10 April 2024

GBON National Contribution Plan: LIBERIA

Systematic Observations
Financing Facility

Weather
and climate
data for
resilience

GBON National Contribution Plan

Liberia

SOFF Beneficiary country focal point and institution	Arthur Gar-Glahn, PR and Director, Liberia Meteorological Service (LMS)
SOFF Peer Advisor focal point and institution	Oluwaseun Wilfred IDOWU, Nigerian Meteorological Agency (NiMet)

Table of contents

Module 1. National Target toward GBON compliance

Table1: GBON National Contribution Target

Type of station	Baseline (Results of the GBON National Gap Analysis)				GBON National Contribution Target	
	Target (# of stations)[1]	GBON-compliant stations (#)	Gap		To improve	New
			New	To improve		
Surface	3	0	0	3	3	0
Upper air	1	0	1	0	0	1
Marine	**2**					

Current State

- The Liberia Meteorological Service (LMS) presently has an observation network of 30 stations comprising six (6) synoptic stations, six (6) agromet stations and eighteen (18) rainfall **stations (figure 1 – rainfall stations not included)**. All the stations are AWOS.
- These stations were deployed by Early Warning System (EWS) project - 11, UNDP at James Spriggs Payne Airfield - 1 and Liberia's National Adaptation Program of Action (NAPA) - 18
- There is no upper air and marine stations in the operations of LMS.
- Only one of the existing stations is currently operational - Roberts International Airport and it is operated by a third party, the Liberia Airport Authority (LAA).
- At the time of the SOFF Team's in-country visit, no station in the country was GBON compliant nor were they transmitting through WIS 2.0.
- Most of the stations are solar power driven but lack internet connectivity to enable them to transmit data.
- Lack of computer hardware networked to serve as a central collation point is also a major challenge.

Overall, the LMS is faced with challenges in skilled and sufficient personnel, logistics, sourcing of equipment and spare parts, maintenance, and data communications, as a result, Liberia currently has no GBON-compliant surface stations and most of its AWS are not transmitting data. Support from SOFF for Liberia will significantly address these challenges.

GBON Targets

Liberia is one of the most biologically diverse countries and was originally covered by continuous, dense tropical rainforest. Liberia has a predominantly equatorial climate, with three (3) distinct topographical belts. The low coastal belt is about 40km wide; and constitutes tidal creeks, shallow lagoons, and mangrove marshes. The second belt includes rolling hills that reach elevations of 60–150m, while the third belt comprises the bulk of Liberia and is marked by abrupt changes of elevation in a series of low mountains and plateaus, which are less densely forested.

In its global GBON gap analysis, the WMO applied the GBON land surface and upper air station targets for Liberia, and this resulted in targets of 3 surface stations and 1 upper air station. In consultation with LMS and their local partners, it has been determined and agreed that the surface stations to be rehabilitated under SOFF intervention are the stations located at:

i. Roberts International Airport,
ii. Zwedru Airstrip
iii. Harper Airstrip

As indicated in Figure 1 below.

Upper air stations

An upper air station is recommended for establishment at Roberts International Airport, Margibi County (figure 2) as a GBON station in the SOFF Investment Phase.

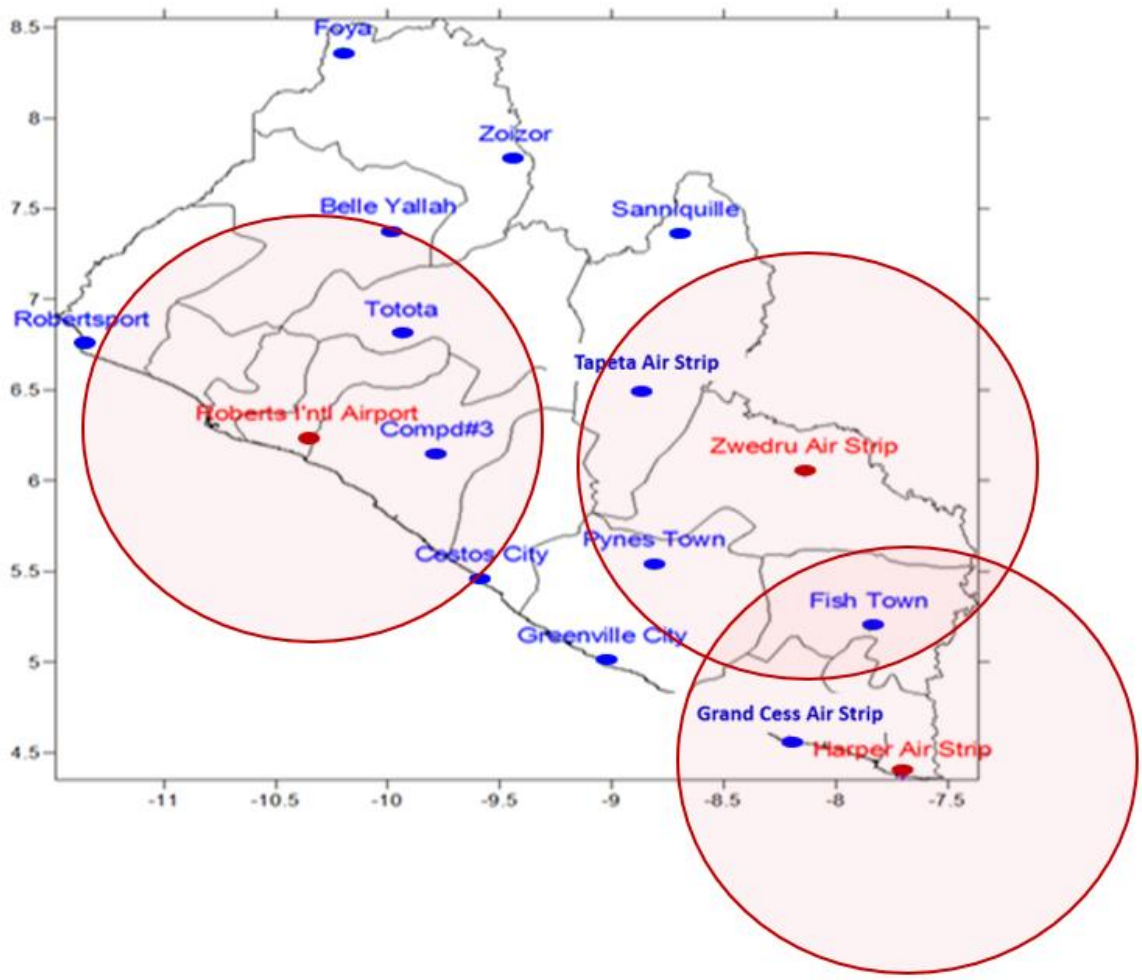

Figure 1: Geographical distribution of proposed GBON surface stations to be supported by SOFF, with a diameter of approximately 200km. **Proposed GBON stations are labelled and circled in red.**

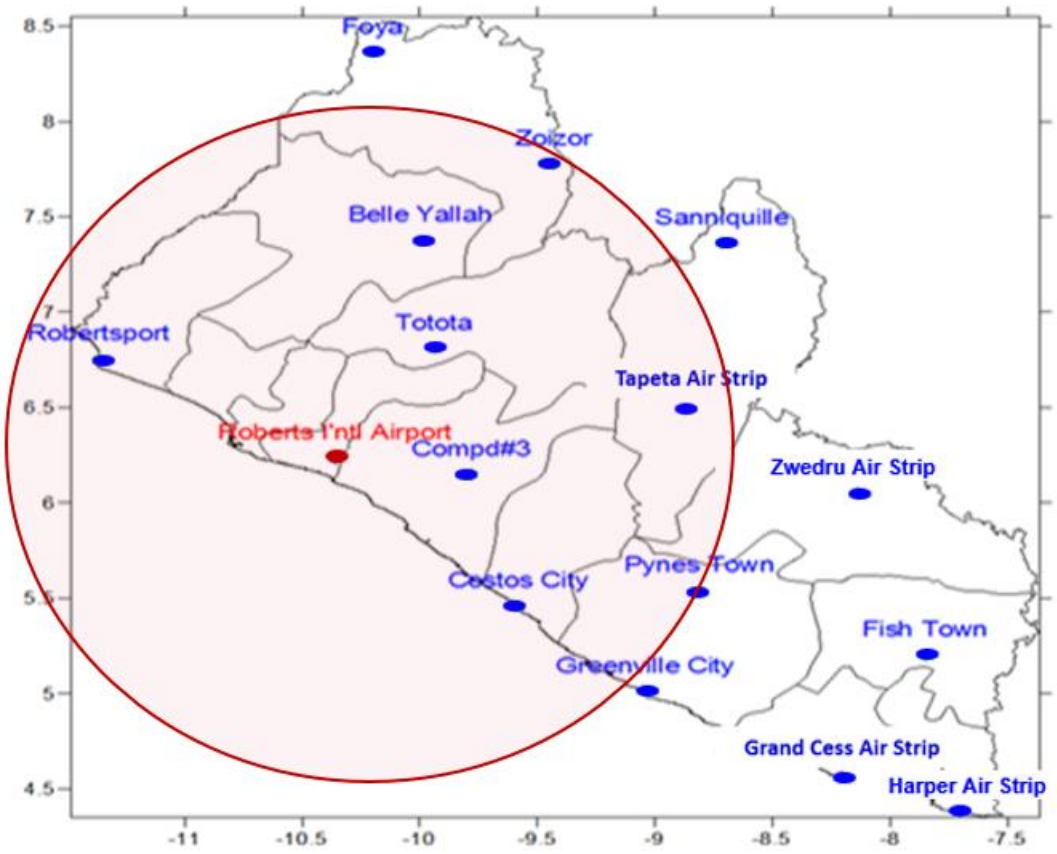

Figure 2: Location of the proposed GBON Upper Air Station to be established by SOFF and located at Roberts International Airport, Margibi, with a horizontal resolution of 500km.

Note:

- While the upper air station will be at Roberts International Airport (RIA) and one surface station will also be rehabilitated at RIA, the other two surface stations to be rehabilitated will be at Zwedru and Harper Airstrips.

Module 2. GBON Business Model and Institutional Development

2.1. Assessment of national governmental and private organizations of relevance for the operation and maintenance of GBON

The Liberia Meteorological Service (LMS) is the Agency of Government charged with the responsibility of advising the Government of Liberia on all aspects of meteorology, as well as collecting, processing, storing, and disseminating meteorological and climatological information in support of national socio-economic development, coordinate and supervise all meteorological, climatological, and other related activities in the country. The LMS is also responsible for cooperating and maintaining relationships with the World Meteorological Organization (WMO), the African Centre of Meteorological Applications for Development (ACMAD), and the International Civil Aviation Organization (ICAO) for the practice and development of meteorology in Liberia.

There is a planned project (Enhancing Climate Information System (CIS) for resilience development in Liberia, funded by the Green Climate Fund (GCF) through the African Development Bank (AfDB)) under the Environmental Protection Agency (EPA) to merge the Liberia Meteorological Service (LMS) and the Liberia Hydrological Services (LHS) into one government agency with legislative backing. This is expected to give a boost to the country's ability to meet GBON requirements in data generation and transmission. Other government agencies currently partnering with LMS though informally include the Environmental Protection Agency (EPA), Ministry of Agriculture, National Disaster Management Agency (NDMA), Ports and Maritime Authority, Liberia Airports Authority, Liberia Civil Aviation Authority, etc. The Liberia Airport Authority (LAA) through the station at Roberts International Airport, Margibi County, maintains the only operational meteorological observation station in Liberia, **figure 2.** There are no private sector operators currently providing meteorological observations and data services in Liberia.

Recommendations:

- Apart from the Liberia Airports Authority and the Liberia Hydrological Service, none of the other government agencies above is currently producing meteorological observations, they however have the potential to key into the rehabilitation and expansion of the observing network of LMS through the provision of physical and technical support.

- There is already an existing working relationship with the Liberia Airports Authority that can be further explored to include allowing the LMS to transmit observation data generated by them through GTS or WIS.2.0.

- There is a need for the LMS to work towards having a Memorandum of Understanding (MoU) with relevant government agencies to formalize their relationship and have legal backing for their future collaborations.

Figure 3. Synoptic Observation Station at Roberts International Airport

2.2. Assessment of potential GBON sub-regional collaboration

There are centres across Regional Association I (RA I) and the West African Sub-region such as ACMAD, RTC Lagos and AGRHYMET providing technical support, capacity development and forecast products for members. LMS has actively participated in regional programs from ACMAD and SWFDP West Africa over the years. Useful support and guidance by WMO have been provided to Liberia through the Office in the region for North, Central and West Africa. The input and collaboration of these centres with LMS in GBON implementation will be important in achieving GBON compliance in Liberia.

The Nigerian Meteorological Agency (NiMet) has years of fruitful working relationship with the Liberia Meteorological Services and would be in a good position to collaborate and assist LMS towards the implementation of GBON.

It is recommended that the LMS continue to leverage its membership in these regional bodies for the training of its staff and technological transfer especially in data transmission and early warnings through Regional Climate Outlook Fora. The LMS should include the reinforcement of regional collaboration as part of its strategic plan.

2.3. Assessment of a business model to operate and maintain the network.

The LMS currently does not have a budgetary allocation for operations and procurement of necessary supplies, as it is currently domiciled as a unit within the Ministry of Transport (MoT). The annual salaries budget of the LMS personnel stands at approximately USD 60,000. 100% of this budget comes from the Ministry of Transport, as the LMS does not generate any revenue on its own. As a result, the Liberia Meteorological Service is ill-equipped to meet its obligations,

especially regarding the provision of Early Warnings for current climate and water threats and future climate- and water-related impacts. These capacity deficits in the LMS have negative impacts on national socio-economic development.

The LMS has in the past benefitted from donated funded projects. However, discussion revealed that these projects had no post-installation programs inserted into them, thus leading to their collapse shortly after the end of the projects. Some of these projects are:

i. The project in which EPA and UNDP-Liberia in consultation with LMS/MoT and LHS/MME collaborated to hire a national consultant to perform the task of drafting a bill to provide legal backing for LMS. Note that EPA is hosting a 5-year GCF/CDSF-funded Project under AfDB targeting LMS, LHS, NDMA, and EPA and the development of this bill is one of the key deliverables. The EPA has been fast-tracking this deliverable under UNDP funding.

ii. The METAGRI ROVING Seminars and the Norwegian Hydrometric Project (NVE) were executed by international partners for LMS recently.

iii. Management of the GEF-funded Early Warning System project, though it was done through the Ministry of Transport (MoT), however, the MoT Project Manager is not a staff of LMS. This caused a significant disconnect in the project, which led to the delivery systems that are of questionable utility for climate risk analysis or for forecasting timescales from seasonal to sub-daily in Liberia.

iv. The Early Warning project which is financed by the GEF/LDCF through UNDP, which contracted the Earth Networks company to install Automatic Weather Stations on mobile phone towers as well as some ground stations. The Early Warning System (EWS) project was developed under Liberia's National Adaptation Program of Action (NAPA) with the objective of rehabilitating the Liberia Meteorological Service (LMS) under the Ministry of Transport and the Liberian Hydrological Service (LHS) under the Ministry of Mines & Energy. The project established five (5) synoptic, six (6) agro-meteorological, and eighteen (18) rainfall stations.

The LMS has limited skilled manpower and the funding to carry out routine maintenance of these stations. Lack of operational budgetary allocation also means that the LMS cannot provide internet connectivity for data transmission from the station. Furthermore, an inadequate number of skilled engineers has led to a lack of regular maintenance of the equipment, **figures 3, 4, 5, 6.**

To meet its GBON National Contribution Plan (NCP) requirements, the LMS requires substantial additional funding resources. However, given the plan of government to merge LMS and LHS into one Agency, the existing skill level in the LMS, and the lack of existing private sector operators in the provision of weather and climate services in Liberia, the preferred business model is the public model – Full State/NMHS owned and operated.

At the moment, the ability of the LMS to carry out GBON-compliant operations and development is dependent on budget funding from the Government, collaboration with international development project partners, and financial support from the Implementing Entity (AfDB) for station maintenance. At present, 100% of government budget funding is spent on staff salaries, as in 2023 the total budget allocation stood at 60,000 USD. However, the

ongoing plan to merge LMS and LHM into an autonomous Agency, with the legal backing for revenue generation, is expected to shore up the finances of the NMHS and enhance its capacity to operate and maintain a network of GBON-compliant stations. The project is already underway and is expected to be completed within the next three years. It is important to note that under the current circumstances in Liberia, SOFF investment will be entirely funded by the SOFF targeted investors as would be recommended by the Implementing Entity. As started earlier, the only budget of LMS is strictly for salaries., hence zero allocation for other activities outside salaries.

A Build-Own-Operate-Transfer (BOOT) type of PPP can also be introduced for Liberia and the LMS, where the government through the Ministry of Transport would grant tax waivers to participating companies and entities in the country.

To forestall the collapse of the projects at the end of SOFF programme, the following are recommended:

1. The establishment of a pooled fund for the LMS solely dedicated to operational activities such as internet provision and routine maintenance of observation of infrastructure is highly needed.
2. A build-and-operate type of PPP has been implemented and is operational at Roberts International Airport, where the Liberia Airport Authority (LAA) oversees the maintenance of meteorological equipment for aeronautical operations and has observers, meteorologists, and engineers in charge of the day-to-day running of the station. The Liberia Meteorological Service (LMS) through WMO provides training opportunities in observations and forecasting for this category of personnel. This can be explored in other viable airstrips/stations around the country. This would help to reduce the burden of operational and maintenance costs from LMS and will help speed up the spread of the observation network across the country.
3. Other potential organisations that could be targeted for BOOT are Government agencies such as the Environmental Protection Agency (EPA), Ministry of Agriculture, National Disaster Management Agency (NDMA), Ports and Maritime Authority, Agro-Allied Companies (Liberia Agricultural Company (LAC), Salala Rubber Corporation (SRC), etc.), Mining Companies (e.g. China-Union Investment (Liberia) Bong Mines Company Ltd, Riders Incorporated, etc.) and Maritime Companies (Blue Ocean Bulk Shipping Limited, Van Oord – Liberia, SMT – Liberia etc.).
4. Regional approach to capacity development could be exploited for the routine maintenance of observation infrastructure. The Nigerian Meteorological Agency (NiMet) for example, already provide capacity building support in observation and forecasting. This support can be extended to cover training for instrument calibration and maintenance.

Figure 4: Early Warning System project AWOS at Buchanan

Figure 5: Early Warning System project AWOS at Cari

Figure 6: Early Warning System project AWOS at Fishtown

Figure 7: Early Warning System project AWOS at Zwedru

2.4. Assessment of existing national strategies and projects related to observing networks.

Though there are no existing formal national strategies, the LMS has in recent years benefited from some internationally funded projects geared towards expanding the observation networks in Liberia. Our interaction revealed that challenges with these past projects are mostly related to a lack of post-project maintenance plans/strategies coupled with inadequate funding from the government. These past projects are:

- The project in which EPA and UNDP-Liberia in consultation with LMS/MoT and LHS/MME collaborated to hire a national consultant to perform the task of drafting a bill to provide legal backing for LMS. Note that EPA is hosting a 5-year GCF/CDSF-funded Project under AfDB targeting LMS, LHS, NDMA and EPA and the development of this bill is one of the key deliverables. The EPA has been fast-tracking this deliverable under UNDP funding.
- The METAGRI ROVING Seminars and the Norwegian Hydrometric Project (NVE) were executed by international partners for LMS recently.
- Management of the GEF-funded Early Warning System (EWS) project, though it was done through the Ministry of Transport (MoT), however, EWS Project Manager is not a staff of LMS. This caused a significant disconnect in the project, which led to the delivery systems that are of questionable utility for climate risk analysis or for forecasting timescales from seasonal to sub-daily in Liberia.
- The Early Warning project which is financed by the GEF/LDCF through UNDP, which contracted the Earth Networks company to install Automatic Weather Stations on mobile phone towers as well as some ground stations.
- The Early Warning System (EWS) project developed under Liberia's National Adaptation Program of Action (NAPA) with the objective of rehabilitating the Liberia Meteorological Service (LMS) under the Ministry of Transport and the Liberian Hydrological Service (LHS) under the Ministry of Mines & Energy.

Recommendations:

i. Establishment and enhancement of coordination mechanisms among different stakeholders, government agencies, and development partners involved in meteorological and hydrometeorological projects. Regular meetings and information sharing to avoid duplication of efforts are encouraged.
ii. Standardization of data collation formats across different projects, to facilitate interoperability between observing networks for ease of data exchange is required.
iii. Encourage collaboration on capacity-building initiatives to avoid redundant training efforts as well as foster partnerships between educational institutions, international organizations, and government agencies for skill development.
iv. Establish/strengthen data-sharing platforms to ensure seamless exchange of meteorological and hydrometeorological data in line with international standards.
v. Conduct regular assessments to measure the progress of ongoing projects against their stated objectives and adjust strategies and activities based on the outcomes of these assessments.
vi. Enhance public awareness of the importance of observing networks and meteorological data and engage with communities to create a sense of ownership and responsibility for the sustained operation of observing stations.

vii. Active involvement of LMS in future projects should be encouraged.

2.5. Review of the national legislation of relevance for GBON

At present, there is no legal framework for LMS or its operations. The initial process of transforming LMS into an Agency of Government has been halted, this was done to accommodate a new proposal that will merge the LMS and LHS as one Agency of Government which is to be called "Liberia Hydromet Agency" (LHA). The process is ongoing with a bill before the parliament.
However, the LMS is empowered to:

1. Collect, process, store and disseminate meteorological and climatological information.
2. Analyse, prepare, and issue weather forecasts, including warnings of severe weather conditions and floods hazardous to human life and property.
3. Collect, process, and archive all meteorological and related data observed by all meteorological and climatological stations including airports and seaports.
4. Exchange data and products and disseminate data, analyses, forecasts, and other interpreted products in accordance with international agreements.
5. Issue weather forecasts, warnings, and other information of use to the public, aviation, coastal and offshore marine, energy (wind, solar and hydro-electric), environmental sectors, water resources management, agricultural production, and food security.
6. Provide meteorological services for the development of national socio-economic activities.

These functions are presently underperformed due to inadequate funding, capacity and competency within the LMS.

The Public Procurement and Concessions Commission (PPCC) is an autonomous entity of the Government established in 2005 by an Act of Legislation and Amended and Restated in 2010 to regulate all forms of Public Procurement and Concessions and provide for institutional structures for public procurement and concessions and stipulates methods and procedures for public procurement and concessions processes in Liberia.

Part V of the Act stipulates that:

i. Public procurement shall be undertaken by means of advertised open bid proceedings, to which equal access shall be provided to all eligible and qualified bidders without discrimination, subject only to the exceptions provided under this Part for particular methods of procurement.
ii. For all methods of procurement other than international open competitive bidding, the Procuring Entity may stipulate in the invitation for bids, request for quotation, request for proposal or the related bidding documents that bidders must quote only in the local currency and in one freely convertible currency and payments must be made wholly in such local currency or freely convertible currency.
iii. Where the participation of the procurement end-user or beneficiary community may result in enhancing the economy, quality or sustainability of the service to be procured,

or the very objective of the project is to create employment and involvement of the beneficiary community, such end-user or community may participate in the delivery of services.

It is worth noting that, all imported goods entering the Customs territory of Liberia are required by law, **Section 14150 of the Revenue Code of 2000** as amended, to make entry to the Department of Customs. Customs undertakes security screening and collects border taxes on behalf of the Government of Liberia. Imported goods are subject to risk criteria and may be subject to the payment of import duty, excise duty, Goods and Sales Tax (GST), the ECOWAS Tax Levy (ETL) and other levies as applicable by other laws and regulations.

However, it is recommended that the Implementing Entity liaise with LMS to get a waiver through the following processes:

- The LMS can request tax-exempt (duty-free) privileges through the Liberia Revenue Authority (LRA).
- The implementing entity should submit the equipment/instruments procurement documentation and shipment details to LMS.
- Upon arrival of the equipment/instruments at the port of entry, LMS will request for tax-exempt under government duty-free privilege through the LRA; and
- Upon approval, the LMS will then, hire the services of a customs broker to clear and deliver the equipment/instruments to them.

The LMS already has the experience of carrying out similar procedures for the implementation of the following past projects:

1. GEF-funded EWS Project
2. EU-funded Projects:
    - Preparation for Use of Meteosat in Africa (PUMA)/Meteosat Second Generation (MSG)
    - PUMA Synergie/Environmental Station (E-Station)
    - Monitoring of the Environment for Security in Africa (MESA)
    - African Monitoring of the Environment for Sustainable Development (AMESD)

Overall, there is no national legislation in Liberia that would present any major constraint to the implementation of GBON.

Module 3. GBON Infrastructure Development

3.1. Surface and upper air observing network and observational practices.

Land surface station

The existing weather stations in Liberia are shown earlier in **Figure 1**. These include synoptic, agromet and rainfall stations. They are all automatic weather observing stations (AWOS). Presently, none of the stations are GBON-compliant. However, with the upgrade and supply of internet connectivity, ten (10) of these stations will become GBON-compliant. When rehabilitated, networked, and provided with internet connectivity, the stations are capable of hourly transmission of weather parameters including rainfall, temperature, humidity, surface pressure, wind speed and direction. The recommended stations for upgrade and the parameters measured are as in **Table 3.**

Table 3: List of observation stations needing upgrade to become GBON-compliant.

Station Name	**Measured Parameters**	**Upgrade needed to become GBON-compliant.**
• Roberts International Airport	○ Atmospheric pressure ○ Temperature ○ Precipitation ○ Humidity ○ wind	▪ Backup power supply ▪ Internet connectivity ▪ Station metadata needs verification
• Zwedru Airstrip • Tapeta Airstrip • Grand Cess	○ Atmospheric pressure ○ Temperature ○ Precipitation ○ Humidity ○ wind	▪ Internet connectivity ▪ Station metadata needs verification
• Harper Airstrip	○ Atmospheric pressure ○ Temperature ○ Precipitation ○ Humidity ○ wind	▪ Internet connectivity ▪ Station metadata needs verification. ▪ Transfer of all instruments to a nearby building as the fencing wire is rapidly corroding due to sea breeze with salt content as the station is just a few miles from the ocean. Or the replacement of the fencing materials with corrosion resistant materials.
• James Spriggs Payne Airfield	○ Atmospheric pressure ○ Temperature	▪ Replacement of the vandalized station

	○ Precipitation ○ Humidity ○ wind	
• Fish Town • CARI • Sarclepea Magisterial Court • Forestry Training Institute • Buchanan • Voinjama	○ Atmospheric pressure ○ Temperature ○ Precipitation ○ Humidity ○ Wind ○ Soil temperatures ○ Wind at 2m ○ leaf wetness	▪ Internet connectivity ▪ Station metadata needs verification

The AWOS were installed at locations as part of the Early Warning System (EWS) project, and they are all ADCON models. They can be calibrated to transmit hourly observations. **However, to achieve this, a central collation point is needed. The LMS office at the Ministry of Transport (MoT) could be equipped with the required computer hardware and software to serve as the collection point.**

The travel and logistics from Monrovia to the locations of some of the stations are very expensive and complex with lengthy travel time over rough terrains required to reach most sites. Budget constraints and technical skills within the LMS have meant that visiting the sites for maintenance has been rare and ineffective.

Observational Practices

To ensure that the SOFF-supported stations will continue to maintain their GBON-compliant status sustainably, the following observational practices will be adopted in each of them.

i. Calibration of Instruments: yearly calibration of all instruments will be adopted in all the GBON stations.
ii. Surface observations of parameters (temperature, surface pressure, wind speed/direction, precipitation, etc) will be transmitted hourly (i.e. 24 observations per day) while upper air sounding will be carried out twice daily.
iii. The LMS will develop and adopt a Standard Observation Procedure, which will include proper techniques for reading instruments, handling data, and recording observations.
iv. Documentation of metadata such as station location, instrument specifications, and observation procedures.
v. Quality control procedures will be applied to identify and correct errors or inconsistencies in observational data.

Observation Instruments specifications

Table 4: Instruments and observing systems for planned GBON surface stations.

Instruments	• Resistance Temperature Device (RTD) dry bulb probe and relative humidity probe @1.25m – 2m. • Wind speed and direction sensors @10m. • Standard 203mm (8-inch) tipping bucket rain gauge.

	• Other automated instruments (barometer, evaporation, solar radiation, soil temperatures) as may be required. • AWS processor to collate data (preferably with a 7–30-day buffer) and send messages at the required intervals.
Structures	• Instrument shelter (Stevenson style), gloss white and double louvered, with a stand to achieve sensor height of 1.25-2m. • Tilting counterweighted 10m mast. • Post to 0.7m to support rain gauge as may be required. • Fencing, adequate for the required security of the site. • Housing for the AWS processor, barometer and power supply separate from other sensors
Facilities	• An observations enclosure sufficient to ensure the exclusion of obstacles impacting on readings (WMO 25 x 25m, BOM 18 x 18m). • Mains and/or solar power supply to the site. • Batteries to support solar, and/or to act as UPS for message transmission. • Signage to inform or deter the public
Communications	• Robust cellular or satellite (preferred) communications to ensure regular, timely message transmission. • Redundant communications system where feasible.

For additional guidance information on instrument specifications, please refer to WMO guidance materials on GBON Tender Specifications for AWSs.

Activities to uplift the stations:

i. Provide perimeter fencing of the station at Harper Airstrip with corrosion-resistant materials, as the location of the station makes it prone to the adverse effects of salt water from the ocean.
ii. Engage the communities around the existing stations for on-ground maintenance and security.
iii. Engage the services of an independent expert site inspection and audit of existing AWS equipment at the three (3) target GBON station sites to identify technical and communication faults and gaps.
iv. Procurement contract to uplift the three (3) stations, as per the audit, to ensure they communicate reliably in real-time to GBON standards.

Further Recommendations:

1. The upgrade through the provision of internet connectivity for the ten (10) synoptic and agromet stations for them to become GBON-compliant

2. Funding to cover logistics for servicing and maintenance of the existing station

3. Supply of spare parts and consumables for the stations.

4. Capacity building on instrument calibration and maintenance.

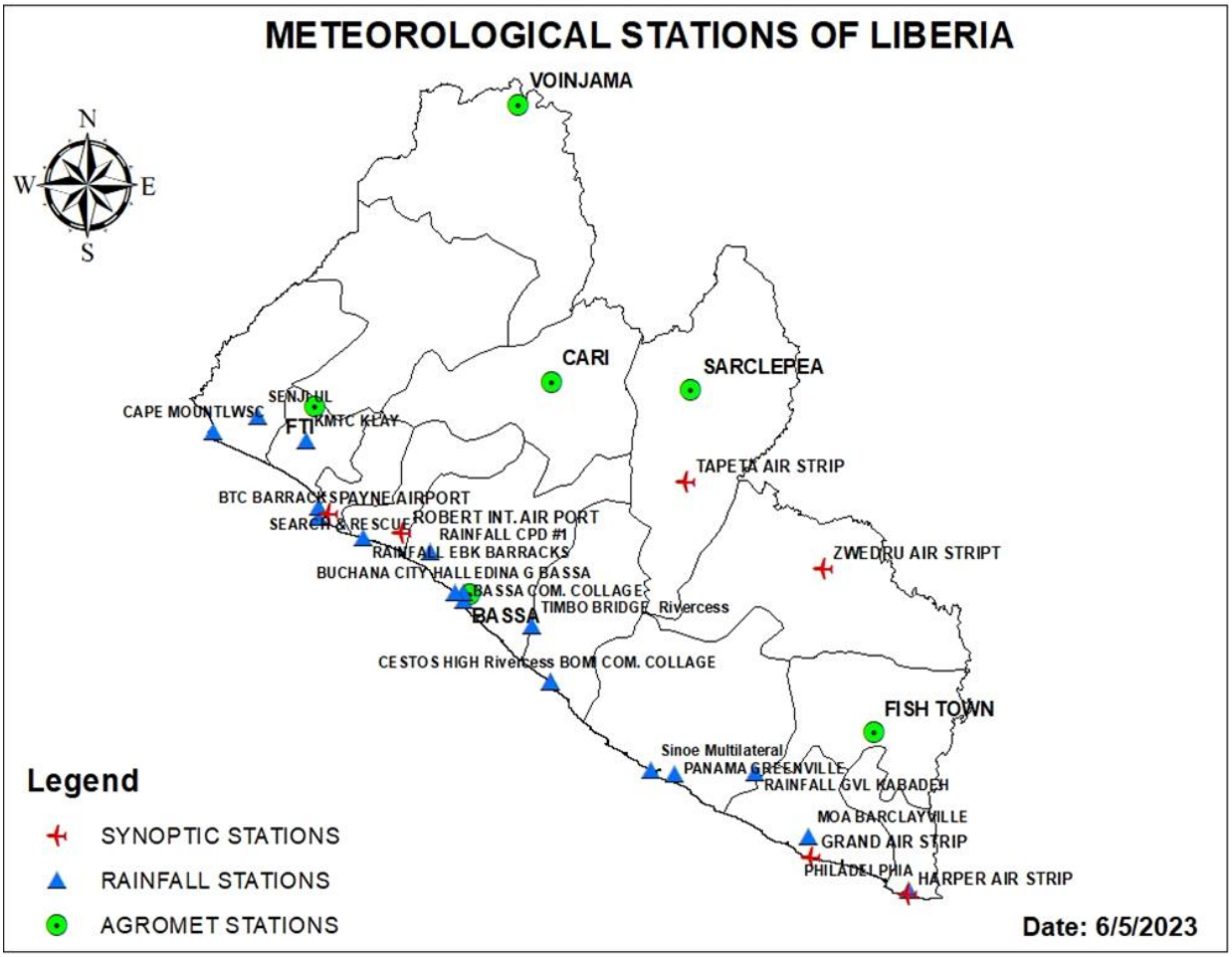

Figure 8: Map of existing Synoptic, AgroMet and Rainfall Stations in Liberia

Upper air station

There is presently no upper station in Liberia. However, a proposed new upper air will be co-located with the staffed surface station at Roberts International Airport. This station is currently operated by a third party – the Liberia Airport Authority (LAA). The station has mains power (will need an inverter to supplement during power failures), a building to service as an operational base, three observers and an engineer, providing a good opportunity for adding upper air observations. Instruments that will be needed in the proposed station are summarised in **Table 5**

Table 5: Instruments and observing systems for planned GBON upper air stations.

Instruments/consumables	• Radiosondes (environmentally sustainable model) • Balloons (environmentally sustainable model) • 'Met' string (environmentally sustainable model) • Personal Protective Equipment (PPE) suitable for dealing with explosive environments.
Structures	• Balloon shed or remote balloon launcher where manually constructed balloon trains can be safely inflated and released. • Separate (or partitioned) Hydrogen generation shed (or storage shed if bottled H2 is available).

	• Fencing, adequate for the required security of the site. • Exclusion zones (painted lines), beacons/lighting and paths within the site.
Facilities	• An enclosure sufficient to ensure the exclusion of the public and obstacles that may impact or be impacted by balloon releases. • A nearby building to house upper air consumables, cleaning materials, various computer and communications systems supporting the upper air observations, and a workstation for the manual observer to assemble balloon trains. • A local display for the radiosonde profile and access to sensors for ground check data (T/RH/WS/WD/press). • A power supply to enable H2 generation and monitoring, constant communication with the radiosonde and the transmission of coded messages. • A hydrogen generation system (HOGEN) and H2 storage facility to ensure adequate supply for the anticipated upper air program. • An uninterruptable power supply to ensure the above. • Supply of clean water for hydrogen generation.
Communications	• Communications systems integral to the upper air program (to receive sonde data, normally supplied with the Upper Air system). • Robust cellular or satellite communications to ensure regular, timely message transmission

For additional guidance information on instrument specifications, please refer to WMO guidance materials on GBON Tender Specifications for Upper-air Stations.

Maintenance activities for the stations

- Basic tasks requiring few consumables or parts may be carried out by LMS technical personnel, local contractors, or observers. These tasks may include cleaning the Stevenson screen, changing the wet-bulb wick, cutting grass/ vegetation, attaching sondes/launching balloons, and changing hydrogen cylinders.
- Technical tasks to be carried out by staff following established SOPs. They include collection of station metadata, replacement of sensors and verification of sensors performance.
- Specialised maintenance activities to be performed by trained staff. Such maintenance includes replacing infrastructure, setting up/configuring new equipment/sensors, annual maintenance of an upper air system and installation of data communications system. These may require advanced knowledge and skill in troubleshooting.
- Specialised repair or replacement by equipment manufacturer or agent.

3.2 ICT Infrastructure and Services & 3.3. Data Management System

Observations from the only staffed station at Roberts International Airport (RIA) are currently recorded by the observers in logbooks and transmitted via AFTN for aviation use. The LMS is the meteorological authority in Liberia with the mandate to collect, process, and archive all meteorological and related data observed by all meteorological and climatological stations including airports and seaports as well as exchange data and products in accordance with international agreements has the authority to host WIS2.0 for the country.

Presently, data generated at RIA are archived in paper format and are prone to damage. The adoption of new technology such as Meteowiz from the Nigerian Meteorological Agency (NiMet) for data collection and the implementation of automatic data archiving systems such as CLIDATA and ClimSoft are recommended, to aid the LMS with the transmission of its observation data.

Meteowiz System is a comprehensive and integrated meteorological and climatological system developed in Nigeria. It is designed to handle various stages of meteorological operations, providing a sophisticated platform for observation, data management, numerical weather prediction, modelling, weather information display, mobile dissemination, upper air observation, synthetic analysis, air quality monitoring, marine observation, and early warning systems.

Key Components of the Meteowiz System:

i. Meteowiz (Observation and Data Management Workstation): This component focuses on the observation and management of meteorological data, serving as a central hub for collecting and processing crucial information.
ii. DPFS (Short-Range Numerical Weather Prediction Workstation): DPFS is dedicated to short-range numerical weather prediction, offering advanced modelling capabilities for predicting near-future weather conditions.
iii. CSIS Software (Sub-seasonal to Seasonal Model Workstation): CSIS deals with sub-seasonal to seasonal modelling, contributing to longer-term weather and climate forecasting.
iv. Weather Dashboard (Stationary Weather Information Display Board): The Weather Dashboard is a visual display tool, presents stationary weather information in a user-friendly format.
v. Mobile Application (Phone Application for Weather Information): The mobile application ensures that weather and climate information is accessible to the public via smartphones, promoting widespread dissemination.
vi. Tephigram Software (Upper Air Observation Workstation): This component focuses on upper air observation, providing essential data for a comprehensive understanding of atmospheric conditions.
vii. WASA/F Web Application (Synthetic Analysis Workstation): The WASA/F web application performs synthetic analysis, offering a consolidated view of various meteorological parameters for comprehensive decision-making.

viii. Air Quality Monitoring and Forecasting System: This system monitors air quality and provides forecasts, addressing the growing concerns related to environmental health.

ix. Marine Observation and Forecasting System: Specifically designed for marine applications, this system observes and forecasts weather conditions at sea.

x. Local to Global Transmission System Compliant: This ensures seamless transmission of meteorological data from local to global scales, facilitating collaboration and information exchange.

xi. Early Warning System: Leveraging monitoring from weather stations and satellite imagery, the Early Warning System issues timely alerts via email, apps, and websites, enhancing public safety.

In summary, the Meteowiz System is a sophisticated and interconnected network of tools and applications designed to cover the entire spectrum of meteorological and climatological operations, from data collection and observation to advanced modelling, forecasting, and public dissemination of critical weather and climate information.

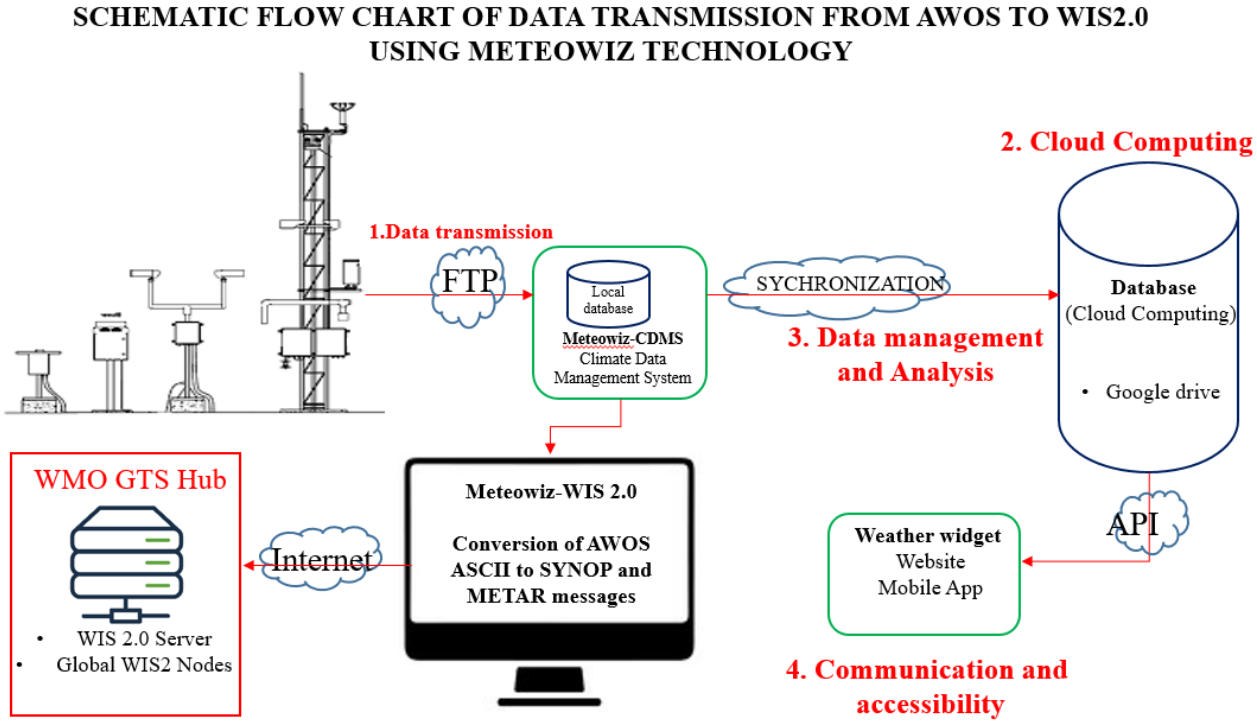

Figure 9: Flow chart of data transmission from AWOS to WIS2.0 using Meteowiz

Steps

1 AWOS Data Acquisition:

- Automatic Weather Observing Station collects meteorological data.

2 Meteowiz-WIS System:

- Data Acquisition from AWOS.
- Quality Control to ensure data accuracy.

- Data Processing for further analysis.
- Data Formatting according to WMO-specified standards.
- Data Transmission to WMO WIS 2.0 Hub.

3 Data Transmission to WMO WIS 2.0 Hub:

- Formatted data is transmitted to the WMO WIS 2.0 Hub using the WIS 2.0 node

4 WMO WIS 2.0 Hub:

- The hub validates and performs additional quality control on the received data.

5. WMO WIS 2.0 Server:

- Validated data is stored on the WMO WIS 2.0 Server.

6. Global WIS 2.0 Nodes:

- Data is disseminated to various global nodes within the WMO WIS 2.0 network.

7 Other Data Receivers:

- Meteorological organizations and other data users access the data from the WMO WIS 2.0 for their specific applications.

This flowchart reflects Meteowiz-WIS as the key system responsible for data collection, quality control, and formatting before transmitting it to the WMO WIS 2.0 hub.

To adopt Meteowiz for LMS, the following provisions must be made and included in the implementation phase of SOFF.

Data Centre: Set up secure, redundant data centres to store and process meteorological data in Monrovia, preferably at the Roberts International Airport; for collection and collation of data from the stations across the country. This would make transmitting on WIS easier.

Networking: Implement a high-speed, redundant network infrastructure to ensure data transmission reliability. All the existing and new stations need to be networked and enabled to transmit data to the central server in Monrovia.

Servers: Deploy servers for data processing and storage.

Internet: provision of internet connectivity.

Storage: Use high-capacity storage solutions for archiving historical weather data.

Capacity Building: Train LMS staff on the use and maintenance of the infrastructure.

Additionally:

- The SIM on the existing stations need to be upgraded to 4G SIM cards; for stronger connections needed for observation data transmission.
- Internet data subscription needs to be covered for a long duration, to ensure the take-off and sustainability of the stations.

The LMS at the time of SOFF assessment, has a computer system donated to them by the WMO to implement WIS2.0. However, the operationality of the system has been hampered by a lack of internet connectivity. To create a robust and flexible data management system that meets the operational needs of the Liberia Meteorological Service, facilitating real-time data exchange while ensuring data integrity and long-term archiving capabilities, the following processing should be implemented. The processes are grouped into five (5) categories.

1. **Short-term Data Storage and Access:**
    i. Real-time Data Processing: - Implement a high-performance data storage system capable of real-time processing to meet the speed requirements of operational applications.
    ii. Standardized Services and Protocols: - Support recognized protocols, Web Services, and standard data formats (e.g. XML) to facilitate seamless integration with national and international operational applications.
    iii. Implement authentication and authorization mechanisms to ensure secure access.
2. **Acquisition of Data from External Sources:**
    i. WIS/GTS Integration: - Deploy interfaces that can efficiently exchange data with the World Meteorological Organization Information System (WIS) and the Global Telecommunication System (GTS).
    ii. Ensure compliance with WIS 2.0 standards for data exchange.
    iii. Implement data transformation capabilities to convert incoming data into a standardized format.
3. **Data Delivery to National CDMS:**
    i. Long-term Archiving Standards: Establish a standard climate data archiving, such as the Climate and Forecast (CF) conventions, to ensure interoperability with the Climate Data Management System (CDMS).
    ii. Implement data versioning and archival policies for long-term data integrity.
    iii. Include data validation processes before archiving to identify and correct any anomalies or inconsistencies.
4. **Discovery and Descriptive Metadata Management:**
    i. Metadata Standards: - Adhere to international metadata standards, such as ISO 19115, to provide comprehensive and standardized descriptive information for discovered datasets.
5. **Monitoring of Data, Processing, and Services:**
    i. Implement real-time monitoring tools to track the status of data processing, storage, and services.
    ii. Set up alerts for any anomalies or performance degradation.
    iii. Logging and Auditing: - Incorporate robust logging mechanisms to record all data transactions, processing steps, and user interactions.
    iv. Conduct regular audits to ensure compliance with data management and security policies.

Additionally, a webpage should be developed to aid in disseminating meteorological and climate information and data to all stakeholders and the public. Wider dissemination of

weather and climate forecasts by the LMS will increase its visibility and it can attract public and government support for the Service.

3.4. Environmental and sustainability considerations

To ensure environmental sustainability, the implementing entity for SOFF is encouraged to adopt the following approaches in Liberia:

Local Supplier Engagement:

- **Approach:** Encourage involvement of local suppliers in the procurement processes to reduce the environmental impact of transportation.
- **Measure:** Establish partnerships with local vendors for the supply of measurement instruments.
- Evaluate the sustainability practices of instrument manufacturers and suppliers.
- Evaluate the percentage of locally sourced materials in station construction.

Material Transparency:

- **Approach:** Require vendors to disclose the materials used in instrument construction.
- **Measure:** Implement guidelines that prioritize materials with lower environmental impact.

Local Workforce Training:

- **Approach:** Train local technicians in sustainable installation, calibration, and maintenance practices.
- **Measure:** Assess the proficiency of the local workforce in adopting sustainable practices.

Renewable Energy Adoption:

- **Approach:** Explore the feasibility of powering GBON stations with renewable energy sources.
- **Measure:** Conduct feasibility studies and implement renewable energy solutions where viable.

Community Engagement:

- **Approach:** Engage local communities in GBON station operations and sustainability efforts.
- **Measure:** Track community involvement and assess the impact on environmental conservation.

Remote Monitoring Technologies:

- **Approach:** Implement remote monitoring technologies to minimize on-site visits.
- **Measure:** Monitor the frequency of on-site visits and assess the reduction in carbon emissions.

Reusable Components:

- **Approach:** Emphasize the use of reusable components in station design.

- **Measure:** Establish guidelines for reusable components and assess their effectiveness.

Sustainable Packaging Practices:

- **Approach:** Encourage suppliers to use sustainable packaging materials.
- **Measure:** Collaborate with suppliers to implement eco-friendly packaging practices.

Environmental Impact Metrics:

- Environmental and Social Impact Assessment (ESIA).
- Develop key performance indicators (KPIs) to track the environmental impact of GBON stations over time.
- Publish localized reports detailing environmental sustainability efforts, achievements, and areas for improvement.
- Solicit feedback from local stakeholders on the environmental sustainability of GBON stations, incorporating their input into continuous improvement strategies.

Module 4. GBON Human Capacity Development

4.1. Assessment of human capacity gaps

The staff and their qualifications at LMS are listed in **Table 2,** and consists of the following categories of sixteen (16) staff:

- Management Staff (1),
- Technicians (7)
- Professionals (Engineers) (1)
- Observers (3)
- Support Staff (4)

Table1: Profiling of LMS Staff

Category	Number of staff	Educational Qualification	Age groups	Gender
Administrators	1	BSc/MSc: 1	Less than 20 years: 20-29 years:0 30-39 years: 0 40-49 years: 0 Over 50 years: 1	Women: 0 Men: 1
Technicians	7	BSc/PGD: 2 BSc: 5	Less than 20 years: 20-29 years: 0 30-39 years: 4 40-49 years: 3 Over 50 years:	Women: 0 Men: 7
Engineers	1	In Training: 1	Less than 20 years: 20-29 years: 30-39 years: 1 40-49 years: Over 50 years:	Women: 0 Men: 1
Observers	3	On-the-job training: 2 BIP-MT: 1	Less than 20 years: 20-29 years: 0 30-39 years: 3 40-49 years: Over 50 years:	Women: 2 Men: 1
Support Staff	4	BA: 1 BSc: 1 High School Diploma: 1 On-the-job training: 1	Less than 20 years: 20-29 years: 1 30-39 years: 3 40-49 years: Over 50 years:	Women: 1 Men: 3

These staff are charged with carrying out both operational and administrative work. SOFF assessments observed and identified the following information and gaps regarding staff skills and education in LMS.

i. The technicians all have a BSc Degree and have the capacity and skills needed for meteorological operations.
ii. Some of the technicians and Observers are currently undergoing on-the-job training locally and internationally at AGRHMET, Niger.
iii. The number of Observers presently with LMS is not enough for the intended GBON coverage.
iv. There is only one (1) Engineer in the services of LMS at present. This is not enough to carry out maintenance work on the current stations.
v. There are gaps in the number of skilled observers and engineers.
vi. Only three (3) out of the sixteen (16) staff, representing approximately 18.8%, are female. There is a need to give more consideration to female employment in LMS during the implementation phase of SOFF.
vii. LMS relies on a third-party engineer at Robert International Airport to service and maintain its instruments. To successfully implement a new Meteowiz and transmit through WIS2.0, further ICT expertise will be required in data and communications systems including HTTP, MQTT, APIs and WIS2.0 data exchange systems.
viii. An enhanced project management capability is required within LMS to oversee SOFF implementation and maintenance of the GBON equipment.

Post SOFF Plans

Post-implementation of SOFF projects to achieve GBON compliance in Liberia, the LMS plans to ensure sustained operation of the rehabilitated and new station through:

- Providing training on instrumentation, data analysis, and station maintenance. This can be achieved by collaborating with regional centres and other international platforms for specialized training.
- The LMS is working on starting mentorship programs, workshops, and knowledge-sharing sessions for knowledge transfer and skill development among its staff.
- Implementation of a real-time monitoring system will help track station performance as well as ensure that quality controls are employed, for the accuracy and reliability of collected data.
- Develop robust partnerships with government agencies, NGOs, and other stakeholders to ensure that the stations remain operational and viable.
- The ongoing process to merge LMS and LHS when completed, is expected to give the new Agency the financial capability to maintain its network of observing stations.

4.2. Design capacity development activities for technical staff

The LMS can be supported by SOFF to recruit new observers and technical staff as it currently has limited manpower to monitor the network of stations under it and the technical skills to service and maintain equipment. The proposed upper air stations need new staff with the required skillsets. This support will be required both during the Investment and Compliance phases.

Furthermore, trainings covering the under-listed aspects are highly recommended:

- Comprehensive training programs for field technicians covering instrument maintenance and station upkeep. Include modules on troubleshooting common issues and conducting preventive maintenance and hands-on sessions for practical experience in field conditions.
- Technicians are encouraged to undergo relevant certifications in instrument maintenance and calibrations. Sponsored certification courses from recognized institutions and continuous learning opportunities through partnerships with industry experts are recommended.
- Conduct regular training sessions for staff on calibration techniques and equipment maintenance.
- Collaborate with regional bodies such as ACMAD and AGRHYMET for expert knowledge exchange and joint training programs. The Regional Training Centre in Nigeria can offer training leading to BIP-MT qualifications to all new observation personnel of LMS.
- Develop training programs for technical staff in ICT system operations including system architecture, data management, and cybersecurity.
- There is a need for the implementation of regular skill assessments for staff of LMS. Conducting periodic evaluations to identify skill gaps and providing targeted training based on assessment results is essential.
- Resources should be allocated for professional development opportunities, including workshops, conferences, and certifications.
- Provide training in the use of meteorological software, data analysis tools, and numerical models, including specialized training on satellite and radar technology for weather monitoring and analysis.
- Establish mentorship programs where experienced staff mentor new recruits, fostering knowledge transfer and skill development.

4.3. Design capacity development activities for senior management

There is a strong need for SOFF-funded capacity development training for senior management of LMS during the Investment phase and the Compliance phase of the project. This training should cover various aspects, including those listed below:

- Leadership and management workshops or courses covering topics such as strategic planning, change management, and decision-making.
- Provide one-on-one coaching and mentoring sessions with experienced leaders or external consultants to help senior managers develop their leadership skills and address specific challenges.
- Facilitate sessions on strategic planning, where senior managers can collectively define LMS's long-term vision, mission, and goals. Also provide tools and guidance for developing strategic plans, monitoring progress, and adapting to changing circumstances.
- Train senior management in effective communication strategies for engaging with internal and external stakeholders, including government agencies, international organizations, and the public.
- Offer training in financial management, budgeting, and resource allocation to help senior managers optimize resource utilization and ensure financial sustainability.

- Offer specialized training on crisis and disaster management, preparing senior managers to respond effectively to weather-related emergencies and natural disasters.

4.4. Gender and CSOs considerations

Gender

In recent years, the development of institutional and legal frameworks has led to significant changes advancing women's rights, opportunities, and equal representation in decision-making activities in Liberia.

According to the UN Women Country Gender Equality Profile for Liberia, in 2012, the government of Liberia developed a Climate Change Gender Action Plan (CCGAP) to provide a framework for enhancing gender equality in both climate adaptation — the process of adjusting to current or expected climate change shocks and effects — and mitigation — the process of tackling the causes of climate change to minimize the possible impacts of environmental hazards. The CCGAP takes into account gender for decision-making processes, capacity-building activities, and measures to guarantee that global warming and climate change vulnerabilities are addressed from a gender perspective. The successful integration of a gender perspective is only feasible once both women and men possess adequate comprehension of climate change, as well as have the capacity to share information on counteracting its negative impacts jointly. However, according to the Afrobarometer, awareness about climate change in Liberia is higher among males than females (67% for males in comparison to 41% for females).

Despite this effort, there remains a gender disparity in the composition staff at LMS. To address this, the WMO Gender Action Plan for Members provides the following supporting guidance that should be considered (*Gender-Action-Plan_2020-2023*):

- Increase the participation of women by: (i) identifying and nominating female experts from NMHSs or other national institutions to participate in the work of WMO governance bodies and their working structures and (ii) seeking equality in the composition of delegations to sessions (1.1.1(c) in WMO Gender Action Plan).
- Strive for gender balance, including in management and working structures (1.1.2(c) in WMO Gender Action Plan).
- Encourage and support female networks of experts (1.1.3(c) in WMO Gender Action Plan).
- Designate NMHS gender equality focal points (1.3.4(c) in WMO Gender Action Plan).
- Develop monitoring mechanisms at the national level by (i) adapting the WMO gender monitoring indicators or (ii) using an existing national framework (2.4.1 in WMO Gender Action Plan).
- Include gender equality (including the WMO Policy, GAP, link to online training and gender webpage, and information on key activities) in the induction of new PRs and NMHS staff (3.1.4(c) in WMO Gender Action Plan)
- Develop the capacity of NMHS staff on unconscious bias, inclusive leadership, gender mainstreaming, and gender-responsive service delivery through training and workshops (3.1.5(c) in WMO Gender Action Plan)

- Offer internships to young professionals, especially females, and secondments of staff from meteorological services on a rotational basis. (3.4.2(c) in WMO Gender Action Plan)
- Engage with international organizations field offices, such as UN Women, UNDP, etc. (5.1.4 (c) in WMO Gender Action Plan)
- Conduct research and provide the Secretariat with case studies, stories and examples of gender mainstreaming, including in-service provision, for the development of a compendium of good practices (5.3.3(c) in WMO Gender Action Plan).
- Develop and disseminate communication materials (i) highlighting the role of women in meteorology, hydrology and climatology, (ii) promoting female role models, and (iii) advocating for gender-responsive weather, hydrological and climate services (5.1.3(c) in WMO Gender Action Plan).

Recommendations:

In addition to the above, the Gender Action Plan of SOFF, recommends that all the GBON National Contribution Plans must include gender considerations at 50% of women's participation in both capacity-building activities and consultations with civil society organizations. However, that is not the case in Liberia presently. To address this, the following recommendations should be considered in the implementation phase of the project.

i. *LMS staff to be involved in implementing SOFF-funded projects should be made up of 50% women.
ii. Annual gender sensitisation workshop for LMS and partner CSO should be considered as part of their Standard Operating Procedure (SOP)
iii. *50% of training opportunities with respect to SOFF, due to LMS should be allocated to the women in its services.

* Where practicable/as much as possible. Current employment information in the LMS would not support this recommendation.

CSOs

The visit by the SOFF team revealed that there is no formal coordination arrangement for both inter- and intra-institutional partnerships. However, there are some levels of informal relationships based on goodwill. Organisations such as the Press Union of Liberia (PUL), Federation of Liberian Youth (FLY) and Liberia Red Cross Society (LRCS) have worked closely with LMS and are considered key stakeholders. Further partnership in the following should be explored:

i. Providing on-the-spot minor (such as grass clearing, cleaning, etc) maintenance at stations within their locality.
ii. Dissemination of weather and climate information from LMS to the rural communities.
iii. Help in securing installation sites.

This would require the LMS to facilitate consultations to find and develop a national mechanism for effective partnership and collaboration on weather, climate, and water information. Gaps in this aspect can be addressed through the following actions:

- Organize inclusive workshops and forums involving CSOs, government agencies, and relevant stakeholders for open discussions, idea-sharing, and collaboration.
- Establish a regular schedule of consultative meetings with all stakeholders.
- Conduct workshops to keep stakeholders and CSOs updated with advances in the weather and climate information value chain.

Module 5. Risk Management Framework

5.1 Assess the risks of the observing network and propose mitigation measures.

Identified Risk	Mitigation Measures	Responsibility	Monitoring and Evaluation
Physical damage or deterioration of observing infrastructure due to extreme weather events, natural disasters, or vandalism.	▪ Implement resilient infrastructure designs. ▪ Install disaster-resistant weather infrastructure and enhance security measures; where it is possible, weather stations can be relocated to a more secure nearby environment.	Ministry of Transport (MoT), LMS, AfDB, EPA, NDMA, LHS	Quarterly
Insufficient funding leading to operational challenges, equipment maintenance delays, or inadequate training.	▪ Advocate for increased budget allocations and secure alternative funding sources (e.g., grants, international partnerships). ▪ Develop contingency plans for budget shortfalls.	Ministry of Transport (MoT), LMS, and AfDB	Bi-annual
Rapid technological advancements making current equipment obsolete.	▪ Regularly update technology through strategic planning. ▪ Establish partnerships with tech providers for continuous upgrades.	Ministry of Transport (MoT), LMS, AfDB	Annually
Inadequate staff capacity and skills leading to suboptimal operations as well as shortage of trained meteorological staff is	▪ Invest in continuous training programs. ▪ Establish partnerships with educational institutions.	Ministry of Transport (MoT), LMS	Annually

a challenge towards data collection and analysis in Liberia.	▪ Investment in capacity development programs for staff training and retention as well as the cross-training of staff to handle multiple roles are essential.		
Interruptions in communication networks leading to data transmission delays or failures.	▪ Regularly maintain and test communication equipment as well as collaboration with telecommunications providers to ensure network reliability.	Ministry of Transport (MoT), LMS	Daily
Calibration errors leading to inaccurate or inconsistent data.	▪ Implement a robust maintenance and calibration schedule. Also, train technical staff to troubleshoot and address common equipment issues.	Ministry of Transport (MoT), LMS	Bi-annually

Module 6. Transition to SOFF investment phase

For the transition to SOFF investment phase it is recommended that the implementing entity carefully consider the detailed report in the Gap Analysis for Liberia and the recommendations made in this GBON National Contribution plan. Both documents were validated by the Peer Advisor and the beneficiary country-Liberia

It is highly recommended that the Implementing entity closely monitor the proposed merger between the LMS and LHS to leverage on opportunities it will provide. The beneficiary country through the LMS is encouraged to provide support to the IE as and when necessary.

Further Recommendations

In its global GBON gap analysis, the WMO applied the GBON land surface and upper air station targets for Liberia, and this resulted in targets of 3 surface stations and 1 upper air station. However, the LMS has ten (10) other synoptic and agromet stations that can potentially become part of its contribution when provided with the needed facelift and maintenance.

To this end, the LMS is also proposing the inclusion of these stations covering parts of the country where observation stations have not been sited, to its network of GBON standard stations. This is with the knowledge that the SOFF project itself will only cover three (3) stations required for standard GBON coverage in Liberia.

To get these stations to meet GBON requirements and transmitting is mostly a matter of providing internet connectivity. Only the vandalized station at Spriggs Airstrip would require a complete replacement, whereas the station at Harper Airstrip may need to be relocated from its present location as the fencing wire is rapidly corroding because of salt-infused sea breeze.

Potential Easy fixes for non-SOFF Invesment: Provision of internet connectivity and upgrade of data logger at the following stations:

- Fish Town, River Gee County (Agromet Station)
- CARI, Bong County (Agromet Station)
- Buchanan, Grand Bassa County (Agromet Station)
- Tapeta Airstrip, Nimba County (Synoptic Station)
- Sarclepea Magisterial Court, Nimba County (Agromet Station)
- Forestry Training Institute, Bomi County (Agromet Station)
- Voinjama, Lofa County (Agromet Station)
- Grand Cess, Grand Kru County (Synoptic Station)

Replacement and relocation

- Harper Airstrip, Maryland County (Synoptic Station)
- James Spriggs Payne Airfield, Montserrado County (Synoptic Station)

Summary of GBON National Contribution Plan

Components	Recommended activities
Module 2. GBON business model and institutional development	1. There is a need for the LMS to work towards having a Memorandum of Understanding (MoU) with relevant government agencies to formalize their relationship and have legal backing for their future collaborations.
	2. The existing working relationship with the Liberia Airports Authority should be further explored to include allowing the LMS to transmit observation data generated by them through GTS or WIS 2.0.
	3. The SOFF project should explore the potential for rehabilitation and expansion of the observing network of LMS through the provision of physical and technical support.
	4. LMS should continue to leverage its membership in these regional bodies for the training of its staff and technological transfer especially in the area of data transmission. The LMS should include the reinforcement of regional collaboration as part of its strategic plan.
	5. A Build-Own-Operate-Transfer (BOOT) type of PPP can also be introduced for Liberia and the LMS, where the government through the Ministry of Transport would grant tax waivers to participating companies and entities in the country.
	6. Establishment and enhancement of coordination mechanisms among different stakeholders, government agencies, and development partners involved in meteorological and hydrometeorological projects. Regular meetings and information sharing to avoid duplication of efforts are encouraged
	7. Enhance public awareness of the importance of observing networks and meteorological data and engage with communities to create a sense of ownership and responsibility for the sustained operation of observing stations.
	8. Conduct regular assessments to measure the progress of ongoing projects against their stated objectives and adjust strategies and activities based on the outcomes of these assessments.
	9. Establishment and enhancement of coordination mechanisms among different stakeholders, government agencies, and development partners involved in meteorological and hydrometeorological projects. Regular meetings and information sharing to avoid duplication of efforts are encouraged

Module 3. GBON infrastructure development	1. The upgrade through the provision of internet connectivity for the eleven (11) synoptic and agromet stations for them to become GBON-compliant
	2. Funding to cover logistics for servicing and maintenance of the existing station
	3. Supply of spare parts and consumables for the stations.
	4. Establishment of one upper air station in Liberia that will be co-located with the staffed surface station at Roberts International Airport.
	5. Engage the Nigerian Meteorological Agency (NiMet) to work out the modalities for the deployment of the Agency's Meteowiz for operational use within the LMS.
	6. A webpage should be developed to aid in disseminating meteorological and climate information and data to all stakeholders and the public. Widely disseminating weather and climate forecasts by the LMS will increase its visibility and is capable of attracting public and government support for the Service.
	7. Implement real-time monitoring tools to track the status of data processing, storage, and services.
	8. Establish a standard climate data archiving, such as the Climate and Forecast (CF) conventions, to ensure interoperability with the Climate Data Management System (CDMS).
	9. Deploy interfaces that can efficiently exchange data with the World Meteorological Organization Information System (WIS) and the Global Telecommunication System (GTS) and ensure compliance with WIS 2.0 standards for data exchange.
	10. Encourage procurement from local suppliers to reduce the environmental impact of transportation.
	11. Develop key performance indicators (KPIs) to track the environmental impact of GBON stations over time.
	12. Publish localized reports detailing environmental sustainability efforts, achievements, and areas for improvement.
	13. Solicit feedback from local stakeholders on the environmental sustainability of GBON stations, incorporating their input into continuous improvement strategies.
	14. Train local technicians in sustainable installation, calibration, and maintenance practices.
	15. Set up secure, redundant data centres to store and process meteorological data in Monrovia, preferably at the Roberts International Airport; for collection and collation of data from the stations across the country. This would make transmitting on WIS easier.

Module 4. GBON human capacity development	1. Only three (3) out of the sixteen (16) staff, representing approximately 18.8%, are female. There is a need to give more consideration to female employment in LMS during the implementation phase of SOFF.
	2. LMS relies on a third-party engineer at Robert International Airport to service and maintain its instruments. To successfully implement a new Meteowiz and transmit through WIS2.0, further ICT expertise will be required in data and communications systems including HTTP, MQTT, APIs and WIS2.0 data exchange systems.
	3. An enhanced project management capability is required within LMS to oversee SOFF implementation and maintenance of the GBON equipment.
	4. The LMS can be supported by SOFF to recruit new observers and technical staff as it currently lacks the manpower to monitor the network of stations under it and the technical skills to service and maintain equipment.
	5. Comprehensive training programs for field technicians covering instrument maintenance and station upkeep. Include modules on troubleshooting common issues and conducting preventive maintenance and hands-on sessions for practical experience in field conditions.
	6. Collaborate with regional bodies such as ACMAD for expert knowledge exchange and joint training programs. The Regional Training Centre in Nigeria can offer training leading to BIP-MT qualifications to all new observation personnel of LMS.
	7. The support of SOFF in recruiting specialized staff for ICT system operations in LMS is needed.
	8. There is a need for the implementation of regular skill assessments for staff of LMS. Conducting periodic evaluations to identify skill gaps and providing targeted training based on assessment results is essential.
	9. Resources should be allocated for professional development opportunities, including workshops, conferences, and certifications.
	10. Provide one-on-one coaching and mentoring sessions with experienced leaders or external consultants to help senior managers develop their leadership skills and address specific challenges.
	11. Facilitate sessions on strategic planning, where senior managers can collectively define LMS's long-term vision, mission, and goals. Also provide tools and guidance for developing strategic plans, monitoring progress, and adapting to changing circumstances
	12. Offer specialized training on crisis and disaster management, preparing senior managers to respond

	effectively to weather-related emergencies and natural disasters.
	13. Implement gender-responsive recruitment policies within the Liberia Meteorological Service (LMS).
	14. Conduct workshops to keep stakeholders and CSOs updated with advances in weather and climate information value chain.
Module 5. Risk Management	1. Implement resilient infrastructure designs.
	2. Install disaster-resistant weather infrastructure and enhance security measures; where it is possible, weather stations can be relocated to a more secure nearby environment
	3. Advocate for increased budget allocations and secure alternative funding sources (e.g., grants, international partnerships).
	4. Establish partnerships with tech providers for continuous upgrades.
	5. Investment in capacity development programs for staff training and retention as well as the cross-training of staff to handle multiple roles are essential.
	6. Regularly maintain and test communication equipment as well as collaboration with telecommunications providers to ensure network reliability.
Module 6. Transition to SOFF investment phase	For the transition to SOFF investment phase it is recommended that the implementing entity follow the Gap Analysis report and the recommendations made in this GBON National Contribution plan.

Report completion signatures

Peer Advisor signature 
Beneficiary Country signature 
WMO Technical Authority signature