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GBON National Contribution Plan of Saint Kitts and Nevis

Systematic Observations Financing Facility

Weather and climate data for resilience

GBON National Contribution Plan
St. Kitts and Nevis

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Abbreviations

ABMS	Antigua and Barbuda Meteorological Service
CMO	Caribbean Meteorological Organization
CIMH	Caribbean Institute of Meteorology and Hydrology
GBON	Global Basic Observation Network
GCF	Green Climate Fund
FMI	Finnish Meteorological Institute
IDB	Inter-American Development Bank
IE	Implementing Entity
NASPA	Nevis Air and Seaports Authority
QMS	Quality Management System
SCASPA	St. Christopher Air and Sea Port Authority
SKNMS	St. Kitts and Nevis meteorological Service
SKMS	St. Kitts meteorological Service
VAMS	Vance W. Amory Air Traffic Services/Nevis Meteorological Service
WMO	World Meteorological Organization

Module 1. National Target toward GBON compliance

Table 1 GBON National Contribution Target

Type of station	WMO GBON Global Gap Analysis, June 2023				GBON National Contribution Target	
	Target	Reporting	Gap		To improve	New
			To improve	New		
	[# of stations]				[# of stations]	
Surface	1	-	1	-	1	-
Upper-air	1	-	-	1	-	-
Marine	*when applicable					

Saint Kitts and Nevis is operating at the moment two GBON nominated surface weather stations in R. L. Bradshaw International Airport and in V. W. Amory International Airport. Both stations are currently manual or semimanual and only used during the operating hours of the airport, thus not reliably fulfilling the GBON availability requirements. The stations are approximately 20 km distance from each other. To fulfill the GBON network compliance in terms of station density only one station is adequate for the St. Kitts & Nevis and the National Contribution plan is drafted based on this approach. However, despite the proximity it is highly recommended later to consider supporting both GBON nominated stations. This would lead to significant increase the redundancy of the network, honor the dual island and meteorological service status, harmonize the network of the two stations thus providing synergy benefits with same spares and maintenance procedures.

Saint Kitts and Nevis has no upper air sounding station of history of operating one. The upper-air sounding network in the region is adequate to cover the area with GBON required density when considering existing station in St. Maarten and Guadeloupe, and the possible SOFF investment to an upper-air sounding station in Antigua and Barbuda. As per the Gap Analysis findings it is not recommended to invest in a sounding station to St. Kitts and Nevis. Moreover, this justification for exemption was supported by the WMO RA IV Nineteenth Session, held 27–29 March 2025 in San Salvador, with the decision of a regional approach for the upper-air component of the Global Basic Observing Network.[1] This decision includes nomination of the regional upper air stations, with exclusion of sounding station from St. Kitts and Nevis, still fulfilling the GBON requirements, based on the regional coverage from the neighboring countries.

[1] https://library.wmo.int/viewer/69541/download?file=WMO-1372_en.pdf&type=pdf&navigator=1

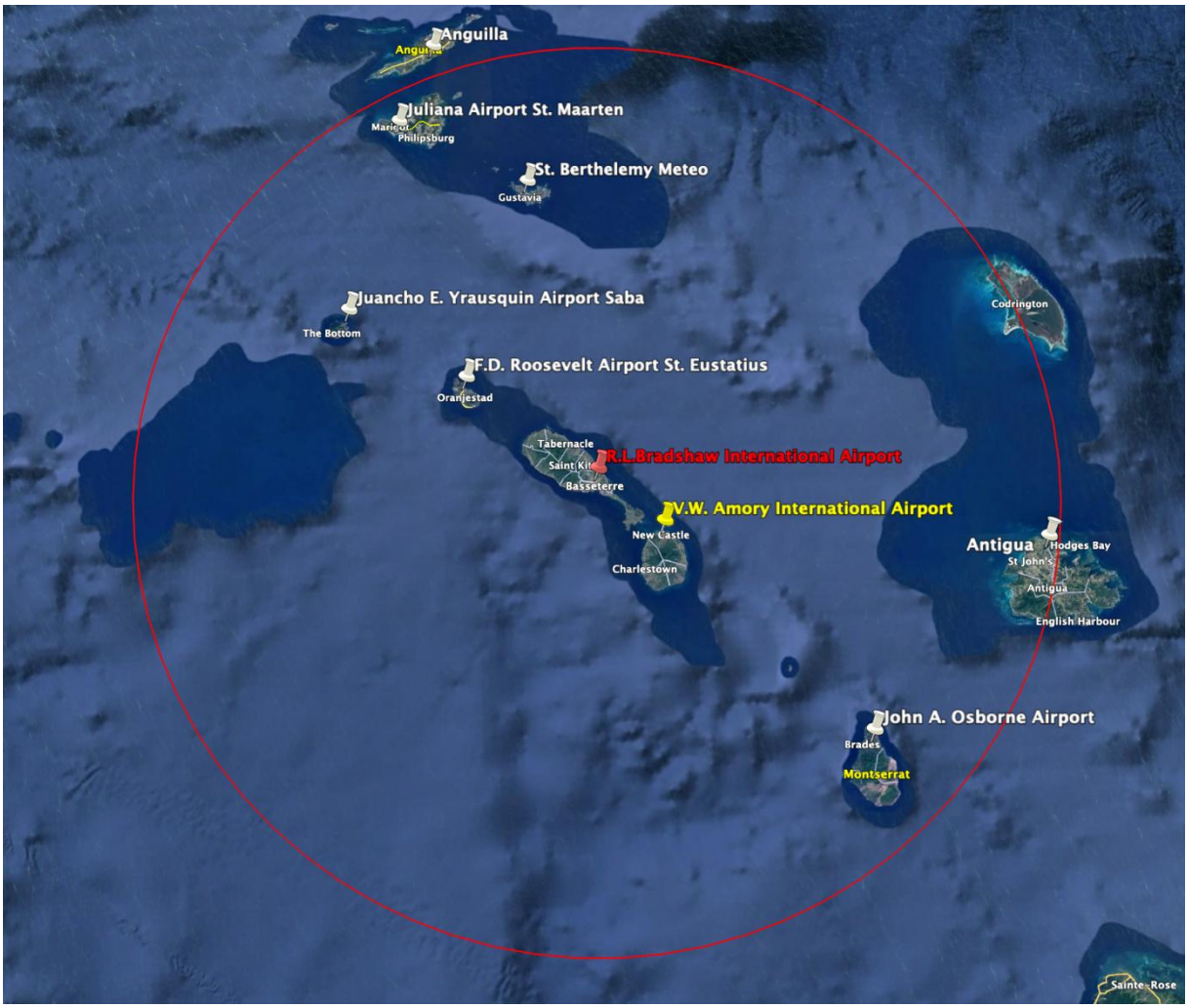

Figure 1 Existing surface weather stations (registered to WDQMS database). Circle indicated with 100 km radius. (250 km radius would be sufficient for SIDS). (Proposed improved station in Kitts in red, Nevis GBON station in yellow, other GBON stations in the region in white)

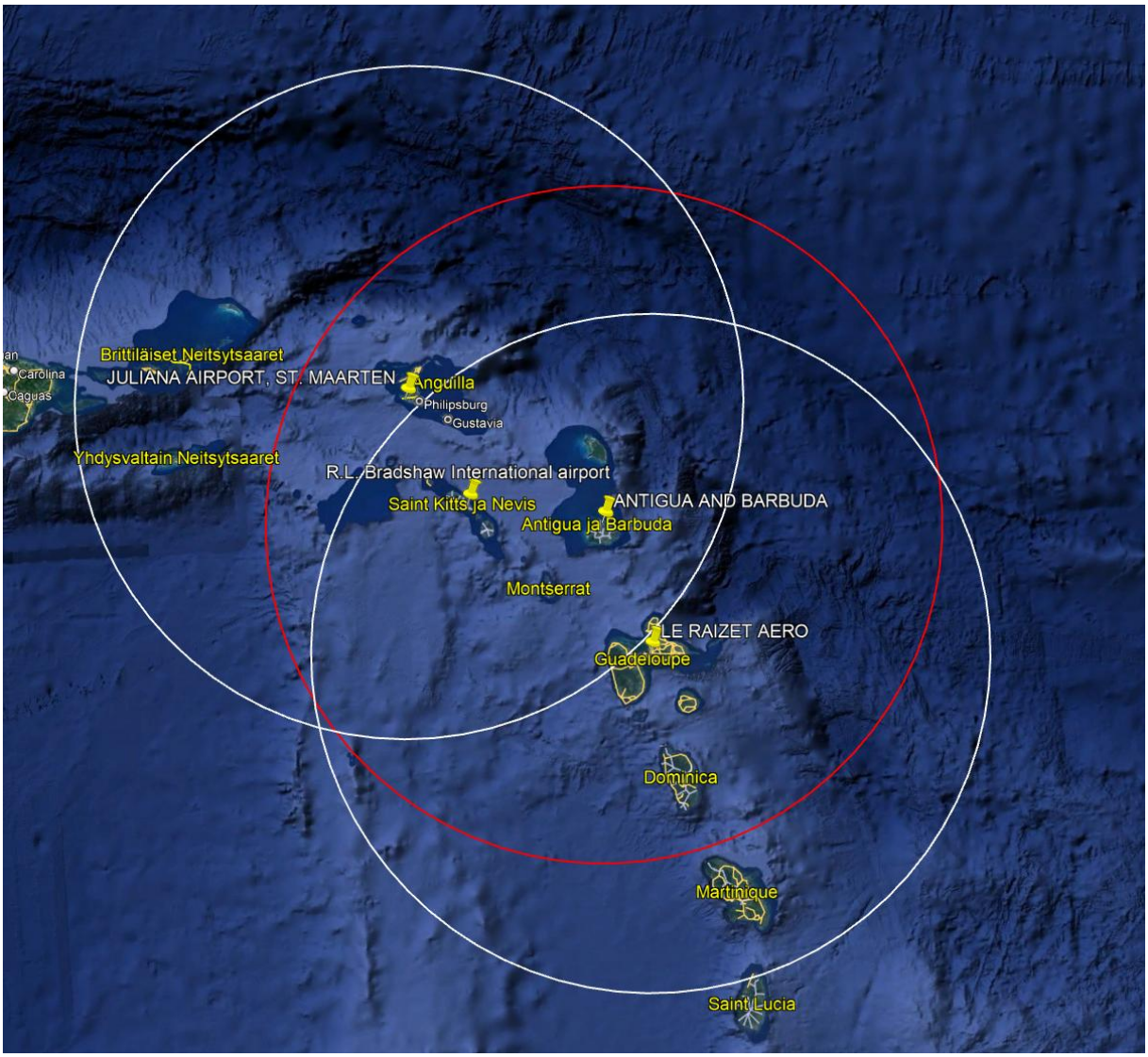

Figure 2 Map of existing and proposed upper-air stations. Existing stations in St. Maarten and Guadeloupe (white circles) and potential new station in Antigua and Barbuda (red circle). Circles are indicated with 250 km radius. (recommended density for SIDS upper-air)

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

In St. Kitts and Nevis, the meteorological services are divided to two separate statutory governmental organizations:

- St. Kitts Meteorological Service (SKMS), which is a section of the St. Chirstopher Air and Seaport Authority (SCASPA) and bears the responsibility of observation networks in St. Kitts and the dissemination of information to regional and international networks, national climate services and dissemination of forecasts and warnings nationally.
- Vance W. Amory Air Traffic Services/Nevis Meteorological Service (VAMS) operating as a part of the Nevis Air and Seaports Authority (NASPA) and responsible for the weather observations in Nevis.

SKMS has been appointed the lead responsibility for meteorology in St. Kitts and Nevis and is the country's main focal point to the national emergency and climate preparedness, regional and other international collaboration, and meteorological investment projects. Both SKMS and VAMS are operating one GBON nominated surface weather station. A long-term objective has been to merge the operations of both SKMS and VAMS into one unit, the St. Kitts and Nevis Meteorological Service (SKNMS).

There are no private sector operators in Saint Kitts and Nevis that could be supporting the GBON efforts. Previously a part of the manual rain gauge network was operated by farmers working with the sugar industry. These stations have not been maintained after the industry shifted from farming to other livelihoods.

2.2. Assessment of potential GBON sub-regional collaboration

Currently public weather forecasts, watches and warning services to St. Kitts and Nevis are provided by the Antigua and Barbuda Meteorological Service (ABMS). SKMS and VAMS provide national observations, both GBON, aviation and other surface weather observations that SKMS shares with ABMS. The forecasters at SKMS work closely with ABMS and offer local knowledge and tailoring of warnings to local conditions. SKMS also acts as the main national dissemination point for the warnings and participates by discussing and interpreting the information to the national stakeholders and users.

Antigua and Barbuda is located only approximately 100 km from Saint Kitts and Nevis and ABMS is the main forecasting office in the close vicinity operating the service on 24 hours a day basis. For these reasons, **it is recommended in the Gap Analysis document to support the investment of an upper air sounding station to Antigua and Barbuda (if at all in these countries) instead of both Antigua and Barbuda and Saint Kitts and Nevis**. The regional

upper-air network is very well covered when considering the GBON registered stations in Julian Airport in St. Maarten, Le Raizet Aero in Point-a-Pitre International Airport in Guadeloupe and possible station in Antigua and Barbuda. Excluding St. Kitts and Nevis of the sounding operations is also supported by the relatively large human capacity building required to start the operation of the new technology and to extend the opening hours of the service to cover required two sounding launches daily. Moreover, this exemption was also decided by the WMO RA IV Nineteenth Session, held 27–29 March 2025 in San Salvador, with the design of a regional upper-air network for the Caribbean.

Sain Kitts and Nevis is a member state in the main regional meteorological organizations: the Caribbean Meteorological Organization (CMO) and Caribbean Institute for Meteorology and Hydrology (CIMH). 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. SKMS received assistance from CMO for the policy and strategy draft and action plan.

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. CIMH is the main provider for technical operation and maintenance training, hosts the regional calibration laboratory, runs a regional numerical model, and hosts the Caribbean Climate Outlook forum. These services are critical to the success of the regional GBON sustainability. SKMS officers have mostly been trained in the joint program of University of West Indies and CIMH and CIMH technical courses and CIMH has been key in supporting SKMS maintenance works for the surface weather stations.

CIMH has taken up the role of drafting a network homogenization plan for the surface weather network in the region. The plan will support their effort to provide effective support and services (calibration of the sensors, spare parts, repair and maintenance services and training) for the countries. The plan has not yet been published but has the potential to guide the regional harmonization of the network, although all countries will remain autonomous in selecting the preferred systems.

SKMS provides national observations to the Caribbean Regional Climate Center hosted by CIMH and in exchange receives the regional climate outlooks. For the climate outlook CIMH is centrally collecting observations from a multitude of countries in the region. Most of the observations shared for the climate center are produced by non-GBON stations. Through the collaboration all members can receive observation information and the climate outlooks created from these.

It is recommended that, when appropriate, regional training activities related to the installation, operation, and maintenance of GBON stations and network and the implementation of WIS2.0 protocol and WIS2Box be coordinated with CMO, CIMH and the other countries in the region. Besides directly GBON related activities, regional

collaboration in developing the marine networks, selecting technologies and benchmarking other institutes is recommended.

When writing the document, the calibration laboratory at CIMH has a very limited capacity to serve the region. Currently the services are limited to pressure sensor calibration. For SKMS to rely on CIMH support the services need to include minimum calibration of pressure, temperature, precipitation, and humidity sensors with high-quality traceable services. **The preferred solution to benefit the entire region is to strengthen the regional calibration laboratory to the needed level. Unless CIMH capacity is improved, SKMS is recommended to look into other options for reliable annual sensor calibration.** Currently St. Kitts and Nevis is already paying for the CIMH services through the annual membership fee, if the services need to be outsourced, **SKMS will need to include the service contract and related costs to the annual budget.**

Collaboration that directly can support the GBON initiative are improving the regional calibration laboratory capabilities, facilitating region wide training activities, continuing the regional support for the wis2.0 protocol between the sister institutes, enhancing observation and limited area model data sharing through CIMH, 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

SCASPA and NASPA are statutory bodies/corporates formed by the Government with responsibility for the ownership and operation of the islands' air and seaports. SCASPA provides the budget to SKMS and NASPA to VAMS. SCASPA and NASPA generate revenue from cost recovery services from the aviation.

The annual budget for SKMS is approximately 708 400 East Caribbean Dollars, which is a bit more than 262 000 US$. The budget covers the salaries (74% of the budget), funds for training activities (23%) and key operational costs (3%) but has no annual investment allocations. Most investments and new development are made using project-based funding which needs to be approved by the Ministry of Finance and allocated to SKMS.

To ensure sustainable operation of GBON observation systems it is important to budget annual maintenance and calibration costs for the systems. To justify the budget allocations for annual works and spare parts, sensor replacements and other needed updates, **a lifecycle plan for AWS operation and related IT hardware needs to be developed and linked to the annual budget planning.** An analysis on the stakeholders and sectors benefiting of improved weather and climate services in St. Kitts and Nevis has recently been conducted as part of the National Strategic Plan development to offer input to the ongoing discussion on the policy and structure regarding meteorological services now and in the future in St. Kitts and Nevis. The findings support the development of a strong policy with potential to establish cost-recovery mechanisms for SKMS to expand with new capabilities and services thus providing improved

financial flexibility and independence. Especially the aviation sector is one of the key-service users that could be considered for additional cost recovery.

As a member of CIMH St. Kitts and Nevis is annually contributing to CIMH budget. In return SKMS should receive the regional calibration services and maintenance and operation training that directly support the GBON initiative.

As the National Gap Analysis document describes, St. Kitts and Nevis is not recommended to invest in an upper-air sounding station as the regional network is fulfilling the GBON requirements. In case the investment would be made later, it is recommended to be included in the US National Weather Service supported Upper-air network to receive the continuous support needed and to select highly automatized solutions.

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

A national Strategy Plan for the National Meteorological Service was developed with the assistance of CMO and funded by WMO CREWS project for a five-year period from 2021 to 2025. The plan includes a national governance structure, providing a platform for effectively address the needs and requirements in development and application of weather, water, and climate services in St. Kitts and Nevis and an Action Plan to support it.

Previous and ongoing projects that are supporting the observation network operations are:

- Green Climate Fund and Caribbean Community Climate Change Centre – Capacity Building to Support Accreditation, Planning, Programming and Implementation of GCF-Funded Activities in St. Kitts and Nevis.
    - Development of Standard Operating Procedures for National Meteorological Services. Finalized in 2022.
- Caribbean Community Climate Change Centre – Enhancing Climate Resilience in CariForum Countries funded by the European Union.
    - St. Kitts and Nevis received one automatic surface weather station.
- Green Climate Fund and Caribbean Community Climate Change Centre. To be initiated.
    - Develop website for SKMS.
    - Develop data repository.
    - Create storm surge model for St. Kitts and Nevis

The planned project with Green Climate Fund and the Caribbean Community Climate Change Centre is aiming to develop a data repository for SKMS. The database solution will support the required GBON data management solution and should be coordinated closely with the SOFF project implementation.

2.5. Review of the national legislation of relevance for GBON

St. Christopher Air and Sea Ports Authority Act and Subsidiary Legislation (Ch 8.07. Revised 2002) is the governing legislation over all air and seaports in St. Kitts and Nevis. This legislation also guides the meteorological department. No separate meteorological legislation exists nor legislation that mandates any department responsible for the meteorological and climatological forecasts, warnings and the national observation network in St. Kitts and Nevis. SKNMS received technical assistance from the CMO to develop national legislation by adopting and adapting the endorsed Model Meteorological Bill. The policy is still under review and will include restructuring of the current services.

Procurement for public goods is typically exempt from duties. The process includes applying for exemption from the Ministry of Finance after the procurement is approved. SKMS follows the tax rules the Ministry of Finance has set out. Shipping costs are based on freight weight.

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 WMO set GBON criteria for SIDS, one surface weather station and one sounding station are required for Saint Kitts and Nevis. St Kitts and Nevis have registered two surface weather stations to the WDQMS database however, to fulfill the GBON network compliance in terms of station density only one station is adequate. **It is recommended that the St. Kitts station in R. L. Bradshaw International Airport will be supported.** It must be noted that the two GBON stations are located close to each other, but to honor the country's twin island status, and to support a harmonized network with resilience and back-up, **it is recommended that support both of these stations will be sought actively later through SOFF or other funding mechanisms.** This approach would not lead to double costs as the stations can share the same spare part pool, maintenance procedures etc and hence it can be considered as a quick-win situation for increasing the amount of data in St. Kitts and Nevis.

The improved station in St. Kitts will need new sets of sensors including the data logger. Currently it is operated manually during the opening hours and is planned to be switching to semiautomatic during the nighttime (rainfall is measured manually). If additional funding is available for Nevis later, the same procedure and needs are present there.

St Kitts and Nevis has no history of operating an upper-air sounding station. The regional network for upper-air soundings (Figure 3) consists of a sounding station in Guadeloupe that is reporting twice a day and one in Saint Maarten that reports less frequently. Antigua and Barbuda is possibly planning to install a upper-air sounding station as part of the SOFF investment. If that realizes, the new station in Antigua and Barbuda would be at only approximately a 100 km distance from Saint Kitts and Nevis. However, even with the two existing stations the required coverage of one upper-air station every 1000 km for SIDS is well covered. SCASPA has no plans to expand the observation network to upper air soundings and would need significant investments in new staff and capacity building if this were pursued. Moreover, this exemption was also decided by the WMO RA IV Nineteenth Session, held 27–29 March 2025 in San Salvador, with the design of a regional upper-air network for the Caribbean. Based on these reasons, **it is recommended to exempt St Kitts and Nevis from installing and operating an upper air sounding system for the GBON.**

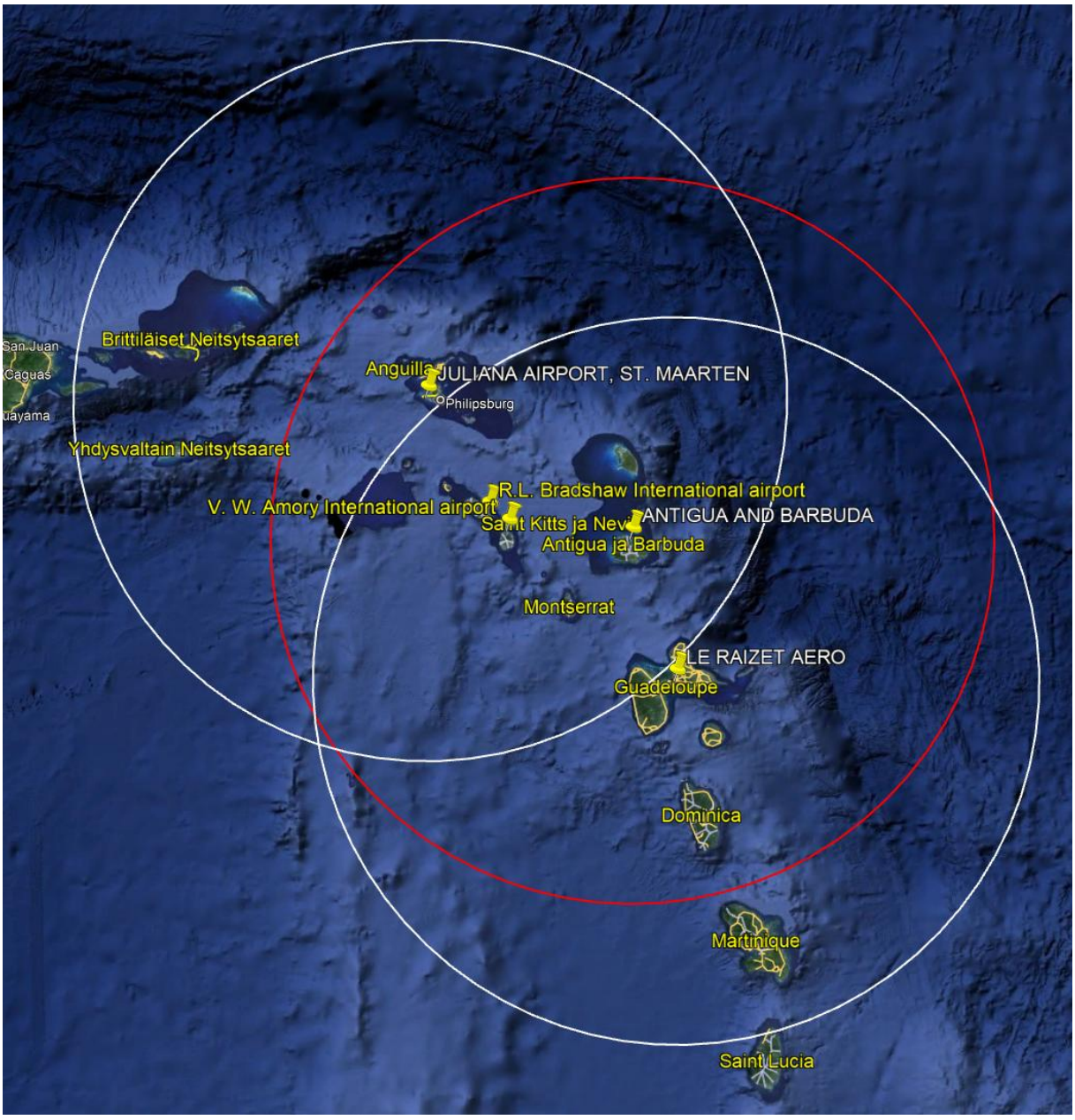

Figure 3 Upper-air stations in the region. Stations in Guadeloupe and Saint Maarten are existing GBON stations, Antigua and Barbuda is a new station, which will be potentially installed as part of SOFF program. Circles are indicated with a 250 km radius.

Based on the Gap Analysis, the following investments are recommended to make Saint Kitts and Nevis GBON compliant:

- Renew existing manual GBON station in St. Kitts to automatic with
    - Temperature sensor
    - Humidity sensor
    - Atmospheric pressure sensor
    - Rain sensor
    - Wind sensor

    - Data logger including solar panel
    - One set of spare sensors for temperature, humidity, atmospheric pressure and wind sensor to be delivered one year after the initial delivery of AWS for a healthy maintenance and calibration cycle.
- Maintenance toolkit and field calibration kit
- IT hardware for data transfer to WIS2.0. Corresponding open access software and capacity building.
- Marine surface observation stations as soon as SOFF will include the support for such capabilities.

A maintenance program for the AWS's will be designed together with SKMS and equipment manufacturer. SKMS has been relying on maintenance support from CIMH (remote and onsite assistance) thus it is recommended to include CIMH in the coordination of the activities. Initial maintenance plan includes annual preventive maintenance visits to the stations and annual calibration of at least temperature, humidity, pressure, and precipitation sensors. The selection of the preferred calibration laboratory will be sought during the investment phase (there is no national calibration laboratory and the regional calibration laboratory operated by CIMH is currently not capable of fully serving the GBON needs). It is also recommended to draft relevant SOPs for the AWSs and to include these in the ongoing QMS scope. The peer advisor will support in drafting, reviewing, and benchmarking the procedures for the observation systems during the implementation phase.

The detailed plan and technical specifications for the station upgrade will be made during the investment phase. However, during the gap analysis phase it was identified that the station is located inside the fencing of an active airport area and for example the security, power supply and communications require at this point less consideration.

3.2. Design of the ICT infrastructure and services

To support the meteorological observations throughout its value chain a modern functional Data Management System (DMS) is key. The ICT infrastructure should support automatic data reception, automatic delivery from station to international and stakeholder distribution (supporting WIS2.0 protocol), storage of the data into a database with automatic Quality Control (QC) of observations and data processing. Enough staff with the relevant skillset and IT knowledge relevant to meteorological data are needed to support the infrastructure. The organization is recommended to gain knowledge and skills in meteorological data, data processing principles and tools, data formats (e.g. NetCDFv4 and BUFR), system architecting, software developing, database, API, network management, as well as web developing.

GBON dataflow is recommended to be through a database to allow centralized real-time monitoring of the system, real-time quality control and centralized source of metadata.

Currently there is no central data management software, data visualization software or database or archiving solution is SKMS. Data is transmitted to CIMH for climatological storage and can be accessed later remotely. Synoptic data is archived locally in an Excel file and

transmitted annually to CIMH. Metadata is collected manually and stored locally in a different file. SKMS has initiated a project with the Green Climate Fund (GCF), in where they will receive a climate data repository.

Data is currently transferred from the observation sites by either real-time telecommunication or manual pickup. Real-time telecommunication has had issues in reliability at some of the sites with poor connections. Data to GTS is disseminated through FTP server and wis2box portal is used for manual dissemination centrally from Saint Kitts of the GBON information.

SKMS share data to the CIMH climate archive and receive the climate outlooks. However, they do not have direct access to the archive and data. Decoding the different data formats has also been and issue in the past.

In addition to the climate data repository a real-time DMS needs to be in place that needs to consider GBON data flow needs when designing and selecting the climate data repository. In addition to the repository, the overall DMS needs to support automatic data downloading and transfer from the automatic GBON stations using WIS2.0 protocol and APIs with automatic quality control features. Improved metadata management and synchronization to data portals is required. Staff capabilities need to be strengthened to independently maintain and operate the new functionalities.

Currently data quality control is fully manual and done when the manual observations are done and disseminated or in periodic checks when the information is cross referenced. SKMS has implemented reliability measures based on quality assurance and quality control as part of the QMS. Staff capacity building on automatized quality control and assurance methods and algorithms and basic IT and programming skills are recommended to be strengthened.

Main improvements needed for ICT environment to support the GBON data quality and sharing are:

- Improving data management system. SKMS is recommended to use systems based on open-source technologies and open protocols (e.g. OpenCDMS) to ensure sustainable and redundant operation, maintenance, and development through their lifecycles and beyond. OpenCDMS is expected to allow seamless processing of real-time and non-real time data to WIS2.0 and to systems to be fully available starting from 2025.
    - DMS system to support the updating of metadata to GBON station web tool.
- Following up on the climate data repository development and coordinating the dataflow with it.
- Automatization of data dissemination with wis2.0 protocol
- Introducing automatic quality control and quality assurance methods and algorithms.
- Human capacity building on IT and programming skills.

The annual operating budget needs to include the operating costs of the DMS. A valid support contract with the hardware vendor is recommended. The lifespan of such hardware is typically between 5 to 8 years before it needs to be renewed. The SOFF project should include funds for

the necessary acquisitions to support full WIS2.0 compliancy. Based on budgetary restrictions it is recommended to prefer license free open software when possible.

Regional coordination and support for the DMS selection is recommended. Supporting the region with e.g. OpenCDMS solution could be facilitated by CMO, CIMH and/or selected countries. Regional approach is expected to improve the sustainability of the solutions and improve the efficient use of resources.

3.3. Design the data management system

Data Management System (DMS) is a key element in the value chain of observation from measurement station to end-user interface. Both technical and budgetary perspectives need to be considered in the selection and specification of the DMS to ensure a long-term sustainable solution. Additionally, a backup solution is required for the essential data.

DMS is recommended to use open-source technologies and open protocols (e.g. open CDMS) to ensure sustainable and redundant operation, maintenance, and development throughout their lifecycles and beyond. DMS can be built cloud-based or on premises-based depending on national legislation and regulation, staff capacity as well as a decision of the organization. DMS must meet the following criteria/specification:

- Ability to ingest and store multiple different types of weather observation data formats. Including, but not limited to the following:
    - surface weather observations
    - aviation weather observations
        - lightning observations
        - upper-air sounding observations

Data ingestion to the data warehouse (database) should be made with a modular approach so that new data feeds may be added with minimal effort and modification to the already existing components and database structures.

For smooth data acquisition, database systems must provide relevant APIs for data ingestion. Supported protocols for data transfer must include at least MSQT and SFPT, as defined in GBON specifications. The ability to receive and decode messages from 3rd party data collection systems must be provided. Additionally, a www-based tool for manual observation entry for stations must be provided.

A data quality control (QC) module should be an independent and/or modular part of the system. The QC module must be made so that it is capable of producing quality control regardless of the underlying database system. Additionally, the QC module must be able to perform real-time QC and should enable non-rea-time manual QC.

The database system should support queries of timeseries with adequate performance system must be able to serve as real-time and long-term (climatological) data storage. Modules to calculate added value parameters and use of data from the archive should be made possible. These may include aggregate parameters like daily means, minimums and maximums.

The data management system must be made capable of offering data to a standard API for a retrieval of the database contents. The API could include following, but not limited to:

- WFS
- EDR
- WMS
- Export to SYNOP & BUFR message format and delivery to GTS-network
- WIS2.0 (required for GBON compliance)

The system must be able to store relevant metadata regarding stations, station networks and observations. Automatic updates to the WMO/OSCAR -systems are preferred.

The delivery of GBON hourly observations should be reported by following WMO guidance (no. 306) and GBON practices.

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 the 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 the 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.

Proposed improved GBON station is recommended to replace existing station with some of the existing civil infrastructure that is reusable. New AWS need to be equipped with renewable energy sources in the form of solar panels. Annual preventive maintenance and calibration needs to be part of all processes. Selected GBON station is located next to the operating and maintenance units thus reducing the need for travel. The detailed specifications for the new equipment will be done during the investment phase and a significant consideration will be also given to the environmental factors and environmental material selections. For example, elimination of single-use plastics from the observation process will be promoted. On the other hand, for St. Kitts and Nevis this is perhaps more straightforward and easier than some other countries, as the investment plan will not include upper air sounding systems, which are the biggest source for waste in day-to day meteorological observation process.

Scheduled preventive maintenance and calibration routines require, as a rule of thumb, about 1.3 times more sensors than there are stations. As an example, for 10 stations with temperature

sensor, the organization is recommended to own 13 temperature sensors, when 3 of them are in storage or under calibration procedure. Frequency for preventive maintenance may be rarefied based on the scientific experience and statistics gained through calibration.

In general, if additional stations are to be renewed later, having a harmonized network with compatible sensors will allow efficient maintenance and instrumentation management. Sensors can be rotated between stations, after been checked in the calibration laboratory. Therefore, extra spare sensors support the whole station network.

Module 4. GBON Human Capacity Development Modul

4.1. Assessment of human capacity gaps

The total number of staff in SKMS is currently 10 people, of which 7 are meteorological officers and 3 junior trainees. Three meteorological officers are trained in forecasting and applied meteorology, and four in basic observations. All officers have trained in the University of West Indies and CIMH joint meteorological training courses. Junior staff have only been trained in-house on-the-job and are waiting for opportunities to train at the regional training center CIMH. Additionally, the Quality Management Officer in SCASPA is sharing her time with the SKMS QMS duties. Currently the total number of staff is enough for the operation of the required services. In case SKMS expands its duties to forecasting and warning services, new staff need to be recruited and existing retrained for the new duties. The number of staff working in VAMS is currently 8 people, all working as meteorological observers with no forecasting training. Merging SKMS and VAMS into SKNMS would increase the headcount of the services and alleviate the staff shortage.

Key shortcomings in the current staff capacity are:

- Need to establish a maintenance team. Refresh training on system and sensor maintenance and effective maintenance practices and fieldwork including calibration is needed.
- Little skills in overall IT management. Human capacity building is needed to support the DMS and database upgrades and the plans to expand into new services.
- Junior staff to be trained up to certified level.
- Limited number of staff sets boundaries on the amount and length of training courses the staff members can participate to.

The Officers with forecasting level degree have attended regional refreshment training courses. Observers have not had similar refreshment training. Technical officers have been trained mainly by CIMH when new equipment has been installed.

SKMS annual budget has an allocation for the training of staff. It is crucial especially when new staff members join without a degree and need to be trained on-the-job or their training at the regional training center in CIMH needs to be covered.

The ongoing Quality Management System work will update the staff competency assessment and framework related to the aviation observer duties.

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[2]. The following training needs were identified in the Gap Analysis:

- **Quality management system (QMS):** Reviewing of sub-processes for GBON surface weather stations that is part of the ongoing QMS work.
- **Observation process:** Effective development of observation process including lifecycle planning and support through benchmarking mature sub-processes in other organizations. Developing and updating of SOPS related to the GBON systems.
- **Data archiving:** Support in programming skills for strong and effective data archiving. Additionally, SKMS is recommended to benchmark other organizations with mature data archiving system and tools to learn best practices.
- **Data transfer**: Support in programming skills on the automatization of data transfer.
- **Data quality control and assurance:** Training on programming skills and scientific understanding that support the applying of QA/QC methods and algorithms. The relevant staff members need capacity building to manage scientific background behind different QA/QC methods. Recommended to benchmark other organizations QA/QC methods. A roadmap for implementing relevant automatic QA/QC methods must be developed.
- **Instrument and station operation and maintenance at site**: Once sufficient technical training for maintaining different sensor types has been received, the technical staff would benefit from good quality SOPs and competence requirement criteria. Both the SOPs and owning required competence support self-confidence at any work. Training in upper-air system operation and lifecycle maintenance is needed since it has not been operational for some time.
- **Newly hired technical staff needs to be trained, it is recommended to train one junior staff member from both SKMS and VAMS in the CIMH certified technical training program.**
- **Network monitoring and ICT system operations**: Training for staff members responsible for ICT on their capacity (e.g., in programming skills and technical understanding) to ensure the 24/7 automatic operation of data pipeline from station to international distribution.
- **Calibration and maintenance at workshop:** Training on the concept of quality through calibration and capacity building in scientific understanding and handling calibration results. It is critically important that scientists are capable of analyzing calibration results to support lifecycle and maintenance planning. SKMS is recommended to benchmark other organizations calibration practices.

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

[2] https://library.wmo.int/records/item/35676-guide-to-the-implementation-of-education-and-training-standards-in-meteorology-and-hydrology-volume-i-meteorology

operation, maintenance, and calibration training, and utilizing the standard technical training programs from the regional training center. It is essential to the sustainability of SKMS capacity building to train all new staff members to the required level.

4.3. Design capacity development activities for senior management

Key trainings for senior management level include:

- **Finance**: to equip SKMS staff with financial 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. Benchmarking processes in other organizations.
- **Project management**: benchmarking of organizations with mature project and portfolio management and coordination culture. Training on efficient planning, executing, and overseeing projects for successful completion, covering international development collaboration projects and new business development.

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[3]. 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[4]. 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 hydrometeorological 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[5]. 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

[3] https://www.undp.org/publications/gender-adaptation-and-disaster-risk-reduction
[4] Disaster Recovery Guidance Series, 2018, Gender Equality and Women's Empowerment in Disaster Recovery
[5] WMO Gender Action Plan

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.

The Government of St. Kitts and Nevis has launched its first National Gender Equality Policy and Action Plan for 2022-2027 and is actively promoting gender equality and empowerment. The Policy and Action Plan guides the day-to-day operations of the Department of Gender Affairs. The Ministry of Social Development and Gender Affairs has several mentorship programs and dedicated programs such as the mainstreaming of gender awareness in order to reduce discrimination and inequality for all government ministries, a program on reduction of gender-based violence and program for female inmate education and career development. Women have been specially highlighted in programs that are investing in community resilience. Gender equality has been a specific topic that has been discussed in the Disaster Risk Management work in St. Kitts and Nevis.

Currently there is no gender policy in SKMS and the current male to female ratio is 7:3. The national strategic plan and framework for weather, water and climate has identified gender equality as one of the core values. Also, SKMS's authority SCASPA is actively promoting gender equality and female empowerment in work life.

SKMS 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 SKMS develops their own institutional Gender Policy**. The workshop and policy should include considerations to SCASPA gender policy. It is also recommended that the following gender quota as recommended by WMO is implemented at SKMS when possible:

- 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 SKMS 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

WMO recommends its members to establish a Quality Management System (QMS) to ensure that customer and end user requirements are met (WMO no. 1100[6]). SCASPA and SKMS as part of it, is currently in the process of QMS ISO9001:2015 certification. During this process SOPs and matrixes for observations and ICT operations should be developed or updated. It is recommended to include the sub-process for GBON surface weather station.

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**	**Risk level** **(low, medium, high)**
Hurricane events to disrupt observations and potentially cause damage to observation systems, buildings, electrical equipment, or communication infrastructure.	Preparedness to deploy staff and spares for fast maintenance. Selection of technology and infrastructure that endures high wind speeds. Seeking of possibility for redundancy (through funding for Nevis station).		Medium
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	IE will be responsible for following up on the regional calibration strengthening. SKMS responsible for monitoring and evaluation of annual calibration practices.	Low

[6] https://library.wmo.int/records/item/50552-guide-to-the-implementation-of-quality-management-systems-for-national-meteorological-and-hydrological-services-and-other-relevant-service-providers

	calibration to system provider.		
Decrease in funding support for operations and maintenance including needed spares.	Sufficient lifecycle planning and subsequent annual budget planning combining different funding sources. (SOFF, budget, project, potential cost-recovery). Effective communication on changes in required budget level.	IE and the management of the SKMS are responsible for monitoring and taking required actions.	Medium
Insufficient staff competence and changes in staff members	Internal capacity building plan is developed including the criteria of competence requirements for technical staff. Training of junior staff members. Succession plan and duplication of skilled staff members for critical tasks.	Management of the SKMS are responsible for monitoring and evaluation.	Low-Medium
The management of observation and data processes is insufficient.	Frequent follow up on how strategic goals and annual targets have been achieved.	Management of the SKMS are responsible for monitoring that work has been conducted.	Low
Issues in station security, power supply and communication.	Station is located already in fenced airport area. Security, power supply and communications can be considered a high in standard already. The detailed installation design will include planning in utilizing most optimal power supply and	Management of the SKMS are responsible for monitoring the situation	Low

	communications methods. Seeking of possibility for redundancy (through funding for Nevis station).		

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 SKMS 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 legislation development for the meteorological services. Facilitate a high-level dialogue to keep the development active.
	Improve regional collaboration with GBON topics such as maintenance and calibration services.
	Draft and update GBON relevant SOPs, lifecycle plan and risk matrixes. Collaborate efforts with ongoing QMS work.
	Ensure strong coordination with other projects ongoing or planned.
	Justify budget and project funding allocations for maintenance, replacement sensors and calibration services.
Module 3. GBON infrastructure development	One new AWS station with GBON relevant sensors and adequate amount of sensor replacements for a healthy calibration and maintenance cycle.
	Field maintenance tool and calibration kits.
	Enhance observation processes and benchmarking equivalent operations in other organizations.
	Implement automatic WIS2.0 compliant data sharing including implementation of data management system.
	Improve data sharing to WIGOS/OSCAR platforms.
Module 4. GBON human capacity development	Training on data transfer and quality control and assurance, ICT systems and data management.
	Training on maintenance and calibration practices.
	Training of junior staff for certified technicians.
	4Conduct 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.
Module 5. Risk Management	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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Beneficiary Country signature

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