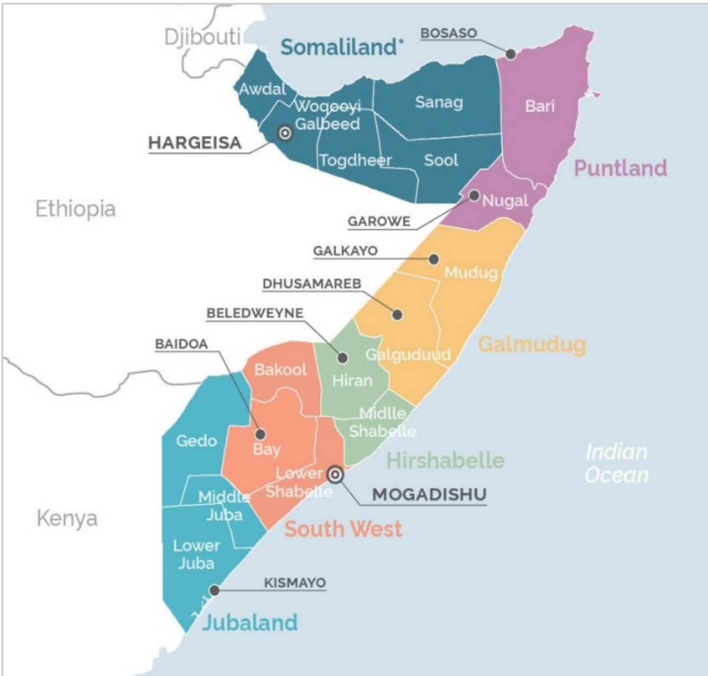

Figure 2.1: Somalia States and Regions map (*Source: open aid*)

2.1 Geographical Features

Distinct geographical areas in the country include: the northern coastal plain of Guban comprised of semi-arid terrain; the northern highlands which are rugged mountain ranges that rise from the Guban region and contains the country's highest peak (2407m); the Ogaden region which descends southwards from the highlands and consists of shallow plateau valleys, wadis and broken mountains which continue until the Mudug plain in central Somalia (Federico and Giovanni, 2000).

The northern region of Somalia also contains the Golis Range Mountains, which run parallel to the Gulf of Aden and ends at Cape Gardafui. The southern part of the country hosts the only two permanent rivers (Jubba and Shabelle) which support the country's agricultural area; and supplies water to the capital city, Mogadishu. Somalia lies downstream of nine river basins including Gulf of Aden, Tug Der/Nugaal, Daroor basins in the north, and Jubba, Shabelle, Lag Badana and Lag Dera River basins in the south, central costal and Ogaden basin in central areas (Fig 2.2).

[7] World Bank. (n.d.). Somalia Country Metadata

Its topography generally slopes in a south-eastern direction towards the Indian Ocean (Awise, 2009 cited in SWALIM, 2012). The highest elevations are in the northeast along the Golis Mountains in the Gulf of Aden. South of the Golis range of mountains the topography of Somalia can be classified as gently sloping with average slopes of less than ~ 1-2% (Kammer, 1989 cited in SWALIM, 2012).

The Jubba and Shabelle are the main and only permanent rivers, both located in the south. Due to the soft valley and ridge topography in large parts of the basins these river basins are the two major catchments contributing to surface flow in southern Somalia. These rivers have large catchment area that contribute to high peak floods during the wet seasons. The Laag Dheera catchment joins the Jubba basin in the lower reaches of southern Somalia (SWALIM, 2012).

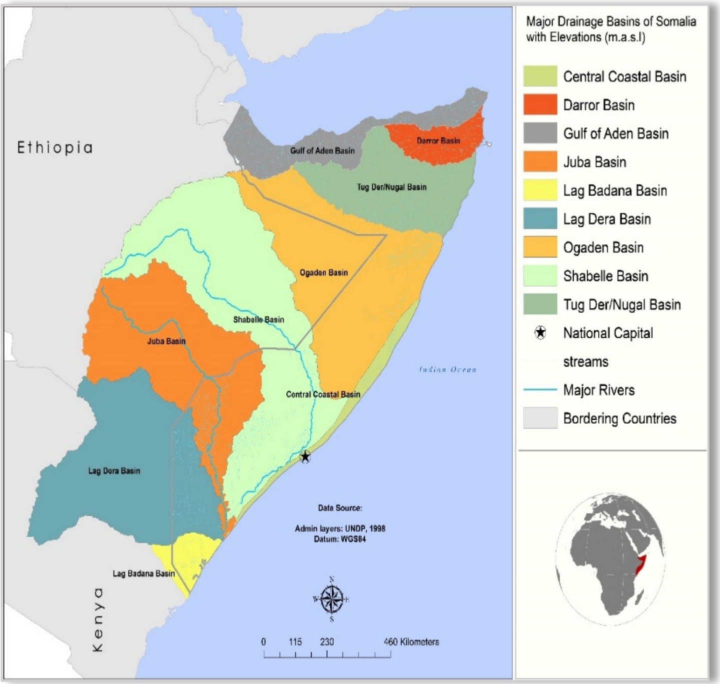

Figure 2.2: Major River Basins of Somalia

The Jubba and Shabelle river basins are shared with Ethiopia, and Kenya, with the most parts of both basins lying outside of Somalia's border. Approximately 30% of the Jubba River basin lies within Somalia, and only 25% of the Shabelle basin lies in Somalia. Originating in the Ethiopian highlands the Jubba and Shabelle traverse the gently sloping terrain in Somalia. At its confluence with the Jubba River, the Shabelle River Basin is 297,000 km2, of which two-thirds are in Ethiopia and the rest in Somalia. After its confluence with the Shabelle, the Jubba River flows downstream through to the Indian Ocean. Somaliland and Puntland are incised with significant dry river valleys (wadis) that flow only during the rainy seasons. Groundwater is usually abundant in quaternary aquifers along all major river valleys. In most of the country, groundwater is frequently saline or brackish and not usable for drinking or irrigation and exacerbated by overconsumption in large agricultural areas.

2.2 Land Use and Land Cover

Approximately 50% of Somalia's land area can be considered as permanent pasture, while 13% is suitable for cultivation (UNDP, 2010). Much of the country is arid and semi-desert making it relatively unproductive for agriculture, with nomadic pastoralism a prevailing livelihood among rural communities (Fig 2.3). Pastoralism is the predominant land use in Somalia and consists of nomadic pastoralism with a growing private sector livestock export industry (Shaie, 1997). This industry provides the greatest source of revenue in Somalia, surpassing crop production fourfold in value. The livestock industry employs over 60% of the population and livestock earnings account for over 80% of Somalia's foreign exchange earnings (GTZ, 1990).

The country comes second in global sheep exports after Australia. Goats, sheep, camels, and cattle are the predominant animals reared by pastoralists. Other types of land uses include rain-fed agriculture, irrigated agriculture and forestry. Most of the northern part of Somalia is dry and cannot support rain-fed agriculture except for small pockets of land in the areas around Hargeisa, Gebiley and Borama. In the rest of the region, sparse rainfall means that agriculture is only possible where there are alternative groundwater sources to support irrigation. This is common within the alluvial plains where shallow wells and permanent springs provide supplementary water for irrigated Pastoralism in Northern Somalia agriculture.

In the South, rain-fed agriculture is practiced in the Shabelle and Jubba River basin. There are two crop growing seasons, coinciding with the Gu and Deyr rain seasons. The crops grown include sorghum, millet, maize, groundnuts, cowpeas, mung beans, sesame, cassava and vegetables. These crops are produced for both human consumption and animal fodder. Crop production is limited by factors such as shallow and stony soil, low soil moisture, rainfall variability, soil erosion and low soil fertility. Irrigated agriculture is practiced in the floodplains along the permanent rivers in south Somalia (Jubba and Shabelle) and along the seasonal streams and springs. In northern Somalia, water is available within pockets of deep soil for irrigated orchards, or from shallow wells and springs, which are the major sources of water for crop irrigation, with water pumped to the fields. Irrigated crops grown on a small scale include maize, sesame, fruit trees and vegetables, while crops such as bananas, guava, lemon, mango and papaya are grown on a large scale for domestic consumption.

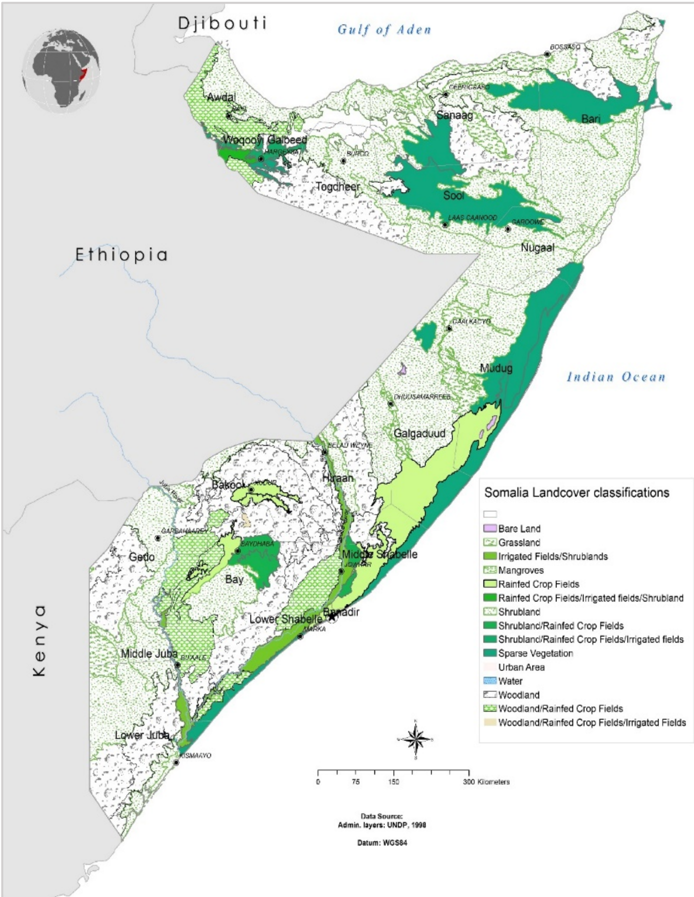

Figure 2.3 Economic Activity and Land Use in Somalia

The vegetation in Somalia is varied and ranges from the forests of the Golis mountains in the North to the bush land in the Lag Badana ecosystem of the South (Mumuli, et al 2010). Patches of mangroves are found in Zeylac, Berbera and Calula on the northern coastline and in Kismayo on the southern coast Expansive the vegetation in Somalia is varied and ranges from the forests of the Golis Mountains in the North to the bush land in the Lag Badana ecosystem of the South (Mumuli, et al 2010). Patches of mangroves are found in Zeylac, Berbera and Calula on the northern coastline and in Kismayo on the southern coast Expansive grasslands are found in Puntland and sparsely covered sand dunes cover a band of several kilometers along the coast. Inappropriate land use has led to the original vegetation cover being heavily degraded, especially in northern Somalia, and in various places it has been destroyed.

2.3 Weather and Climate Summary

Somalia generally can be divided into two climatic zones with an arid zone in the northernmost and central regions, and a semiarid zone in small area in northwest, northern mountains and most of southwest, with two seasonal rainfall seasons. Climate in Somalia is influenced by several factors, including the Inter-Tropical Convergence Zone (ITCZ), monsoonal winds and ocean currents, jet-streams including the Somali Jetstream or Somalia Current, easterly waves, tropical cyclones, neighboring Indian Ocean and Red Sea conditions (NAPA, 2013). The climate also varies across the country with the topography and the country can be divided into different physio-geographic zones: northern coastal zone which has the highest variation in temperature and the driest zone in Somalia (Fig 2.4).

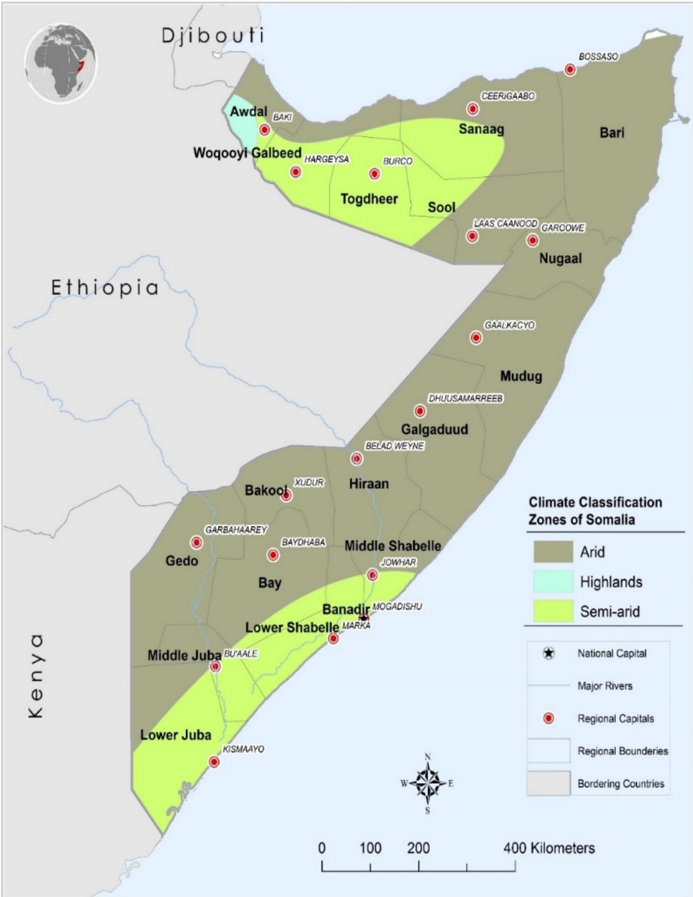

Figure 2.4 Climate Classification Zones of Somalia

Historical Climate

Since 1950, annual average temperatures in Somalia have ranged from approximately 25°C to 27°C, with more recent years exhibiting higher average temperatures. Specifically, average annual temperatures have been rising at a rate of approximately 0.1°C to 0.3°C per decade. The average annual temperature in the 2010s was approximately 26.7°C, which is 1.1°C higher than that during the 1950s. Northern regions of the country are typically warmest from the months of June to September, while southern regions are warmest from December to March. (WFP 2021 and World Bank Group 2024)

Somalia experiences, on average, very low precipitation levels year-round. Rainfall often manifests in the form of light showers or localized torrential downpours, with most occurring during the two rainy seasons: the Gu from April to June and the Deyr from October to December. Total annual precipitation averages approximately 200 mm across most of the country, with higher levels in the south (about 400 mm) and southwest (about 600 mm) and lower levels along the northern coast (about 50 mm) (World Bank Group 2024).

Somalia has, in the past, experienced fluctuations in climatic conditions, including cycles of drought and occasional periods of heavy rain. El Niño-Southern Oscillation (ENSO) events heavily influence rainfall patterns, increasing precipitation and chances of flooding. Conversely, there is a heightened risk of drought during La Niña events. Extreme rainfall followed the most recent period of severe drought (2021–2023), which led to overtopping at the Shabelle and Juba Rivers and flash flooding throughout much of the country, including in the Resilience Zone. The flood event washed away homes, crops, and livestock, and caused school and hospital closures in southern regions of the country. The Somali Disaster Management Agency estimated that the floods in Beledweyne alone, the hardest hit city, displaced more than 245,000 people. In some locations, floods were so severe that they submerged entire houses, leaving only roofs above water (Binder, L., et. al. 2022, NASA, 2023 and Reuters, 2023).

In addition to extreme fluctuations in precipitation, Somalia experiences an average of one tropical cyclone per year, predominantly impacting the northern regions of Puntland, Somaliland, and Galmudug. Cyclone Gati, which struck in November 2020 as a Category 2 on the Saffir-Simpson scale, was the strongest cyclone on record to make landfall in Somalia, with sustained wind speeds reaching 170 km/hr. and dropping more than an average year's amount of rain in two days. In some areas of northeastern Somalia, Cyclone Gati destroyed or damaged 75 percent of schools, health facilities, water access points, transportation infrastructure, and privately owned properties. Gati also damaged livestock populations and fishing vessels in areas where nearly 80 percent of the population are either pastoralists or fishing communities (NASA, 2023 and OCHA, 2020).

Future Climate

According to the State of the Climate in Africa, 2019 issued by WMO[8], "Temperatures in Africa have been rising in recent decades at a rate comparable to that of most other continents and thus somewhat faster than global mean surface temperature. The year 2019 was among the three warmest years record for the continent. Annual rainfall in Africa exhibited sharp geographical contrasts in 2019, with above average rainfall recorded particularly in East Africa.

While climate scenarios have varying degrees of uncertainty, most models show projected increases in average and extreme surface air temperatures across all regions of Somalia, with slightly higher increases occurring in the northern and inland regions of the country. Nationwide, annual average temperatures are projected to increase by almost 1°C by 2020-2039, and by 1.5°C to 2°C by 2040-2059 (mid-century) under a high emissions scenario. Annual maximum temperatures are also projected to increase across Somalia through mid-century, with highest increases occurring in the northwestern region of the country. Similarly, nationwide averages show that annual maximum temperatures could increase by almost 1°C by the 2030s, and by almost 2°C by mid-century (World Bank Group, 2024).

Projections indicate small increases in precipitation totals across Somalia, with slightly higher increases occurring during the months of October, November, and December. Nationwide, annual precipitation totals are projected to increase by approximately 15 mm by 2020-2039, and by approximately 50 mm by mid-century, though models show potential for both increases and decreases at both time horizons. Climate change is projected to drive increasing inter-annual variability in precipitation patterns, leading to increases in the intensities of both wetter and drier years (World Bank Group, 2024).

Climate change is projected to drive increasing variability in precipitation patterns, resulting in both wetter and drier extremes. As such, there is high potential for flash flood severity to increase in the future with more intense rainfall events, especially when following a period of prolonged drought. Climate change will also increase the likelihood of heat waves and severe drought in the Resilience Zone through mid-century. Studies show that increasing temperatures and evapotranspiration rates combined with changing rainfall patterns due to climate change have already made severe drought events 100 times more likely in this region (IPCC, 2023; World Weather Attribution, 2023).

[8] State of Africa: https://library.wmo.int/records/item/57196-state-of-the-climate-in-africa-2019

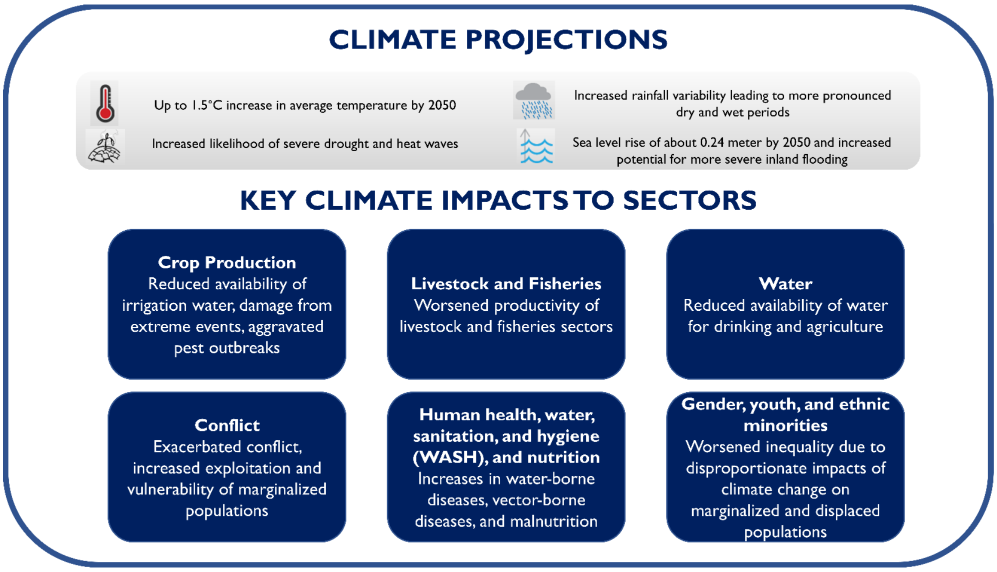

Figure 2.5 Key climate projections and associated impacts

In addition to changes in temperatures and precipitation patterns, the Somali Coast is expected to experience significant impacts from sea level rise. Somalia has the longest coastline of all countries in mainland Africa, and the Resilience Zone falls along the southern portion of this coastline. Projections show that sea level rise in 2030 could reach approximately 0.1 m relative to a baseline average sea level of 1995–2014, and that by 2050, this total could increase to approximately 0.24 m. Sea levels are projected to increase approximately 5.1 mm per year in the 2020–2039 period, and by approximately 7.2 mm per year from 2040–2059 (IPCC, 2023)

While there is little research on the influence of climate change on tropical cyclones, climate change links to warming ocean temperatures and warmer waters are driving higher-intensity cyclones and tropical storms worldwide. A greater proportion of future tropical storms and cyclones are expected to be more extreme, bringing higher rainfall, more damaging wind speeds, and greater storm surges. The Indian Ocean is warming rapidly, and storms often intensify quickly. This trend is expected to continue as ocean warming rises in the region and the Resilience Zone could see an increase in extreme storm risk moving forward. (17, 20, 21, 22) (IPCC, 2023; NOAA, 2021; Vallangi, N. 2021; Singh, V.K., et. al. 2022)

Historical Climate-Induced Natural Disasters in Somalia

Somalia has faced severe challenges linked to climate variability, which has been exacerbated by conflict and limited governance that persisted for decades. Somalia, a member of the World Meteorological Organization (WMO), is classified as the least developed country by the UNFCCC, has been devastated not only with the long-lasting civil war but also by the natural disasters.

Many of the hazards affecting Somalia that originate from hydro-meteorological events such as heavy precipitation prolonged dry spells or extreme temperatures that have adversely affected the lives, property, and livelihoods of the Somali people for centuries. These are primary hazards which lead to secondary and tertiary hazards, including floods and flash floods, drought, cyclones and other climate-related diseases and epidemics. Floods and flash floods follow weather events, heavy rain. While droughts could result in heat waves and water scarcity, both droughts and frosts will result in damage or loss of crops and important impacts on human and animal health. Pest and disease outbreaks may be triggered by drought or excess precipitation. The distinction of hazards in such a cascading manner is the first step in progressing from weather forecasts and warnings to multi-hazard, impact-based forecasts and warnings (Table 2.1).

Climate change in Somalia is not an uncertain, "potential" future risk but a genuine, present threat whose impacts have already been felt by the Somali people across the country. Somalia has a low capacity to adapt to climate change because of its poor socioeconomic development. The vast majority of Somali's rural population is highly susceptible to climatic uncertainty – they live in deserts or marginal and infertile areas, often with highly erodible soils, poor ground cover, and limited water supplies where food security is a serious concern.

Table 2.1 Primary, Secondary and Tertiary Hazards Cascading from Hydro-meteorological Events

Event	Primary Hazard	Secondary Hazard	Tertiary Hazard
Thunderstorm	- Heavy rainfall - Strong winds - Lightning	- Flash floods - River floods	- Damage to structures, embankment, irrigation and drainage facilities, pumping facilities - Submerging fields - Loss of infrastructure systems and services (shelter, energy, transport, schools, hospitals, communications) - Widespread economic losses - Infectious disease - Insect and pest problems - Sand and silt deposition - Waterborne diseases - High sediment runoff into reservoirs
Drought	- High temperatures - Heat waves - Less rainfall	- Water scarcity - Low flow - Less inflow - Crop damage	- High evaporation loss in reservoirs - Shortage of storage water in reservoirs - Insufficient diversion in channels - Salt-affected soil - Salt-affected soil - Energy shortages - Pumping system difficulties
- **Extreme** - **Temperature**	- Heat waves - Heat-related complications with livestock and animals	- Heat stroke - Biological hazards - Stress on vegetation - Water insecurity	- Socioeconomic impacts - Hydropower shortage - Changes in groundwater level - Waterborne diseases - Food shortages

During the past 28 years, Somalia has been affected by six moderate-to-strong El Niño events in which floods of different magnitudes were reported (Fig 2.6). These floods led to the collapse of virtually all large irrigation schemes and damaged the major flood relief channels, roads and other major infrastructure. The flood recurrence at the Jubba and Shabelle Rivers pose significant flooding risks along the two rivers, mainly in the middle and lower reaches.

Observational data for the 1985-2018 period show that drought, floods, cyclones, and climate-related diseases and epidemics, whose frequency, occurrence, and impacts have increased in recent years, already pose a significant risk to the country's vulnerable population. In recent decades, this has led to massive problems of food insecurity and population exodus from the worst-hit areas.

The country is home to a large pastoralist population, living on poor quality pasture lands, and the impact of climate-related changes on livestock production could be significant. According to the World

Bank's Natural Hotspots Study, 43% of Somalia's land area is exposed to flooding and droughts which entails that 54% of the population is highly exposed to climate extremes.

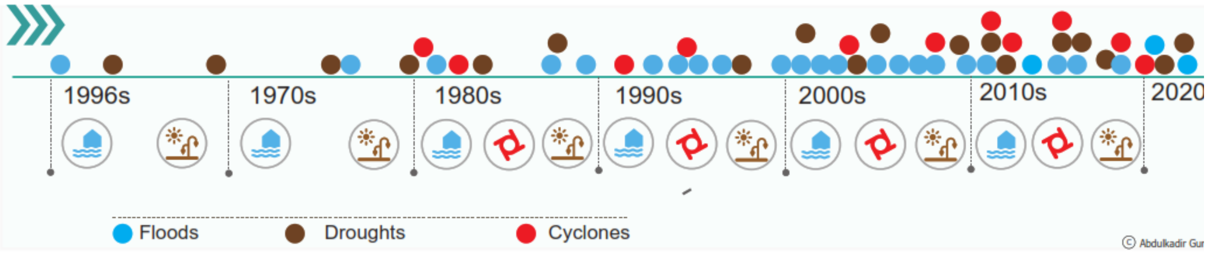

Figure 2.6 Historical natural disasters (droughts, floods and cyclones) in Somalia (Source: Gure, 2021)

The charts below (Fig 2.7) provide overview of the most frequent natural disaster in each country and understand the impacts of those disasters on human populations.

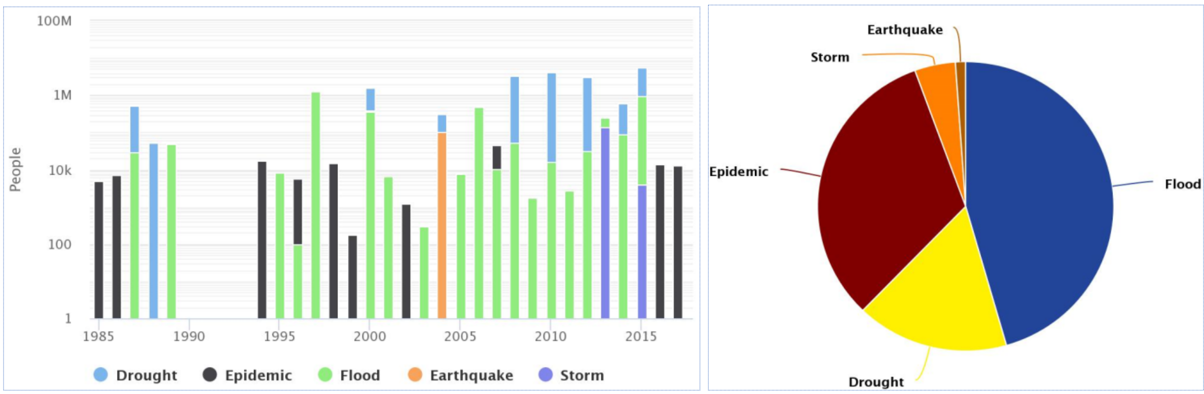

Figure 2.7 Key Natural Hazard Statistics for Somalia 1985-2018 (Left); Average Annual Natural Hazard Occurrence for 1900-2018 (Right)[9]

[9] EM-DAT: The OFDA/CRED International Disaster Database, Université Catholique de Louvain, Brussels, Belgium.

3. Status of Hydro-Meteorological Services

3.1 Brief History of Hydro-Meteorological Services in Somalia

Hydrological and meteorological data collection and observation in Somalia started in the late 1894 by installation of first weather station in Kismayo. The hydro-meteorological network expanded rapidly, and other stations were in the coastal areas where Italian and British colonizers settled at the turn of the twentieth century. In the 1920s a more concerted collection of rainfall data began.

Despite lack of data collection continuity at some stations, most of Somalia was covered with rainfall stations. The two oldest hydrometric stations are the uppermost stations of Luuq, in Jubba, and Belet Weyne in Shabelle, river basins respectively. Records of water level readings for the two stations are dated back to 1951. After independence in 1960, many of the old stations were strengthened. Direct river flow measurements were carried out between 1963 and 1989 by all agencies that were involved in hydrometric activities. Before then, no direct discharge measurements were carried out (Muchiri, 2007).

The Ministry of Agriculture then took over responsibility for the national weather monitoring network. Substantial amounts of data have since been located, especially rainfall data. There is evidence that the documentation was not up to date because the data that had been traced so far was obtained from different, not always reliable sources. Organizations that were involved in weather data collection included: The International Civil Aviation Organization (ICAO), British Meteorological Office (BMO), and other then existing development foreign-aided projects.

Before 1990, Somalia had one of the best meteorological monitoring systems in the Horn of Africa, when the civil war in Somalia intensified, all the hydrometric and weather stations that were operated by the Ministry of Agriculture (MoA) fell into disrepair or were looted, the whole weather recording system collapsed and this saw the loss of valuable data and unfortunately, most equipment were rendered non-functional or destroyed. The civil war and its aftermath led to degradation of traditional observation networks, prevalence of outdated and inefficient technologies, and lack of modern instruments and ICT. The absence of forecasts and weather information reversed years of development gains in farming and civil aviation operations.

In 1997 FAO-Food Security and Nutrition Analysis Unit (FSNAU) in collaboration with some of the NGOs (CEFA, IH…etc) and UN agencies re-established a few more rainfall stations in Somalia with the hope of reviving the network of weather observations. Unfortunately, this network did not last long due to lack of maintenance and prevailing insecurity. Since the civil war and especially at the times when Somalia was particularly hard-hit by drought and famine early warning activities in Somalia relied heavily on satellite data for rainfall estimates.

In 2002, FAO-Somalia Water and Land Information - SWALIM project started efforts to rehabilitation of non-functional weather stations network and installation of new stations throughout Somalia. This has been a welcome initiative which will generate essential ground data to supplement satellite predictions. The network is still extremely sparse with a few river level radar sensors and groundwater sensors functioning in the south. Since then, SWALIM has been reinstated and is the lead agency in collecting, processing and reporting of weather data including temperature, precipitation and weather forecasts. All hydro-meteorological data that have been recovered is archived in HYDATA, which is dedicated database software that has the capability to store and analyze hydro-meteorological data developed by the Institute of Hydrology. The database contains both historical and current river level data. The parameters of the rating equations for all the stations are also included in the HYDATA database.

For the past 5 years, there has been some rehabilitation of non-functional weather stations and installation of new stations by FAO SWALIM, IGAD-ICPAC, UNDP and World Vision. Hydro-metrological department under MoEWR has also been reinstated and is the lead agency now in collecting, processing and reporting of hydromet data. The FAO SWALIM, IGAD-ICPAC and USAID's FEWSNET initiatives have focused on improving regional forecasting for Somalia, making use of the rehabilitated network of monitoring stations in addition to stations abroad.

Somalia is classified as a least developed member of the WMO, whose journey of hydromet data collection and analysis has been just restarting. This is while the country is one of the most vulnerable from the adverse impacts of climate change and still suffer from a constantly increasing poverty.

The absence of accurate forecasting, weather and water information resulted in hundreds of millions of USD economic losses and thousands of deaths in the past two decades. One of the most affected sectors was the agriculture and livestock sector, which is the foundation of Somali's economy and livelihoods, supporting about 80% of the country's population, either directly or indirectly.

3.2 Policy & Institutional Arrangements Context

Somalia currently faces a challenge with the legal status of hydromet services. There's no specific legislation outlining the responsibilities and relationships between various government and non-governmental agencies that provide weather and water-related information.

However, Somalia's 2012 Constitution provides a foundation for environmental protection and resource management. Articles 25(1), 45, and 26 emphasize the right to a healthy environment, the importance of environmental restoration and protection, and the safeguarding of natural resources. Additionally, the 2012 "Six Pillar Policy" calls for enacting environmental protection laws and integrating environmental education into the national curriculum.

Ministry of Energy and Water Resources (MoEWR) manages hydro-meteorological activities and monitoring at the federal level, alongside its standard ministerial functions. While MoEWR leads the development of a National Water Resource Strategy (NWRS) to improve coordination, there remains a lack of cohesion in water resource management between federal and state entities.

Ministry of Environment and Climate Change (established August 2022) is responsible for developing and implementing federal policies on climate planning and adaptation. It also serves as Somalia's focal point for the United Nations Framework Convention on Climate Change (UNFCCC).

The current situation highlights the need for a clear legal framework for hydromet services in Somalia. This framework should define the roles and responsibilities of various actors involved in data collection, analysis, and dissemination; this will help to:

- Improve coordination and streamline communication and collaboration between different agencies, fostering a more unified approach to hydromet services.
- Enhance data quality and promote data standardization and improve access to reliable hydromet information for stakeholders
- Strengthen disaster preparedness and climate resilience

3.2.1 National Hydrological and Meteorological Services Policy Framework

The MoEWR developed a comprehensive National Hydromet Policy (Hydromet Policy). The policy developed in 2022 and provides the basis for establishing an effective and efficient hydromet service and address unclear institutional roles in disaster risk management and hydromet activities (e.g., data sharing and early warnings). This arrangement is meant to improve data production, management, and information sharing to issue timely alerts on hydromet disasters to help protect the country's critical infrastructure and economy and minimize the impact of climate and weather disasters on vulnerable communities and groups. The policy aims to:

- Identify user needs for hydromet services.
- Align with existing policies for a cohesive approach.
- Include various stakeholders (public, private, NGOs) in the hydromet value chain.
- Define the scope and delivery of hydromet services.
- Establish a data-sharing mechanism for hydromet and hydrogeological data.
- Improve access to data for national, regional, and international institutions.

The Hydromet Policy prioritizes establishing a mechanism for efficient access and sharing of hydromet and hydrogeological data. This policy lays the foundation for stronger cooperation and coordination between data producers and users at all levels:

- Local: Decentralizing data sharing within communities and districts.
- State: Facilitating data exchange between state-level institutions.
- National: Ensuring smooth data flow between federal entities.
- Regional & International: Encouraging data exchange with regional and international organizations.

The policy outlines clear guiding principles that define the roles and responsibilities of all actors involved in the hydromet value chain. This includes data providers, users, and other stakeholders. It clarifies their rights and obligations, promoting a more transparent and accountable system. To ensure effective implementation, the policy establishes a robust coordination framework across various levels of government.

The policy's implementation framework outlines a series of activities delivered through flagship projects. These activities focus on key areas like:

1. Upgrading and expanding monitoring stations and networks to collect more comprehensive data.
2. Developing robust data and information management systems for efficient data storage, analysis, and dissemination.
3. Investing in training and resources to improve the skills and capabilities for data analysis and interpretation.

The policy emphasizes the importance of securing adequate funding to achieve its goals. This includes funding for:

1. Network and system development
2. Operationalization of services and products
3. Maintenance of established procedures

3.2.2 Other Related Policies and National Frameworks

Somalia has the following policies, strategies and plans about environment, development, disaster risk reduction, climate change adaptation relevant to hydro-meteorological services:

1. **Somalia National Development Plan (NDP-9) 2020-2024:** Somalia's National Development Plan (NDP-9) 2020-2024 recognizes the importance of hydromet services, even though it doesn't explicitly mention them.
    - NDP-9 acknowledges climate change as a major contributor to poverty and a constraint to security and economic development.
    - The plan outlines strategies to partner with development agencies and strengthen food security in response to climate shocks like droughts. This indirectly implies the need for accurate climate data for informed decision-making.
    - Pillar 3 of the plan emphasizes building resilience in traditional agriculture and livestock sectors to better handle climate challenges. Improved hydromet services can provide vital information for this purpose.
    - NDP-9 highlights the importance of data collection related to disasters (events predictable through hydromet services) and early warning systems. This suggests an understanding of the role improved hydromet services can play in disaster preparedness.

2. **National Water Resource Strategy (NWRS) and Roadmap 2021-2025:** The NWRS has been intentionally designed to provide synergy with NDP-9's four pillars. The NWRS targets to unlock key actions and align with the Constitution (2012), Sustainable Development Goals and sectorial policies and laws to:
    - Tackle water challenges and secure water for future generations.
    - Aligned with national goals, the NWRS prioritizes reducing poverty and promoting sustainable development through water management.
    - Recognizing climate change's impact, the NWRS emphasizes Integrated Water Resources Management (IWRM) for better water resource planning.
    - To improve weather forecasting and preparedness, the NWRS calls for establishing a National Hydrometeorological and Monitoring Service (NMHS).
    - The NWRS acknowledges the need for better data and information.
    - To achieve this, the NWRS highlights the importance of stronger environmental monitoring networks and a robust data management system.
    - This data system will collect, analyze, and share water-related information to support informed decision-making.
    - Overall, the NWRS aims to create a comprehensive water resource management system through improved data collection, analysis, and dissemination.

3. **The National Disaster Risk Management Policy (NDRMP) 2017:** Sets out institutional, legal and policy context, as well as mechanisms for preparing for disaster risk management in the country. It promotes a management culture to reduce vulnerability among at-risk populations and emphasizes strengthening linkages between disaster risk management, resilience, and sustainable development. The policy provides a robust framework for water sector flood and drought response actions. It also identifies the lack of a centralized data management system, coordination among agencies, and the absence of an effective EWS as the main challenges affecting the establishment an effective DRM system in Somalia. The

policy recommends a comprehensive approach to risk and vulnerability assessments, and that data be gathered systematically, analyzed, and disseminated to relevant national, state, and district stakeholders.

4. **Recovery and Resilience Framework (RRF) 2018:** The Recovery and Resilience Framework provides guiding principles and a road map for developing comprehensive and integrated strategies to address famine risk and other drought-related needs. It provides the foundation for policymaking, institutionalization, and recovery financing. The Drought Impact informs its Needs Assessment (DINA), which identifies and prioritizes drought-caused needs in an integrated, sector-based recovery strategy. The Frameworks advocate for developing integrated and harmonized policies and strategies for disaster recovery, resilience, and risk management by supporting flexible and adaptive strategies to address national development priorities that are climate-smart, environmentally friendly, and gender-sensitive, as well as addressing displacement drivers. Given the importance of hydromet services in risk management, this section indirectly addresses the need for hydromet services. The frameworks also advocate for information generation by calling for robust disaster recovery monitoring and evaluation mechanisms at the programmatic and project levels.

5. **Somalia National Climate Change Policy (NCCP) 2020:** outlines a vision for a thriving economy that can withstand the challenges of climate change. This is achieved by implementing effective adaptation and mitigation measures. The policy directly aligns with the goals of hydromet services and products. Its focus on adaptation includes:
    - Minimizing the negative impacts of climate change on Somalia.
    - Building the ability of communities and ecosystems to adjust to climate change.
    - Developing proactive measures to lessen climate-related risks.
    - Empowering people to cope with and recover from climate shocks.

6. **Somalia National Durable Solutions Strategy (NDSS) 2020-2024:** its act as an operational roadmap setting out a collective vision to guide the implementation of durable solutions programing over a five- year period in Somalia. The NDSS has closely aligned its priorities with the direction set forth by NDP-9 and Recovery and Resilience Framework (RRF). Invest in early and long-term solutions to reduce and prevent displacement caused by drought and floods are one of the strategic priorities in NDSS.

7. **National Program of Action (NAPA) 2016 and Intended National Determined Contribution (INDC) 2015:** After detailing the climate change risks facing Somalia, the NAPA provides a 'framework for an adaption program', outlining possible adaption initiatives, and implementing a monitoring structure. Somalia's Intended National Determined Contribution sets out policies for mitigating the effects of climate change, highlighting especially water use management and the use of indigenous knowledge.

8. **Other Policies and Plans:** Somalia has made also progress in the development of other policies, plans and institutional frameworks relevant to climate change, Natural Resource Management and overall National development. Below are some of the other policies and plans:
    1. Draft of National Policy for Hydrometeoerological services (Hydromet)
    2. Draft of Strategy plan for National hydrometeorloical and monitoring services

3. Draft Somalia livestock sector development strategy
4. Irrigation policy
5. Initial National Communication for Somalia to the UNFCCC (2018)
6. The National Environment Policy (2019)
7. Somalia Social Protection Policy (2019)
8. Somalia’s National Adaptation Plan (NAP) Framework (2022)
9. Somalia’s First Adaptation Communication to the UNFCCC (2022)

The existence of policies and regulatory frameworks are steps in the right direction although implementation challenges still exist at both the Federal and State levels.

Somalia faces many challenges to institutional governance and implementation of these policies, including the effects of ongoing civil war, violence, and significant gaps in government capacity to carry out monitoring and delivery of services. Southern Somalia has especially fragmented public services due to a lack of staff, funding, and access to the most rural or remote areas.

3.2.3 Institutional Arrangements

The current intuitional arrangement for EWS divides responsibilities among various institutions. This division of responsibilities raises some coordination and communication challenges among the involved institutions, which adversely impacts on the effectiveness of the EWS in the country.

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. 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.

Department of Hydrometeorology under the Ministry of Energy and Water Resources has the role of managing hydro-meteorological activities and monitoring at the federal level as well as its standard ministerial roles. The Ministries of Energy and Water Resources have similar roles for their respective states. None of these ministries have specialized personnel trained in hydrogeology, hydro-informatics and meteorology. New Climate Information/Early Warning Centers were recently established in Mogadishu, Hargeisa and Garowe, however, they are lacking the technical and operational capacities to analyze and present data. Coordination of hydrometeorological issues is equally complex.

Beyond its cross or multi-sectoral nature many of the current coordination mechanisms are lead and financed by Somalia’s development partners. They are both fragmented and often support the coordination of their own areas of interest, agendas or priorities (i.e. emergency flood response, rather than watershed management).

A. Hydrometeorological Department (HD) under The MoEWR

The Ministry of Energy and Water Resources (MoEWR) spearheads the development of a national hydromet service through the Department of Hydrometeorology. This department plays a crucial role in:

- Leading the creation of policies for effective hydromet services.
- Providing nationwide hydrometeorological data, including information on the water cycle, water resource trends, weather forecasts, and river flow.

- Issuing timely flood forecasts to mitigate flood risks and minimize damage.
- Conducting research to improve forecasts and warnings and leading the development of a master plan for flood control in flood-prone areas.

The Ministry of Energy and Water Resources' Hydrometeorological Department has four key sub-sections (Fig 3.1), each with distinct responsibilities:

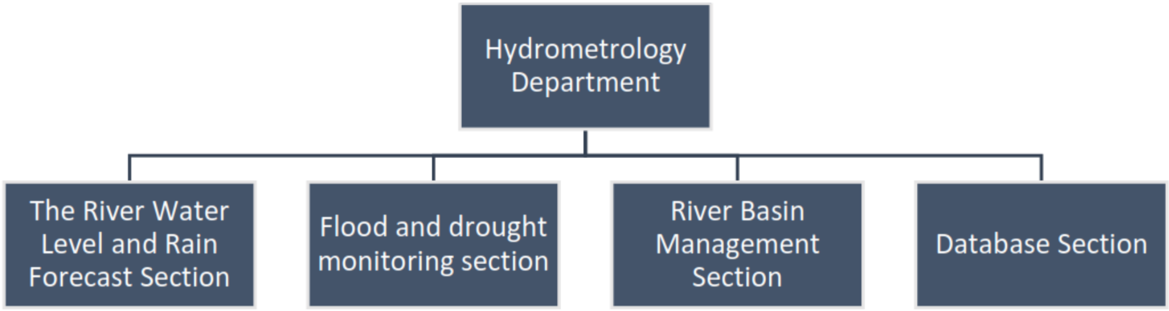

Figure 3.1: Four different sub-sections under the Hydro-metrological department of MoEWR

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.

B. Other Ministries at the Federal Level

- **Ministry of Agriculture (MoA) - Department of Irrigation and Agro-meteorology:** Provides irrigation and meteorological services, forecasts, and information to stakeholders.
- **Ministry of Air and Land Transport - Somali Civil Aviation Authority (SCAA):** Offers aviation-related weather forecasts and supports technology transfer for hydromet services.
- **Somalia Disaster Management Agency (SODMA):** Coordinates disaster management and issues early warnings for floods, droughts, and other hazards.
- **Ministry of Livestock, Forestry, and Range (MoLFR):** Provides resources and information on livestock, forestry, and rangeland management in response to climate events.

C. State Government Agencies:

- **Puntland Information Management Centre (IMC):** Collaborates with institutions to provide water and land resource information for sustainable management.
- **National Disaster Preparedness and Food Reserve Authority (NADFOR):** Collects early warning data, designs response plans, and disseminates risk information.
- **Somaliland Information Management Centre:** Established to improve access to water and land management information, particularly for rural communities.

D. Non-Governmental Agencies (NGOs):

- **Somalia Water and Land Information Management (SWALIM) Project:** Collects and stores data on Somalia's water and land resources.
- **IGAD Climate Prediction and Application Centre (ICPAC):** Provides regional climate forecasts and enhances forecasting capabilities in member states, including Somalia.
- **United Nations Development Programme (UNDP):** Funds projects that integrate hydromet services for water access and disaster reduction.
- **German Agency for International Cooperation (GIZ):** Supports the Ministry of Energy and Water Resources (MoEWR) in improving water resources monitoring in the Shebelle River basin.
- **The World Meteorological Organisation (WMO):** Supports early warning systems for weather, climate, and hydrological hazards.
- **UNICEF-WASH Cluster:** Coordinates water, sanitation, and hygiene (WASH) activities across various agencies, considering hydromet data for informed response.

3.2.4 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.

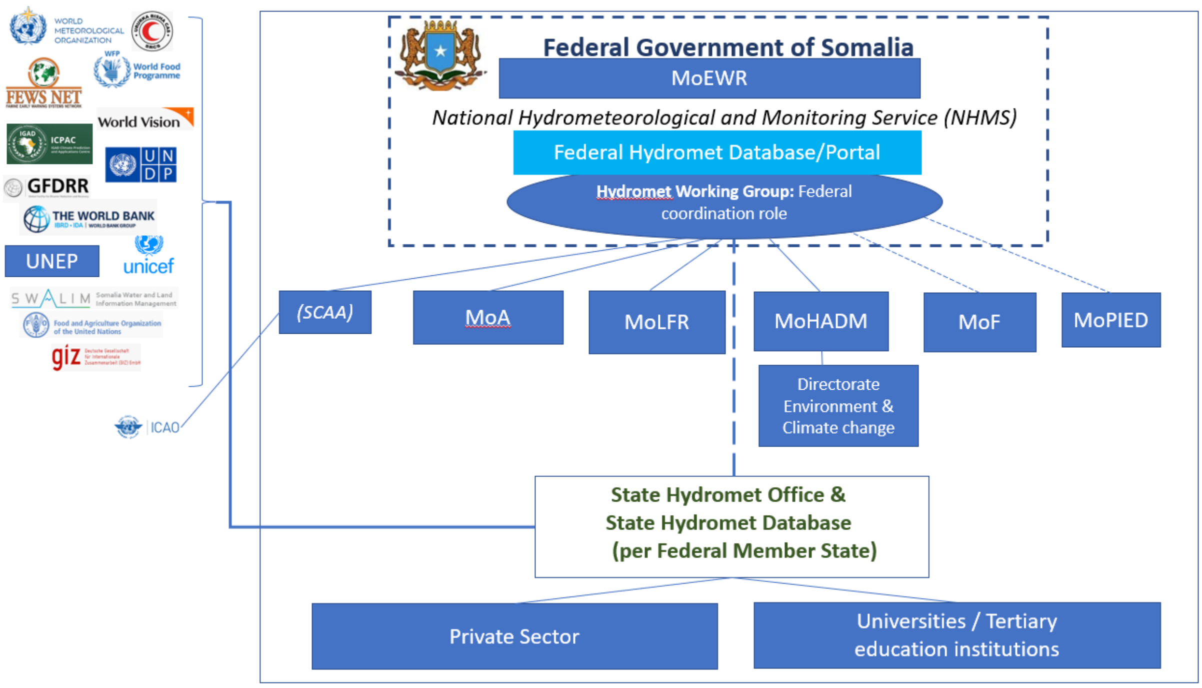

Figure 3.2: Composition & Role of the Hydromet Working Group *(Source: hydromet policy)*

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.

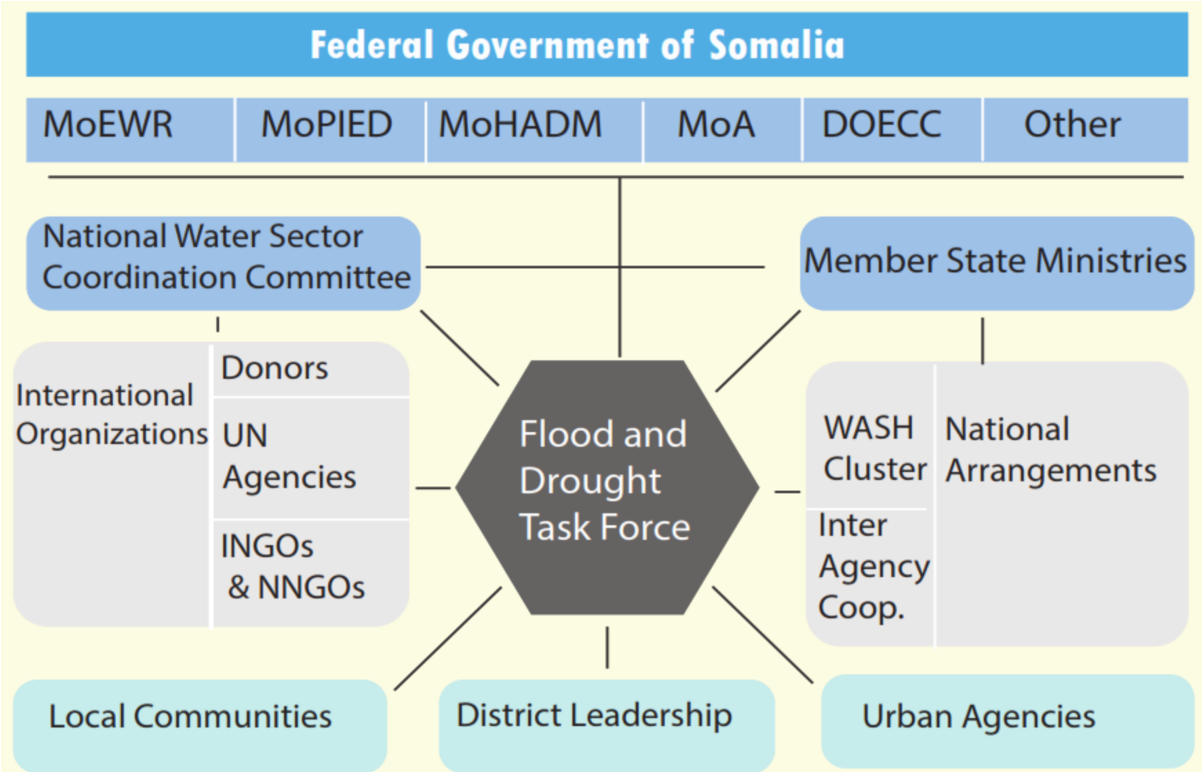

Figure 3.3 The structure of Flood and Drought Task Force *(Source MoEWR)*

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.

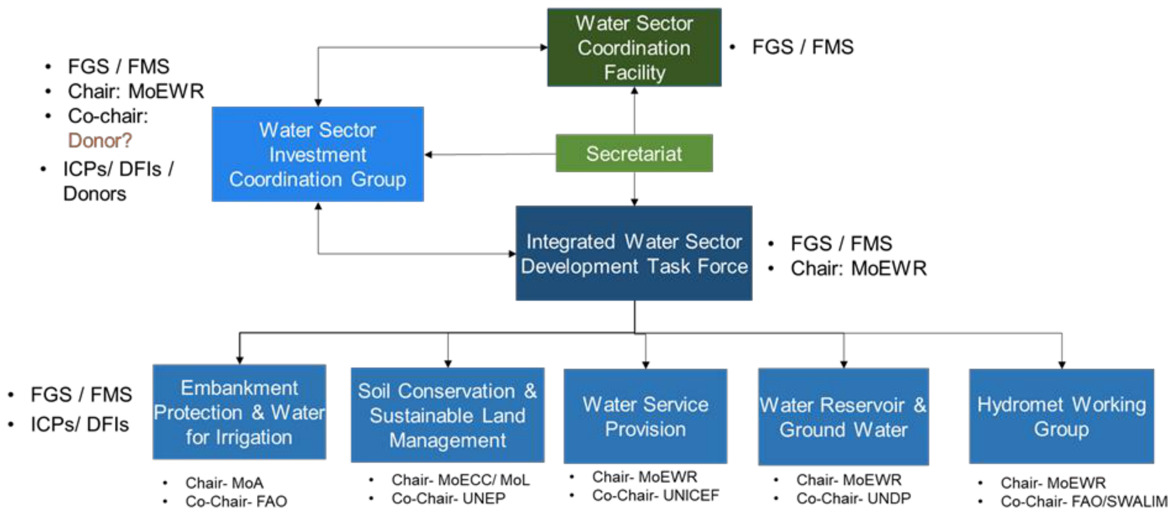

Figure 3.4: Structure of the Water Sector Coordination Facility. *(Source MoEWR)*

3.3 Early Warning Systems (EWS) in Somalia

Somalia is constantly under threat from natural disasters like droughts, floods, and cyclones. These events can devastate lives, destroy livelihoods, and damage infrastructure. Early Warning Systems (EWS) are crucial tools to lessen the impact of such disasters. They provide timely information to communities, allowing them to prepare and act.

However, Somalia lacks a centralized and systematic EWS at the national level. While disaster-related documents mention EWS policies and plans, a long-term, comprehensive system is still missing. International organizations like FAO-SWALIM, FEWS NET, and FSNAU play a significant role in drought, floods, cyclones monitoring and other climate-related diseases and epidemics, but there's a need for a more unified approach.

In the current arrangements, MoHADM (Federal level), HADMA (Puntland) and NADFOR (Somaliland), Hydro-meteorological Department under MoEWR, National Multi-Hazard Early Warning Center and Somali WASH Cluster are the main providers of early warning and climate information and are at the forefront of the risk reduction system in the country through provision of the required information and warnings are disseminated to the public through their websites and social media accounts and sometimes through mass media channels. However, responsibility for different elements of an effective EWS is divided between various institutions in Somalia as well as lacking technical and institutional capacity to disseminate timely early warnings and accurate hydrological information to enable the efficient and economic management of water resources. Overall, EWS in Somalia requires extensive attention and improvement. There is no doubt that the application of an early warning system is the most cost-effective and efficient measure for disaster prevention. The current setup for EWS faces numerous challenges that need to be addressed including:

1. Limited collaboration between government agencies, international organizations, and local communities creates communication gaps and hinders a unified response.
2. Lack of infrastructure, outdated equipment, and a shortage of expertise in data collection, analysis, and dissemination further limit the effectiveness of EWS.
3. Additionally, securing sustainable financing for EWS operations and maintenance remains a challenge, as relying solely on donor funding creates uncertainty for long-term planning.

There are positive developments too. The Ministry of Energy and Water Resources leads the National Hydromet Working Group, aiming to establish a dedicated Hydromet Agency. This agency would be crucial in coordinating and strengthening hydromet services, which are a vital component of EWS. Traditionally, Somali pastoralist communities have relied on their own knowledge and networks to predict weather patterns and prepare for droughts. Integrating these local practices with modern scientific data collection methods holds great potential.

Moving forward, a unified national EWS framework with clear roles and responsibilities for all stakeholders is essential. This would improve communication, resource allocation, and overall effectiveness. Upgrading monitoring infrastructure with modern equipment for data collection and dissemination is also crucial. Training local communities, government officials, and technical personnel in EWS operation, data analysis, and risk communication is vital for long-term sustainability.

Finally, exploring diverse funding options like public-private partnerships, user fees for specific services, and integrating EWS costs into national development plans can reduce reliance on donor funding. By addressing existing challenges, fostering collaboration, and investing in technology and capacity building, Somalia can build a robust EWS. This will empower communities to anticipate and prepare for natural hazards, ultimately saving lives and livelihoods.

3.4 Stakeholder Involvement:

Effective hydromet services in Somalia require a collaborative effort from a diverse range of stakeholders. The following key stakeholder groups have been identified with responsibility for delivery of services relevant to hydromet in Somalia:

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.

3.5 Data Sharing:

Somalia recognizes the importance of sharing hydromet data for effective water resource management, disaster risk reduction, and climate change adaptation. However, a formalized national policy for hydromet data sharing is still not in place. Right now, government agencies rely on informal arrangements to share data amongst themselves. This can be slow and lacks consistency, making it difficult to get the right information at the right time. While external users like researchers and NGOs currently have limited access to hydromet data, Somalia recognizes the potential benefits of open data sharing.

To address these challenges, Somalia needs to develop a national hydromet data sharing policy. This policy will act as a rulebook, outlining clear guidelines for everyone involved. It will specify data formats, ensuring compatibility across agencies. The policy will also establish data access protocols, clearly defining which agencies have access to what type of data. Timeliness is crucial for effective decision-making, so the policy will set standards for how quickly data needs to be shared within the network. Finally, the policy will address data quality control procedures to maintain data accuracy and reliability for all users.

A key step towards achieving these goals is strengthening institutional capacity. This means investing in training staff within relevant agencies on best practices for data management, archiving, and dissemination. Additionally, Somalia needs to upgrade its data infrastructure. This could involve improving data storage facilities and potentially creating a central data repository managed by a designated agency, like a Hydromet Department. Such a repository would streamline data access for authorized users within the government network.

Somalia also recognizes the value of open data sharing with external users. Increased access to hydromet data can empower various stakeholders. Researchers can utilize the data for climate change studies, agricultural research, and developing improved weather forecasting models. NGOs can leverage the data for drought and flood monitoring and targeting humanitarian assistance efforts more effectively. The private sector can utilize data for weather-based insurance products or developing climate-smart agricultural practices, ultimately benefiting the Somali economy.

There are, however, challenges to consider when moving towards open data. Security concerns, data quality inconsistencies, and a lack of resources for data management and dissemination need to be addressed. Additionally, ensuring equitable access for all user groups, particularly those in rural areas with limited internet connectivity, requires careful planning.

Somalia can overcome these hurdles by implementing pilot projects that demonstrate the value of open data sharing. These projects can serve as a springboard for wider adoption. Collaboration with international partners can provide technical assistance and resources for developing user-friendly data portals and training programs on data access and utilization.

4. Monitoring and Observation Systems

Meteorological and hydrological observations constitute the first step in producing high-quality weather and flood forecasts with proper lead time, as well as providing baseline data for water resources management, drought forecasting, and a long-term climate trend. Depending on their purpose, stations record temperature, precipitation, pressure, humidity, evaporation, wind speed, solar radiation, soil moisture, depth, and density, and hydrological regime parameters (water levels, discharges, and reservoir storages) as well as agromet parameters (soil temperature and soil moisture). Monitoring and observation systems consist of observation stations as well as data transmission, telecommunication networks, and data processing and storage systems, that is, data management systems.

4.1 Global Data System

Hydrometeorological Department under MoEWR has access directly or indirectly to observation data from certain global centers such as NASA, NOAA, USGS and ECMWF through FAO-SWALIM, IGAD-ICPAC and USAID's FEWSNET initiatives. Several other international programs also offer satellite data and analysis benefits:

- United Nations Platform for Space-based information for Disaster Management and Emergency Response (UN-SPIDER) helps developing countries use satellite data for emergencies.
- The FAO Global Information and Early Warning System (FAO GIEWS) monitors food security worldwide.
- The Global Disaster Alerts and Coordination System (GDACS) provides automatic alerts and impact analysis for natural disasters.
- Other initiatives include UNOSAT, DLR-ZKI, SERTIT, the Dartmouth Flood Observatory, the Global Monitoring for Environment and Security (GMES) of the European Commission and the European Space Agency (ESA), PREVIEW (Prevention, Information and Early Warning pre-operational services to support the management of risks), LIMES (Land and Sea Integrated Monitoring for Environment and Security), GMOSS (Global Monitoring for Security and Stability), SAFER (Services and Applications For Emergency Response), and GMOSAIC (GMES services for Management of Operations, Situation Awareness and Intelligence for regional Crises).

4.2 National Data Systems

In addition to Hydrometeorological Department (HD) under MoEWR, several other non-government organizations, notably FAO-SWALIM and IGAD-ICPAC, collect various observation data through their own networks. The status of the data collected by each organization is described below.

4.2.1 Surface Meteorological Observations Network

Currently, there are three types of surface meteorological monitoring stations some of them are not functional including Manual Rainfall Stations (MRS), manual Synoptic Stations (SS), and Automatic Weather Stations (AWS) run by MoEWR-HD, FAO-SWALIM and IGAD-ICPAC (Fig 4.1 – See annex 1) which collect a variety of data as follow:

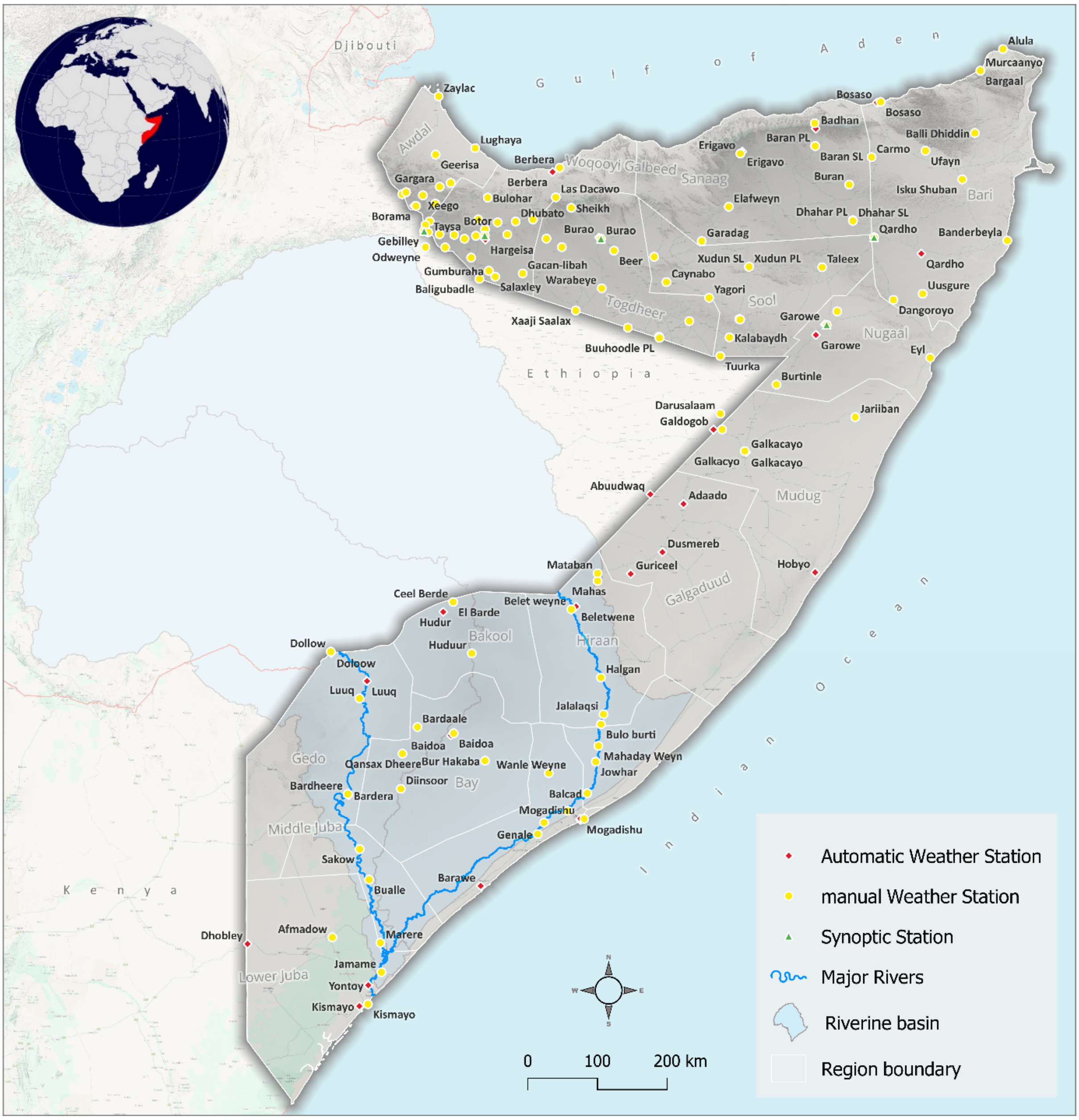

Figure 4.1: Locations of Surface Meteorological Observations Network

I. Status of Automatic Weather Stations (AWS):

These stations represent the most advanced technology, automatically collecting and transmitting data from various sensors in near-real-time via satellite feeds every four hours. This data include temperature, humidity, wind speed and direction, rainfall, and barometric pressure. While offering real-time data and reduced human error, they require reliable power supplies and proper maintenance.

1. Number of Stations

There has been a significant increase in the number of AWS deployed across Somalia over the past 5 years. 44 stations were established between 2009 and 2024 by FAO-SWALIM, IGAD-ICPAC, World Vision and UNDP through MoEWR and currently managed by different stakeholders. MoEWR is currently installing 6 new stations. This expansion is attributed to the cost-effectiveness and efficiency of AWS compared to manual weather observation methods.

2. Geographical Distribution

The map below (Fig 4.2) shows the distribution of the automatic weather stations varies considerably across the different regions of Somalia, with some regions having significantly more stations than others. For instance, Mudug has the highest number of stations (6), while Hiiran and Lower Shabelle have only one station each.

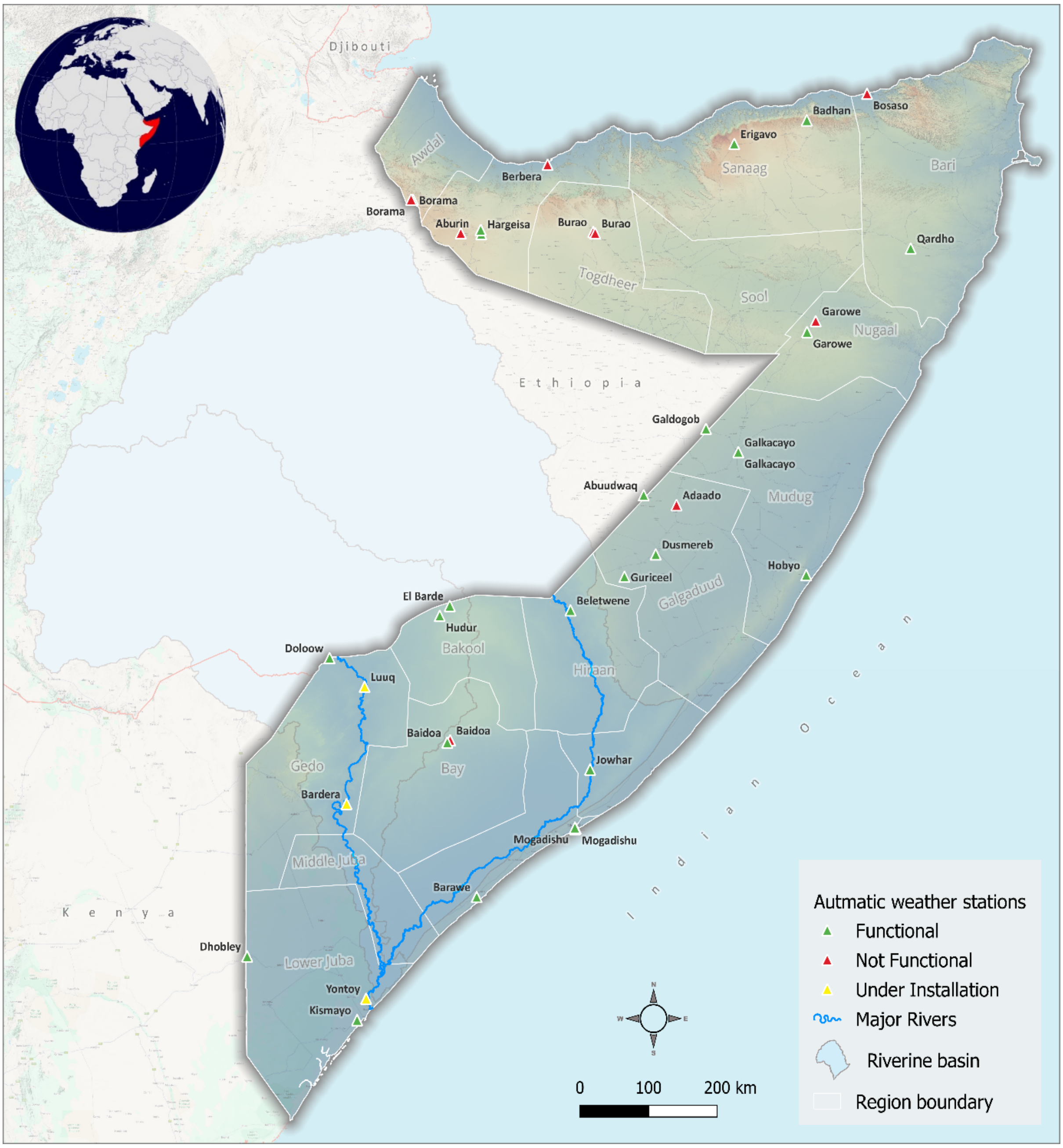

Figure 4.2: Location of the automatic weather stations.

Other regions, particularly in the southern and eastern parts of the country, have fewer stations. According to HD-MoEWR, the current weather station coverage is insufficient, and this pose challenges for accurate weather monitoring and forecasting in those areas. This concentration of stations in certain areas, due to factors such as the security, accessibility, population density, infrastructure availability, and the perceived importance of weather data in those regions.

3. Installation Agency

The chart (Fig 4.3) depicts the distribution of station installations by various agencies between 2009 and 2024. As evident, IGAD-ICPAC played a significant role by installing 19 stations, followed by MoEWR (16 stations), FAO-SWALIM (7 stations), and World Vision (2 stations). While the Installation Agency takes the lead in initially installing all stations, the long-term responsibility for maintenance and repair varies.

Some stations remain under their direct care, while others are transferred to the institutions where they are located. A potential challenge exists in ensuring these handovers are accompanied by sufficient training and ongoing support to maintain station functionality.

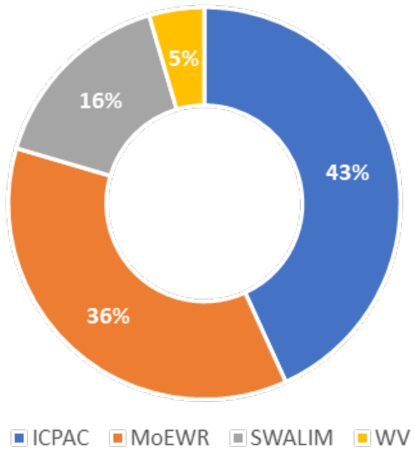

Figure 4.3: Distribution of AWSs installations by agencies

4. Functionality

Out of the 44 stations listed, 24 are functional, representing 54.5% of the total stations. This leaves 20 stations (45.5%) that are not functional out of which 11 stations (25%) are not functional, 6 stations (13.6%) are under installation and 2 installed stations (4.5%) whose conditions are unknown (Fig 3.9). Detailed information about each station is provided in annex 1.

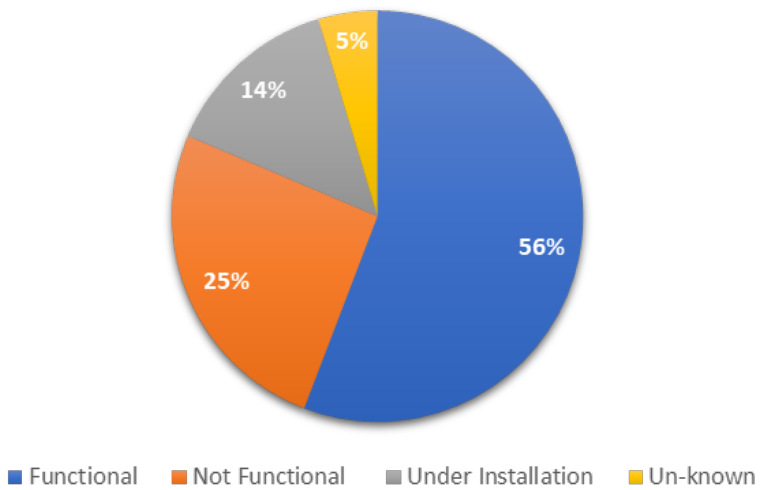

Figure 4.4: Functionality of the automatic weather stations

Table 4.1: Functionality of the automatic weather stations per agency

No	Agency	Number of Installed Stations	Functional Stations	Not Functional Stations
1	IGAD-ICPAC	19	14	5
2	MoEWR	16	8	8 (6 under installation)
3	FAO-SWALIM	7	2	5
4	World Vision	2	-	2 (unknown condition)

5. Parameters Measured

These stations collect a range of valuable environmental data, including:

1. Air temperature
2. Relative humidity
3. Solar radiation
4. Precipitation
5. Wind speed
6. Wind direction
7. Air pressure

6. Brands of Automatic Weather Stations in Use

While GSM/GPRS technology is currently used to transmit data to dashboards at SWALIM, ICPAC, or MoEWR, this method has limitations. Exploring alternative or complementary data transmission technologies, such as satellite networks, could improve data reliability, especially in remote areas with poor GSM/GPRS coverage. Data from the stations are provided to SWALIM, ICPAC, and MoEWR on a real time basis.

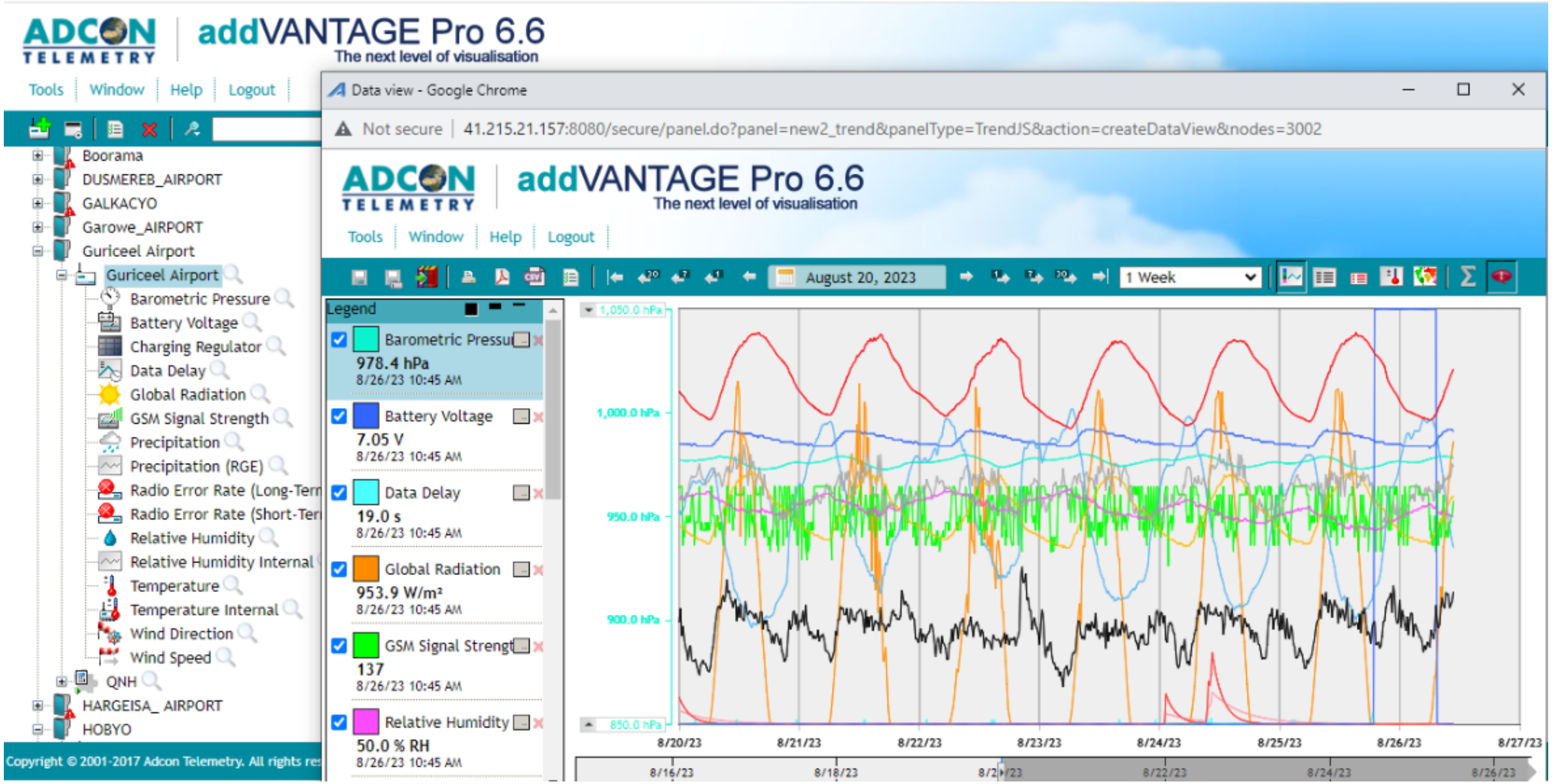

Figure 4.5: IGAD-ICPAC dashboard showing Guriel Automatic Weather Stations parameters *(Source ICPAC)*

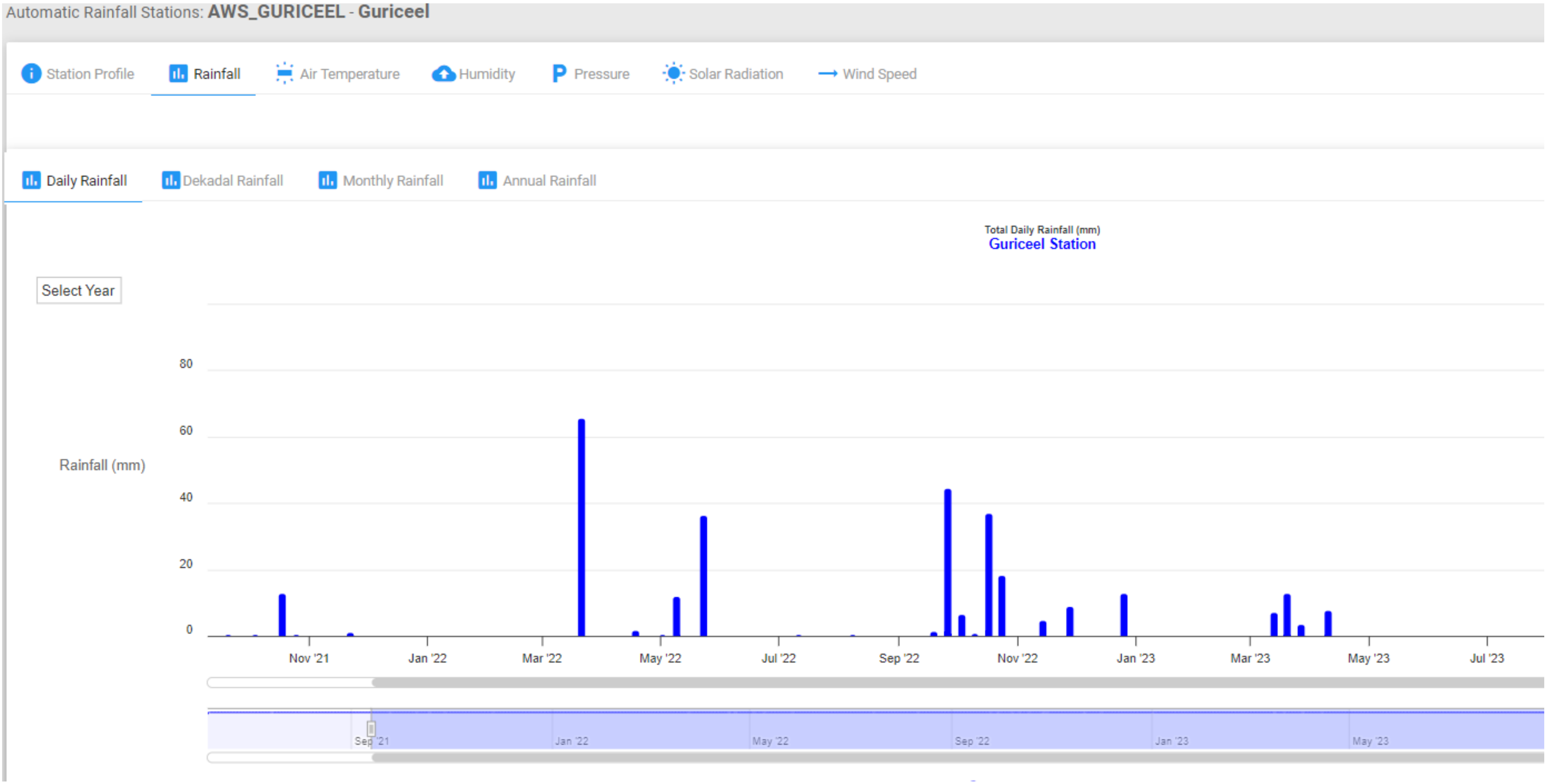

Figure 4.6: SWALIM dashboard showing the Automatic Rainfall Stations: AWS_ABUDWAQ – Abudwaq *(Source SWALIM)*

Table 4.2 provides a list of the various brands or types of automatic weather stations (AWS) currently in operation across Somalia. It's important to note that all these AWS were imported and assembled on-site by teams of qualified experts and usually 1- or 2-days training provided by them to the local staff.

Table 4.2 Automatic weather stations in use

Brand Name	Parameters	Communication
METOS	Air Temperature, Rainfall, solar Irradiance, Relative Humidity, Wind direction, Wind Speed	GSM, GPRS
DAVIS	Air Temperature, Rainfall, solar Irradiance, Relative Humidity, Wind direction, Wind Speed, pressure	Various Proprietary RF options
ADCON	Air Temperature, Rainfall, solar Irradiance, Relative Humidity, Wind direction, Wind Speed	RF (WSN support), GPRS

7. Power Supply and Storage

Automatic weather stations primarily rely on a combination of solar energy and rechargeable batteries for power supply. Solar panels convert sunlight into electricity, charging the batteries that keep the station operational. This approach offers a sustainable and environmentally friendly solution. However, some stations utilize components with dedicated batteries that require replacement upon depletion. These batteries, like those found in ADCON transmission units and DAVIS data loggers, are not readily available in local markets, creating logistical challenges for maintenance. Many of the weather station observers are not able to perform battery replacements or maintenance of any kind (See Annex 1).

8. Technical Challenges and Maintenance

The automatic weather station network faces several challenges that hinder its effectiveness:

- Rain gauge sensor and wind vane (in particular), are susceptible to mechanical damage, potentially leading to inaccurate data collection.
- Improper sensor calibration can compromise data accuracy, requiring regular maintenance and recalibration.
- A combination of sensor issues and limited maintenance can result in stations collecting unreliable or inaccurate data.
- Replacing damaged components can be expensive, impacting the sustainability of the network.
- The selection of batteries not readily available in local markets creates logistical difficulties for replacements, leading to potential station downtime.
- Insufficient funding allocated for operation and maintenance and a lack of skilled personnel further hinder the network's upkeep.
- The current distribution of stations falls short of adequately representing the country's diverse climatic zones.
- Several stations remain unknown to HD-MoEWR, limiting the accessibility and utilization of valuable weather data.

II. Status of Synoptic Stations (SS)

These stations collect a wider range of meteorological data at set times throughout the day using instruments like anemometers (wind speed), wind vanes (wind direction), pressure sensors, thermometers, hygrometers (humidity), and rain gauges. However, only five such stations exist in Somalia.

1. Number of Stations

Currently there is only 5 synoptic stations were installed and managed by FAO-SWALIM (see annex 2).

Geographical Distribution

The map below (Fig 4.7) shows the distribution of the synoptic stations concentrated only in Puntland and Somaliland; no synoptic station installed in southern regions. According to HD-MoEWR, the current station coverage poor and insufficient, and this pose challenges for accurate weather monitoring and forecasting in those areas.

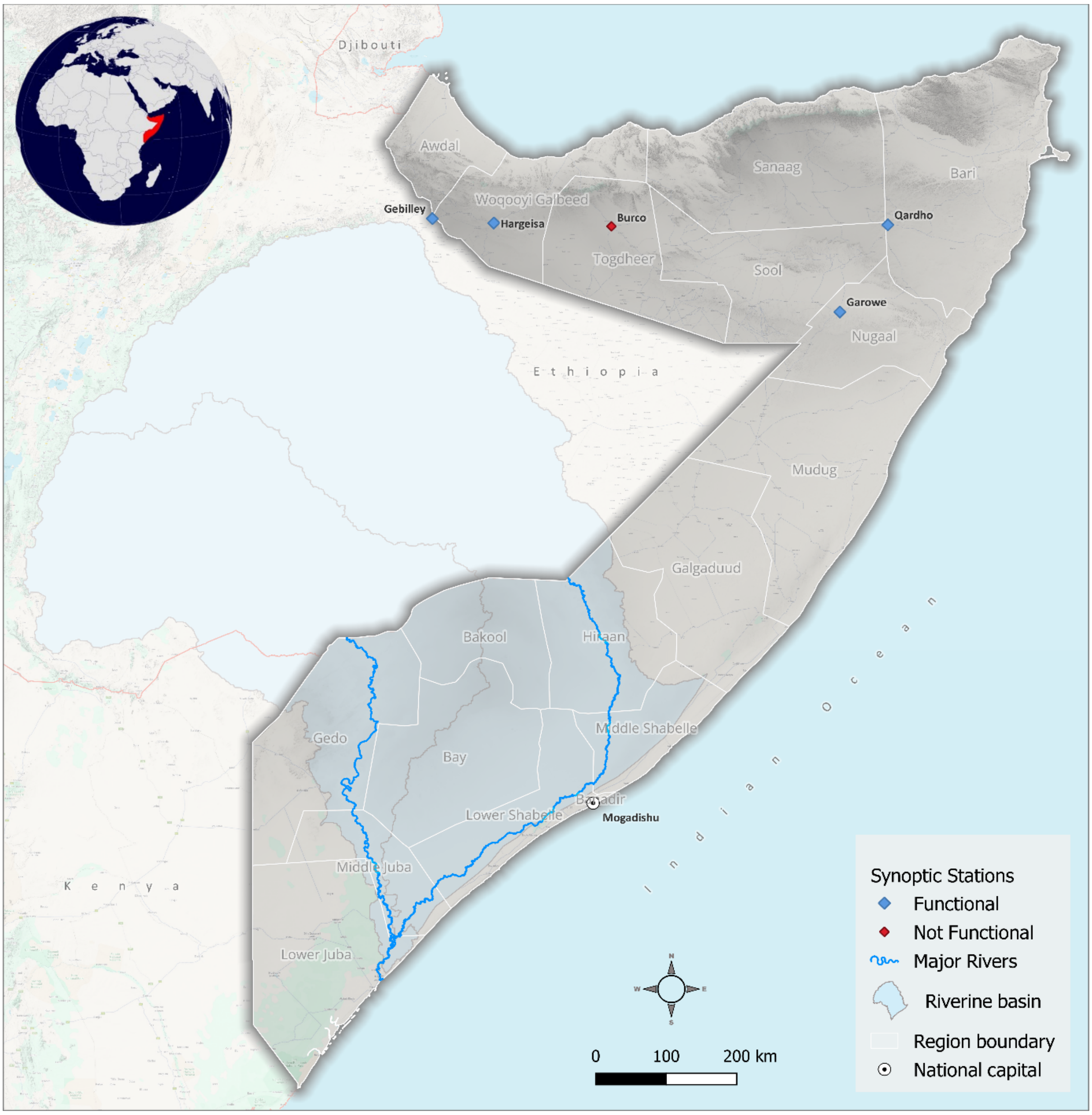

Figure 4.7: Location of the Synoptic Stations across Somalia.

Some stations remain under SWALIM direct care, while others are transferred to the institutions where they are located. A potential challenge exists in ensuring these handovers are accompanied by sufficient training and ongoing support to maintain station functionality.

Table 4.3 Synoptic Station stations

Station Number	Station Type	Name	Region	District
SS_BAQAR	Synoptic Station	Qardho	Bari	Qardho
SS_NUGAR	Synoptic Station	Garowe	Nugaal	Garowe
SS_WGGEB	Synoptic Station	Gebilley	W.Galbeed	Gebilley
SS_WGHAR	Synoptic Station	Hargeisa	W.Galbeed	Hargeisa
SS_TGBUR	Synoptic Station	Burco	Togdheer	Burco

2. **Functionality**

Out of the 5 stations listed, 4 are functional, representing 80% of the total stations. This leaves 20% stations that are not functional (Fig 4.8). Detailed information about each station in annex 2.

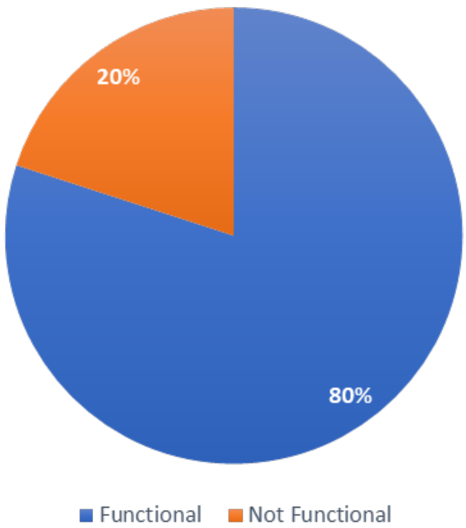

Figure 4.8: Functionality of the automatic weather stations

3. **Parameters Measured**

These stations collect meteorological information at synoptic time 00h00, 06h00, 12h00, 18h00 (UTC) and at intermediate synoptic hours 03h00, 09h00, 15h00, 21h00 (UTC). The functional stations according to SWALIM currently collect only:

1. Air temperature
2. Evaporation

GSM/GPRS technology is currently used to transmit the data to SWALIM dashboard. This method has limitations. Exploring alternative or complementary data transmission technologies, such as satellite networks, could improve data reliability, especially in remote areas with poor GSM/GPRS coverage.

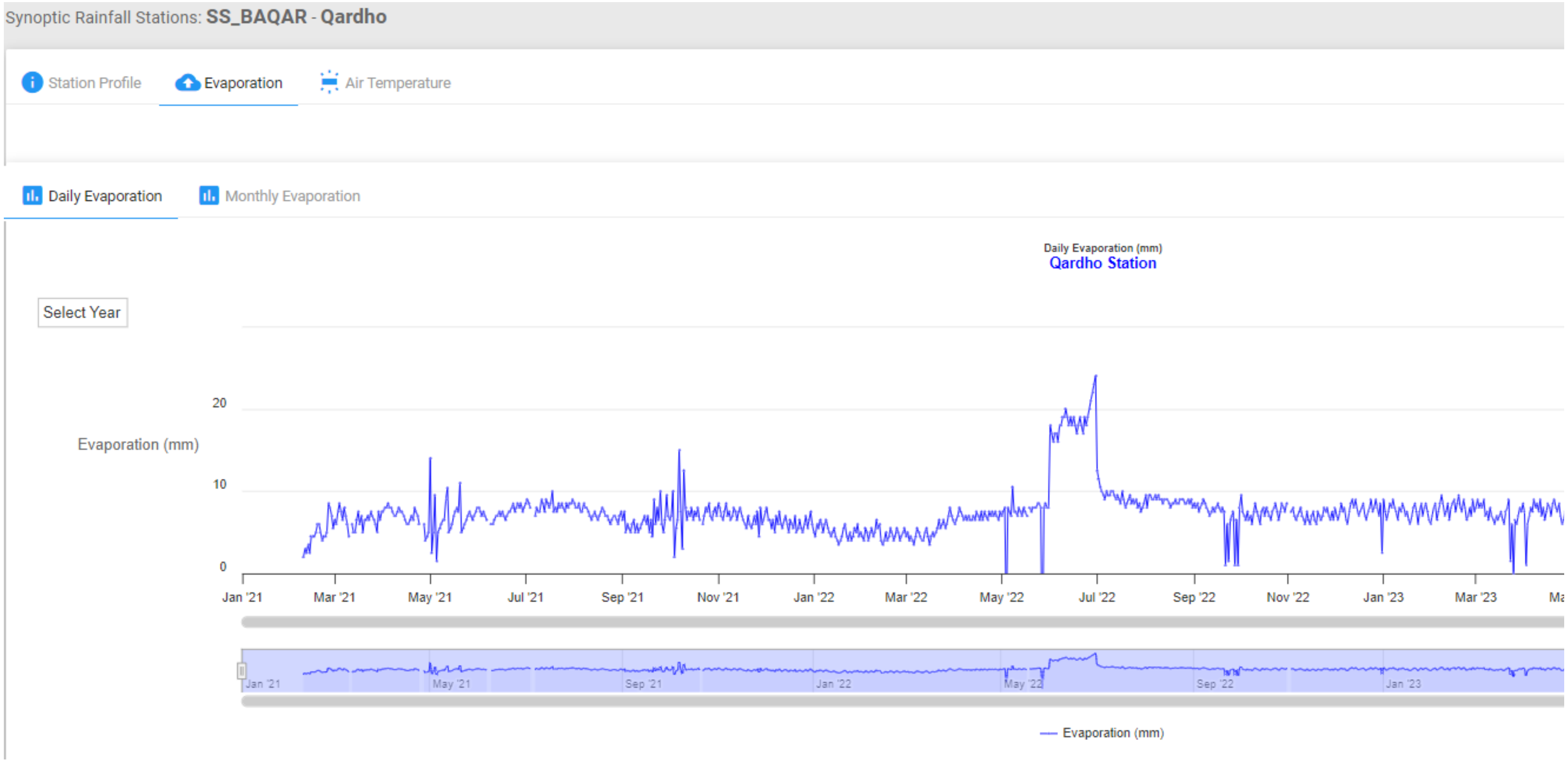

Figure 4.9: SWALIM dashboard showing the Synoptic Rainfall Stations: SS_BAQAR – Qardho *(Source SWALIM)*

3. Technical Challenges and Maintenance

The synoptic station network faces several challenges that hinder its effectiveness:

- No Information available on the ground about the stations
- The stations are not spread evenly across the country, with some regions having significantly fewer stations than others.
- Remote areas often lack weather stations due to installation and maintenance difficulties, resulting in limited data from these crucial regions.
- Environmental interferes with the readings
- Poor coordination among the stakeholders
- A significant number of the stations are non-functional due to various reasons like equipment failure, lack of repairs, or incomplete handover procedures.
- Limited skilled personnel can hinder effective maintenance and repairs.
- Difficulty in obtaining spare parts for imported equipment leads to extended downtime.
- Insufficient funding restricts preventative maintenance and timely repairs.
- Sensor vulnerability to damage and improper calibration can compromise data accuracy.
- Many parts are vandalized
- Non-functional stations and unreliable data transmission contribute to missing data points.
- The stations remain unknown to HD-MoEWR, limiting the accessibility and utilization of valuable weather data. Only authorized personnel from SWALIM view the data.

According to the HD-MoEWR strategic plan, Somalia requires around 50 SYNOP stations to adequately monitor the weather elements across the country. In addition to the rehabilitation of the non-functional stations.

III. Status of Manual Rainfall Stations (MRS):

These stations use rain gauges to manually measure, and record rainfall amounts (usually in mm) over a specific period. While simple and cost-effective, they require regular human intervention and mostly outdated producing incomplete and unreliable data.

1. Number of Stations

The current Manual Rainfall Stations network comprises 118 active rainfall stations (according to SWALIM). SWALIM operates all these rain gauges, mainly manually, at their current meteorological stations (see annex 3).

2. Geographical Distribution

Figure 4.10 shows the locations of existing rain gauges. Gaps are found particularly in the Mudug, Galgaduud, Gedo and Lower Jubad regions. Some of these gaps are due to difficulties of access and/or security issues.

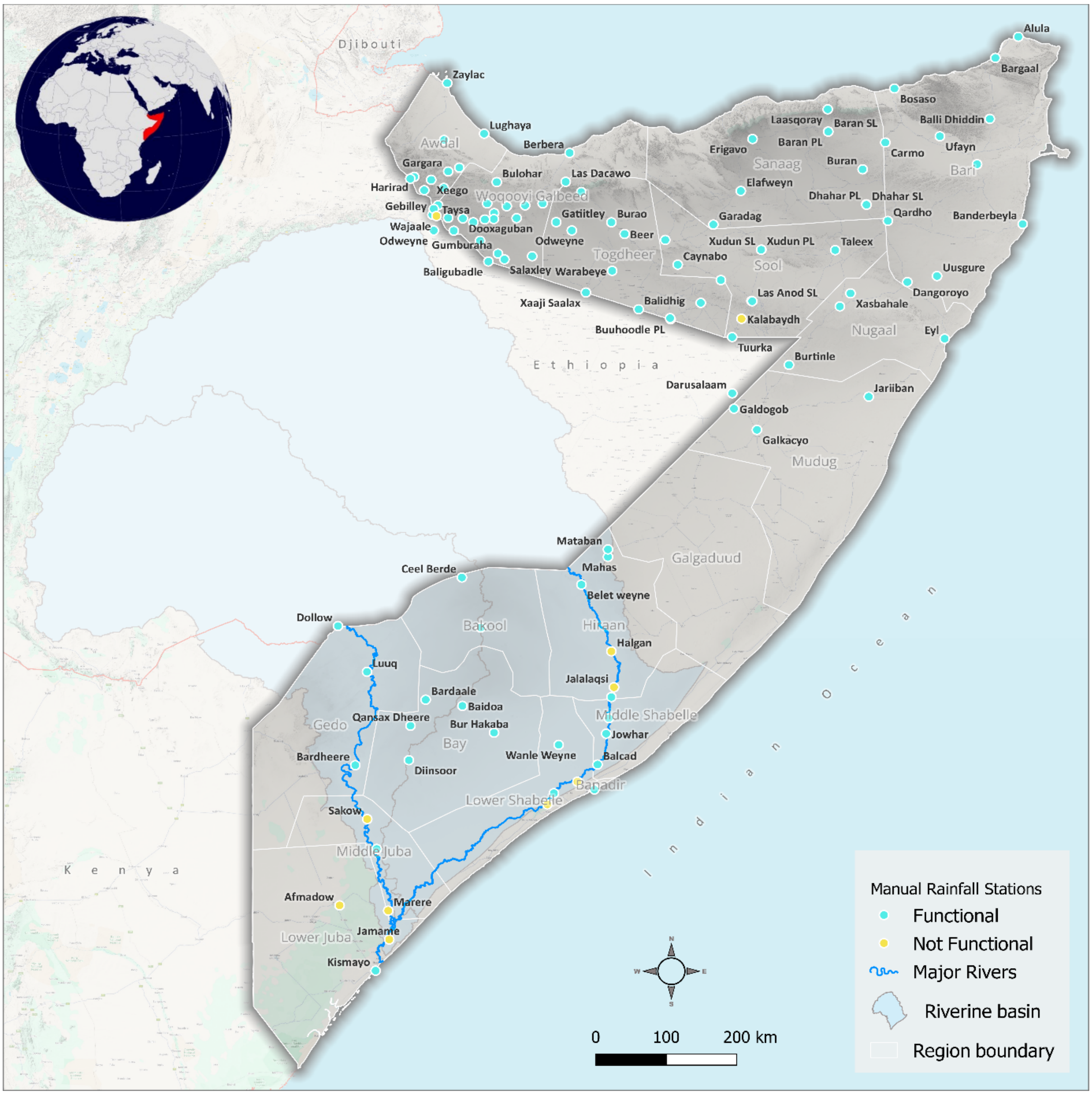

Figure 4.10: Location of the Manual Rainfall Stations across Somalia

Other regions, particularly in the southern of the country, have fewer stations. According to HD-MoEWR, the current weather station coverage is insufficient, and this pose challenges for accurate weather monitoring and forecasting in those areas.

3. Installation Agency

Despite lack of data collection continuity at some stations, most of Somalia was covered with rainfall stations (according to MoEWR). No information available, and no data from the filed confirming the existing of the 118 rain gauge stations, except from SWALIM data base. (See annex 3)

4. Functionality

Out of the 118 stations listed, 108 are functional, representing 92% of the total stations. This leaves 10 stations (8%) that are not functional and most of them are concentrated in southern part of the country, (Fig 4.11). Detailed information about each station in annex 4.

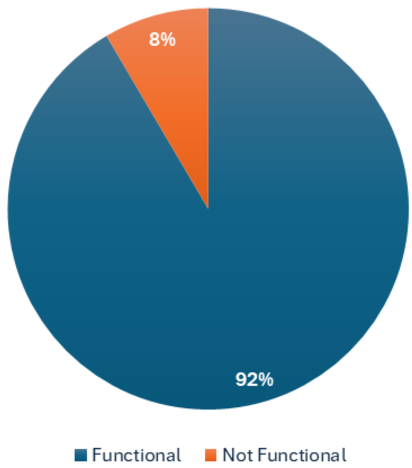

Figure 4.11: Functionality of the manual weather stations

5. Parameters Measured

These stations collect Rainfall record manually. Data from these stations is collected by gauge readers and sent to the SWALIM by phone call, email as well as other mobile network data services (SWALIM 2024). When data is received by SWALIM, it is compiled from all stations into required format and coded. Data is edited to remove any errors and validated using data obtained through automatic weather stations and then disseminated through SWALIM Dashboard (Fig 4.12).

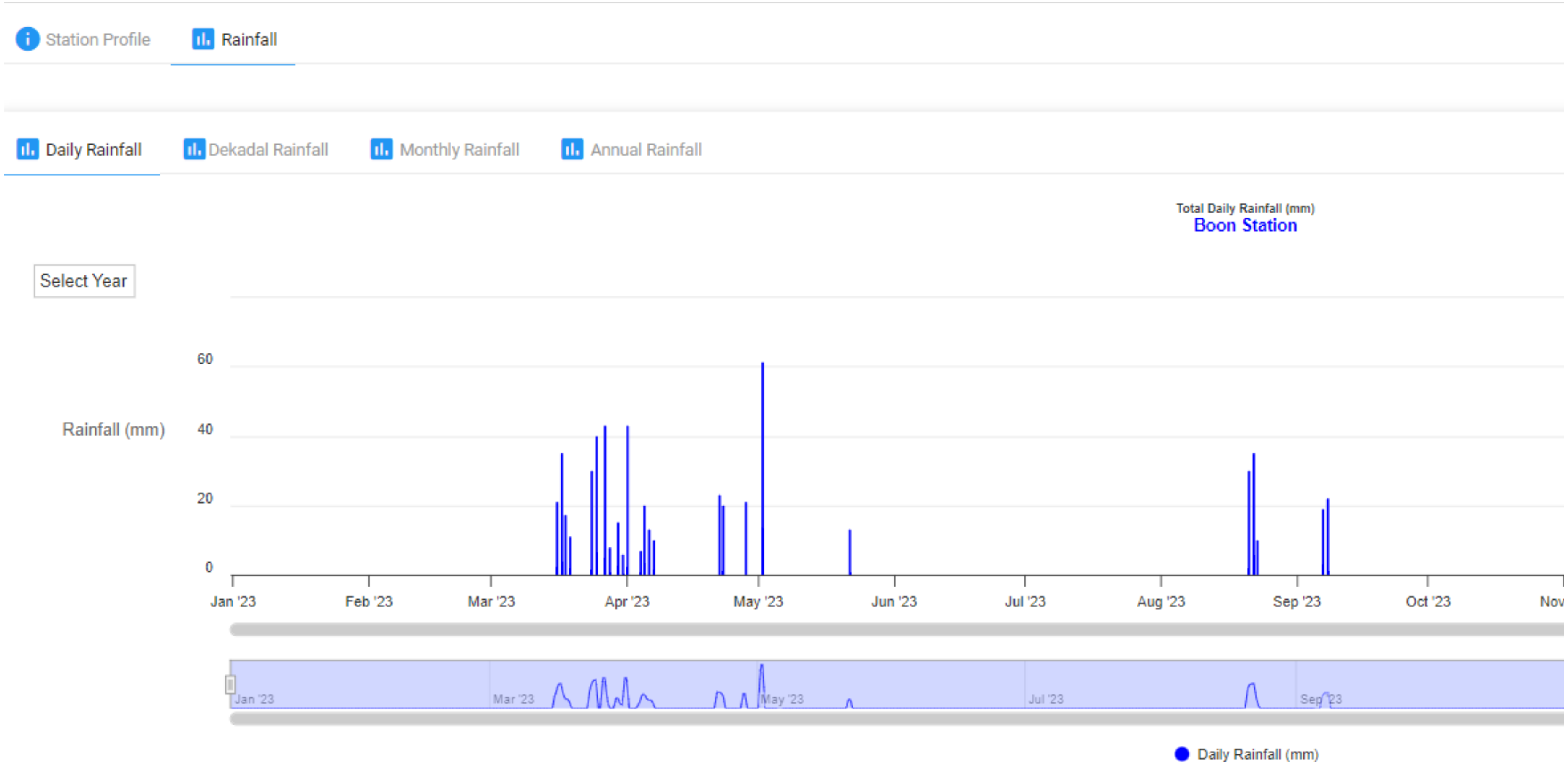

Figure 4.12: SWALIM dashboard showing the Manual Rainfall Stations: MRS_AWBOO – Boon *(Source SWALIM)*

6. Technical Challenges and Maintenance

According to SWALIM, all the stations lacked supplies while some lacked instruments. The general condition of the stations was not impressive and in some instances some instruments have been missing for many years. In general, the manual weather station network faces several challenges that hinder its effectiveness:

1. There is an insufficient number of weather stations in the country.
2. The entire geographical distribution of the weather stations is far from reaching the level that is representative of the country.
3. Many stations are either partially or completely nonoperational.
4. All the stations are not known by HD-MoEWR and as such, the data they collect is only accessed by SWALIM only.

4.2.2 Surface Hydrological Observations Network

Somalia has only two perennial rivers, the Juba and the Shabelle, both of which flow through the southern part of the country, but originate in neighboring countries, principally Ethiopia where the main streams and their tributaries are deeply incised into the steep slopes of the upper reaches. However, in Somalia, in the middle and lower reaches, there is a virtual absence of tributaries and other drainage channels; there are some spring-fed streams and some local runoff, but these contribute to river flow only in times of heavy rainfall.

Over long reaches, particularly on the Shabelle, the riverbanks lie above the level of the surrounding land, so that any spillages are lost permanently from the river and no return flow occurs. The areas of the Juba and Shabelle basins are 218 114 km^2 (to Jamaame, excluding Shabelle basin) and 296 972 km^2 (to the Juba confluence), respectively.

Water level readings were reportedly taken from the earliest days of the Italian colonial settlements in Somalia, at various locations including the important upstream stations of Luuq on the Juba and Belet Weyne on the Shabelle (Fig 4.13). Studies during the 1960s (Faillace 1964, Selchozpromexport 1965, FAO/Hunting/MacDonald 1969) led to the establishment of a rudimentary hydrometric network.

This was strengthened after the 1981 flood because of a FAO study (Gemmell 1982), and the input of staff from CEH Wallingford (then the Institute of Hydrology, IH) and Mott MacDonald Ltd (then Sir M. MacDonald and Partners), who provided technical assistance and training to the Hydrology Section of the Department of Irrigation and Land Use in the Somali Ministry of Agriculture. This support was funded by the UK Overseas Development Administration (now the Department for International Development, DFID), as part of the UK government's program of technical cooperation with developing countries. The hydrometric network was consolidated and a database and flow forecasting model for both the Juba and Shabelle rivers were developed and successfully operated by Ministry of Agriculture staff (MacDonald/IH 1986, 1990b).

The pre-war hydrometric network comprised 23 monitoring stations, including eight river gauging stations on the Juba and seven on the Shabelle. In 1980, a large off stream storage reservoir was constructed at Jowhar in the middle reaches of the Shabelle, south of Mahadey Weyne. The Jowhar Offstream Storage Reservoir (OSR) was commissioned primarily to collect surplus river flow during the wet season, for release for irrigation during the subsequent dry season, though the supply channel was also used as a flood relief channel when required, diverting up to 40 $m^3 s^{-1}$ of flow. Several of the other gauging stations were associated with the Jowhar OSR, and with sediment and water quality monitoring programs.

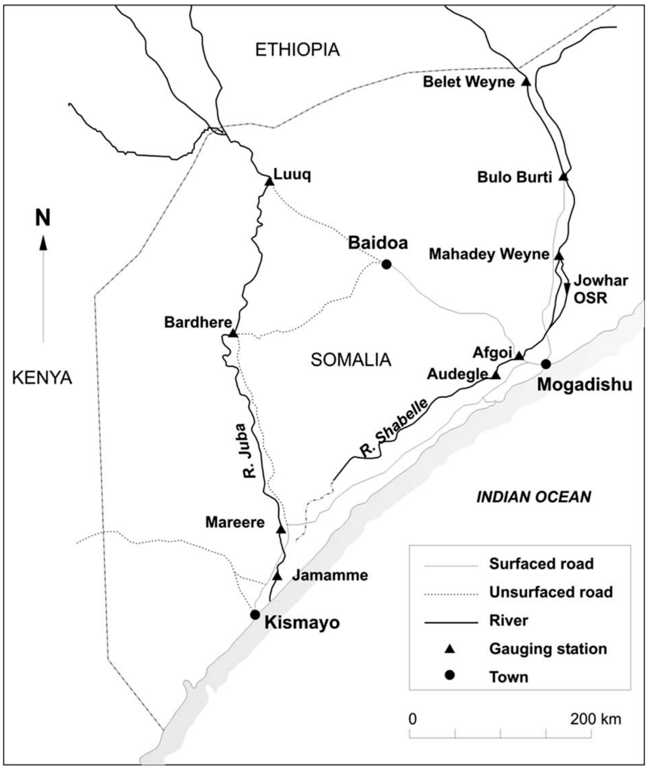

Figure 4.13: Map of southern Somalia showing the Juba and Shabelle rivers and locations of past and present river gauging stations (Jowhar OSR is Jowhar Off stream Storage Reservoir, where the supply channel was also used as a flood relief channel).

The development of the river gauging station network over time is summarized in Figure 4.14. Figure 4.14(a) shows the number of stations operating each year from 1951 to 2010, whilst Fig. 4.14(b) shows the distribution of pre-war record lengths. There is a steady increase in the number of operating stations from 1963 through to 1990, the most significant sustained periods of growth being in the early 1960s and the 1980s. Many of the principal gauging stations on the Juba and the Shabelle have record lengths more than 25 years, whilst the remainder and the stations associated with the Jowhar OSR have record lengths ranging up to 20 years, mostly between five and ten years.

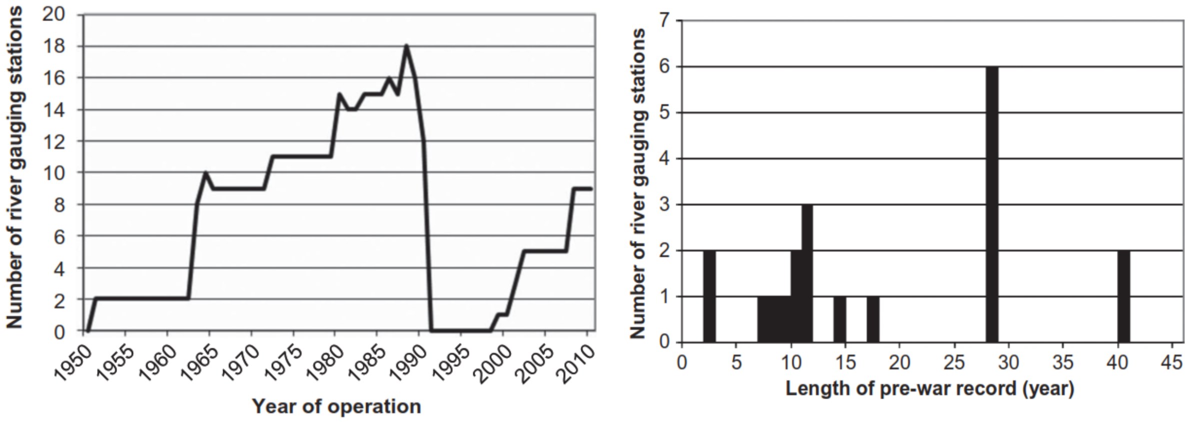

Figure 4.14: (a) Development of river gauging station network over time. (b) Distribution of pre-war flow record lengths.

The war resulted in the neglect and abandonment of monitoring stations and an enforced cessation of data collection and management. In 2001 and 2002, part of the pre-war hydrometric network was reinstated, and water levels were again recorded at some stations. 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 3.18) which collect a variety of data.

I. Status of River Gauging Stations (RGS)

With the support of FAO Somalia Water and Land Information-SWALIM Project, Somalia has been strengthening hydrological services since 2002. SWALIM support includes the restructuring of the RGS and the installation and operation of these stations. As in many countries in east Africa including Somalia, the potential use of data for real-time water resources management is not realized due to a lack of telemetry (automated monitoring and communication) and data processing and management systems. In some countries, telemetry systems are in use at a limited number of stations. Other countries have no telemetered stations at all.

1. Number of Stations

Currently 17 stations (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. These stations rely on trained personnel, known as "gauge men," who collect water level data manually twice a day.

2. Geographical Distribution

Figure 3.20 illustrates the spatial distribution of the river gauging stations along Shebelle and Juba Rivers basins. Overall, many parts of the country are adequately gauged. The ungauged areas center in the Juba River Basin, the southeastern part of Shebelle River Basin. These monitoring gaps are mainly due to difficulties of access and/or security issues.

The main criteria to select hydrological stations are: (i) strategic importance of historical and new locations; (ii) experience and knowledge of national and international experts; (iii) uniform coverage in the river basins and sub-basins using old maps and Google Earth Images; and (iv) security situation.

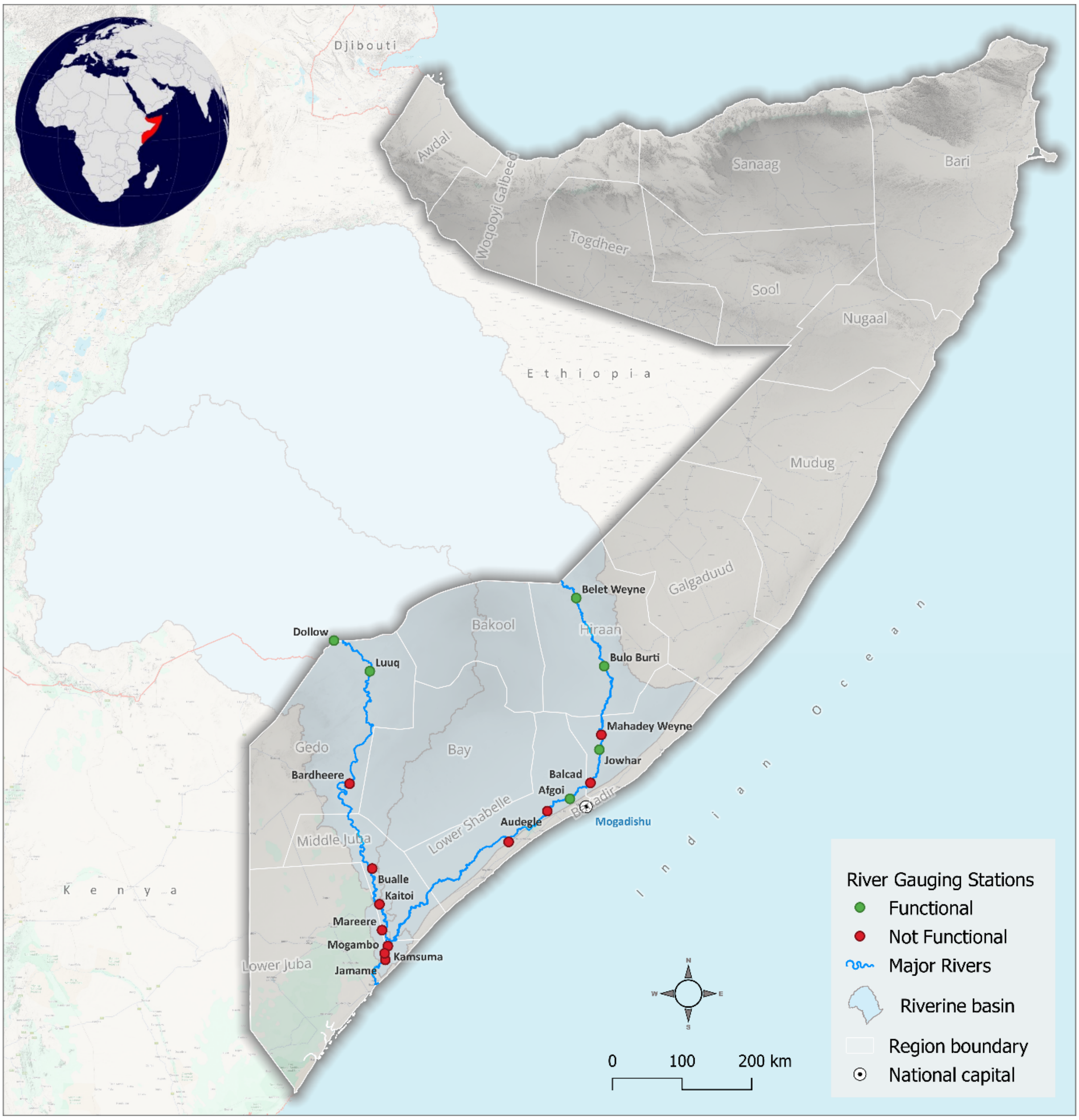

Figure 4.15: Location of the river gauging stations

3. Installation Agency

The 17 gauges 17 stations along the Shebelle and Juba Rivers were rehabilitated previously by the SWALIM, CEFA, CARE and World Vision International. An effort was made by IGAD-ICPAC to fix new staff gauges at the same level datum of the gauges that were maintained before the war but not yet installed due to some technical issues with the stations, but the station houses were constructed. Below some information about the existing stations

- **Belad Weyne Staff Gauge Description:**

Belad Weyne river gauge was installed in Buundo Weyne bridge site in 1963. The station is situated on the left bank of the river, attached to the downstream side of the bridge and consist of six 1.0 m guage plates which are graduated in two centimeters divisions and attached to angle line face the right bank of the bridge. 0-2 meter added later due to siltation of lower original set.

River	Shabelle	**Location**	Balad Weyne	**Station Number**	SHB. 1
Latitude	4.733 N	**Longitude**	45.203 E	**Altitude**	176.11 m a.s.l.
Number of Staff Gauge			1. 0 – 6 m 2. 0 – 2 m		

River flow in Belad Weyne follows a bi-annual pattern, reaching peaks in the Gu and Deyr rainy seasons. Seasonal flow variation at the station is however great, and most of the flow occur during the wet season or soon after. The estimated daily mean flow at the station is 78.3 m^3/s (SWALIM). River levels remain low during dry season even though the river never dries completely.

Figure 4.16: Jowhar staff gauging station

- **Buulo Barde Staff Gauge Description:**

Buulo Burti river gauge was installed at the bridge in 1963. The staff guages consist 7.0 m range, with the 0-1 m assumed to avoid minus readings. Three gauge post (1-3 m, 3-5 m, 5-7 m) embedded in concreate, and each fitted with two one meter length enamelled matel gauge plates, graduated in centimeters. These gauages are all in level with no overlaps between the gauges. The estimated daily mean flow at the station is 69.7 m^3/s (SWALIM). The mean annual flow volume at Buulo Barde is about 2 207 million cubic meters, which is much less than the flow at Belad Weyne.

River	Shabelle	**Location**	Buulo Burti	**Station Number**	SHB. 2
Latitude	3.853 N	**Longitude**	45.570 E	**Altitude**	133.39 m a.s.l.
Number of Staff Gauge			1. 1 – 3 m 2. 3 – 6 m		

The significant loss of flow could be attributed to the diversion of river flows for irrigation and high evaporation losses. The river flow is lowest in the months of January to March.

Figure 4.17: Buulo Burti staff gauging station

- **Mahaday Weyne Staff Gauge Description:**

Mahaday Weyne river gauge station was installed in 1963 and situated on the left bank of the river downstream of the bridge. The staff guages consist 0-7 m gauge fitted to Angaleline stand embadedd in concrete piller of the bridege LB, plates graduated in centimeters. The estimated maximum and minimaum mean flow at the station is 176 and 130.2 m^3/s repectively (SWALIM). River levels remain low during dry season even though the river never dries completely. The mean annual flow volume at

Mahaday Weyne is much less than the flow at Bula Burdi. The significant loss of flow could be attributed to the diversion of river flows for irrigation and high evaporation losses. The river flow is lowest in the months of January to March.

River	Shabelle	**Location**	Mahaday Weyne	**Station Number**	SHB. 3
Latitude	2.970352	**Longitude**	45.530450	**Altitude**	117 m a.s.l.
Number of Staff Gauge			0 – 7 m		

Figure 4.18: Mahaday Weyne staff gauging station

- **Jowhar Staff Gauge Description:**

Jowhar river gauge station was re-installed by SWALIM in 2008 at a position where the old CEFA gauge used to be in bridge. The staff guages consist 0-6 m gauge fitted to Angaleline stand embadedd in central concrete piller of the bridege, plates graduated in centimeters

River	Shabelle	**Location**	Jowhar	**Station Number**	SHB. 4
Latitude	2.767	**Longitude**	45.500	**Altitude**	95 m a.s.l.
Number of Staff Gauge			1. 0 -6		

The estimated daily mean flow at the station is 65.0 m^3/s (SWALIM). Seasonal variations in river flow at Jowhar is less pronounced than the upstream stations. The previous government had constructed some structures for diverting excess water during high flows and re-directing it to the river during low flows. Much of these structures are however no longer functional. A lot of water is diverted for irrigation around this area.

Figure 4.19: Jowhar staff gauging station

Afgooye Staff Gauge Description:

Afgooye river gauge was installed at old bridge in 1963. The staff guages consist 6 m gauge plates fixed to a metal frame which is bolted to the center upstream trestle support pillars of the bridge. The estimated daily mean flow at the station is 48.0 m^3/s (SWALIM). River flow in Afgooye remains almost the same in several months, other than January to March when they are low. The river channel at this point is shallow, and easily reaches bank full even when the flows upstream are not so high.

River	Shabelle	**Location**	Afgooye	**Station Number**	SHB. 5
Latitude	2.140	**Longitude**	45.122	**Altitude**	77.4 m a.s.l.
Number of Staff Gauge			0 – 6 m		

Figure 4.20: Afgoye staff gauging station

4. Functionality

Out of the 17 stations listed, only 6 are functional (2 along Juba River and 4 along Shabelle River), representing 36% of the total stations. This leaves 11 stations (65%) that are not functional (7 along Juba River and 4 along Shabelle River) (Fig 4.21). Detailed information about each station in annex 5.

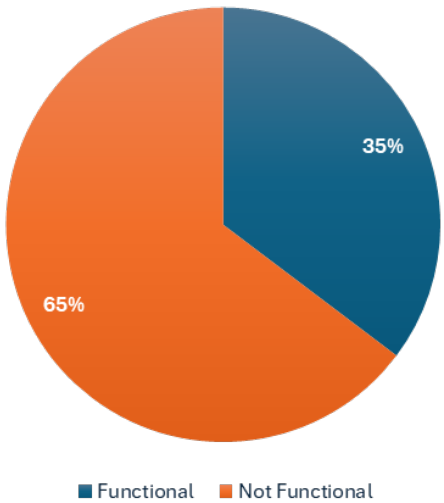

Figure 4.21: Functionality of the river gauging stations

5. **Parameters Measured**

These stations collect a range of valuable environmental data, including:

1. Daily level
2. Daily flow
3. Peak flow

6. **Data Transmission**

Data from river gauging stations is typically transmitted weekly or upon request from SWALIM's office. Transmission methods include email or telephone, depending on availability and urgency. During periods of rapid water level rise, gauge men collect data more frequently and transmit it immediately to SWALIM. SWALIM experts then analyze the data in comparison with historical records from the same river and consider weather forecasts and geographical factors to determine flood warning thresholds (Fig 4.22).

7. **Technical Challenges and Maintenance**

Staff gauge stations along the Jubba and Shabelle River encounter numerous challenges that hinder their effective operation and compromise data quality. These challenges can be categorized as follows:

- Many staff gauge stations are situated in isolated and difficult-to-reach areas, making regular maintenance and observations arduous.
- Harsh environmental conditions, coupled with a lack of maintenance, lead to the degradation and damage of essential equipment.
- Manual data recording and transmission processes are prone to errors and delays, particularly in regions with limited communication infrastructure.
- There is a persistent shortage of trained personnel to conduct regular observations and maintain staff gauge stations.
- Factors such as low wages, remote work locations, and challenging conditions contribute to low staff morale and turnover.
- Operating in conflict-affected areas exposes staff to significant security risks.
- Staff gauge stations are often targets of vandalism, resulting in equipment damage and data loss.
- Manual data recording methods are susceptible to human error, leading to inconsistencies in the dataset.
- Inadequate data storage systems and procedures can result in data loss or difficulties in data retrieval.
- Staff gauge stations located in flood-prone areas are at risk of damage or destruction, leading to data gaps.
- Insufficient financial resources hinder maintenance, repairs, and staff training, impacting the overall performance of staff gauge stations.

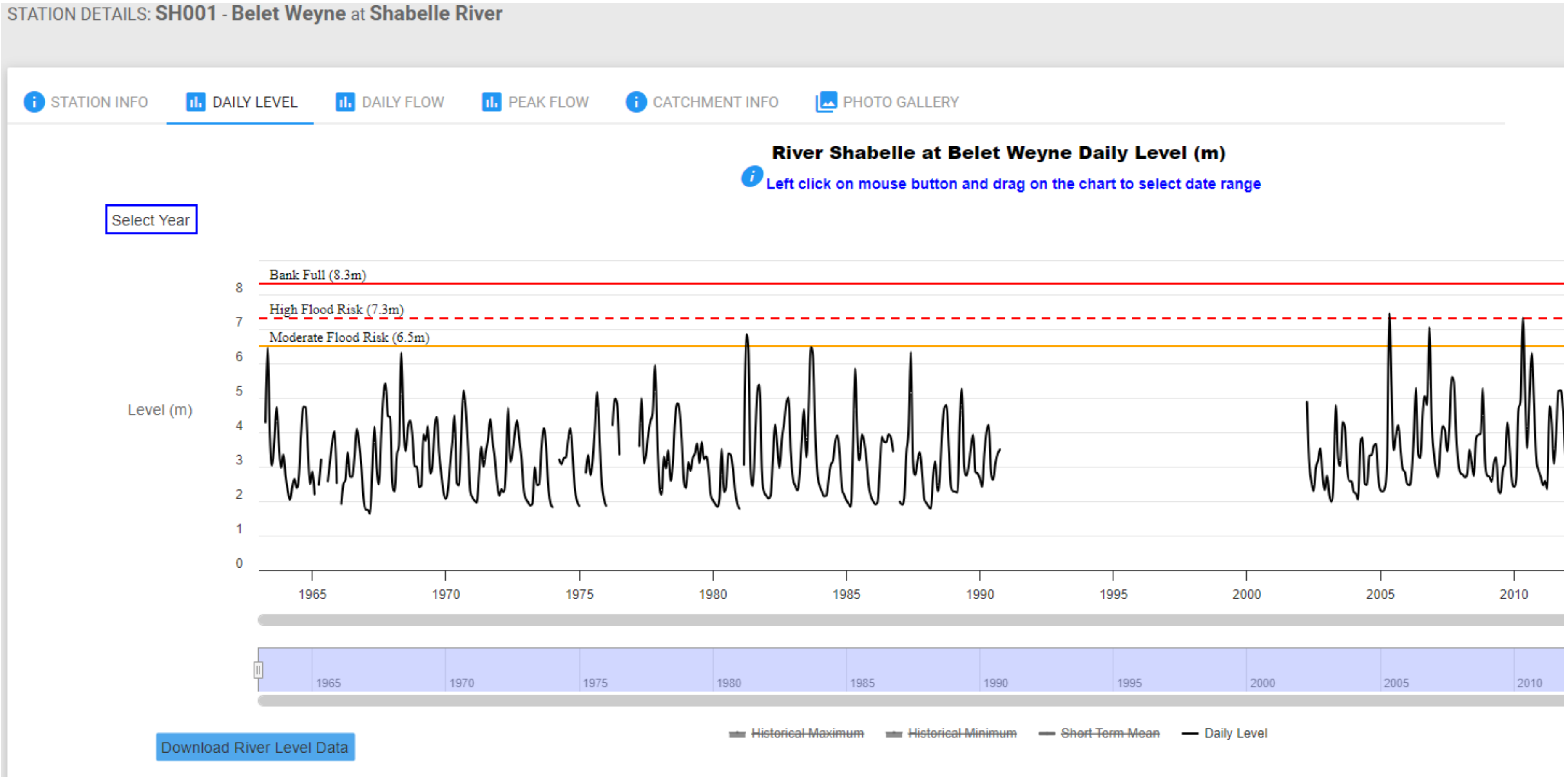

Figure 4.22: SWALIM dashboard showing the river gauging station: SH001 - Belet Weyne at Shabelle River *(Source SWALIM)*

II. Status of Radar Water Level Sensors (RLS):

1. Number of Stations

Only 1 new station was installed recently in Beledweyne along the Shebelle River. Established and maintained by MoEWR-HD. The HD-MoEWR is planning to install 3 more. The RLSs are non-contact instruments used to measure the distance between the sensor and a water surface. This distance is then used to determine the water level at that location. They provide real-time or near real-time data on water levels, allowing for continuous monitoring of the river's levels.

2. Geographical Distribution

Figure 4.23 illustrates the spatial location of the RLS in Beledweyne along Shebelle River. The HD-MoEWR is currently installing 3 stations in Luuq, Bardhere and Yoontoy along Juba River (Fig 4.23).

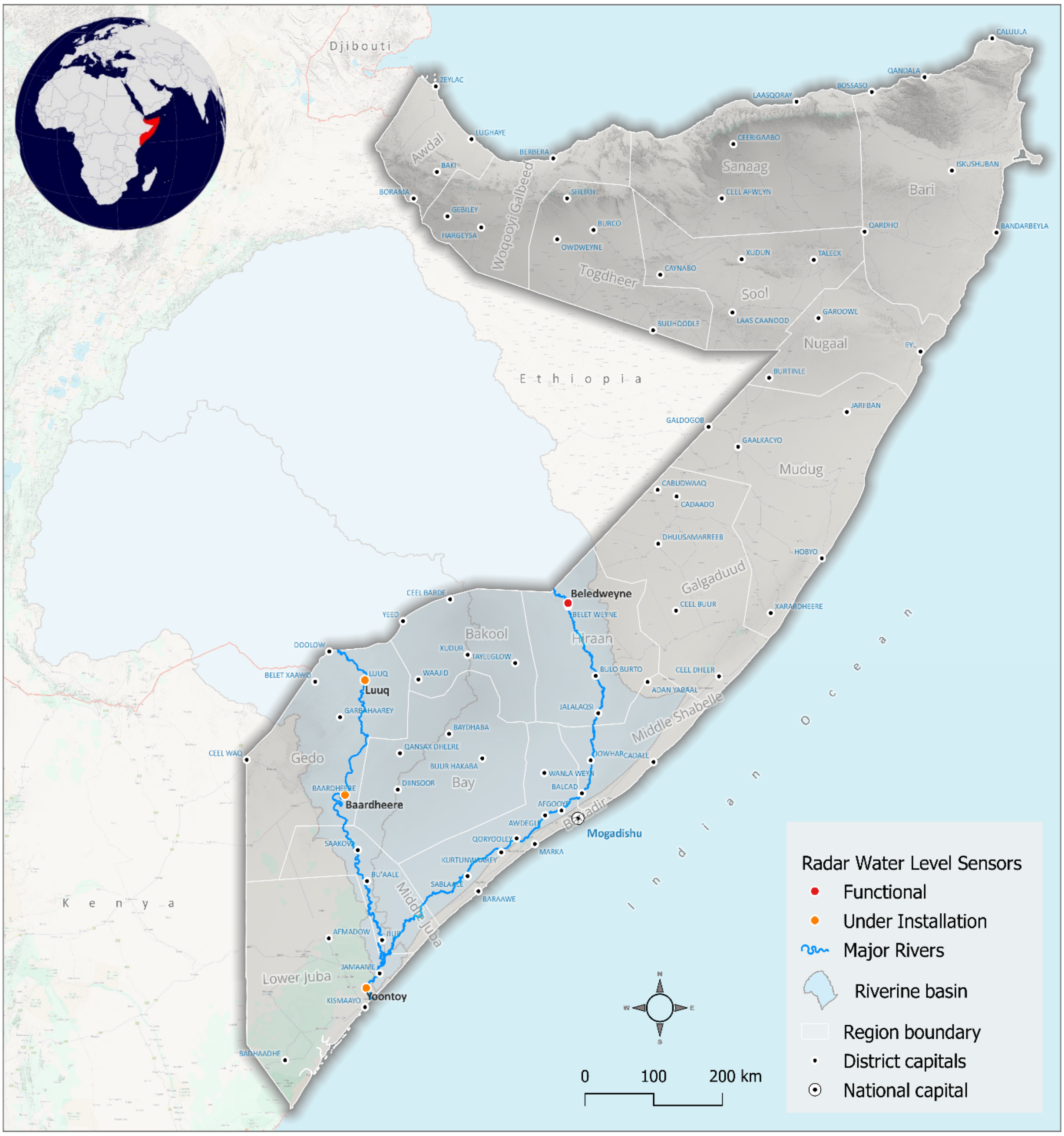

Figure 4.23: Location of the Radar Water Level Sensors

3. Functionality and Measurement

The station is newly installed and it's working very well and typically the senser transmit data to a data logger and then the data logger then stores the water level data and transmit it to MoEWR server. Detailed information about each station in annex 6. The station collects:

1. Daily level
2. Daily flow

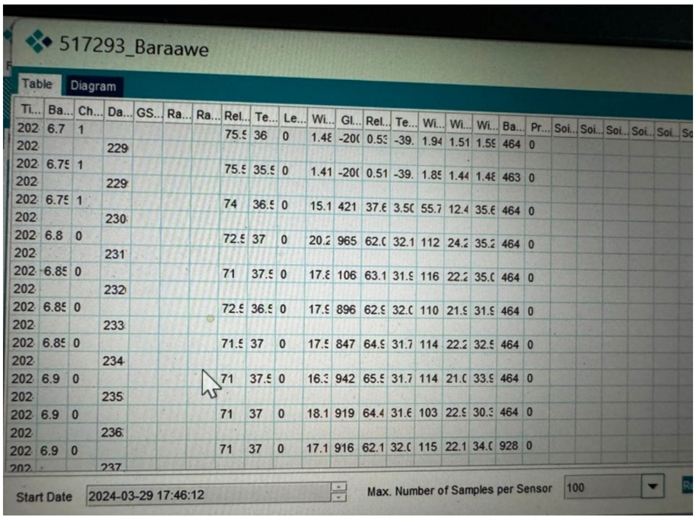

Figure 4.24: MoEWR dashboard showing the Radar Water Level Sensor: RLS001 - Beledweyne at Shabelle River.

4. Technical Challenges and Maintenance

The RLS network faces several challenges that hinder its effectiveness:

- Radar accuracy can be affected by factors like water surface conditions (waves, debris), vegetation growth near the sensor, and variations in water salinity. This can lead to inaccurate water level readings.
- Heavy rainfall, strong winds, and extreme temperatures can interfere with radar signals, causing data gaps or unreliable measurements.
- Like synoptic weather stations, reliable electricity access can be an issue, especially in remote locations. Dependence on solar panels might be limited during extended periods of cloud cover or dust storms, impacting station operation.
- Like weather stations, reliable data transmission from remote locations can be hindered by weak or limited telecommunication infrastructure.
- Interpreting raw radar data requires specialized knowledge and software. A lack of skilled personnel can limit the ability to fully utilize the data.
- Regular calibration and maintenance of radar sensors are crucial for maintaining accuracy. This can be challenging due to the need for specialized skills and potential access limitations to the sensor location (e.g., mounted on a bridge).
- Obtaining replacement parts for specialized radar equipment can be difficult and time-consuming, especially for imported models. This can lead to extended periods of station downtime.

- Insufficient funding for maintenance activities can limit the ability to procure spare parts, pay for specialized technician training, and conduct regular preventative maintenance checks.

III. Groundwater Level Sensors (GLS):

These are stations that monitors water depth and quality parameters such as temperature, conductivity and salinity in boreholes and other groundwater sources. The stations are telemetric, recording and transmitting data at least once a day. Groundwater monitoring provides information on short-term and long-term changes in groundwater recharge and aquifer storage.

1. Number of Stations

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. The HD-MoEWR have no access to these stations.

2. Geographical Distribution

Figure 4.25 illustrates the spatial distribution of the GLS installed by world vision in Puntland and Somaliland. 13 stations installed in Bay, Bakool and Gedo regions and the other 9 stations have been installed in Sool, Sanag, Waqoy Galbed, Awdal Saxil and Togdheer regions. The entire geographical distribution of the stations is far from reaching the level that is representative of the country as indicated by the HD-MoEWR.

3. Installation Agency

All the 22 stations were installed and managed by World Vision International.

4. Functionality and Measurement

Groundwater level sensors use the GSM/GPRS/LTE modems integrated into the sensor system to transmit data via cellular networks to a central monitoring system of World Vision.

No information available about the current condition of the functional stations. Detailed information about each station in annex 6. The type of the sensors is OTT and measure:

1. Water Level
2. Water temperature
3. Electrical Conductivity
4. Salinity
5. Total dissolved solids (TDS)

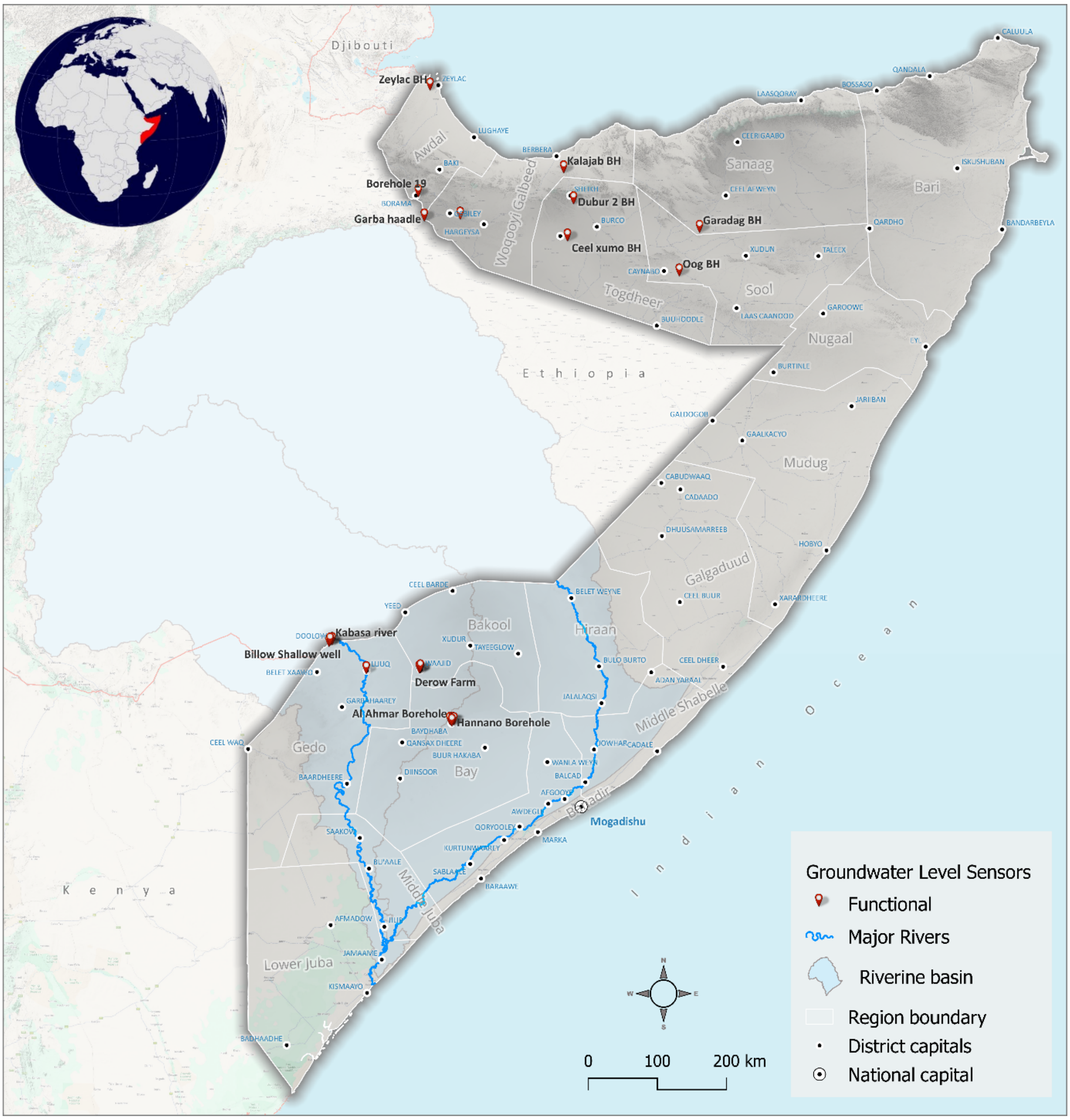

Figure 4.25: Location of the Groundwater Level Sensors

5. Technical Challenges and Maintenance

The GLSs network faces several challenges that hinder its effectiveness:

- A combination of issues and limited maintenance can result in stations collecting unreliable or inaccurate data.
- Insufficient funding allocated for maintenance and a lack of skilled personnel further hinder the network's upkeep.
- The current distribution of stations falls short of adequately representing the country's diverse climatic conditions. Many stations are either partially or completely non-operational.
- Several stations remain unknown to HD-MoEWR, limiting the accessibility and utilization of valuable weather data.

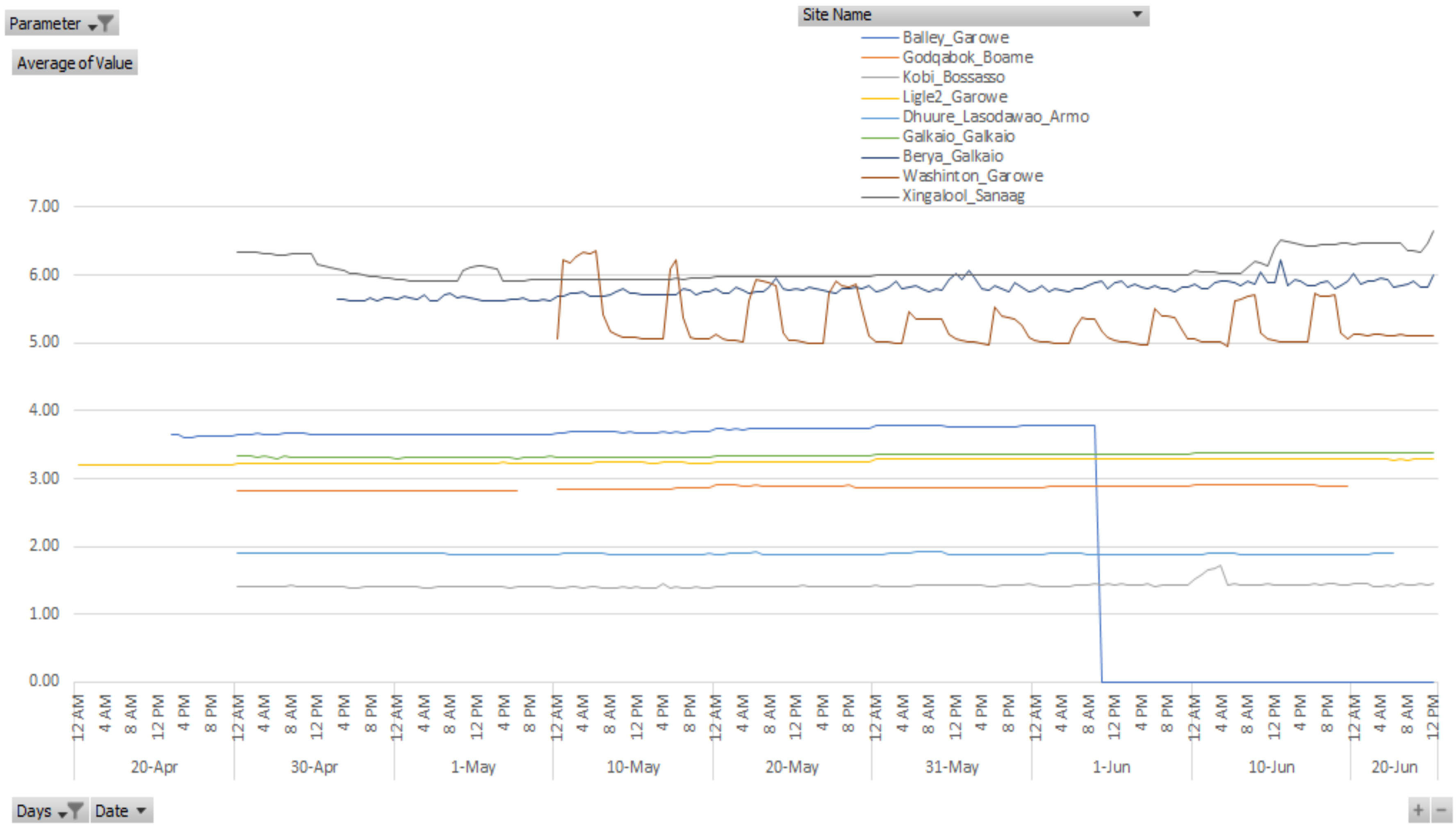

Figure 4.26: MoEWR dashboard showing the Groundwater Level Sensor: GLSS001 – EC *(Source World Vison)*

4.2.3 Data Management Process

Data from the Meteorological and Hydrological stations is transmitted in real time or is collected by gauge readers and sent to the SWALIM, ICPAC or HD-MoEWR by phone call, email, physical delivery or GPRS as well as other mobile network data services. When data is received by SWALIM, ICPAC or HD-MoEWR, it is compiled from all stations into required format and coded. Data is edited to remove any errors and validated using existing data. Figure 4.27 below presents the data management processes that are done before weather information is disseminated to the stakeholders.

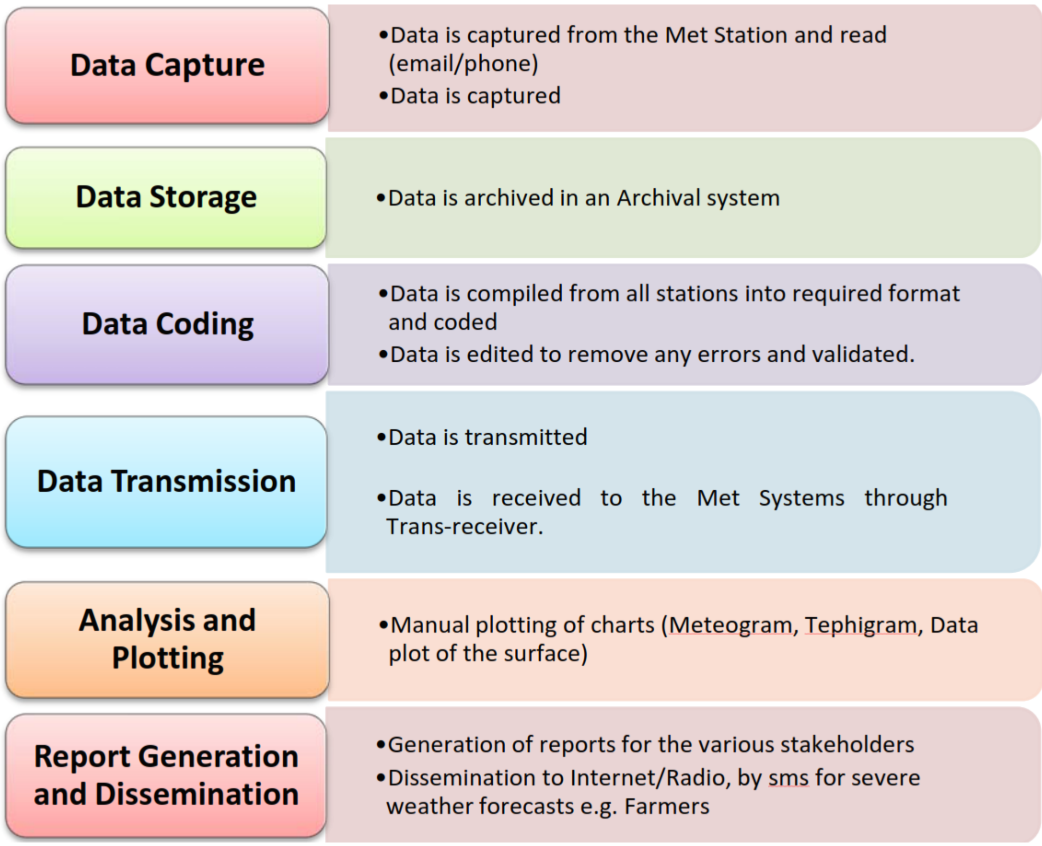

Figure 4.27: The Data Management Process

4.2.4 Numerical Weather Prediction Activities

Currently the SWALIM or HD MoEWR do not run any Numerical Weather Prediction Models but use ENSEMBLE forecasting which combine several projection models. Model and products are obtained from the World Forecast centers – AWS-NOAA (Am, UK Weather Service...Etc. Satellite images are used in conjunction with plotted charts to generate forecasts. The satellite data typically has a spatial resolution of 8 kilometers and a temporal resolution of 15 minutes. The primary parameter derived from these images is rainfall.

4.3 Current Status and Gaps in Human Resource

This section assesses the current state of human resources dedicated to Hydromet services in Somalia. The information is based on interviews and self-reported data.

1. **Staff Numbers and Unclear Distribution:**

Identifying the exact number and location of government staff working on Hydromet issues proved difficult. While 9 staff were confirmed within MoEWR's Department of Hydrometeorology, additional personnel might exist in states or other ministries (Agriculture, Multi-Hazard Early Warning Centre) but their affiliation remains unclear. This suggests a fragmented workforce and limits institutional capacity.

2. **Staff Qualifications and Experience:**

The study successfully gathered information on the nine MoEWR staff members. Six reported that they are skilled in data analysis and interpretation. Few reported experiences with or the skills for the design and operation of surface and groundwater monitoring, assessments (including water quality), surface and groundwater data analysis and reporting. All possess at least a bachelor's degree in water and environmental engineering, with two holding master's degrees in environmental management and sustainability. However, experience levels are concerning. Half have only 1-2 years of experience, and only one has over 10 years. This highlights a potential lack of expertise for crucial Hydromet tasks.

3. **Skill Gaps and Training Needs:**

While staff have relevant academic qualifications, data management skills like data entry and archiving are lacking in over half the respondents. Similarly, only six reported proficiencies in data analysis and interpretation. Skills for essential tasks such as surface and groundwater monitoring, assessment, and data analysis are also limited. It was also noted there was lack of personnel with ICT skills. The ICT related training requirements that would greatly benefit staff are:

a) There is a need to have programmers who can develop/design the necessary software needed for the new data capture methods as well as kick start dormant tools on Linux and numerical weather prediction models.
b) Lack of general ICT skills to collect, process, organize, send, store, preserve data. Skills for computerized analysis and forecasts to replace the manual plotting of charts which is tedious with delays.
c) SWALIM and MoEWR has huge volumes of data presenting the need to improve accessibility and storage of data. Some of the existing software cannot be redesigned to suit the demands because of lack of database designers and developers who are familiar with weather data. This skill is necessary to reduce the time taken to produce the required analysis.
d) Modeling skill will be useful in producing tailored products for the different stakeholders as well as improving the accuracy of forecasting.
e) Hardware and Systems Maintenance skills for configuring servers for transmission as well as sustaining the hydromet service operations. Due to shortage of competent staff, NMS has servers for transmission but are not yet configured.
f) Network management skills required to ensure that there is communication between the departments for timely reporting.

4. **Challenges in Staff Recruitment and Retention:**

The interviews revealed difficulties in employing technical staff due to low salaries, high-risk working environments (details not provided), and a lack of incentives in government institutions. Salary figures suggest a single senior staff member earns more than $2,500/month, while others likely earn considerably less. This creates a disincentive for qualified professionals.

5. **Limited Research and Modeling Capabilities:**

Currently, the Department of Hydrometeorology lacks the capacity to conduct research or develop/modify Hydromet models. This significantly hinders their ability to improve forecasting and data analysis techniques.

6. **Inadequate Workspaces and Infrastructure:**

Government Hydromet staff, both federal and state, lack dedicated office spaces. At the federal level, they share congested offices with MoEWR staff, falling short of recommended space standards. While basic equipment like printers and GPS devices are available, internet and electricity are unreliable. Computer access is limited, with only five out of six federal staff computers being functional. Software requires updates, and no MoEWR office meets the minimum requirements for a data center. Currently, Hydromet data is stored, analyzed, and processed outside the country by non-governmental organizations.

4.4 Challenges

The Ministry of Energy and Water Resources, Department of Hydrometeorology (HD-MoEWR) faces several challenges in implementing effective Hydromet services across Somalia.

Our stakeholder surveys, including interviews with SWALIM, ICPAC, MoA, and others, revealed a key challenge in deploying hydrological and meteorological stations. Projects governed by foreign institutions, such as NGOs, often dictate station locations based on their specific project needs. Since their primary focus is local data collection within their project areas, this approach can lead to a network that doesn't comprehensively address national Hydromet requirements.

A significant contribution of this report is the identification of comprehensive coverage of existing stations (Fig 4.28) and suitable locations for new stations, considering a broader national perspective. This data-driven approach will help ensure a more strategically distributed network that fulfills both national and local needs.

The following site selection parameters should be considered:

- Climatological zones of Somalia
- Locations of existing operational stations
- Network Coverage
- Network Reliability Index
- Security
- Land ownership

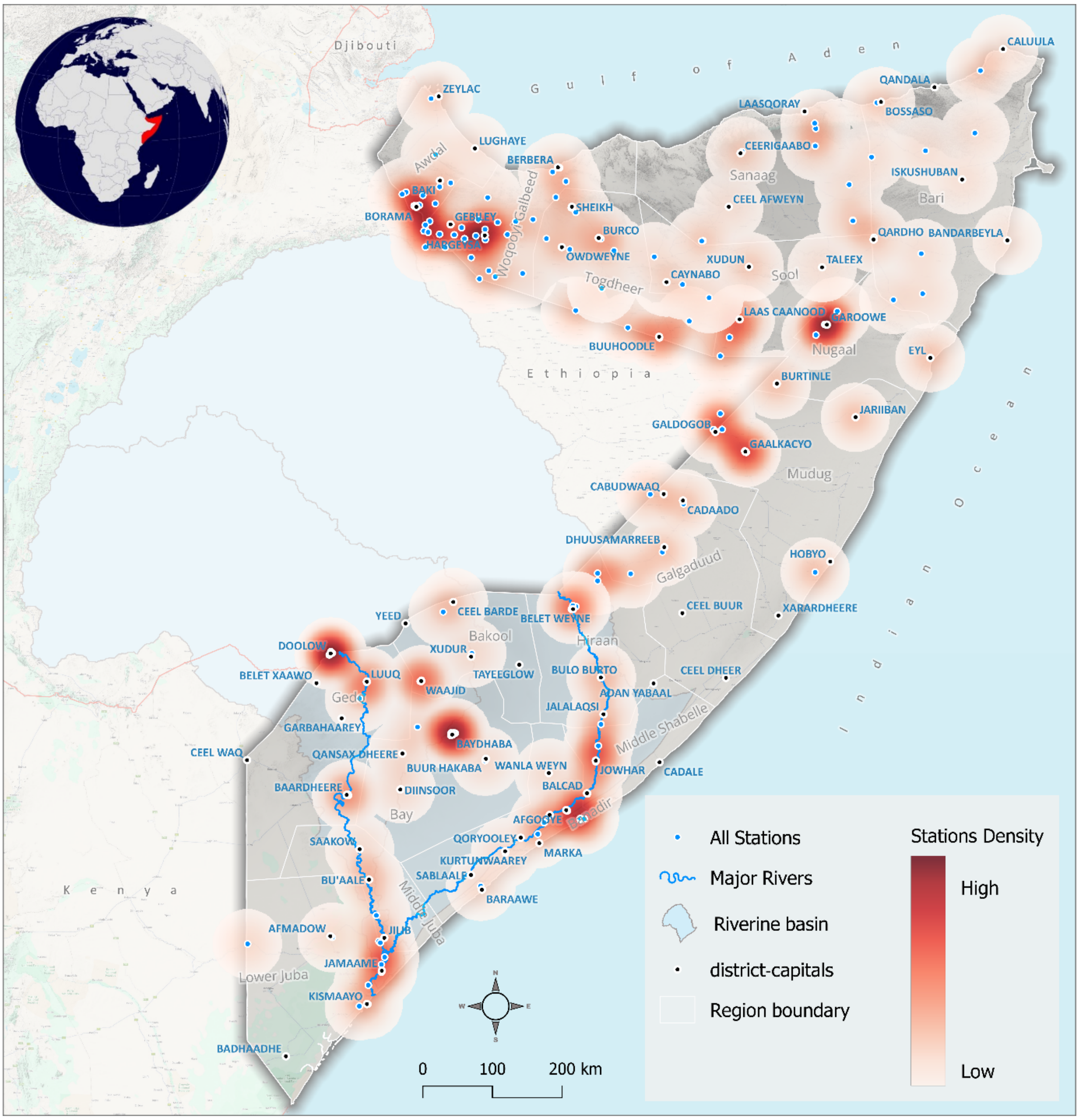

Figure 4.28: Comprehensive coverage of hydrological and meteorological stations across Somalia

Other challenges are also identified and can be categorized as follows:

a) **Challenges Hindering Large-Scale Deployment of Modern Technologies:**

- Insufficient funding restricts the acquisition and maintenance of modern technologies crucial for improved data collection, analysis, and forecasting. Most of the weather stations cannot send their data because of an inability to pay for their communication infrastructure.
- A lack of adequately trained personnel hinders the effective operation and maintenance of advanced Hydromet equipment. Of the weather stations visited, most of weather stations have insufficient human resource both in skill, number and commitment. Basing on a threshold of at least 3 observers per station, all the AWS that were visited did not meet this baseline.

- The absence of supportive policies can create bureaucratic hurdles and limit investment in essential Hydromet infrastructure.
- Difficulties in maintaining equipment due to a lack of resources or expertise can lead to station downtime and data gaps. There is an insufficient number of stations in the country. Many regions poorly covered by the station network.
- The reliance on imported equipment can make obtaining replacement parts challenging and time-consuming, further impacting station functionality. Different station models will at times give enormously different parameter readings even in the same area.

b) Challenges in Communicating with Local Communities:

- Unreliable telecommunication networks can hinder the timely dissemination of critical weather information through text messages.
- Limited understanding of weather information by communities can reduce its effectiveness in promoting preparedness and risk reduction.
- Negative user attitudes, lack of feedback mechanisms, and potentially poor service delivery can hinder effective communication and outreach efforts.

c) Other Operational Challenges:

- Incidents of vandalism targeting weather stations necessitate security improvements to protect vital infrastructure. Many weather station parts get damaged easily.
- The high cost of acquiring and maintaining weather equipment can limit network expansion and technology upgrades.
- Low salaries and a lack of motivation can lead to staff turnover and hinder workforce development within the Hydromet sector.

4.5 Potential Gaps in Coverage

Based on the data collected, it's evident that there are potential gaps in the hydro-metrological stations coverage across Somalia. These gaps could hinder effective monitoring and forecasting, particularly in regions with fewer stations.

- Remote areas, often characterized by difficult terrain and limited access, might have fewer stations due to the challenges of installation and maintenance. This could lead to a lack of reliable weather data for these areas.
- Regions with sparse station coverage might experience challenges in obtaining accurate and timely weather information, which could impact decision-making related to agriculture, water management, and disaster preparedness.

Implications for Weather Monitoring and Forecasting

The uneven distribution of weather stations across Somalia has implications for weather monitoring and forecasting in the country:

- The accuracy of weather forecasts can be affected by the availability of reliable data from different regions. Areas with fewer stations might have less precise forecasts, potentially leading to under preparedness for extreme weather events.

- Weather data is crucial for informed decision-making in various sectors, such as agriculture, water management, and disaster preparedness. Regions with limited station coverage might face challenges in making data-driven decisions due to the lack of comprehensive weather information.
- Effective early warning systems for weather hazards rely on accurate and timely weather data. Gaps in station coverage could hinder the effectiveness of these systems, particularly in regions with fewer stations.

Recommendations for Improvement

To address the potential gaps in station coverage and improve weather monitoring and forecasting in Somalia, consider the following recommendations:

- Prioritize the installation of new stations in areas with currently limited coverage, particularly in remote or data-sparse regions.
- Ensure regular maintenance and upgrades of existing stations to maintain data quality and reliability.
- Invest in training and capacity building for local personnel to manage, maintain, and utilize weather station data effectively.
- Promote data sharing and collaboration among various agencies and institutions involved in weather monitoring and forecasting.
- Explore the use of advanced technologies, such as satellite-based data collection and remote sensing, to supplement traditional station networks.

5. Conclusion and Recommendations

Somalia has been devastated not only with the long-lasting civil war but also by hydro-meteorological hazards including drought, floods, cyclones, and other climate-related disasters that have adversely affected the lives, property, and livelihoods of the Somali people for centuries and it's ranked among the most vulnerable countries in the world to climate change and has a low capacity to adapt to climate change because of its poor socioeconomic development.

Observational data for the 1985-2018 period show that drought, floods, cyclones, and climate-related diseases and epidemics, whose frequency, occurrence, and impacts have increased in recent years, already pose a significant risk to the country's vulnerable population.

Somalia has a long history of hydromet (hydrological and meteorological) monitoring. The first weather station was established in Kismayo in 1894, and the network expanded rapidly during the 1960s and 1970s. By 1990, Somalia boasted one of the best meteorological monitoring systems in the region. However, the civil war caused the entire weather recording system to collapse, leading to data loss and equipment destruction. In 2002, a critical step towards revival began. The FAO-SWALIM project, in collaboration with NGOs and UN agencies, initiated efforts to rehabilitate existing weather stations and install new ones across Somalia. This initiative provides essential ground data to supplement satellite predictions, but the network remains sparse. Notably, river level radar sensors and groundwater sensors in the south are still non-functional.

With SWALIM reinstated as the lead agency for weather data collection, processing, and reporting, Somalia currently operates three types of surface meteorological monitoring stations:

- 118 Manual Rainfall Stations (MRS) - Some are non-functional
- 5 Manual Synoptic Stations (SS) - Some may be non-functional
- 44 Automatic Weather Stations (AWS) - Run by MoEWR-HD, FAO-SWALIM, and IGAD-ICPAC. Some are non-functional

For hydrological monitoring, there are three types of stations observing water levels and flow along the Juba and Shabelle rivers (Some stations may be non-functional):

- 17 River Gauging Stations - Run by MoEWR-HD and FAO-SWALIM. Run by MoEWR-HD, FAO-SWALIM, and IGAD-ICPAC
- 1 Radar Water Level Sensor - functional
- 22 Groundwater Level Sensors - Some are non-functional

Despite the goals and objectives of the Hydro-meteorology Department, Ministry of Energy and Water Resources, the challenges faced by the government, the hydro-meteorology services in Somalia are overwhelming. There is still a big gap in the existing human resource, infrastructure and training. This assessment evaluated the current state of Somalia's Hydromet (Hydrological and Meteorological) monitoring network and identified critical gaps that hinder its effectiveness.

Key Findings:

- Uneven Network Distribution: Stations are concentrated in certain regions, leaving vast areas with limited or no data collection capabilities.

- Non-Functional Stations: A significant portion of the network is not operational due to various reasons, including equipment failure, lack of maintenance, or incomplete handover procedures.
- Limited Human Resources: A shortage of skilled personnel hinders effective station operation, maintenance, and data analysis.
- Technical Challenges: Harsh environmental conditions, unreliable power supplies, and sensor vulnerability can compromise data quality and station functionality.
- Data Sharing Barriers: Some stations might not be registered with the central data collection agency, limiting data accessibility and utilization.
- Outdated Technology: Older stations may use inefficient equipment incompatible with modern data processing systems.

Challenges in Implementing Effective Services:

- Limited budget restricts investments in modern technologies, maintenance, and personnel training.
- Unreliable communication infrastructure hinders timely dissemination of weather information.
- Difficulties in communicating weather data to local communities due to potential misunderstandings or lack of engagement.
- Project-specific station deployment by international organizations creates a network that doesn't fulfil broader national needs.

The report recommends a multi-pronged approach to address these gaps and improve the network:

- Expanding station coverage to achieve a more representative national network.
- Investing in maintenance and capacity building for station personnel.
- Ensuring proper sensor calibration and data quality control.
- Establishing clear protocols for data sharing across all stations and the central data collection agency.
- Upgrading older stations with more efficient and compatible technology.
- Advocating for increased funding to support network development and maintenance.
- Developing strategies for better communication and outreach to local communities.
- Implementing a strategic plan for station deployment that considers both national and local needs.
- Developing a comprehensive maintenance plan and ensuring its implementation.
- Providing training programs for network personnel.
- Establishing partnerships with stakeholders to share resources and expertise.
- Developing clear policies and platforms for data access and dissemination.

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7. Annexes:

KEY INFORMANT INTERVIEW (KII)

DEPARTMENT OF HYDROMETEOROLOGY (DOH) UNDER MOEWR

Participant Name	
Designation	
Address	
Contact Number	
Date of Interview	

We are a team of consultants from Optimal Performance and Development Limited (OPDL), acting on behalf of the Ministry of Energy and water resources (MoEWR). We have been tasked to undertake hydro-met capacity needs assessment following a series of climate shocks and the accompanying impacts on lives and livelihoods. This is aimed at improving governments preparedness and management of climate extremes to avoid famine and loss of livestock and lives in future by coming up with an efficient hydro-met network and working operation and maintenance plan as products of this assessment. All the information obtained through this interview will be used solely for the purpose stated in this questionnaire and the contact details will be used for following ups in case of further inquiries and will be kept confidential.

S/N	Discussion Point	Responses
1.	Roles and Responsibility of the Hydromet Department	
2.	Can you provide an overview of the existing hydro-met network in Somalia, including the number and types of stations currently operational?	
3.	Existing condition of groundwater and surface water resources in Somalia?	
4.	Is there any River flooding/flash flooding and duration	
5.	Riverbank erosion scenario and bank protection structures/ practices	
6.	Nearest water level measuring gauge station/max flood level in the last 20-30 years	
7.	Danger level of the gauge station	
8.	Flash flooding condition/prevention measurement	
9.	River dredging/any restoration program	

S/N	Discussion Point	Responses
10.	Is there any existing/proposed embankment/dyke along the riverside?	
11.	Any flood proofing measurement suggestion/recommendation for the areas effected by flood	
12.	Purpose and use of groundwater	
13.	Which sources of water are used for domestic and irrigation purposes?	
14.	During dry season, what is the source of water for daily uses?	
15.	How much water extracted from the aquifer?	
16.	Existing groundwater management plan	
17.	Does authority require any certificate from WR for construction of hydraulic structure on River?	
18.	Any suggestion from the authority?	
19.	What are the biggest challenges your department faces in terms of maintaining and operating the existing hydro-met network?	
20.	Are there any existing data quality assurance/control procedures in place for hydro-met data collection?	
21.	What are the current gaps in the hydro-met network compared to WMO standards, particularly in areas critical for disaster risk reduction (e.g., flood-prone regions)?	
22.	Does the DoH have any existing plans or strategies for future network expansion or modernization?	

S/N	Discussion Point	Responses
23.	What are the DoH's priorities for the types of equipment and data collection needed for improved hydro-met services (e.g., meteorological, hydrological, water quality)?	
24.	Does the DoH have any existing data management systems for storing and disseminating hydro-met data?	
25.	How does the DoH currently integrate hydro-met data with existing early warning systems for natural hazards?	
26.	What is the current staffing structure within the DoH for hydro-met network operation and maintenance?	
27.	Are there any existing training programs for hydro-met personnel on station maintenance and data quality control?	
28.	How does the DoH currently finance the operation and maintenance of the hydro-met network? Are there any challenges in securing sustainable funding?	
29.	How does the DoH envision collaboration with other government agencies and stakeholders (e.g., Ministry of Agriculture, Disaster Management Agency) in utilizing hydro-met data for improved decision-making?	
30.	What are the DoH's expectations for the outcomes of this project to strengthen hydro-met and hazard monitoring in Somalia?	
31.	Are there any specific concerns or questions the DoH has regarding the proposed approach to this project?	

KEY INFORMANT INTERVIEW (KII)

MINISTRY OF AGRICULTURE AND IRRIGATION

Participant Name	
Designation	
Address	
Contact Number	
Date of Interview	

We are a team of consultants from Optimal Performance and Development Limited (OPDL), acting on behalf of the Ministry of Energy and water resources (MoEWR). We have been tasked to undertake hydro-met capacity needs assessment following a series of climate shocks and the accompanying impacts on lives and livelihoods. This is aimed at improving governments preparedness and management of climate extremes to avoid famine and loss of livestock and lives in future by coming up with an efficient hydro-met network and working operation and maintenance plan as products of this assessment. All the information obtained through this interview will be used solely for the purpose stated in this questionnaire and the contact details will be used for following ups in case of further inquiries and will be kept confidential.

S/N	Discussion Point	Responses
1.	How do limitations in current hydro-met data impact agricultural planning and decision-making within the MoAI? (e.g., crop selection, irrigation scheduling)	
2.	What specific types of hydro-met data (e.g., rainfall forecasts, soil moisture data) would be most beneficial to MoAI for improving agricultural productivity and mitigating drought impacts?	
3.	How can improved hydro-met information dissemination be tailored to reach and benefit farmers throughout Somalia?	
4.	How does the MoAI currently utilize DoH data and early warning systems for drought and other weather-related hazards that impact agriculture?	
5.	Are there any specific improvements or functionalities within the hydro-met network that would be most valuable for the MoAI's disaster preparedness efforts?	

6.	How can collaboration between MoAI and DoH be strengthened to ensure timely and effective communication of drought and flood risks to farmers?	
7.	Does the MoAI have any existing collaboration mechanisms with the DoH for data exchange or joint projects related to hydro-met information and agriculture?	
8.	How can the MoAI best participate in and contribute to the DoH strengthening project to ensure the new system effectively addresses agricultural needs?	
9.	Are there any specific data formats, communication channels, or training needs within the MoAI that should be considered for improved integration with the upgraded hydro-met network?	
10.	Does the MoAI have any concerns or suggestions regarding the proposed approach to strengthening the DoH and hydro-met monitoring?	
11.	Are there any specific outcomes or deliverables from this project that would be particularly valuable for the MoAI's agricultural development programs?	

KEY INFORMANT INTERVIEW (KII)

MINISTRY OF PLANNING, INVESTMENT AND ECONOMIC DEVELOPMENT (MoPIED)

Participant Name	
Designation	
Address	
Contact Number	
Date of Interview	

We are a team of consultants from Optimal Performance and Development Limited (OPDL), acting on behalf of the Ministry of Energy and water resources (MoEWR). We have been tasked to undertake hydro-met capacity needs assessment following a series of climate shocks and the accompanying impacts on lives and livelihoods. This is aimed at improving governments preparedness and management of climate extremes to avoid famine and loss of livestock and lives in future by coming up with an efficient hydro-met network and working operation and maintenance plan as products of this assessment. All the information obtained through this interview will be used solely for the purpose stated in this questionnaire and the contact details will be used for following ups in case of further inquiries and will be kept confidential.

S/N	Discussion Point	Responses
1.	What are common functions or roles played by the local land department?	
2.	How does MoPIED view the economic benefits of strengthening hydro-met and hazard monitoring in Somalia? (e.g., improved disaster preparedness, water resource management, agricultural productivity)	
3.	From MoPIED's perspective, what data are most critical to justify the investment in this project and demonstrate its potential return on investment (ROI)?	
4.	How can the project be designed to ensure its long-term sustainability and ongoing budgetary allocation within the national development framework?	
5.	How can the improved hydro-met data and information generated by this project be effectively integrated with existing national development plans and strategies (e.g., National Development Plan)?	
6.	How can MoPIED facilitate collaboration between DoH and other relevant ministries (e.g., Agriculture, Disaster Management) to ensure hydro-met data informs decision-making across various sectors?	

S/N	Discussion Point	Responses
7.	Are there any specific development goals or economic indicators that MoPIED would like to track using data from the upgraded hydro-met network?	
8.	How can MoPIED ensure that the hydro-met data collected by the DoH is accessible and readily usable by various stakeholders involved in national development planning (e.g., private sector, NGOs)?	
9.	What are MoPIED's recommendations for data dissemination strategies to reach different user groups and maximize the utilization of hydro-met information for economic development?	
10.	Does MoPIED foresee any challenges in terms of data ownership, access, or management that need to be addressed within the project framework?	
11.	Does MoPIED have any suggestions for potential funding sources or partnerships that could contribute to the long-term sustainability of the DoH strengthening project?	
12.	Are there any specific performance indicators or monitoring mechanisms that MoPIED would recommend tracking the project's impact on national development goals?	

KEY INFORMANT INTERVIEW (KII)

MINISTRY OF ENVIRONMENT AND CLIMATE CHANGE (MoECC)

Participant Name	
Designation	
Address	
Contact Number	
Date of Interview	

We are a team of consultants from Optimal Performance and Development Limited (OPDL), acting on behalf of the Ministry of Energy and water resources (MoEWR). We have been tasked to undertake hydro-met capacity needs assessment following a series of climate shocks and the accompanying impacts on lives and livelihoods. This is aimed at improving governments preparedness and management of climate extremes to avoid famine and loss of livestock and lives in future by coming up with an efficient hydro-met network and working operation and maintenance plan as products of this assessment. All the information obtained through this interview will be used solely for the purpose stated in this questionnaire and the contact details will be used for following ups in case of further inquiries and will be kept confidential.

S/N	Discussion Point	Responses
1.	How can improved hydro-met data from the DoH strengthen MoECC's ability to monitor and assess the impacts of climate change on Somalia's environment (e.g., drought, floods, desertification)?	
2.	What specific types of hydro-met data (e.g., long-term climate trends, extreme weather events) would be most valuable for the MoECC in developing climate change adaptation strategies?	
3.	How can collaboration between MoECC and DoH be enhanced to ensure effective integration of hydro-met data into national climate change policies and action plans?	
4.	How does the MoECC currently utilize DoH data and early warning systems for environmental emergencies related to weather events (e.g., flash floods, landslides)?	
5.	Are there specific functionalities within the hydro-met network upgrade that would be particularly valuable for the MoECC's environmental management and disaster preparedness efforts?	

S/N	Discussion Point	Responses
6.	How can communication channels be improved between MoECC and DoH to ensure timely and effective warnings reach communities vulnerable to environmental hazards?	
7.	Does the MoECC have any existing collaboration mechanisms with the DoH for data exchange or joint projects related to hydro-met information and environmental management?	
8.	How can the MoECC best participate in and contribute to the DoH strengthening project to ensure the new system addresses environmental data needs?	
9.	Are there specific data formats, communication channels, or training needs within the MoECC that should be considered for improved integration with the upgraded hydro-met network?	
10.	Does the MoECC have any concerns or suggestions regarding the proposed approach to strengthening the DoH and hydro-met monitoring?	
11.	Are there specific data sets or environmental monitoring aspects that the MoECC would like prioritized within the project framework?	
12.	How can the project contribute to enhancing Somalia's fulfillment of its international commitments related to climate change and environmental sustainability (e.g., Paris Agreement)?	

KEY INFORMANT INTERVIEW (KII)

MINISTRY FOR HUMANITARIAN AFFAIRS AND DISASTER MANAGEMENT

Participant Name	
Designation	
Address	
Contact Number	
Date of Interview	

We are a team of consultants from Optimal Performance and Development Limited (OPDL), acting on behalf of the Ministry of Energy and water resources (MoEWR). We have been tasked to undertake hydro-met capacity needs assessment following a series of climate shocks and the accompanying impacts on lives and livelihoods. This is aimed at improving governments preparedness and management of climate extremes to avoid famine and loss of livestock and lives in future by coming up with an efficient hydro-met network and working operation and maintenance plan as products of this assessment. All the information obtained through this interview will be used solely for the purpose stated in this questionnaire and the contact details will be used for following ups in case of further inquiries and will be kept confidential.

S/N	Discussion Point	Responses
1.	How does the MoHADM currently utilize DoH data and early warning systems for weather-related disasters in Somalia (e.g., floods, droughts)?	
2.	What specific improvements in the hydro-met network (e.g., data accuracy, lead time for warnings) would be most beneficial for the MoHADM's disaster preparedness efforts?	
3.	How can collaboration between the MoHADM and DoH be strengthened to ensure timely and effective communication of early warnings to vulnerable communities?	
4.	How can the upgraded hydro-met data be effectively integrated with existing early warning systems and disaster risk reduction (DRR) strategies used by the MoHADM?	
5.	How can the project facilitate improved communication and data exchange between the MoHADM, DoH, and other relevant stakeholders (e.g., local authorities, NGOs) for a coordinated disaster response?	
6.	Are there specific training needs for MoHADM personnel regarding interpreting and utilizing hydro-met data for improved disaster preparedness and response?	

S/N	Discussion Point	Responses
7.	How can the project contribute to building long-term resilience of Somali communities to weather-related disasters? (e.g., integrating hazard maps with early warning systems)	
8.	How can the improved hydro-met data be used to inform the development of disaster risk reduction plans at the national and local levels?	
9.	Does the MoHADM have any suggestions for incorporating community-based disaster preparedness initiatives into the project framework?	
10.	Does the MoHADM have any concerns or suggestions regarding the proposed approach to strengthening the DoH and hydro-met monitoring?	
11.	Are there specific data formats or communication protocols that the MoHADM uses for disaster response that the project should consider?	
12.	How can the project ensure the sustainability of the upgraded hydro-met network and its ongoing utilization for effective disaster management in Somalia?	

KEY INFORMANT INTERVIEW (KII)

IGAD CLIMATE PREDICTION AND APPLICATIONS CENTRE (ICPAC)

Participant Name	
Designation	
Address	
Contact Number	
Date of Interview	

We are a team of consultants from Optimal Performance and Development Limited (OPDL), acting on behalf of the Ministry of Energy and Water Resources (MoEWR) of Somalia. We have been tasked to undertake hydro-met capacity needs assessment following a series of climate shocks and the accompanying impacts on lives and livelihoods. This is aimed at improving governments preparedness and management of climate extremes to avoid famine and loss of livestock and lives in future by coming up with an efficient hydro-met network and working operation and maintenance plan as products of this assessment. All the information obtained through this interview will be used solely for the purpose stated in this questionnaire and the contact details will be used for following ups in case of further inquiries and will be kept confidential.

S/N	Discussion Point	Responses
1.	How can ICPAC collaborate with the DoH strengthening project to improve access to regional climate data and forecasts for Somalia?	
2.	Are there existing ICPAC products or services (e.g., seasonal forecasts, drought monitoring) that could be beneficial for integration with the upgraded DoH network?	
3.	How can data sharing mechanisms be established between ICPAC and DoH to ensure effective utilization of regional climate information for Somalia's specific needs?	
4.	Does ICPAC offer any training programs or workshops relevant to hydro-met data analysis, forecasting techniques, or climate applications that could benefit DoH personnel?	
5.	How can collaboration between ICPAC and DoH be facilitated to enhance the technical skills and knowledge of Somali meteorologists and hydrologists?	
6.	Are there opportunities for knowledge exchange or mentorship programs between ICPAC staff and DoH professionals to promote best practices in climate monitoring and prediction?	
7.	How can the strengthened DoH network contribute to improved regional monitoring	

S/N	Discussion Point	Responses
	and early warning systems for transboundary hazards (e.g., floods affecting multiple IGAD countries)?	
8.	How can ICPAC and DoH collaborate on developing standardized data formats and communication protocols for effective exchange of hydro-met information within the IGAD region?	
9.	From ICPAC's perspective, how can the DoH strengthening project contribute to a more comprehensive approach to hazard management and climate resilience across the IGAD region?	
10.	Does ICPAC have any suggestions for incorporating regional climate models or seasonal forecasts into the design of the upgraded DoH network?	
11.	Are there any specific challenges or opportunities related to climate data sharing or capacity building in the IGAD region that the DoH strengthening project should consider?	
12.	How can ICPAC and MoEWR collaborate on future initiatives to enhance regional cooperation on climate prediction and applications for improved disaster preparedness in Somalia and the wider IGAD region?	

KEY INFORMANT INTERVIEW (KII)

FAO Somalia Water and Land Information Management Unit (SWALIM)

Participant Name	
Designation	
Address	
Contact Number	
Date of Interview	

We are a team of consultants from Optimal Performance and Development Limited (OPDL), acting on behalf of the Ministry of Energy and Water Resources (MoEWR) of Somalia. We have been tasked to undertake hydro-met capacity needs assessment following a series of climate shocks and the accompanying impacts on lives and livelihoods. This is aimed at improving governments preparedness and management of climate extremes to avoid famine and loss of livestock and lives in future by coming up with an efficient hydro-met network and working operation and maintenance plan as products of this assessment. All the information obtained through this interview will be used solely for the purpose stated in this questionnaire and the contact details will be used for following ups in case of further inquiries and will be kept confidential.

S/N	Discussion Point	Responses
1.	How can data collected by the upgraded DoH network (e.g., rainfall, river discharge) be effectively integrated with existing SWALIM water resource monitoring systems?	
2.	Are there opportunities to utilize SWALIM's expertise in data management and analysis to enhance the quality and accessibility of hydro-met data collected by the DoH?	
3.	How can collaboration be strengthened between SWALIM and DoH to ensure standardized data formats and protocols for efficient data exchange and utilization?	
4.	How can improved hydro-met data from the DoH project contribute to SWALIM's efforts in drought monitoring and early warning systems for water scarcity?	
5.	Is there specific DoH data products (e.g., soil moisture data, drought severity indices) that would be most valuable for SWALIM's water resource management activities?	
6.	How can collaboration be established to develop joint informational resources or drought advisories that integrate hydro-met data with water availability forecasts?	
7.	Does SWALIM offer any training programs or technical assistance relevant to hydro-met data collection, analysis, or water resource management that could benefit DoH personnel?	

S/N	Discussion Point	Responses
8.	How can SWALIM and DoH collaborate on capacity building initiatives to enhance the technical skills of Somali professionals in both water and meteorological fields?	
9.	Are there opportunities for knowledge exchange or joint projects between SWALIM and DoH to promote integrated approaches to water resource management and hazard monitoring?	
10.	Does SWALIM have any existing collaborations or partnerships with regional or international organizations working on hydro-met data collection or drought monitoring that could be leveraged for the DoH strengthening project?	
11.	Are there any specific challenges or opportunities related to water resource information management in Somalia that the DoH strengthening project should consider?	
12.	How can SWALIM and MoEWR collaborate on future initiatives to ensure effective long-term utilization of hydro-met information for sustainable water management and drought resilience in Somalia?	

KEY INFORMANT INTERVIEW (KII)

United Nations Development Program (UNDP) Somalia

Participant Name	
Designation	
Address	
Contact Number	
Date of Interview	

We are a team of consultants from Optimal Performance and Development Limited (OPDL), acting on behalf of the Ministry of Energy and Water Resources (MoEWR) of Somalia. We have been tasked to undertake hydro-met capacity needs assessment following a series of climate shocks and the accompanying impacts on lives and livelihoods. This is aimed at improving governments preparedness and management of climate extremes to avoid famine and loss of livestock and lives in future by coming up with an efficient hydro-met network and working operation and maintenance plan as products of this assessment. All the information obtained through this interview will be used solely for the purpose stated in this questionnaire and the contact details will be used for following ups in case of further inquiries and will be kept confidential.

S/N	Discussion Point	Responses
1.	Does UNDP Somalia have any experience or best practices to share regarding similar projects that have strengthened national hydro-met services in other developing countries?	
2.	Can UNDP offer recommendations on effective project management strategies and stakeholder engagement approaches for the DoH strengthening project?	
3.	Are there any existing UNDP programs or initiatives in Somalia that could be leveraged or integrated with the DoH strengthening project to maximize impact?	
4.	How can the DoH strengthening project be aligned with Somalia's National Adaptation Programme of Action (NAPA) and other national strategies on climate change adaptation and disaster risk reduction (DRR)?	
5.	How can improved hydro-met data from the DoH contribute to strengthening early warning systems and preparedness measures for climate-related hazards in Somalia?	
6.	Does UNDP offer any technical assistance or capacity building programs that could support the integration of hydro-met information into Somalia's DRR policies and practices?	
7.	What are UNDP's recommendations for ensuring the long-term sustainability of the upgraded DoH network, including financing mechanisms and institutional capacity building?	

S/N	Discussion Point	Responses
8.	How can the DoH strengthening project contribute to building a culture of preparedness and resilience among Somali communities towards climate-related hazards?	
9.	Can UNDP assist in identifying potential partners or donors for ongoing technical support and capacity development for the DoH after the project's completion?	
10.	Does UNDP have any existing partnerships or collaborations with regional organizations (e.g., IGAD) working on climate change or disaster risk reduction that could be beneficial for the DoH strengthening project?	
11.	Are there any specific challenges or opportunities related to climate change adaptation or DRR in Somalia that the DoH strengthening project should consider?	
12.	How can UNDP and MoEWR collaborate on future initiatives to leverage improved hydro-met information for evidence-based decision making and promoting climate-resilient development in Somalia?	

KEY INFORMANT INTERVIEW (KII)

National WASH Cluster of Somalia

Participant Name	
Designation	
Address	
Contact Number	
Date of Interview	

We are a team of consultants from Optimal Performance and Development Limited (OPDL), acting on behalf of the Ministry of Energy and Water Resources (MoEWR) of Somalia. We have been tasked to undertake hydro-met capacity needs assessment following a series of climate shocks and the accompanying impacts on lives and livelihoods. This is aimed at improving governments preparedness and management of climate extremes to avoid famine and loss of livestock and lives in future by coming up with an efficient hydro-met network and working operation and maintenance plan as products of this assessment. All the information obtained through this interview will be used solely for the purpose stated in this questionnaire and the contact details will be used for following ups in case of further inquiries and will be kept confidential.

S/N	Discussion Point	Responses
1.	How can improved hydro-met data from the DoH project (e.g., rainfall forecasts, drought severity indices) be effectively integrated into WASH programming activities?	
2.	What specific types of hydro-met information would be most valuable for the National WASH Cluster to improve the targeting and effectiveness of WASH interventions in Flood or drought-prone areas?	
3.	How can collaboration be established between the DoH and WASH Cluster to develop drought preparedness plans and contingency measures for WASH services in vulnerable communities?	
4.	How can early warnings of floods or droughts generated by the DoH be effectively communicated to WASH actors to prepare for potential WASH emergencies?	
5.	What specific WASH needs (e.g., water trucking, hygiene promotion) would be most critical to address during floods or droughts based on early warning information?	
6.	How can the DoH strengthening project contribute to building the capacity of WASH actors to utilize hydro-met data for informed decision-making and emergency response planning?	
7.	Does the National WASH Cluster have any existing mechanisms for data collection or information sharing with other sectors (e.g.,	

S/N	Discussion Point	Responses
	health) that could be leveraged for improved collaboration with the DoH?	
8.	How can MoEWR and the National WASH Cluster facilitate effective communication and data exchange between the DoH and WASH actors at national and local levels?	
9.	Are there opportunities to develop joint training programs or capacity building initiatives for WASH professionals to enhance their understanding and utilization of hydro-met data?	
10.	Does the National WASH Cluster have any ongoing projects or initiatives related to foold, drought preparedness or climate change adaptation that could be strengthened through collaboration with the DoH?	
11.	Are there specific challenges related to WASH service provision during droughts or floods that the DoH strengthening project should consider?	
12.	How can the National WASH Cluster and MoEWR work together to ensure WASH actors are well-equipped to utilize improved hydro-met data for delivering sustainable and climate-resilient WASH services in Somalia?	

Inspection Tool for Manual Rainfall Station

This inspection tool is designed to assess the functionality and data quality of a manual rainfall station in Somalia. It can be used by technicians or trained personnel to conduct routine inspections and ensure accurate rainfall measurements.	
General Information:	
Station Name:	
Station ID:	
Date of Inspection:	
Inspector Name(s):	
Location:	
Verify the station's geographic coordinates using a GPS device and record any discrepancies.	
Check the general condition of the surrounding area. Note any obstructions that may affect wind flow and rainfall collection (e.g., buildings, trees, tall structures).	
Ensure the rain gauge is mounted on a secure, level platform at the recommended height (typically 1 meter above ground).	
Rain Gauge:	
Inspect the rain gauge body for cracks, leaks, or damage. Ensure the funnel is securely attached and free of debris.	
Check the measuring cylinder or collecting bottle for cracks, clarity, and markings. Verify the graduations are accurate and easy to read.	
Observe the current water level in the cylinder and record it. If there is water present during dry weather, it indicates a leak or malfunction.	
Data Recorder (if applicable):	
If the station uses a data logger or electronic recorder, ensure it is functioning properly and securely mounted.	
Check the battery level and replace if necessary. Data loggers may also require solar panel inspection for cleanliness and functionality.	

Download recent rainfall data (if possible) and compare it with manual readings for consistency.	
Maintenance and Housekeeping:	
Check the general cleanliness of the station and surrounding area. Remove any debris, vegetation, or objects that may interfere with rainfall collection.	
Ensure proper drainage around the rain gauge base to prevent pooling water.	
Inspect the tools used for manual readings (e.g., measuring stick) for damage or readability issues.	
Record Keeping:	
Review the station logbook for completeness and accuracy of recent rainfall records.	
Note any unusual readings or missing data entries.	
If discrepancies are found, investigate the cause and document corrective actions taken.	
Additional Considerations:	
Take photographs of the rain gauge station, surrounding area, and any identified issues.	
Document any repairs or maintenance performed during the inspection.	
Leave a record of the inspection in the station logbook for future reference.	

Inspection Tool for Automatic Weather Stations (AWS)

This inspection tool is designed to assess the functionality and data quality of an Automatic Weather Station (AWS) in Somalia. It can be used by technicians or trained personnel to conduct inspections and ensure accurate weather data collection.	
General Information:	
Station Name:	
Station ID:	
Date of Inspection:	
Inspector Name(s):	
Location:	
Power Supply:	
Primary Power Source (Grid/Solar)	
Verify the primary power source is functioning properly.	
Battery Backup System	
Check the battery level and health. Replace batteries if necessary. For solar systems, inspect panel cleanliness and functionality.	
Communication System:	
Verify the AWS is successfully transmitting data to the designated receiving station.	
Ensure the communication protocol settings are correct for reliable data transfer.	
Sensors and Data Acquisition:	
Perform manual tests or utilize diagnostic tools to verify proper operation of all sensors (e.g., temperature, humidity, wind speed/direction, rainfall).	
Review recent data for outliers, inconsistencies, or unexpected values. Compare with secondary data sources (e.g., nearby stations) if available.	
Check the calibration schedule and ensure sensors are calibrated according to manufacturer's recommendations.	
Data Logger and Recorder:	
Ensure the data logger or recorder is functioning properly and securely mounted.	

Check available data storage and download data if necessary.	
Maintenance and Housekeeping:	
Inspect the station and surrounding area for debris, vegetation, or objects that may interfere with sensor operation.	
Check data cables for damage or wear and tear. Ensure proper connections.	
Record Keeping:	
Review the station logbook for completeness and accuracy of recent maintenance records and any data anomalies.	
Investigate the cause of discrepancies and document corrective actions taken.	
Additional Considerations:	
Take photographs of the gauging station, equipment, surrounding area, and any identified issues.	
Document any repairs or maintenance performed during the inspection.	

Inspection Tool for River Gauging Station in Somalia

This inspection tool is designed to assess the functionality and data quality of River Gauging Station in Somalia in Somalia. It can be used by technicians or trained personnel to conduct inspections and ensure accurate weather data collection.	
General Information:	
Station Name:	
Station ID:	
Date of Inspection:	
Inspector Name(s):	
Location:	
Location and Access:	
Verify the station's geographic coordinates using a GPS device and record any discrepancies.	
Assess the accessibility of the station by road or other means. Note any access limitations due to weather, security concerns, or infrastructure damage.	
Check the general condition of the surrounding area for potential hazards (e.g., erosion, unstable slopes).	
Station Structure and Equipment:	
Gauging Structure: Inspect the gauging weir, flume, or other structure used to control and measure water flow. Look for cracks, leaks, damage, or sedimentation buildup that may affect measurements.	
Verify the staff gauge is securely mounted, level, and free of damage or obstructions. Ensure the markings are clear and readable.	
Water Level Sensor (if applicable): Check the functionality and proper installation of electronic water level sensors. Ensure they are free of debris and biofouling.	
Data Recorder (if applicable): If the station uses a data logger or electronic recorder, ensure it is functioning properly and securely mounted.	

Reference Marks: Verify the reference marks (benchmarks) used for datum control are stable and haven't been disturbed.	
Discharge Measurement Equipment:	
Inspect the equipment used for manual discharge measurements (e.g., current meter, wading rod). Ensure they are in good working condition and properly calibrated.	
Check for the availability and functionality of any boat or safety equipment required for accessing the river for measurements.	
Record Keeping and Data Management:	
Review the station logbook for completeness and accuracy of recent discharge measurements and water level readings.	
Note any unusual readings or missing data entries.	
If discrepancies are found, investigate the cause and document corrective actions taken.	
Assess the data transmission procedures (if applicable) and ensure timely data transfer to central collection points.	
Safety Considerations:	
Evaluate the overall safety of the station site, considering factors like slippery surfaces, uneven terrain, and potential flooding risks.	
Ensure proper signage is displayed to warn of potential hazards and restricted access areas.	
Assess the availability and condition of personal protective equipment (PPE) for personnel working at the station.	
Additional Considerations:	
Take photographs of the gauging station, equipment, surrounding area, and any identified issues.	
Document any repairs or maintenance performed during the inspection.	

Annex 2:

Weather Stations

Station Number	Station Type	Name	Status	First Update	Last Update	Recording Type	Latitude	Longitude	Installation Agency	Managed by	Condition
AWS_ABUDWAQ	Automatic Weather	Guriceel	Functional	Aug. 16, 2023	Up to date	Automatic	6.218695	46.2024	ICPAC	MoEWR	It's in Abduwaq University New and Functional weather station
AWS_ADAADO	Automatic Weather	Adaado	Not Functional			Automatic	6.095278	46.632222	MoEWR	MoEWR	Maintenance of the sensor and cleaning is required
AWS_GALDO	Automatic Weather	Galdogob	Functional		Up to date	Automatic	7.053889	47.018611	MoEWR	MoEWR	
AWS_AWBOR	Automatic Weather	Borama	Functional	Oct. 1, 2009	Up to date	Automatic	9.940072	43.17916	SWALIM		
AWS_BARA	Automatic Weather	Barawe	Functional		Up to date	Automatic	1.161944	44.013889	MoEWR	MoEWR	It's in Barawe Airport New and Functional weather station
AWS_BABAI	Automatic Weather	Baidoa	Not Functional	Sept. 26, 2019	March 17, 2023	Automatic	3.13333	43.66667	SWALIM		No Internet Low power battery causing breakage of the digits
AWS_BABAI	Automatic Weather	Baidoa	Functional	March 5, 2024	Up to date	Automatic	3.1058	43.62883	MoEWR	Somali Civil Aviation Authority and MoEWR	It's in Baidoa Airport New and Functional weather station
AWS_BADHAN	Automatic Weather	Badhan	Functional	Aug. 21, 2023	Up to date	Automatic	10.939046	48.338728	ICPAC	Somali Civil Aviation Authority	
AWS_BERBER	Automatic Weather	Berbera	Not Functional	April 23, 2024		Automatic	10.379722	44.943056	MoEWR	MoEWR	Fixating the sensors precision is required
AWS_BELETWENE	Automatic Weather	Beletwene	Functional	Aug. 28, 2022	Up to date	Automatic	4.769212	45.24314	ICPAC		It's in Beletwene Airport New and Functional weather station
AWS_BOORAMA	Automatic Weather	Borama	Not Functional	Sept. 7, 2022	March 7, 2024	Automatic	9.94156	43.15504	ICPAC		No Internet Data logger battery spoilt and so data captured cannot be received
AWS_BOSASO	Automatic Weather	Bosaso	Not Functional	June 5, 2021	May 19, 2024	Automatic	11.272946	49.12837	ICPAC		No Internet Data logger battery spoilt and so data captured cannot be received
AWS_BURAO	Automatic Weather	Burao	Not Functional	Sept. 27, 2023	March 14, 2024	Automatic	9.53344	45.541408	ICPAC		It's in Burao Airport New and Functional weather No airtime or Internet
AWS_DHOBLEY	Automatic Weather	Dhobley	Functional	Aug. 30, 2023	Up to date	Automatic	0.24	40.59	ICPAC	Somali Civil Aviation	It's in Dhobley Airport New and Functional weather station

										Authority and MoEWR	
AWS_DOLOOW	Automatic Weather	Doloow	Functional	Sept. 11, 2023	Up to date	Automatic	4.51384	42.08142	ICPAC	Somali Civil Aviation Authority and MoEWR	It's in Doloow Airport New and Functional weather station
AWS_DUSMEREB	Automatic Weather	Dusmereb	Functional	Aug. 30, 2022	Up to date	Automatic	5.4733	46.35987	ICPAC		New and Functional weather station
AWS_EREGAVO	Automatic Weather	Erigavo	Functional	Aug. 29, 2023	Up to date	Automatic	10.641753	47.388879	ICPAC		It's in Erigavo Airport New and Functional weather station
AWS_GALKACYO	Automatic Weather	Galkacayo	Not Functional	June 5, 2021	Nov. 7, 2023	Automatic	6.760079	47.441711	ICPAC		Non-existent Removed from the School to outside of the town but not yet fixed
AWS_GALKACYO	Automatic Weather	Galkacayo	Functional	April 9, 2024	Up to date	Automatic	6.760079	47.441711	UNDP	Somali Civil Aviation Authority and MoEWR	It's in South Galkayo Airport New and Functional weather station
AWS_GURICEEL	Automatic Weather	Guriceel	Functional	August 8, 2021	Up to date	Automatic	5.193	45.95	ICPAC	Somali Civil Aviation Authority and MoEWR	It's in Guriceel Airport New and Functional weather station
AWS_HARGEISA	Automatic Weather	Hargeisa	Functional	June 28, 2023	Up to date	Automatic	9.506122	44.074316	ICPAC		New and Functional weather station
AWS_HOBYO	Automatic Weather	Hobyo	Functional	Aug. 25, 2023	Up to date	Automatic	5.2126	48.33152	ICPAC	Somali Civil Aviation Authority and MoEWR	It's in Hobyo Airport New and Functional weather station
AWS_HUDUR	Automatic Weather	Hudur	Functional	Sept. 8, 2023	Up to date	Automatic	4.7	43.53	ICPAC	Somali Civil Aviation Authority and MoEWR	It's in Hudur Airport New and Functional weather station
AWS_KISMAYO	Automatic Weather	Kismayo	Functional	Dec. 20, 2022	Up to date	Automatic	-0.388252	42.447346	ICPAC		It's in Kismayo Airport
AWS_MOGADISHU	Automatic Weather	Mogadishu	Not Functional	Aug. 11, 2021	Nov. 12, 2023	Automatic	2.02208	45.31214	ICPAC		No airtime or Internet Data logger battery spoilt and so data captured cannot be received
AWS_MOGADISHU	Automatic Weather	Mogadishu	Functional	March 11, 2024	Up to date	Automatic	2.015	45.303611	MoEWR	Somali Civil Aviation Authority and MoEWR	It's in Mogadishu Airport New and Functional weather station
AWS_MOGADISHU	Automatic Weather	Mogadishu	Functional	March 11, 2024	Up to date	Automatic	2.03351	45.30092	MoEWR	MoEWR	It's in MoEWR New and Functional weather station
AWS_MSJOW	Automatic Weather	Jowhar	Functional	Jan. 23, 2020	Up to date	Automatic	2.76667	45.5	SWALIM		
AWS_GAROWE	Automatic Weather	Garowe	Functional	July 9, 2020	Up to date	Automatic	8.2741	48.3422	ICPAC		It's in Garowe Airport

AWS_NUGAR	Automatic Weather	Garowe	Not Functional	May 13, 2009	Aug. 18, 2023	Automatic	8.410173	48.45601	SWALIM		No airtime or Internet Low power battery causing breakage of the digits Many vandalized parts
AWS_QARDHO	Automatic Weather	Qardho	Functional	Aug. 11, 2023	Up to date	Automatic	9.325	49.7	ICPAC	Somali Civil Aviation Authority	It's in Qardho Airport New and Functional weather station
AWS_TOBUR	Automatic Weather	Burao	Not Functional	Jan. 1, 2006	Jan. 29, 2023	Automatic	9.51667	45.56667	SWALIM		No airtime or Internet Data logger battery spoilt and so data captured cannot be received Many vandalized parts
AWS_WGABU	Automatic Weather	Aburin	Not Functional	Sept. 30, 2009	Feb. 27, 2024	Automatic	9.51743	43.80575	SWALIM		No airtime or Internet Data logger battery spoilt and so data captured cannot be received Many vandalized parts
AWS_WGHAR	Automatic Weather	Hargeisa	Not Functional	Jan. 12, 2009	Jan. 29, 2023	Automatic	9.55975	44.0668	SWALIM		No airtime or Internet Data logger battery spoilt and so data captured cannot be received Many vandalized parts
AWS_WAJALE	Automatic Weather	Wajaale	Functional	April. 26, 2024	Up to date	Automatic	9.55975	44.0668	MoEWR	MoEWR	New and Functional weather station
SS_BAQAR	Synoptic Station	Qardho	Functional	Jan. 1, 2021	May 31, 2024	Automatic	9.535479	49.092093	SWALIM		No personnel available on daily basis
SS_NUGAR	Synoptic Station	Garowe	Functional	Jan. 1, 2020	May 31, 2024	Automatic	8.4062	48.48024	SWALIM		Environment interferes with the readings
SS_WGGEB	Synoptic Station	Gebilley	Functional	Jan. 1, 2014	May 31, 2024	Automatic	9.61667	43.28333	SWALIM		
SS_WGHAR	Synoptic Station	Hargeisa	Functional	May 1, 2013	May 31, 2024	Automatic	9.55975	44.0668	SWALIM		
MRS_AWBOO	Rainfall Station	Boon	Functional	Jan. 1, 2023	June 28, 2024	Manual	10.11714	43.05097			
MRS_AWBOR	Rainfall Station	Borama	Functional	Jan. 1, 2007	June 28, 2024	Manual	9.940072	43.17916			
MRS_AWGAR	Rainfall Station	Garbodadar	Functional	Jan. 1, 2019	June 28, 2024	Manual	10.23838	43.62694			
MRS_AWGARG	Rainfall Station	Gargara	Functional	Jan. 1, 2023	June 28, 2024	Manual	10.18784	43.48506			
MRS_AWGEE	Rainfall Station	Geerisa	Functional	Jan. 1, 2019	June 28, 2024	Manual	10.60353	43.43364			
MRS_AWHAR	Rainfall Station	Harirad	Functional	Jan. 1, 2023	June 28, 2024	Manual	10.11714	43.05097			
MRS_AWLUG	Rainfall Station	Lughaya	Functional	Jan. 1, 2020	June 28, 2024	Manual	10.68671	43.94323			
MRS_AWQUL	Rainfall Station	Qulujeed	Functional	April 1, 2007	June 28, 2024	Manual	10.09167	43.0019			

MRS_AWRUQ	Rainfall Station	Ruqi	Functional	Jan. 1, 2020	June 28, 2024	Manual	9.97025	43.42828			
MRS_AWXEE	Rainfall Station	Xeego	Functional	Jan. 1, 2020	June 28, 2024	Manual	10.07747	43.26803			
MRS_AWZAI	Rainfall Station	Zaylac	Functional	April 30, 2024	June 28, 2024	Manual	11.35455	43.47282			
MRS_BAALU	Rainfall Station	Alula	Functional	Jan. 1, 2011	June 28, 2024	Manual	11.96532	50.756099			
MRS_BABAI	Rainfall Station	Baidoa	Functional	Jan. 1, 2006	May 27, 2024	Manual	3.13333	43.66667			
MRS_BABAL	Rainfall Station	Balli Dhiddin	Functional	Jan. 1, 2011	June 28, 2024	Manual	10.881566	50.392501			
MRS_BABAN	Rainfall Station	Banderbeyla	Functional	Jan. 1, 2011	June 28, 2024	Manual	9.493722	50.811797			
MRS_BABAR	Rainfall Station	Bardaale	Functional	Jan. 1, 2005	June 28, 2024	Manual	3.2146	43.19809			
MRS_BABAR	Rainfall Station	Bargaal	Functional	Jan. 1, 2005	June 28, 2024	Manual	11.6864291	50.463996			
MRS_BABOS	Rainfall Station	Bosaso	Functional	Jan. 1, 2007	June 28, 2024	Manual	11.28265	49.17605			
MRS_BABUR	Rainfall Station	Bur Hakaba	Functional	Jan. 1, 2014	June 21, 2024	Manual	2.78	44.07			
MRS_BACA	Rainfall Station	Carmo	Functional	Jan. 1, 2024	June 28, 2024	Manual	10.5700995	49.059831			
MRS_BADAN	Rainfall Station	Dangoroyo	Functional	Jan. 1, 2011	June 28, 2024	Manual	8.727925	49.341293			
MRS_BADIN	Rainfall Station	Diinsoor	Functional	Jan. 1, 2006	May 31, 2024	Manual	2.41667	42.98333			
MRS_BAELB	Rainfall Station	Ceel Berde	Functional	Jan. 1, 2005	May 31, 2024	Manual	4.82821	43.65993			
MRS_BAHUD	Rainfall Station	Huduur	Functional	Jan. 1, 2005	May 31, 2024	Manual	4.16667	43.9			
MRS_BAISK	Rainfall Station	Isku Shuban	Functional	July 1, 2009	June 28, 2024	Manual	10.283123	50.230219			
MRS_BAMOG	Rainfall Station	Mogadishu	Functional	Jan. 1, 2014	June 21, 2024	Manual	2.03	45.35			
MRS_BAMU	Rainfall Station	Murcaanyo	Functional	Jan. 1, 2024	June 28, 2024	Manual	11.6864291	50.463996			
MRS_BAQAR	Rainfall Station	Qardho	Functional	April 1, 2007	June 28, 2024	Manual	9.535479	49.092093			
MRS_BAQUA	Rainfall Station	Qansax Dheere	Functional	Jan. 1, 2009	May 27, 2024	Manual	2.87123	43.004341			
MRS_BAUFA	Rainfall Station	Ufayn	Functional	Jan. 1, 2023	June 28, 2024	Manual	10.652335	49.756256			

MRS_BAWAN	Rainfall Station	Wanle Weyne	Functional	Jan. 1, 2014	June 21, 2024	Manual	2.61945	44.89357			
MRS_GEBAR	Rainfall Station	Bardheere	Functional	Jan. 1, 2006	June 21, 2024	Manual	2.35	42.3			
MRS_GEDOL	Rainfall Station	Dollow	Functional	Jan. 1, 2015	June 21, 2024	Manual	4.187771	42.079382			
MRS_GELUU	Rainfall Station	Luuq	Functional	Jan. 1, 2007	June 21, 2024	Manual	3.58333	42.45			
MRS_HIBEL	Rainfall Station	Belet weyne	Functional	Jan. 1, 1997	June 21, 2024	Manual	4.73386	45.1845			
MRS_HIBUL	Rainfall Station	Bulo burti	Functional	Jan. 1, 1999	June 21, 2024	Manual	3.25	45.56667			
MRS_HIHAL	Rainfall Station	Halgan	Not Functional	Jan. 1, 2005	Feb. 28, 2015	Manual	3.85357	45.56596			Non-existent
MRS_HIJAL	Rainfall Station	Jalalaqsi	Not Functional	Jan. 2, 2005	Feb. 28, 2015	Manual	3.37951	45.59941			Non-existent
MRS_HIMAH	Rainfall Station	Mahas	Functional	Jan. 1, 2020	June 21, 2024	Manual	5.1	45.52284			
MRS_HIMAT	Rainfall Station	Mataban	Functional	Jan. 1, 2014	June 21, 2024	Manual	5.19937	45.52284			
MRS_LJAFM	Rainfall Station	Afmadow	Not Functional	Jan. 1, 2008	March 31, 2012	Manual	0.5	42.1			Non-existent
MRS_LJJAM	Rainfall Station	Jamame	Not Functional	Jan. 1, 2007	Dec. 10, 2023	Manual	0.05	42.73333			Non-existent
MRS_LJKIS	Rainfall Station	Kismayo	Functional	Jan. 1, 1935	May 27, 2024	Manual	-0.3619	42.55903			
MRS_LSAFG	Rainfall Station	Afgooye	Not Functional	Jan. 1, 2005	Dec. 31, 2019	Manual	2.13333	45.13333			Non-existent
MRS_LSAWD	Rainfall Station	Awdheegle	Functional	Jan. 1, 2024	May 27, 2024	Manual	1.9805	44.833			
MRS_LSBAL	Rainfall Station	Balcad	Functional	Jan. 1, 2013	June 21, 2024	Manual	2.35926	45.38964			
MRS_LSGEN	Rainfall Station	Genale	Not Functional	Jan. 1, 2005	Dec. 31, 2019	Manual	1.83333	44.75			Non-existent
MRS_MACAD	Rainfall Station	Cada	Functional	Jan. 1, 2023	June 28, 2024	Manual	9.57545	43.48413			
MRS_MAGUM	Rainfall Station	Gumburaha	Functional	Jan. 1, 2023	June 28, 2024	Manual	9.10411	44.1195			
MRS_MJBUA	Rainfall Station	Bualle	Functional	Jan. 1, 2007	June 21, 2024	Manual	1.24477	42.57317			
MRS_MJMAR	Rainfall Station	Marere	Not Functional	Jan. 1, 2009	Dec. 31, 2013	Manual	0.43	42.72			Broken Manual Rain gauge
MRS_MJSAK	Rainfall Station	Sakow	Not Functional	Jan. 1, 2006	Dec. 31, 2019	Manual	1.63938	42.45217			Non-existent

MRS_MSJOW	Rainfall Station	Jowhar	Functional	Jan. 1, 2000	June 21, 2024	Manual	2.76667	45.5				
MRS_MSMAH	Rainfall Station	Mahaday Weyn	Functional	Jan. 1, 2024	May 27, 2024	Manual	2.9716	45.5335				
MRS_MUDAR	Rainfall Station	Darusalaam	Functional	Jan. 1, 2023	June 28, 2024	Manual	7.2597768	47.1083676				
MRS_MUGAL	Rainfall Station	Galkacyo	Functional	April 1, 2007	June 28, 2024	Manual	6.77719	47.42272				
MRS_MUGALD	Rainfall Station	Galdogob	Functional	Jan. 1, 2011	June 28, 2024	Manual	7.05644	47.130558				
MRS_MUJAR	Rainfall Station	Jariiban	Functional	Jan. 1, 2009	June 28, 2024	Manual	7.214609	48.848876				
MRS_NUBUR	Rainfall Station	Burtinle	Functional	Jan. 1, 2009	June 28, 2024	Manual	7.63487	47.831029				
MRS_NUEYL	Rainfall Station	Eyl	Functional	July 1, 2009	June 28, 2024	Manual	7.980522	49.816453				
MRS_NUGAR	Rainfall Station	Garowe	Functional	April 1, 2007	June 28, 2024	Manual	8.4062	48.48024				
MRS_NUGUU	Rainfall Station	Uusgure	Functional	Jan. 1, 2024	June 28, 2024	Manual	8.80725301	49.719718				
MRS_NUXAS	Rainfall Station	Xasbahale	Functional	Jan. 1, 2018	June 28, 2024	Manual	8.57917	48.61611				
MRS_SABARPL	Rainfall Station	Baran PL	Functional	April 2, 2007	June 28, 2024	Manual	10.7143	48.33042				
MRS_SABARSL	Rainfall Station	Baran SL	Functional	Jan. 1, 2020	June 28, 2024	Manual	10.71344	48.33253				
MRS_SABOD	Rainfall Station	Bodale	Functional	Jan. 1, 2023	June 28, 2024	Manual	10.0476	4410444				
MRS_SABUL	Rainfall Station	Bulohar	Functional	Jan. 1, 2023	June 28, 2024	Manual	10.04761	44.10443				
MRS_SABUR	Rainfall Station	Buran	Functional	Jan. 1, 2021	June 28, 2024	Manual	10.21618	48.77067				
MRS_SADHAPL	Rainfall Station	Dhahar PL	Functional	March 1, 2024	June 28, 2024	Manual	9.7557216	48.81717				
MRS_SADHASL	Rainfall Station	Dhahar SL	Functional	Jan. 1, 2020	June 28, 2024	Manual	9.74799	48.81988				
MRS_SADOO	Rainfall Station	Dooxaguban	Functional	Jan. 1, 2023	June 28, 2024	Manual	9.57183	44.35789				
MRS_SAELA	Rainfall Station	Elafweyn	Functional	April 1, 2007	June 28, 2024	Manual	9.93027	47.2168				
MRS_SAERI	Rainfall Station	Erigavo	Functional	April 1, 2007	June 28, 2024	Manual	10.61667	47.36667				
MRS_SAGAR	Rainfall Station	Garadag	Functional	Jan. 1, 2018	June 28, 2024	Manual	9.48701	46.86693				

MRS_SALAA	Rainfall Station	Laasqoray	Functional	Jan. 1, 2024	June 28, 2024	Manual	11.008279	48.32556			
MRS_SOAYN	Rainfall Station	Caynabo	Functional	April 1, 2007	June 28, 2024	Manual	8.95755	46.4125			
MRS_SOLASPL	Rainfall Station	Las Anod PL	Functional	April 1, 2007	June 28, 2024	Manual	8.47927	47.35301			
MRS_SOLASSL	Rainfall Station	Las Anod SL	Functional	Jan. 1, 2020	Oct. 10, 2023	Manual	8.47511	47.36239			
MRS_SOTAL	Rainfall Station	Taleex	Functional	Jan. 1, 2011	June 28, 2024	Manual	9.149283	48.421146			
MRS_SOWAR	Rainfall Station	Waridaad	Functional	Jan. 1, 2020	June 28, 2024	Manual	9.28387	46.25364			
MRS_SOWID	Rainfall Station	Widh widh	Functional	Jan. 1, 2023	June 28, 2024	Manual	8.4538425	46.7060966			
MRS_SOXUDPL	Rainfall Station	Xudun PL	Functional	May 1, 2024	June 28, 2024	Manual	9.15585833	47.479508			
MRS_SOXUDSL	Rainfall Station	Xudun SL	Functional	April 30, 2024	June 28, 2024	Manual	9.154294	47.476422			
MRS_SOYAG	Rainfall Station	Yagori	Functional	Jan. 1, 2020	June 28, 2024	Manual	8.754485	46.962834			
MRS_TOBAL	Rainfall Station	Balidhig	Functional	Jan. 1, 2020	June 28, 2024	Manual	8.36858	45.91417			
MRS_TOBEE	Rainfall Station	Beer	Functional	Jan. 1, 2018	June 28, 2024	Manual	9.36314	45.73507			
MRS_TOBUR	Rainfall Station	Burao	Functional	April 1, 2007	June 28, 2024	Manual	9.51667	45.56667			
MRS_TOBUUPL	Rainfall Station	Buuhoodle PL	Functional	Jan. 1, 2020	June 28, 2024	Manual	8.23739408	46.321882			
MRS_TOBUUSL	Rainfall Station	Buuhoodle SL	Functional	Jan. 1, 2011	June 28, 2024	Manual	8.251603	46.315717			
MRS_TOGAT	Rainfall Station	Gatiitley	Functional	Jan. 1, 2019	June 28, 2024	Manual	9.51868	44.86263			
MRS_TOODW	Rainfall Station	Odweyne	Functional	April 1, 2007	June 28, 2024	Manual	9.40858	43.30104			
MRS_TOODW	Rainfall Station	Odweyne	Functional	April 1, 2007	June 28, 2024	Manual	9.40858	45.0617			
MRS_TOSHE	Rainfall Station	Sheikh	Functional	April 1, 2007	June 28, 2024	Manual	9.91667	45.18333			
MRS_TOWAA	Rainfall Station	Warabeye	Functional	Jan. 1, 2012	June 28, 2024	Manual	8.876506	45.576434			
MRS_TOXAA	Rainfall Station	Xaaji Saalax	Functional	Jan. 1, 2020	June 28, 2024	Manual	8.58998	45.2415			
MRS_WGABU	Rainfall Station	Aburin	Functional	April 1, 2007	June 28, 2024	Manual	9.51743	43.80575			

MRS_WGALL	Rainfall Station	Allaybaday	Functional	Jan. 1, 2016	June 28, 2024	Manual	9.405506	43.556303			
MRS_WGBAL	Rainfall Station	Baligubadle	Functional	Jan. 1, 2012	June 28, 2024	Manual	8.999311	43.99736			
MRS_WGBER	Rainfall Station	Berbera	Functional	April 1, 2007	June 28, 2024	Manual	10.43333	45.03333			
MRS_WGBOT	Rainfall Station	Botor	Functional	Jan. 1, 2016	June 28, 2024	Manual	9.637806	44.070527			
MRS_WGCAD	Rainfall Station	Cadaadley	Functional	Jan. 1, 2011	June 28, 2024	Manual	9.76634	44.69001			
MRS_WGDAR	Rainfall Station	Dararweyne	Functional	Jan. 1, 2011	June 28, 2024	Manual	9.7283	44.23264			
MRS_WGDHU	Rainfall Station	Dhubato	Functional	Jan. 1, 2011	June 28, 2024	Manual	9.74013	44.4659			
MRS_WGDIL	Rainfall Station	Dilla	Functional	Jan. 1, 2007	June 28, 2024	Manual	9.741881	43.35675			
MRS_WGGAC	Rainfall Station	Gacan-libah	Functional	April 30, 2024	June 28, 2024	Manual	9.069167	44.556303			
MRS_WGGEB	Rainfall Station	Gebilley	Functional	Jan. 1, 2004	June 28, 2024	Manual	9.61667	43.28333			
MRS_WGGEE	Rainfall Station	Geed deeble	Functional	Jan. 1, 2020	June 28, 2024	Manual	9.76598	43.98228			
MRS_WGHAR	Rainfall Station	Hargeisa	Functional	Jan. 1, 2005	June 28, 2024	Manual	9.55975	44.0668			
MRS_WGKAL	Rainfall Station	Kalabaydh	Not Functional	Jan. 1, 2016	Dec. 31, 2017	Manual	8.2432	47.2264			Faulty Rain gauge No personnel available on daily basis
MRS_WGLAS	Rainfall Station	Las Dacawo	Functional	Jan. 1, 2020	June 28, 2024	Manual	10.05142	44.98405			
MRS_WGMAG	Rainfall Station	Magalo-Cad	Functional	Jan. 1, 2020	June 28, 2024	Manual	9.6942	43.30104			
MRS_WGMAL	Rainfall Station	Malawle	Functional	Jan. 1, 2020	May 31, 2024	Manual	9.55448	43.95229			
MRS_WGSAL	Rainfall Station	Salaxley	Functional	Jan. 1, 2020	June 28, 2024	Manual	9.02686	44.20228			
MRS_WGSAY	Rainfall Station	Sayla Bari	Functional	Jan. 1, 2020	June 28, 2024	Manual	9.27339	43.89133			
MRS_WGTAY	Rainfall Station	Taysa	Functional	Jan. 1, 2020	June 28, 2024	Manual	9.5675	43.67275			
MRS_WGTUU	Rainfall Station	Tuurka	Functional	Jan. 1, 2018	Dec. 31, 2018	Manual	8.002344	47.107228			
MRS_WGWAJ	Rainfall Station	Wajaale	Not Functional	Jan. 1, 2020	June 28, 2024	Manual	9.59982	43.335589			Faulty Rain gauge No personnel available on daily basis

Staff River gauging Station

Station Number	Station Type	Station Name	Status	First Update	Last Update	Missing Data	Area Km2	Latitude	Longitude	Elevation	River	Time Series	Managed by	Condition
JB001	Gauging Station	Luuq	Functional	1951	To Date	1968,1991-2000	166,000	3.79172	42.54264	140	Juba	Daily flow		Poor condition
JB002	Gauging Station	Dollow	Functional	2015	To Date			4.18777	42.079382	177	Juba	Daily flow		Poor condition
JB003	Gauging Station	Bardheere	Not Functional	1963	July 5, 2024	1968,1990-2000	216,730	2.33989	42.28115	87	Juba	Daily flow		Bardheere Bridge, which anchored the river gauge, was swept away by floods on the 8th of November 2023. The station will be re installed once the bridge is repaired.
JB004	Gauging Station	Kaitoi	Not Functional	1963	Dec. 31, 2008	1965 - 1971	240,000	0.783333	42.66667	34	Juba	Daily flow		
JB005	Gauging Station	Bualle	Not Functional	2008				1.24477	42.57317	51	Juba	Daily flow		Bualle river gauge broke down on 14 March 2024, SWALIM is working on repairing it as soon as its feasible.
JB006	Gauging Station	Jamame	Not Functional	1963	1990	1968	268,800	0.065758	42.742337		Juba	Daily flow		No information available
JB007	Gauging Station	Mareere	Not Functional	1977	1990		240,000	0.45	42.7	10	Juba	Daily flow		No information available
JB008	Gauging Station	Kamsuma	Not Functional	1972	1989	1977-1987	255,000	0.244444	42.775		Juba	Daily flow		No information available
JB009	Gauging Station	Mogambo	Not Functional	1983	1989		260,000	0.15	42.733333	14	Juba	Daily flow		No information available
SH001	Gauging Station	Belet Weyne	Functional	1963	To Date	1953, 1991-2001	207,000	4.73598	45.20596	182	Shabelle	Daily flow	SWALIM	
SH002	Gauging Station	Bulo Burti	Functional	1963	To Date	1991-2001	231,000	3.85702	45.56727	133	Shabelle	Daily flow	SWALIM	

SH004	Gauging Station	Mahadey Weyne	Not Functional	1963	To Date		255,300	2.97098	45.53038	115	Shabelle	Daily flow		
SH003	Gauging Station	Jowhar	Functional	1999	To Date			2.77872	45.50486	105	Shabelle	Daily flow	SWALIM	
SH007	Gauging Station	Balcad	Not Functional	1963	1979		272,700	2.350172	45.390534	95	Shabelle	Daily flow		
SH005	Gauging Station	Afgoi	Functional	1963	To Date		278,000	2.144444	45.124999	84	Shabelle	Daily flow	SWALIM	
SH006	Gauging Station	Audegle	Not Functional	1963	Dec. 31, 2008			1.986111	44.833333	76	Shabelle	Daily flow	SWALIM	No information available
SH008	Gauging Station	Kurtunwaarey	Not Functional					1.588222	44.334023		Shabelle	Daily flow		No information available

Groundwater Level Sensor

Station Number	Station Type	Station Name	Region	District	Status	Latitude	Longitude	Depth	Installation Agency	Managed by
GLSS001	Groundwater Level Sensor	Al Ahmar Borehole	Bay	Baidoa	Un-known	3.138623	43.633353		World Vision	World Vision
GLSS002	Groundwater Level Sensor	Hannano Borehole	Bay	Baidoa	Un-known	3.138623	43.666317		World Vision	World Vision
GLSS003	Groundwater Level Sensor	Nahiris Shallow Well	Bay	Baidoa	Un-known	3.135715	43.686097		World Vision	World Vision
GLSS004	Groundwater Level Sensor	ceel busley shallow well	Bay	Baidoa	Un-known	3.11695	43.65853		World Vision	World Vision
GLSS005	Groundwater Level Sensor	Daqare shalow well	Bakool	Wajid	Un-known	3.80282	43.247836		World Vision	World Vision
GLSS006	Groundwater Level Sensor	Birdhere bore hole	Bakool	Wajid	Un-known	3.807681	43.246377		World Vision	World Vision
GLSS007	Groundwater Level Sensor	Derow Farm	Bakool	Wajid	Un-known	3.804858	43.234069		World Vision	World Vision
GLSS008	Groundwater Level Sensor	Geedi Farm	Bakool	Wajid	Un-known	3.81798	43.248716		World Vision	World Vision
GLSS009	Groundwater Level Sensor	Qansahley-IDP Shallow well	Gedo	Dollow	Un-known	4.145847	42.059836		World Vision	World Vision

GLSS010	Groundwater Level Sensor	Billow Shallow well	Gedo	Dollow	Un-known	4.165014	42.076639		World Vision	World Vision
GLSS011	Groundwater Level Sensor	Kabasa river	Gedo	Dollow	Un-known	4.169219	42.100278		World Vision	World Vision
GLSS012	Groundwater Level Sensor	Dollow water utility Company River	Gedo	Dollow	Un-known	4.162661	42.074528		World Vision	World Vision
GLSS013	Groundwater Level Sensor	Logging for Shallow well	Gedo	Luuq	Un-known	3.79414	42.54493		World Vision	World Vision
GLSS014	Groundwater Level Sensor	Oog BH	Sool	Oog	Un-known	8.927015	46.619113		World Vision	World Vision
GLSS015	Groundwater Level Sensor	Arabsiyo BH	Waqoy Galbed	Arabsiyo	Un-known	9.6596	43.7681		World Vision	World Vision
GLSS016	Groundwater Level Sensor	Garba haadle	Waqooyi Galbed	Gabiley	Un-known	9.63709	43.3011		World Vision	World Vision
GLSS017	Groundwater Level Sensor	Borehole 19	Awdal	Borama	Un-known	9.9500268	43.22265		World Vision	World Vision
GLSS018	Groundwater Level Sensor	Zeylac BH	Salel	Zeylac	Un-known	11.325926	43.375197		World Vision	World Vision
GLSS019	Groundwater Level Sensor	Kalajab BH	Saxil	Berbera	Un-known	10.257722	45.114777		World Vision	World Vision
GLSS020	Groundwater Level Sensor	Dubur 2 BH	Saxil	Sheekh	Un-known	9.857718	45.242825		World Vision	World Vision
GLSS021	Groundwater Level Sensor	Ceel xumo BH	Togdheer	Odwayne	Un-known	9.3787945	45.164203		World Vision	World Vision
GLSS022	Groundwater Level Sensor	Garadag BH	Sanag	Garadag	Un-known	9.4902697	46.883129		World Vision	World Vision