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GBON National Contribution Plan of Barbados

Systematic Observations Financing Facility

Weather and climate data for resilience

GBON National Contribution Plan
Barbados

SOFF Beneficiary country focal point and institution	Sabu Best, BMS
SOFF Peer advisor focal point and institution	Anni Karttunen, FMI

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Abbreviations

BMS	Barbados Meteorological Service
CHUAS	Cooperative Hurricane Upper Air Station
CMO	Caribbean Meteorological Organization
CIMH	Caribbean Institute of Meteorology and Hydrology
FMI	Finnish Meteorological Institute
GBON	Global Basic Observation Network
IDB	Inter-American Development Bank
IE	Implementing Entity
NWS	National Weather Service
QA/QC	Quality Assurance/ Quality Control
QMS	Quality Management System
SOP	Standard Operating Procedures
WMO	World Meteorological Organization

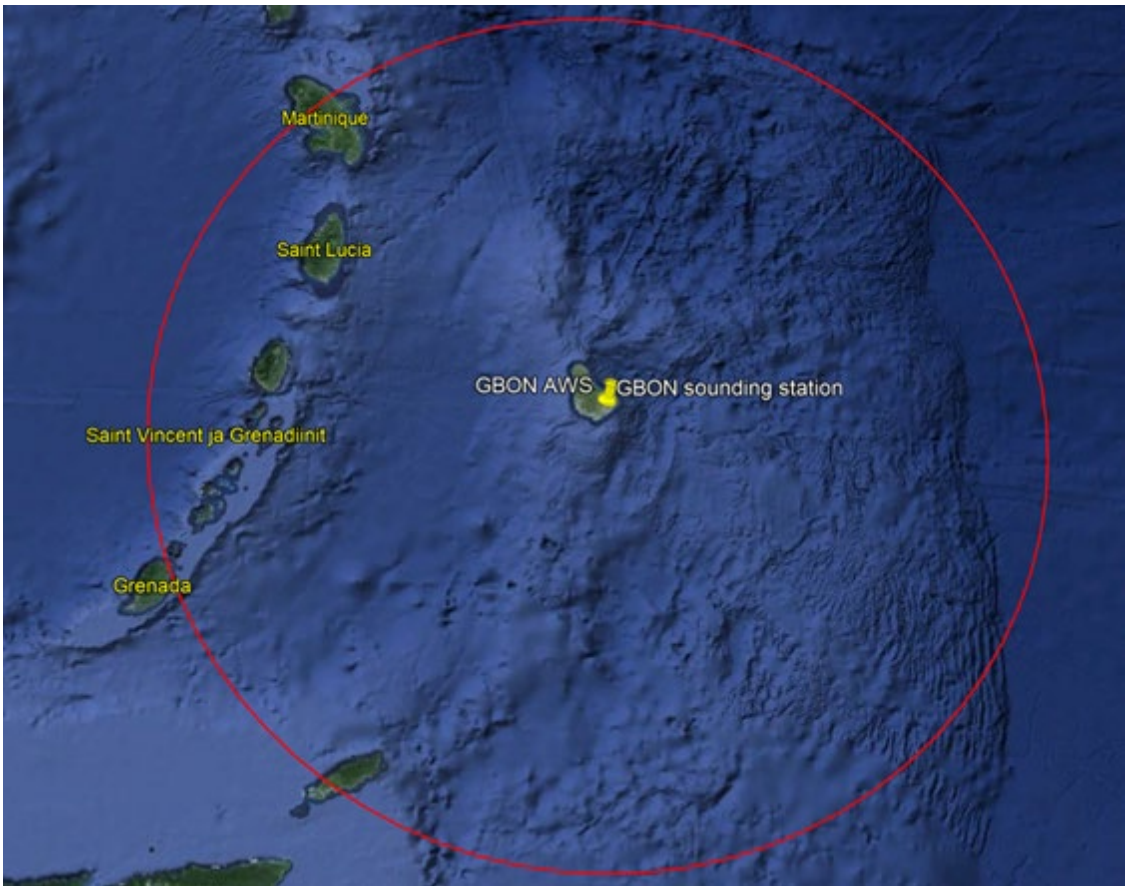
Module 1. National Target toward GBON compliance

Based on the Gap Analysis results Barbados is fully compliant with GBON requirements.

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	1	1	0	0	0	0
Upper-air	1	1	0	0	0	0
Marine	***when applicable**					

Table1. GBON National Contribution Target

Picture 1. Map of existing surface and upper-air station. Circle diameter is 500km.



[1] For SIDS, for the WMO GBON Global Gap Analysis in June 2023, the EEZ area has been added to the total surface area which is the basis for the target number of stations. The standard density requirements for SIDS have been calculated with 500 km for surface stations and 1000 km for upper-air stations.

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 Barbados Meteorological Service (BMS) is responsible for the meteorological observation networks in Barbados. They collaborate with a multitude of national stakeholders and neighboring countries in sharing observations. Besides forecasts and services, many of the other governmental organizations, for example the Barbados Water Authority, Ministry of Agriculture, and the Department of Environmental Protection, utilize the observation data as key input to their own systems and models. These organizations also have an interest in the sustainable operation of the networks and the expansion to new parameters and areas, especially in the marine areas. **BMS is recommended to strengthen and formalize identified key partnerships with other governmental organizations.**

The BMS is collaborating with some private companies in the energy sector by locating the BMS observation stations on the company's premises. In exchange for land use private companies receive observation data directly from their area of interest.

Currently there are no privately owned weather observation networks in Barbados that the BMS knows of. Draft meteorological legislation includes regulation for meteorological service provision, including meteorological data, where any private provider will need to apply for permission from the Department for such activities.

The BMS is currently expanding the national observation networks to cover more marine areas. New additions to the national observation capabilities have been investing in autonomous surface vessels to collect essential sea level temperature and pressure information in advance of hurricane formation. Marine observations are essential in the area to improve hurricane forecasting and services for tourism and fishing. **Developing potential partnerships with the marine sector and stakeholders for mutual benefits of improved marine observation density is recommended. Expansion to buoy stations would require further investments and is recommended to be considered when SOFF support extends to include marine areas.**

The BMS is working with the private sector by utilizing external programmers to assist in the development of central data management, forecasting and service creation system. The system is designed by the BMS, and all work is led and supervised by the BMS, but the contracted workers are key in developing the systems at the pace necessary. Also, the BMS has experience of outsourcing some of the other ICT capabilities e.g. server space.

2.2. Assessment of potential GBON sub-regional collaboration

The BMS participates actively in collaboration with neighboring countries and in the wider Caribbean collaborations. Relevant regional organizations to GBON implementation are the Caribbean Meteorological Organization (CMO) and the Caribbean Institute for Meteorology and Hydrology (CIMH), also located in Barbados. The CMO is a specialized agency of the Caribbean Community that coordinates the joint scientific and technical activities in weather, climate and water related sciences in sixteen English-speaking Caribbean countries. The CMO has assisted its members in, for example, drafting of meteorological legislation and most recently in the regional implementation of WIS2.0 support. As agreed in the CMO Resolution 1 -CMC51[2] Barbados is responsible for forecasts and warnings to the islands and coastal waters or not only Barbados, but also Dominica, St. Vincent and the Grenadines.

The CIMH is a training and research organization that assists in improving and developing meteorological and hydrological services and awareness of the benefits of such services for the economic well-being of its member states. The CIMH provides training courses, hosts the regional calibration laboratory, runs a regional numerical model, and hosts the Caribbean Climate Outlook forum (CariCOF). CariCOF collects national weather observations from the member countries and runs the regional climate model, providing climate outlooks to the region.

The CIMH also has some surface weather stations in Barbados, but these are mainly used for training activities and the institutions own purposes and are not included in the national weather network. Neither is maintenance assistance utilized from the CIMH as the BMS has a very skillful in-house technical maintenance team.

Regional coordination and collaboration are recommended when providing GBON related training and when developing marine networks, selecting technologies and benchmarking other institutes.

When writing the document, the regional calibration laboratory at the CIMH has a very limited capacity to serve the region. Currently the services are limited to pressure sensor calibration. For the BMS to rely on the CIMH calibration laboratory, it must be operational and capable of providing high-quality, traceable services for at least temperature, humidity, pressure, and precipitation measurements. **The preferred solution to benefit the entire regions is to strengthen the regional calibration laboratory to the required level (reliable and fast service, support all GBON parameters, support all selected GBON vendors).** The BMS is already paying for such services through the annual membership fee. **Unless CIMH's capacity significantly improves, the BMS is recommended to look into other options for reliable annual sensor calibration and in this case the cost of potential service contract and related costs needs to be included in the annual budget.**

[2] http://cmo.org.tt/resolutions.html

The upper-air station in the Barbados is part of the Cooperative Hurricane Upper Air Station (CHUAS) network and therefore supported by US National Weather Service (NWS) and the National Oceanic and Atmospheric Administration (NOAA). Through the CHUAS NWS provides support that includes consumables, spares, and repairs for the systems. This support translates into direct support to the implementation of the GBON network at regional scale. **It is recommended that the existing MoU between the BMS and US NWS as part of the CHUAS initiative is updated to ensure that long-term support is provided sufficiently to maintain the upper-air station as required by GBON standards.** Long-term plans include migration from the manual sounding operation to an automatic solution which would support the effective use of staff time and capacity for more value-added work.

Regional collaboration that directly support the GBON initiative are improving the regional calibration laboratory capabilities, enhancing observation and limited area model data sharing through the CIMH, coordinating regional training activities, continuing the support on national legislative development and facilitating coordination in the region.

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

Currently the BMS is fully funded by the government. According to the BMS the budget has been sufficient for the current operations, and it has been modestly increasing when the maintenance and operation costs of the network have increased. The total annual budget for 2023 was approximately 5 000 000 USD. The staff costs took up some 20% of the budget, operational costs 21%, investments 33% and other costs 26%.

As there is currently no legal mandate for the BMS, no cost-recovery services can be implemented. As a part of the draft meteorological legislation the BMS has outlined which services will be Public Good Meteorological Services that are provided free of cost and which services can be provided on a cost-recovery basis. **Having the possibility of cost-recovery services will give the BMS more financial flexibility and it is recommended to be included in the Bill.**

The existing collaboration and support in the upper-air observations from the CHUAS network will continue to directly support GBON. **It is recommended to renew the existing Memorandum of Understanding with US NWS to ensure that long-term support is provided sufficiently to maintain the station as required by GBON standards.**

The BMS is recommended to continue operating with the current business model.

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

The BMS has been successfully deploying a project with the assistance of the University Corporation for Atmospheric Research (UCAR) to manufacture and deploy a network of 3D-

printed Automatic Weather Stations. The vision of the project has been to launch a dense network of low-cost stations that The BMS is independently printing and deploying to cost-efficiently fill gaps in the network. Currently the network consists of more than 80 3D printed stations. As the observation accuracy and site representativeness are not up to WMO synoptic standards for the 3D-stations they cannot contribute to the GBON efforts, but they provide valuable additional information locally. Recently BMS has expanded to printing components for new coastal weather stations.

The BMS has been investing in new marine observation systems and has successfully deployed unmanned service vehicles AutoNauts to monitor marine parameters such as swell heights and direction and temperature. **As a frontrunner in testing and developing new observation systems in the region, it is recommended for the BMS to share the experiences with the marine observation systems with the peer organizations.** The BMS marine network plans include investing in a denser coastal station network and fixed marine stations.

The BMS Strategic plan was published in 2022 and is valid and up-to-date until 2026. The current strategy focuses on the following objectives:

- Providing products and services that ensures the safety of life and property against all meteorological and hydrometeorological hazards.
- Help to reduce the social and economic impacts related to natural disasters across all timescales.
- To help support essential services in providing better community health, recreation and quality of life.
- Provision for the need of future generations as it relates to the operational structure of the department to support ongoing weather-related activities and climate change planning and mitigation for the public good.
- The development of a legal framework to support the operations of the National Meteorological and Hydrological Service.

Each of the objectives have a specific strategy and related KPSI's.

Direct actions related to the national observation network and data collection that are mentioned in the strategy are assessing the spatial and temporal monitoring and data collection and following the operational uptime and data quality. There are no planned development projects or initiatives directly related to GBON and the activities proposed within the SOFF project are well inline to support the general strategy.

2.5. Review of the national legislation of relevance for GBON

Currently there is no relevant legislation on the field of meteorology in Barbados. A "Draft Model Meteorological, Hydro-meteorological and Climate Service Bill for Barbados" has been drafted with the support of the CMO by agreement with the WMO. The bill is yet to pass. Although there is no formal legislation, the BMS is the recognized national meteorological

authority for weather and climate forecasts and warnings and responsible for the national observation network.

The BMS operates as a self-contained department within the Ministry of Home Affairs, Information and Public Affairs. And the objective of the organization is to meet the needs of all Barbadians for the meteorological information, understanding and services that are essential for their safety, security and general wellbeing, as well as to ensure that meteorological data and knowledge are effectively applied to Barbados' national and international goals".

The BMS has identified the development of the legal framework as a key strategy goal with the following actions and selected Key Performance Indicator:

Actions:

- Work with national and regional offices to co-develop a meteorological bill and policy.
- Identification of key components to the bill and policy which ensures that the NMHSs is in a position of authority as it pertains to the products and services offered nationally.
- Ensuring that NMHSs are a part of any committee/member group as it relates to planning and decision processes related to meteorological and hydrometeorological projects and services.
- A bill and policy review process to ensure that the legal and policy aspects are still relevant.

KPSs:

- Adoption and cabinet approval of the national meteorological bill and policy.
- A quantitative measure of unauthorized statements/publications of the meteorological information.
- Review of performance evaluation/assessment of the expertise added by the BMS in any planning and decision policy processes.

The BMS can apply for exemption of customs and duties with a formal letter. Such exemptions are usually granted. The BMS needs to cover any shipment costs, and the handling fee included in the receiving of the shipments.

Module 3. GBON Infrastructure Development

3.1. Design the surface and upper-air observing network and observational practices

The aim of SOFF investment phase project is to maximize the impact of observations on global numerical weather prediction (NWP) skill through:

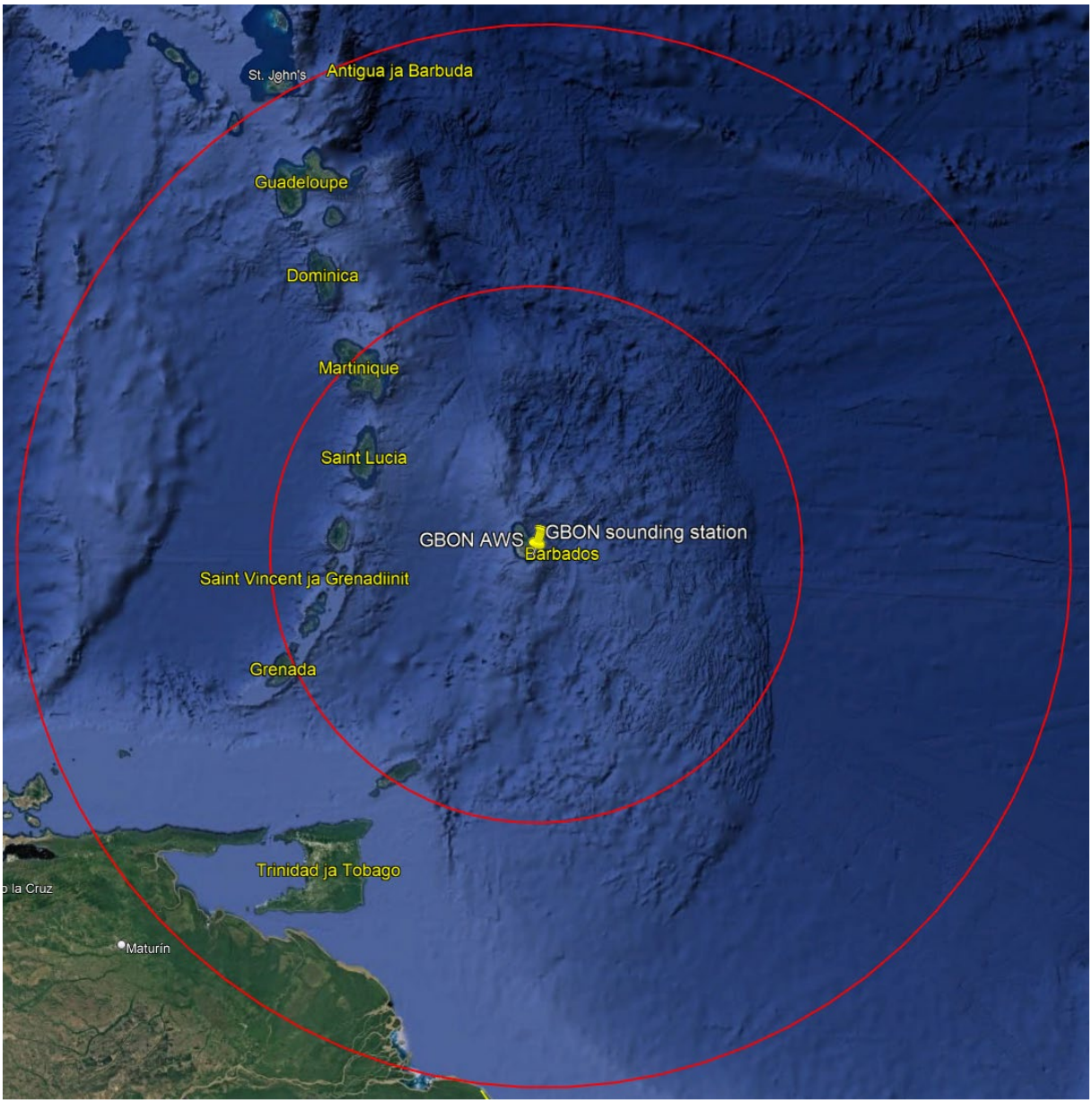
- Installing or rehabilitating upper-air sounding stations.
- Installing surface weather stations in significantly under-observed regions (far from currently reporting stations).
- A sub-regional optimization of the network design.

According to the WMO set GBON criteria one surface weather station and one sounding station is adequate for Barbados. **The BMS has registered a surface weather station and one upper-air station to WDQMS database that are fully compliant with GBON requirements and reporting data at the GBON required intervals.**

The existing GBON surface weather station is equipped with the required GBON specified sensors. The site is in the BMS premises next to the headquarters and is fenced off. The site has a supply of constant power and communication and is regarded as very secure.

The existing GBON upper-air station is fenced of and has a building for the equipment (stock of balloons and radiosondes, hydrogen generator, balloon filling equipment, receiving equipment) and the balloon filling. The site has a supply of constant power and communication and is regarded as very secure. The equipment is supplied by the NWS as part of the CHUAS cooperation and the BMS is in charge of providing the premises and the staff for the manual operation.

Picture 2. The GBON surface weather station with 250km radius circle (inner) to indicate the required GBON horizontal resolution for SIDS and the GBON upper-air sounding station with 500km radius circle (outer) to indicate the required GBON horizontal resolution for SIDS.



Based on discussions with the BMS it is recommended to invest in the following:

- Wind sensor using ultrasonic technology.
    - The BMS is currently utilizing cup anemometers for wind measurements. It is recommended to co-located the technologies for a comparison. Cup-anemometer calibration is not available easily in the region and it is recommended to consider ultrasonic technologies to replace these.
    - It is recommended to invest in three ultrasonic wind sensors to guarantee enough spare sensors for continuous observations.

The BMS is successfully operating the upper-air sounding system with the GBON required twice a day interval, or even more frequent during the hurricane season. Launches are performed manually with hydrogen filled balloons using GRAW GP20 radiosonde. The support provided through CHUAS includes consumables, spares, calibration of the pressure sensor and repairs

for the systems. The BMS's preference is to transition into an automatic sounding system in order to direct human resources into more value-added services, finish the full automatization of its observation network and to be better equipped to support more frequent sounding operations. **It is recommended to consider the automatization of the upper-air sounding system when the current system reaches the end of the technical lifespan**. This is also supported by the World Bank report Charting a Course for Sustainable Hydrological and Meteorological Observation Networks in Developing Countries.

The BMS has SOPs and maintenance plans in place for its systems. It is recommended to revise the plans especially regarding the calibration of the surface weather station sensors. Annual calibration of temperature, humidity, pressure, and precipitation sensor are recommended. The selection of the preferred calibration laboratory will be sought during the investment phase (the BMS does not have a calibration laboratory, and the regional calibration laboratory operated by the CIMH is currently not capable of serving the BMS's needs or the GBON standards).

The BMS is operating QMS for the aviation weather services but it does currently not include upper-air stations and surface weather stations that are not aviation specific. The BMS plans to expand the QMS coverage from not only aviation weather services but to cover the full range of its services portfolio in the future.

3.2. Design of the ICT infrastructure and services

The BMS is operating a modern ICT solution built for their own needs. The ICT infrastructure currently supports automatic data reception and delivery to international and internal distribution. WIS2.0 protocol has been implemented utilizing the wis2box that is seamlessly integrated into the BMS data management system. All-in-all the BMS has focused a lot of effort to create a centralized ICT solution that combines the data management and the forecasting and service creation software and tools including, and the automatic production and dissemination of products to the different channels into software solution "Apparatus". The solution has been developed by the BMS and they aim to integrate all additional software and protocols into the existing systems to enhance the level of automatization and efficiency through it and to minimize the operation and maintenance of systems.

The solution is capable of monitoring and ingesting data from all the different observation systems: marine, surface weather, sounding, radar etc. and has inbuilt tools to run checks on the systems. In addition, it has the capability to monitor BMS web server and dissemination links.

3.3. Design the data management system

The DMS system used in the BMS has both short-term and long-term data storage including the Climate data management system. It supports the WIS2.0 protocol data sharing. The DMS

is ingesting data from all different data sources including weather radar data, and the system is capable of decoding the different message types bufr/netcdf etc.

Currently all data is stored in the central database raw format without any initial quality control. Quality control will be performed when pulling the data for use. Metadata is currently stored separately in an excel based format. The storage is not considered a registry but includes the inventory on sensors. The current metadata handling is fulfilling the needs of the OSCAR system.

Main improvement needs for the BMS ICT environment to support the GBON data quality and sharing are:

- improving the quality control and quality assurance methods and algorithms to support data sharing internationally and to stakeholders directly utilizing APIs and WIS2.0 protocol.

New QC/QA methods should be built on top of the existing DMS solution to support the BMS's approach in having one centralized system to operate and maintain. Also, key stakeholders such as the Environmental Protection Department have an interest in receiving access to the quality-controlled data as an input to their own systems, thus improving the overall use of the national observation data.

3.4. Environmental and sustainability considerations

The key success factor of sustainable investment, and day-to-day operation of GBON stations relies on highly competent and motivated management and staff in the organization. Generally, environmental and sustainability considerations should be included in any procurement process as part of the specifications. Sustainability of the systems is improved by budgeting and scheduling preventive maintenance and calibration and including these in the SOPs thus lengthening the lifecycle of sensors.

Frequency of preventive maintenance can be modified based on the scientific experience and statistics gained through calibration. Additionally, holistic network management and planning including the selection of technologies, models and suppliers will support sustainability as a smaller spare part stock is needed, sensor calibration circulation can be optimized, and all maintenance procedures and tools are well known. Using maintenance service providers from close by the site will not only improve the response time, but also decrease the need for travel to the site.

Scheduled preventive maintenance and calibration routines require, as a rule of thumb, about 1.3 times more sensors than there are stations. In cases when there is only a few of the sensor or station type it is recommended to have a higher number of spares e.g. one ultrasonic wind measurement and two sensors for spares, to guarantee that the operations can run even if unexpected damages from e.g. hurricanes might occur.

The BMS has been successfully operating a maintenance unit and has managed to operate systems with long lifetimes. The only identified direct gap in the current operations is the lack of systematic calibration of sensors due to the shortcomings of the WMO regional calibration center services.

When investing in new systems e.g. automatic upper-air sounding system, it is recommended to consider the use of biodegradable materials for the sondes, balloons and string. Also generating hydrogen locally instead of importing gas increases the sustainability and independency of the station.

Module 4. GBON Human Capacity Development Modul

4.1. Assessment of human capacity gaps

The total number of staff is currently 43, consisting of 39 permanent members of staff and 4 contract workers.

Table 1 Number of staff and established positions in the BMS

Position	Number of staff
Management	3
Meteorologist	11
Meteorological Technicians	18
Assisting staff	7

The meteorological staff consisting of management, meteorologists and meteorological technicians have been trained in the WMO classified CIMH training programs or studying in the University of West Indies and CIMH joint meteorological programs. The BMS staff have also attended other training courses and programs by the CIMH and the CMO in specific topics e.g. system maintenance trainings. In addition to this, the BMS has been working with other training institutes on an ad-hoc basis and the staff has attended operation and maintenance training courses by system manufacturers when procuring new technologies and systems.

The male to female ratio in the BMS is currently 28:15 and females are well represented throughout the organization tiers. The BMS has no gender policy or strategy in place. Salary levels for all positions are set by the Government and no dependency on gender has been observed in them.

4.2. Design capacity development activities for technical staff

The recommendations on training activities within SOFF framework to support work towards gaining minimum competence relative to WMO guiding no. 1083[3]. The following training needs were identified in the Gap Analysis:

- **Data quality control and assurance:** Training in programming skills and scientific understanding that support the applying of QA/QC methods and algorithms. Recommended to benchmark other organizations QA/QC methods. A roadmap for implementing relevant automatic QA/QC methods must be developed.
- **Network and data management:** training in tools for automatic network and metadata management (instead of manual). Benchmarking of mature organizations.
- **Instrument and station operation and maintenance at site:** Training for the technical staff in upper-air system operation and lifecycle maintenance. The training is

[3] WMO-No. 1083

recommended to be provided by the US NWS who support the station as part of the CHUAS network.

- **Calibration and maintenance at the workshop:** Training on the concept of quality through calibration and capacity building in scientific understanding and handling of calibration results. It is critically important that scientists are capable of analyzing calibration results to support lifecycle and maintenance plannings. Other mature organizations are recommended to be benchmarked for their calibration practices.
- **Marine observations:** The BMS is working to expand its capabilities in the marine service sector. It is recommended to develop a strategy on the expansion of observation networks on marine areas, including reflection on the regional benefits and sharing of the observations. Other organizations are recommended to be benchmarked.
- **Quality Management System (QMS):** Effective and continuously developing QMS is the basis for the systematic operation and maintenance of observation networks. The BMS is recommended to develop the GBON related sub-processes in QMS, including the lifecycle planning. The BMS has experience of implementing QMS on aviation services but doesn't have a sub-component for the surface weather stations excluding specific aviation stations or the upper-air sounding station. To support this development, it is recommended to benchmark the sub-processes in organizations with mature QMS processes.

It is recommended to develop a detailed capacity building plan with components to monitor and evaluate the training. It is also recommended to utilize regional collaboration and coordination for shared GBON specific training programs e.g. in the field of instrument operation, maintenance and calibration training.

4.3. Design capacity development activities for senior management

Key training topics for senior management level include:

- **Finance**: to equip the BMS staff with financial and compliance management best practices, and advanced financial management and planning techniques. Benchmarking processes in other organizations.
- **Strategy**: tools and practices for strategy development and follow-up and aligning project portfolio and financial planning with strategy. Practices for staff resource strategy and management. Benchmarking processes in other organizations.
- **Project and resource management**: benchmarking of organizations with mature project and portfolio management and coordination culture. Training in efficient planning, executing, and overseeing projects for successful completion, covering international development collaboration projects and new business development.
- **Performance Management:** best practices for evaluating outcomes and utilizing data-driven insights for continuous improvement.

4.4. Gender and CSOs considerations

Climate change and extreme weather events are not gender neutral, but they affect women, girls, men, and boys differently[4]. This is due to socioeconomic circumstances, cultural beliefs or traditions that can all contribute to inequality, resulting in women being put in situations of disadvantage when disasters strike. Therefore, it is important that in the pre-disaster context, those who likely will be the most affected by crisis, are also included in the preparedness process[5]. This includes having equal access on political, social, and economic levels as well as being able to participate in decision making. Not only is it fair, that population is equally engaged in climate change adaptation and resilience building, but there is also substantial evidence that shows that women are often the most resilient members of society and the powerful agents of change in the event of a disaster. They also have historic coping mechanisms that can be of use when designing and tailoring local grass-root level early warning systems or other climate change adaptation services and activities. To include women in designing hydro-meteorological and climate services directly leads to saving lives and livelihoods, as the needs of different groups have been better identified.

The rational for organizations to pursue gender equality in governance, strategy, programs, and decision making, is highlighted in WMO's recently updated Gender Action Plan[6]. It emphasizes that organizations that respect and value gender equality and diversity attract and retain talented staff and improve overall organizational performance, have more satisfied employees, are more innovative and have better governance. Teams that have gender diversity have better decision-making processes and attract more external partnerships, as well as have better access to local communities. Encouraging women to take up leadership positions has also shown to lead to important achievements in the field of climate change adaptation and disaster preparedness.

Convention on the Elimination of All forms of Discrimination Against Women in was ratified in Barbados in 1980 and Barbados signed the Beijing Platform for Action in 1995 that is a comprehensive agenda outlining the key goals and objectives for achieving women's rights. The commitment to improve gender equality has spurred action in reforming the Constitution (Acti 2000-18), establishing Family Law Act, Domestic Violence Act and Sexual Offences Act. The Bureaus of Gender Affairs was established to ensure the integration of gender in all national development plans and policies for achieving gender equity and equality.

The current male to female ratio in the BMS staff is 28:15 and females are well represented throughout the organization tiers.

The BMS is recommended to conduct a gender assessment as part of the human capacity assessment. This could be included as part of a Gender Workshop. Based on the findings of the analysis, it is recommended that the BMS develops their own institutional Gender Policy. It is also recommended that the following gender quota as recommended by WMO is implemented at BMS:

[4] UNDP - Gender adaptation and disaster risk reduction
[5] Disaster Recovery Guidance Series, 2018, Gender Equality and Women's Empowerment in Disaster Recovery
[6] WMO Gender Action Plan

- Women should represent at least 50 % of all participants in SOFF-related and supported trainings
- Women should represent at least 50 % of all participants in SOFF consultations, planning workshops, etc.
- Women should represent at least 50 % of staff for operating and maintaining GBON stations
- Women should represent at least 50 % of decision-making and project management positions where applicable

The following actions from the WMO Gender Action Plan, have been selected as recommendations to include in the Gender Policy and to be discussed during the gender workshops:

- 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 trainings and gender webpage, 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 trainings and workshops (3.1.5(c) in WMO Gender Action Plan)
- Offer internships to young professionals, especially female, 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).
- Customize weather and climate services to the particular needs and roles of women and men and (ii) Provide education and training to target female users in accessing and using weather and climate information and products (7.3.1(c) in WMO Gender Action Plan

The engagement of the civil society is an important factor and including CSO engagement during and after the SOFF implementation phase will bring mutual benefit and grounds for sustainable operation. The following actions are recommended to ensure that CSO's are regularly consulted during the entire length of the program cycle:

- Conduct stakeholder engagement workshops on the implementation of the SOFF project deliverables (observational data exchange to support weather/climate and water services and products), bringing together key stakeholders and CSOs, to involve and collaborate with the BMS and the SOFF project team from the early onset, as well as ensure the stakeholders are consulted on operations and maintenance.
- Organize high level dialogues on benefits, co-production, and ownership of the new national GBON infrastructure.

During SOFF investment it is strongly recommended to promote 50% of women participating in capacity building activities and in consultations with civil society organizations.

Module 5. Risk Management Framework

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

As stated in the SOFF Operations Manual, the risk mitigation procedures of IE will be relied upon the SOFF implementation during the Investment phase. The Operational phase is supported by the risk mitigation procedures of beneficiary.

Potential key risks during SOFF implementation	**Mitigation measures and responsibilities**	**Monitoring and evaluation**
US NWS to stop supporting upper-air observations through CHUAS network.	Updating of the MoU (from 1975) between NWS and the BMS. Highlight the value of the CHUAS initiative.	
Damage to observation systems due to hazardous weather events (hurricanes, volcanic ash events).	Adequate spare part stock for sensor replacements.	
Annual calibration not performed in calibration laboratories; regional calibration center not capable of supporting the services.	Annual calibration costs need to be included in the budget. Strengthening the capabilities of the regional calibration laboratory, establishing relations with other calibration facilities or outsourcing calibration to system provider.	IE will be responsible for following up on the regional calibration strengthening. The BMS responsible for monitoring and evaluation of annual calibration practices.
Decrease in funding support for operations.	Sufficient lifecycle planning and subsequent annual budget planning combining different funding sources. (SOFF, budget, project, potential cost-recovery) Increasing the visibility of the national benefits the BMS provide.	IE and the management of BMS are responsible for monitoring and taking required actions.

Staff competence focused only on a few critical personnel and lost when staff changes happen.	An internal capacity building plan is developed including the criteria of competence requirements for technical staff. Succession plan and duplication of skilled staff members for critical tasks.	Management of the BMS are responsible for monitoring and evaluation.
Short of staff resources to cover all tasks and new development.	Continuing with the plan of full use of automatization to free staff time for value-added tasks. Strategy to include staff resource management.	Management of the BMS are responsible for monitoring and evaluation.

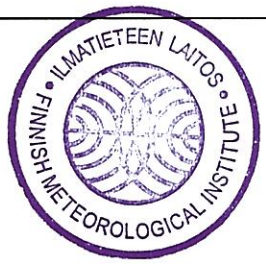
Module 6. Transition to SOFF investment phase

The transition to SOFF investment phase is recommended to be carried out by following the Gap Analysis and National Contribution Plan. It is recommended that, on approval of the Investment Phase Funding Request, a virtual workshop with the peer adviser, IDB and the BMS is arranged to review the outputs of the readiness phase and discuss the transition to the investment phase.

Summary of GBON National Contribution Plan

Components	Recommended activities
Module 2. GBON business model and institutional development	Follow-up on the development of the meteorological legislation. Facilitate a high-level dialogue to keep the development active and promote including cost-recovery mechanisms in the legislative framework.
	Continue close collaboration with key stakeholders. Seek new mutually beneficial collaboration opportunities, especially in the marine sector.
	Improve regional collaboration with GBON topics such as maintenance and calibration services. Establish ways to receive regional information on the surface weather observations and limited area models directly as input to the local forecasting process.
	Update MoU with NWS on continuous support for the upper-air observation station.
	Update GBON related lifecycle plans, risk matrixes and relevant SOPs. Supports the future expansion of QMS.
Module 3. GBON infrastructure development	Spare parts for upper-air soundings hydrogen generator.
	New ultrasonic wind sensor and spares for GBON surface weather station.
Module 4. GBON human capacity development	Training on data quality control and assurance
	Technical training to maintenance and calibration practices.
	Conduct a gender analysis and draft a new organizational Gender Policy, with specific actions that are measurable and regularly monitored, which are based on the WMO Gender Action Plan.
	Project management and product portfolio management training.
	Training on financial planning and tools and strategy work for management.
Module 5. Risk Management	SOFF Risk Management Framework to be monitored and updated regularly. Any new risks and mitigation measures should be added to the matrix as soon as they are identified.
Module 6. Transition to SOFF investment phase	The transition of SOFF investment phase is recommended to be carried out by following the Gap Analysis and National Contribution Plan documents.

Report completion signatures

Peer Advisor signature  
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