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GBON National Contribution Plan Bangladesh

Systematic Observations Financing Facility

Weather and climate data for resilience

GBON National Contribution Plan

Bangladesh

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Abbreviation List

ADPC	Asian Disaster Preparedness Centre
APCC	APEC Climate Centre
API	Application Programming Interface
ARG	Automatic Rain Gauge station
AWS	Automatic Weather Station
AWOS	Automated Weather Observing System
BBS	Bangladesh Bureau of Statistics
BBTS	Broad Band Telecom service limited
BCC	Beijing Climate Centre
BCCSAP	Bangladesh Climate Change Strategy and Action Plan
BSC	Bangladesh Civil Service
BCWC	BIMSTEC Centre for Weather and Climate
BDT	Bangladeshi Taka
BIMSTEC	Bay of Bengal initiative for Multi-sectoral Technical and Economic Cooperation
BIWTA	Bangladesh Inland Water Transport Authority
BMD	Bangladesh Meteorological Department
BTCL	Bangladesh Telecommunication Company ltd
BUFR	Binary Universal Form for the Representation (of meteorological data)
BWDB	Bangladesh Water Development Board
BWCSRP	Bangladesh Weather and Climate Services Regional Project
CAAB	Civil Aviation Authority of Bangladesh
CCNP	Cisco Certified Network Official
CDMS	Climate Database Management System
CMA	Chinese Meteorological Administration
CSO	Civil Society Organisation
DAE	Department of Agricultural Extension
DRM	Disaster Risk Management
FFWS	Flood Forecasting and Warning Centre
FTP	File Transfer Protocol
GBON	Global Basic Observations Facilities
GISC	Global Information System Centre
GoB	Government of Bangladesh
GPRS	General Packet Radio Service
GTS	Global Telecommunication System
HIWAT	High-Impact Weather Assessment Toolkit
HTTPs	Hypertext Transfer Protocol
ICAO	International Civil Aviation Organization
ICIMOD	International Centre for Integrated Mountain Development
ICT	Information Communication Technology
IE	Implementing entity for SOFF
INGOs	International non-governmental organization
INFCOM	WMO Commission for Observation, Infrastructure, and Information Systems
IOC	Intergovernmental Oceanographic Commission
IP	Internet Protocol
IsDB	Islamic Development Bank
ISO	International Standardisation Organisation
JICA	Japan International Cooperation Agency
JMA	Japan Meteorological Agency

KMA	Korea Meteorological Administration
KOICA	Korea International Cooperation Agency
LAN	Local Area Network
MAZZAK	Trading and Indenting & supply business unit
MET Norway	Norwegian Meteorological Institute
MoU	Memory of Understanding
MQTT	Standard based messaging protocol (machine to machine communication)
NDC	Nationally Determined Contributions
NGA	National Gap Analysis
NGOs	Non-Governmental organization
NMHS	National Meteorological and Hydrological Services
NPDM	National Plan for Disaster Management
NWP	Numerical Weather Model
OGC	Open Geospatial Consortium
OPeNDAP	Open-source Project for a Network Data Access Protocol
OSCAR	Observing System Capability Analysis and Review Tool
PMO	Port Meteorological Officers
PPE	Public Private Engagement
PPR	Public Procurement Rule
QA	Quality Assurance
QC	Quality Control
QMS	Quality Management System
RIMES	Regional Integrated Multi-Hazard Early Warning System for Africa and Asia
SAHF	The South Asia Hydromet Forum
SDG	Sustainable Development Goals
SOFF	Systematic Observation Financing Facility
RCC	Regional Climate Center
RIC	Regional Instrument Centre
RSMC	Regional Specialised Meteorological Centre
RTH	Regional Telecommunication Hub
SACOF	South Asian Climate Outlook Forum
SIDS	Small Island Developing States
SLCP	Short-lived Climate Pollutants
SOPs	Standard Operating Procedures
SWC	Storm Warning Centre
TC	Tropical Cyclones
TCC	Tokyo Climate Center
TCP	Transmission Control Protocol
WB	World Bank
WCMP	WMO Core Metadata Profile
WDQMS	WIGOS Data Quality Monitoring System
WIGOS	WMO Integrated Global Observing Systems
WIS	WMO Information System
WMS	Web Map service

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	4	0	4	0	5[1]	0
Upper-air	1	4	0	0	1	0
Marine	**1**					

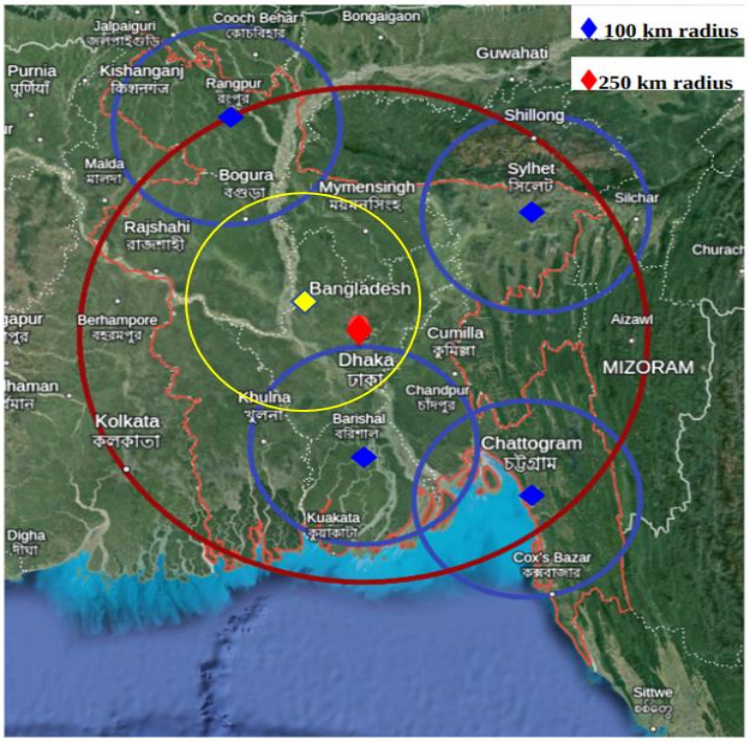

Fig 1: Map of Bangladesh with proposed surface stations (blue and yellow circle) and upper air stations to be improved (red- circle).

[1]Bangladesh will require five surface stations to fulfil the 200 km horizontal resolution GBON requirement

Results of Bangladesh GBON National Gap Analysis (NGA) report showed that BMD will require five surface stations (see Fig 1) to fulfil the 200 km standard density resolution for surface land stations. The NGA could not confirm the compliance of four upper air stations declared as reporting in the June 2023 WMO GBON Global Gap Analysis. Only one upper air station in Bangladesh makes two soundings per day. However, these upper air soundings have not been received in the WDQMS monitoring system. For this reason, and in accordance with the GBON compliance standards, we find that the data transmission and data management system problems at BMD must be addressed before the upper air station may be deemed as GBON compliant. Based on the NGA , Bangladesh will thus become GBON compliant by improving five surface land stations and one upper air station operated from the land (Table 1).

Table 2: Bangladesh National Contribution Target toward GBON compliance

Requirements	SOFF progressive threshold	National target toward GBON compliance and timeline	Vision for long-term target toward full GBON compliance
Horizontal resolution			
Surface-based	4 stations	60% of stations by 2027	100% of stations by 2028
Upper- air	1 station	60 of stations by 2027	100% of stations by 2028
Reporting cycle			
Surface-based	80% of monthly reports exchanged	60% of monthly reports exchanged by 2027	80% of monthly reports exchanged
Upper-air	80% of monthly reports exchanged	60% of monthly reports exchanged by 2027	80% of monthly reports exchanged
A three-year target for SOFF's minimal progress towards GBON compliance is recommended. BMD will not make significant procurements during the investment phase because most of the infrastructure has been secured following the Bangladesh Weather and Climate Services Regional World Bank-supported Project.			

Module 2. GBON Business Model and Institutional Development

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

The Bangladesh Meteorological Department (BMD) is a government organization established under the administrative control of the Ministry of Defence. BMD is the only government organization with the authority to carry out all duties related to meteorological services in Bangladesh. This is provided in chapter III of the BMD Meteorological Act, 2018[2], which addresses the establishment of the department, functions, and institutional framework for meteorological services. As a result, no other institution or entity may provide notifications involving meteorological observation forecasts and warnings. Other government ministries and organisations, on the other hand, are allowed to use and modify the BMD forecast as they see fit.

Furthermore, in accordance with chapter IV of the act, BMD with the approval of the government, shall have the mandate of the establishment of observatories, management, and maintenance of the networks. **Current activities at BMD are therefore considered as a fully public business model (government-owned and government-operated networks**). All weather observation networks in Bangladesh are therefore installed and maintained by BMD. Presently, BMD does not use other organization's (3rd party station) meteorological observational data. Nevertheless, there exist some institutes that run weather observation stations in Bangladesh. However, BMD does not have information on their observation routines and station maintenance.

Relevant to GBON, BMD is responsible for ensuring that meteorological observations are collected and issued in accordance with WMO standards, as well as Intergovernmental Oceanographic Commission (IOC), International Civil Aviation Organization (ICAO), and International Maritime Organization (IMO) regulations. Bangladesh, however, has no marine stations and will need SOFF support for at least one marine station installation based on the 500 km horizontal resolution at the Bay of Bengal.

There exist several governmental and non-governmental stakeholders that BMD collaborates with by offering their services. Most of them generally have no major relevance for the operation and maintenance of GBON station network in Bangladesh. They include:-

- Ministry of Agriculture - they own and operate agricultural stations mainly for rainfall observations - BMD shares data, forecast and warnings daily including generated alerts.
- Bangladesh Water Development Board (BWDB) - Flood Forecasting and Warning Centre (FFWS) under Ministry of Water Resource - BMD sends warnings daily including generated alerts.
- Ministry of Transport and Tourism - they receive early warnings from BMD.
- Department of Disaster Management - they receive early warnings from BMD.

[2] Meteorological Act, 2018.pdf

- Civil aviation Authority of Bangladesh – BMD shares data, forecast and warnings daily including generated alerts for aviation purposes regularly.
- Bangladesh Inland Water Transport Authority (BIWTA) – BMD sends warnings daily including generated alerts.
- Ministry of Fisheries – they receive early warnings from BMD.
- Ministry of Livestock – they receive early warnings from BMD.
- Ministry of Health – they receive early warnings from BMD.
- Media – Bangladesh Television, Bangladesh Betar (Radio), print and electronic media – BMD shares forecasts and warnings daily including generated alerts.
- Life Insurance Companies – they purchase data as per their requirement.
- NGOs and INGOs – BMD shares data, forecasts and warnings daily including generated alerts.

A Memorandum of Understanding (MoU) was recently signed by BMD, Department of Agricultural Extension (DAE), Ministry of Agriculture, and BWDB regarding third-party data sharing and cooperation in generating quality hydro-meteorological data on a common platform in support of improved weather, water, climate, and early warning services for Bangladesh as part of a World Bank-supported hydromet development project. One key objective of this MoU is facilitating real-time-data sharing. This will allow continuous, automatic data sharing of the observation among the involved parties. This might potentially benefit other stakeholders in the future, making it relevant to GBON.

Private sector operators providing meteorological observations and data services in Bangladesh

There are currently no private sector providers of meteorological observations and data services in Bangladesh. Other parties, including private agencies, have collaborated with BMD on issues relevant to GBON, which are summarised in module 2.5.

Private entities[3] that acquires meteorological observations from BMD should contribute to the support of GBON compliance in Bangladesh. There should therefore be continuous engagements through stakeholders' workshops and other forums to encourage future engagement with BMD and support.

Potential new partners and recommendations of their roles.

Notwithstanding the current model of network operation and maintenance in place at BMD, the following recommendations on partnerships and collaborations could contribute to sustained compliance to GBON strategy in Bangladesh: -

Academia – Institutions of higher learning play an important role in scientific research and the advancement of meteorological and climate services. The significant expansion of the observation network in BMD necessitates a higher degree of emphasis on automatic observation network and ICT infrastructure competences and capabilities which are currently lacking at BMD. Establishment or strengthening of existing formal agreements (MoUs) can benefit BMD because

[3] BMD's Data Users' List.

these institutions can serve as national hubs for training and staffing. BMD has affiliation with the Department of Meteorology, University of Dhaka[4]. This arrangement should be strengthened.

Print and electronic media (including TV and radio) - Media has a significant role in shaping the weather and climate policy in a country and how issues related to weather and climate services are framed and reported. Positive public feedback on services provided by BMD can be key for funding opportunities for stakeholders.

Telecommunication service providers - Formal agreements with telecommunication providers like the Bangladesh Telecommunication Company ltd. BTCL, and Broad Band Telecom service limited BBTS can be beneficial for reliable communication and internet service for real time data transfer from the AWS distributed across the country to the national HQ and through the GTS/WIS 2.0 to global NWP centres.

Civil Aviation Authority of Bangladesh (CAAB) - BMD offers aviation meteorological services (observers, forecasters, and technicians) to 03 international and 05 national airports in Bangladesh. It is typical for aviation authorities to pay a cost recovery charge for meteorological services. While the BMD's meteorological offices are located on the CAAB premises, there is no clear regulation governing the cost recovery of aviation meteorological services by BMD. An evaluation can be undertaken to compare the cost of BMD services to CAAB, including the quality of the services, as well as the benefits received from CAAB. If necessary, CAAB can boost its support to BMD to facilitate upgrading and maintaining of the stations at their premises for GBON compliance.

Bay of Bengal initiative for Multi-sectoral Technical and Economic Cooperation (BIMSTEC)[5] - BIMSTEC Centre for Weather and Climate (BCWC) signed an MoA on 2014 for weather and climate service (BCWC) to promote cooperation between BIMSTEC member countries for fundamental and applied scientific research in weather prediction and climate modelling, capacity building, assist publication of important results of research obtained within the framework of the BIMSTEC cooperation on weather and climate. It can be relevant to BMD especially with regards to development of marine stations in BMD.

Intergovernmental Regional Organisations (RIMES, ADPC, ICIMOD, SAHF) - BMD is a member to several regional organisation including Regional Integrated Multi-Hazard Early Warning System for Africa and Asia (RIMES)[6] , Asian Disaster Preparedness Centre (ADPC)[7] and the International Centre for Integrated Mountain Development (ICIMOD)[8]. The main focus of these regional collaborations with BMD has been on building capacities in a number of hydromet disciplines including the generation and application of user-relevant early warning, including providing expertise to build regional platforms for data sharing. Through these collaborations, BMD has since had training on storm surge, NWP, RADAR systems, HIWAT, programming languages, IBF and ICT etc.

The South Asia Hydromet Forum (SAHF) IV in February 2024 identified and made it clear that all the national NHMSs in the region in the SOFF programme had a common problem in capacity, especially technical capacities. This leaves an open market for more or less well function

[4] University of Dhaka. Department of Meteorological Act
[5] https://bimstec.org/
[6] https://www.rimes.int/
[7] https://www.adpc.net/igo/?
[8] https://www.icimod.org/country/bangladesh/

solutions sold by private entities. The challenge with some of these solutions is that the NHMS often ends in a lock-in situation where they are totally dependent on often foreign consultants. This results in unnecessary long lead times e.g. updates of the systems and high costs, which again isn't a sustainable solution. Regional actors could fill this gap between needed capacity and real capacity of the organisations with common solutions to common challenges and common advice. Another role for the regional actors could be as facilitators for exchanges on data and knowledge among the NHMSs.

2.2. Assessment of potential GBON sub-regional collaboration

Bangladesh has land boundaries with India to the north, west, and east, and Myanmar to the southeast. None of these neighbouring countries are GBON compliant. Three other nations however in Southeast Asia (Bhutan, Nepal, and the Maldives) are implementing SOFF work and Bangladesh will significantly benefit from sub-regional collaboration with these countries in the context of the Global Basic Observing Network (GBON). The four countries have the opportunity to work together on the implementation of GBON. During the SAHF 1V in Colombo, Sri Lanka, in February 2024, where SOFF was represented, it was agreed that uniform regional training should be adopted, especially as capacity and personnel difficulties were identified as a common problem. One example here is that multiple countries, including Bangladesh, have state of the art calibration labs and infrastructure, but have no capacity to operate the facilities. One of the most critical elements in lack of capacity at BMD is the lack of a climate database partly due to the lack of personnel to operate such a database. This is of great relevance to SOFF and the flow of data to the global NWP centres.

Additionally, BMD has had collaborations with several countries within the region but not limited to: -.

India - Collaborations have mainly been on capacity building training related to instruments and calibration services, tropical cyclones, and Numerical Weather Prediction. For international data exchange globally, BMD uses the Global Telecommunication System (GTS) through the New Delhi Regional Telecommunication Hub (RTH). For extreme weather events, BMD shares data with RSMC-IMD[9], especially during the tropical cyclone season. This includes also sharing bulletins via email and WhatsApp. Regionally, BMD participates in South Asian Climate Outlook Forum (SACOF). This is usually coordinated through the Regional Climate Centre (RCC) RAII region[10], in Pune India. Continuous cooperation and exchange of technical expertise and best practices will be beneficial

Japan - BMD has direct relationship with the Japan Meteorological Agency (JMA) and Japan International Cooperation Agency (JICA)[11]. JMA/JICA conducts meteorological training to contribute to capacity building in the meteorological services of developing countries where BMD have been recipients. BMD also hosts Radars from JICA. With regards to data sharing and product use, BMD shares observational data with WMO's Global Information System Centre (GISC), Tokyo and uses products from Tokyo Climate Centre (TCC). BMD has also previously received support and training from the regional instrument centre RIC-Tsukuba in Japan. To improve their capacity in instrument calibration, continuous partnership with RIC-Tsukuba is highly recommended.

[9] Regional Specialized Meteorological Centre (RSMC) for Tropical Cyclones over North Indian Ocean
[10] https://rcc.imdpune.gov.in/index.php
[11] https://www.jma.go.jp/jma/en/Activities/jica_training.html

China - BMD has had collaborations with the China Meteorological Administration (CMA) mainly on capacity building training. BMD uses data from Beijing Climate Centre (BCC). CMA plans to facilitate workshops on the training on metrology (calibration) to enhance personnel's abilities at BMD on metrology standards.

South Korea - BMD has received a satellite receiving station from Korea Meteorological Administration (KMA). In addition, BMD has benefited with capacity training from Korea International Cooperation Agency (KOICA) and KMA. BMD also uses products from the APEC Climate Centre (APCC)[12]. KOICA can in future be instrumental in providing capacity building targeted towards Early Warnings for All (EW4All) initiative or in enhancing BMD's IT expertise relevant for SOFF.

Nepal - BMD collaborated with Nepal via ICIMOD. BMD has benefited from capacity-building training on a variety of issues. ICIMOD assisted in installing HIWAT at BMD. As equal beneficiaries of SOFF, Nepal and Bangladesh can benefit from customised training pertinent to SOFF through ICIMOD.

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

The operation and maintenance of BMD weather observation infrastructure is currently funded through the Government of Bangladesh (GoB) revenue budget, under the administrative control of the Ministry of Defence. The overall annual expenditure for the operations of the observation networks at BMD is **$9750410.36** during 2023/2024 Fiscal year. This includes budgets for permanent staff salary and the running costs for operation and maintenance for surface and upper air stations. They include 58 manual (synop) stations, 6 upper air stations, 10 pilot balloon observatories, 12 AWS, 10 Seismic observatories and 5 Radar Stations. Table 3 and 4 shows the budgets breakdown.

Table 3: Annual expenditure for operations of the observation networks at BMD

Budget sent to Bangladesh Meteorological Department in 2024 (2023-2024 Fiscal Year) for the purpose of stations administration			
Reason for budget sending	**Sending interval**	**Amount sent in BDT**	**Remark**
Running cost including station inspection	Every year	**4 542 810 00**	
Purchase of Meteorological Instruments	Every year	**55 450 000**	
Permanent Staff salary	Every year	**501 930 000**	
Sum (in BDT)		**1,011,661,000**	
Sum (in USD)		**9,196,918 (Approx)**	

Table 4: Annual expenditure for operations of upper air stations at BMD

Annual running cost for upper air observing stations (Six stations)			
Expenditures		**Amount in BDT**	**Remark**

[12] https://www.apcc21.org/?lang=en

Expenditure for purchasing Balloons (350 gram) and radiosonde - including transport and custom charge [Examples of unit prices for radiosonde (21440 BDT), 350gm balloon (2272 BDT)		**60 584 160**	At BMD Dhaka we make only radiosonde observations in the morning and evening and the remaining 5 RS observations are taken once in a day.
Expenditure for purchasing other consumables listed below (caustic soda, Ferro Silicon)		**300 000**	
Sum (in BDT)		**60 884 160**	
Sum (in USD)		**553 492.36(Approx)**	
Total Current annual expenditure sum (in USD)		**9,750,410.36 (Approx)**	

BMD increased its observational infrastructure in 2023 as part of the World Bank, Bangladesh Weather and Climate Services Regional Project,[13] to include 35 new AWS, 3 AWOS, 125 Agricultural AWS, 65 Automatic Rain Gauges (ARG), 7 Hydrogen gas generators, calibration facilities and a Climate Data Base Management System (CDMS) - Clidata. These costs are not included in the budget estimate provided in Table 3 & 4. Mazzak Inter Trade was tasked with installing, maintaining, and operating all the new AWS infrastructure deployed at BMD until May 2025. The total maintenance cost for three years for these new observing networks, as specified in the contract[14] by Mazzak Inter Trade, is $569 418,18.

Additionally, BMD receives technical support from external development partners and through sub-regional collaboration (see 2.2)

Recommendation of a business model to operate and maintain the GBON infrastructure, considering arrangements for SOFF financial support during the Compliance phase.

The three possible SOFF business models[15] include (a) government-owned and government-operated networks (access to available resources and national legislative frameworks; (b) Government-owned and privately operated networks (public -private partnerships - e.g., instrument design and operation) and (c) Privately owned and privately operated networks.

BMD's present business approach is completely public (government-owned and controlled networks). Currently, this is the best model for BMD. Funding for observation networks, particularly from the private sector, has been found to fail to account for the sustainability (total cost of network operation and maintenance) of the station networks. Furthermore, according to our observations, outsourcing vendors for the installation and partial management of their newly acquired infrastructure has resulted in some loss of control over certain procedures. This could have been prevented if, during the acquisition of the new infrastructure, some of the BMD staff (in charge of operation and maintenance of the station network) had received the requisite onsite and factory level training to be well-equipped to comprehend the AWS needs and expectations. Based on this, the government-owned and privately operated network business model is

[13] Bangladesh Weather and Climate Services Regional World Bank Project

[14] Price Quotation for AWS_Mazzak.pdf

[15] See chapter 4 of the Operational Guidance Handbook on SOFF private sector archetypal business models.

unsuitable for BMD. Total reliance on outside consultants can be costly, especially for issues that can be easily resolved in-house.

As a result, it is highly recommended and in the best interests of BMD that SOFF financial support during the investment phase be directed toward equipping and developing capacity, particularly technical capacities of in-house personnel for GBON compliance.

Potential private sector operators depending on the proposed business model

Currently the framework at Bangladesh does not support public-private partnerships in network operation. As a result, it is recommended that BMD continues to operate its network autonomously. Furthermore, as already mentioned, solutions outsourced to private organisations have resulted in excessively long lead times e.g. system changes, as well as inflated expenses. Nevertheless, BMD can leverage on possible private sector funding willing to finance the installation, upgrade, and maintenance of existing infrastructure.

Financial plan for operating the modernised infrastructure, including considerations on the total cost of ownership.

The following budget breakdown for operating the modernised infrastructure through SOFF is required for BMD to reach GBON compliance. The total rough estimate to BMD during the investment phase is $2,075,650. **Annex II** provides detailed information on the budget that will be considered in detail during the Investment phase funding proposal writing.

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

The BMD has a national strategy document[16] in place for establishing and improving the observing network. The focused write-up document was created with the goal of improving and modernising the organization's infrastructure, as well as its forecasting and warning systems. While the document is viewed as just a procurement plan, it contains six approaches that, if followed, will enable BMD to accomplish significant departmental goals. The Eight Five Year Plan (8FYP) (FY 2021-2025) is one of the approaches outlined in the document. The development and objective target for 8FYP were developed with the goal of addressing both global climate change and the GoB vision 2041. This is in addition to BMD's goal of being effective in early warning forecasting, which aligns with the Sustainable Development Goals. The primary goals of the 8FYP include:

- Ensuring the provision of quality time and timely service
- Strengthening quality in the domestic and international networks
- Enhancing meteorological knowledge to improve capabilities and responsibility; and
- Strengthening interactions and corporations amongst stakeholders in the national and international level

The priority interventions that are well aligned with the needs for establishing and improving its observing networks include, but not limited to the following targeted activities

[16] BMD's Eight Five Year Plan (8FYP) 2021 - 2025.pdf

- Infrastructure development of BMD's meteorological observatories for better weather observation and forecast
- Strengthening of marine weather forecasting and early warnings for three major ports in Bangladesh
- Modernization of meteorological training institute
- Establishment of a multipurpose hall for trainings/seminars and conference
- Establishment of automatic observing systems and wind profiles in BMD
- Modernization of meteorological workshop and laboratory in Dhaka

There are also other several strategic documents in Bangladesh of relevance to BMD and GBON including the National Plan for Disaster Management, NPDM (2021-2025)[17]"Action for Disaster Risk Management (DRM) towards Resilient Nation". Priority 1: "Understanding disaster risk" of the vision, strategies, and priorities of NPDM 2021-2025 identifies the need for improvement of weather and climate monitoring, prediction, and forecasting and that current observation stations and satellites would best be modernised using cutting-edge technology. In addition to hydrometeorological hazards, information systems and models for tracking landslides and riverbank erosion will be developed.

NPDM also identifies strengthening regional and international DRM networks, as well as building new ones, in order to share and learn from other countries' experiences as priority 1. Building a regional hub for the transboundary sharing of hydrometeorological catchment and maritime data, as well as other data such as seismic and tectonic information is therefore highlighted in the report.

The Climate Change Initiatives of Bangladesh report[18] also highlights various national strategies that could be relevant for improving observing networks. The national policy documents include: -

- Bangladesh Climate Change Strategy and Action Plan (BCCSAP), 2009[19]
- National Adaptation Programme of Action, 2005, updated in 2009
- Bangladesh Climate Change Trust Act, 2010
- Nationally Determined Contributions (NDC), 2015, Enhanced & Updated in 2021
- NDC Implementation Road Map, 2018
- Bangladesh Delta Plan, 2100
- Mujib Climate Prosperity Plan 2030 (Draft)
- National Disaster Management Policy, 2015
- Standing Orders on Disaster 2019
- Plan of Action to Implement Sendai Framework for Disaster Risk Reduction 2015-2030
- National Strategy on Internal Displacement Management 2021
- National Plan for Disaster Management 2021-2025
- Bangladesh Energy Efficiency and Conservation Master Plan up to 2030
- Renewable Energy Policy of Bangladesh, 2008
- Bangladesh National Action Plan for Reducing SLCPs, 2012, Updated in 2018

[17] National Plan for Disaster Management, NPDM (2021-2025)

[18] Climate Change Initiatives of Bangladesh

[19] Bangladesh Climate Change Strategy and Action Plan (2009)

To better align with national strategic plans, initiatives, and overall organisational management, BMD should continue to update its strategic plan on a regular basis while closely monitoring national policies and strategies. National stakeholder forums can also help harmonise these policies and strategic development.

Review of existing or planned hydromet development projects related to GBON

BMD is purely a meteorological institute, not hydrological. However, BMD provides data and partners with the Bangladesh Water Development Board (BWDB) who is responsible for hydrological information and management in Bangladesh. Existing or planned hydromet development projects related to GBON include: -

World Bank supported hydromet development project," Bangladesh Weather and Climate Services Regional Project BWCSRP (2016-2024)[20]" is well aligned with the SOFF project. The project involves Bangladesh Meteorological Department (BMD), Bangladesh Water Development Board (BWDB), and the Department of **Agricultural** Extension (DAE). Based on the Project Implementation Status and Results Report[21], BMD has increased its observational infrastructure to include: -

- Synoptic AWS: 35 total, 35 installed, 35 functioning;
- AWOS: 3 total, 3 installed, 3 functioning;
- Ag AWS: 125 total, 118 installed, 113 functioning;
- ARG: 65 total, 65 installed, 61 functioning;
- Hydrogen gas generator: 7 total, 7 installed, 7 functioning and
- Calibration facilities including

According to the project report, some BMD staff have benefited from capacity development from the project. However, from discussions with BMD, the capacity received is not yet sufficient for operation and maintenance of the new infrastructure. The SOFF project will use the new infrastructure created as part of this project to achieve GBON compliance. There have also been recent MoUs signed, including one between BMD, DAE, and BWDB on third-party data exchange and cooperation in providing quality hydrometeorological data on a single platform to promote enhanced weather, water, climate, and early warning services in Bangladesh. Another MoU was signed with the University of Dhaka, with the goal of expanding meteorological information services and early warning systems, as well as developing academic exchanges and collaboration in teaching and research. SOFF may leverage these improvements to ensure long-term GBON compliance in Bangladesh.

Mazzak Inter Trade[22] - A company enlistment with the Ministry of Defence was tasked with installing, maintaining, and operating all of the new AWS infrastructure deployed at BMD as part of the BWCSRP project in 2023. They are expected to offer these services until May 2025, when BMD will take over. However, subcontracting Mazzak for this task meant that BMD staff did not receive sufficient factory training on the newly procured AWS. As a result, there is a gap and lack of in-house skills/capacity to maintain the newly installed AWS station network. This may necessitate an extension of the contract with Mazzak Inter-Trade during the SOFF investment phase. This however may not be the best option for GBON compliance because of the observed long lead times in communication and feedback during the readiness phase. Focus should

[20] Bangladesh Weather and Climate Services Regional World Bank Project

[21] World Bank Project Implementation Status and Results Report

[22] Mazzak Inter-trade

therefore be on empowering technical capabilities of in-house staff under SOFF for BMD to gain the requisite expertise and take full control of the station's operation. The gaps highlighted in this report should be taken up during the SOFF investment phase.

Islamic Development Bank (IsDB)[23] is BMDs implementing entity and has assisted the country to reach some socio – economic milestones. Procurement and investment activities through the IsDB throughout the SOFF implementation and compliance phase will help to increase understanding of the private sector's involvement in the BMD program. IsDB can additionally assess and enhance its assistance for BMD beyond SOFF across multiple highlighted gaps, such as infrastructure development and system maintenance.

SAREPTA project by MET Norway (Norad)[24]: Since 2013, MET Norway has collaborated with BMD to provide Institutional Support and Capacity Building for Weather and Climate Services. The project's primary goal is the use of open-source software (and open, free data whenever possible) and enhancing IT solution competencies at all levels (infrastructure, network, operating system, software, maintenance, and so on). The digitalization and organization of observation data are also covered, as is the use of meteorological, climatic, and ocean models. Through this co-operation, BMD and MET Norway have published two reports, one on the status of the climate of Bangladesh (2016)[25] and the Changing Climate of Bangladesh (2024)[26]. These reports are based on weather observations from Bangladesh. This support is well matched with SOFF, particularly with the benefits of data analysis.

CMA – There is an ongoing online discussion between BMD and CMA on future collaborations. BMD has proposed to get assistance from CMA on following fields,

- Installation of GRAPES-MESO model at BMD
- Installation of GRAPES-Typhoon model at BMD
- Capacity building on Lightning and Thunderstorm prediction
- Capacity building on MICAPS and SWAP
- Global Model output Data sharing for medium range and monthly/seasonal Forecast data
- MW channel data from CMACast reception system
- Global Model output Data sharing for S2S forecast at BMD
- Storm Surge and ocean state forecast model at BMD
- Upgradation of existing CMACast reception system and receive data from FY2A at BMD.

CMA is also committed to ensure that BMD staff have necessary capacity development in metrology (calibration) under the SOFF project.

JICA – Improvement of radars

a. Capacity building on the same to start in 2024

2.5. Review of the national legislation of relevance for GBON

[23] https://www.isdb.org/bangladesh
[24] https://bistand.met.no/en/Bangladesh
[25] Climate of Bangladesh
[26] Changing Climate of Bangladesh

Chapter 1V of the BMD's Meteorological Act, 2018, contains the national legislation governing the responsibility for measuring and providing weather observations related to GBON (see 2.1). Furthermore, the Act calls for mutual interaction, including the exchange of data, with national and international organisations based on national requirements and international liabilities. Chapter V of the Act provides for the standardisation of meteorological observations, as well as the development and implementation of procedures for the collecting of reliable data in accordance with WMO principle. Additionally, it states that BMD will take WMO's strategy and development plans into account while formulating a planning and implementation plan during procurement of modern equipment.

With regards to the legislation related to procurement, importation, and customs processes of relevance for the proposed plans activities and investments, BMD adheres to chapter five of the Public Procurement Rules (2008)[27] in Bangladesh.

The evaluated national laws show that there will be no constraints to the implementation of GBON in Bangladesh.

[27] The Public Procurement Rules (2008)

Module 3. GBON Infrastructure Development

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

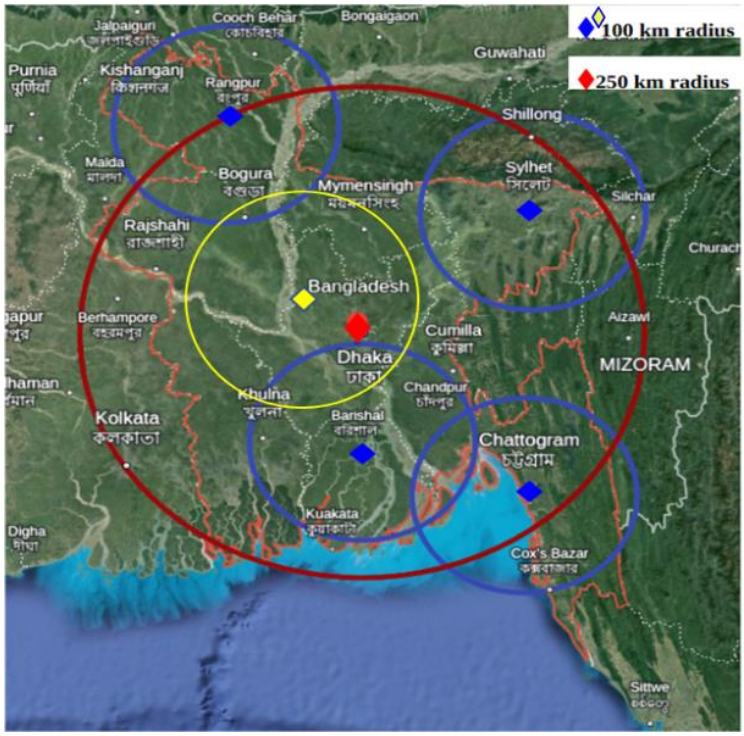

Fig 2: Map of Bangladesh with proposed surface stations (blue and yellow circle) and upper air stations to be improved (red- circle).

The Bangladesh Meteorological Department operates about 314 observation station networks of varying classes. There are 58 manual (synoptic) observatories, 61 are AWS, 125 agricultural AWS, 65 automatic rain gauge stations and six 6 upper air stations. All the country's manual synoptic and AWS stations are installed at the same location. As already mentioned in module 2 BMD through the WB project acquired several new automatic observation stations in 2023.

BMD relies on the GTS for international data transmission every 3 hours. This is mainly done for data from their manual (synoptic stations), as such, none of the newly installed AWS stations is integrated for data transmission to the Global NWP centres in real-time.

To fulfil the 200 km horizontal resolution requirement, AWS stations with automatic data transmission systems have to be established at the five locations, including one upper air station and preferably 1 marine station with the SOFF project. Data transmission automatically to a central server and to the global data exchange via GTS/WIS 2.0[28] should also be facilitated. The stations should measure all GBON variables. Table 5 provides a list of GBON variables observed and systems per site[29] for the five stations and one upper air station selected for improvement

[28] https://docs.wis2box.wis.wmo.int/en/1.0b4/

[29] List of observation instruments and systems per site

during SOFF. A comprehensive list for all stations managed by BMD is provided in the Gap analysis report.

Technical specification for the existing instruments and observing systems is provided in annex I. The report includes details of the AWS sensors specification and other auxiliary components of the AWS. Based on the information provided by the BMD SOFF team, the newly installed station sensors meet GBON requirements and recommended measurement range described in the tender specifications for GBON Automatic Weather Stations[30]. For data acquisition and transmission[31], both the frequency of data acquisition and the frequency of sending them with FTP protocol can be programmed on the device. For upper air stations, BMD has six operational stations with one upper air station making two soundings per day. Technical specification of the upper air system is included in annex I. Data transmission systems should be automated for GBON compliance. The physical assessment of other components relevant to the sustainability of the observation network i.e., fencing and security, stands, power reliability, showed that while BMD does not require start-up investments for their observation network sites (Figure 3), rehabilitation cost of these components during the lifetime of the stations will be considered during the investment phase.

Fig 3: Observational site for the five surface stations and one upper air station to be improved during the SOFF investment phase.

[30] Tender specifications for GBON Automatic Weather Stations

[31] https://www.siapmicros.com/en/data_acquisition/datalogger/

The study of present BMD stations suggests that the majority of the investments and actions required for GBON compliance will be directed at improving existing stations and ICT infrastructure in order to enable real-time (hourly) data transfer from the stations to Global NWP Centres via WIS 2.0. Bangladesh will thus not require extensive procurement procedures.

The investment activities needed for GBON compliance in Bangladesh based on the assessment of GBON land stations against the GBON tender specifications are described in the SOFF Expenditure Estimate for Bangladesh annex II.

Table 5: List of observation instruments and systems per site

Station Name	Station type	Start date	Requirement	GBON variable measured					Comments
				SLP	T	H		P	
Dhaka	UA	1993*	Improve		x	x	x		Data transmission needs (data logger, sim card, power)
Rangpur	S	2023	Improve	x	x	x	x	x	Data transmission needs (data logger, sim card, power)
Sylhet	S	2023	Improve	x	x	x	x	x	Data transmission needs (data logger, sim card, power)
Barishal	S	2023	Improve	x	x	x	x	x	Data transmission needs (data logger, sim card, power)
Chattogram	S	2023	Improve	x	x	x	x	x	Data transmission needs (data logger, sim card, power)
Tangail	S	2023	Improve	x	x	x	x	x	Data transmission needs (data logger, sim card, power)

*PC based UA station established in 1993

Observational practices for the surface observing network.

Automation of observational networks increases the dependence on staff needed for the maintenance, inspections, system and software design and update, and calibration of electronic instruments in the AWS. A more skilled workforce is required in the areas of telecommunications, information technology (IT) infrastructure, metrology, and engineering.

For BMD, the optimal performance of the observational practices for the surface observing network requires careful consideration of the capability of the available staff who will be responsible for the maintenance of instruments and system performance, fault diagnostics including the repair of faulty instruments and systems and the monitoring of performance of instruments and communication systems. The cost of infrastructure and maintenance and the various impacts on data quality and volume is equally highly required as the BMD has been mostly dependent on observation from manual (synoptic) observations.

It is therefore of great importance that BMD staff responsible for the operation of observation systems receive relevant training on meteorological requirements and understanding of the new AWS instrument systems, the systems configuration, AWS hardware and software, site configuration, maintenance plan on the instruments and systems in accordance with Standard Operating Procedures (SOPs) for quality control of the system to minimise automatically the number of inaccurate measurement data and metadata management. During the investment phase, the peer advisors (CMA) will facilitate workshops on the training of metrology (calibration)

personnel's abilities at BMD and the promotion of metrology standards. If necessary, comparative work can be carried out on BMD's measuring standard instruments.

General activities might include, but is not to be limited to:

a. Sites' suitability maintenance (fencing, community awareness for ownership and safety);
b. Acquire AWS spare parts (sensors, power accessories) for maintenance and improvement;
c. Ensure sufficient upper air operations equipment (sensors, including spare parts, gas and cylinders, power backup, balloons and radiosondes);
d. Assess the calibration equipment and procedures for all sensors;
e. Provide training (factory training and/or local) in stations' operations and maintenance;
f. Provide calibration training on the operation of meteorological metrology calibration standard equipment, application of metrology calibration regulations, and quality management system for metrology works, and organise metrology comparison between BMD and CMA or other regional meteorological metrology standard instruments;
g. Upgrading of the CDMS (Climate Database Management System) - CLIDATA - to integrate AWS data or acquire another backup CDMS for GBON compliance
h. Ensure that laptops for field use in servicing and maintenance are fit for purpose
i. Make sure that mechanisms and funding for scheduled field maintenance are in place;
j. Acquire a system for monitoring and data processing;
k. Develop stations operations and status monitoring unit;
l. Develop SOPs (Standard Operating Procedures) for all stations' operations and maintenance, including calibration;
m. Develop institutional and human capacity building (ICT infrastructure, servers room enhancement, CDMS improvement, local network improvement; OSCAR and WDQMS, NWP analyses and applications);

The Observational practices defined per network should be in line with Guide to Instruments and Methods of Observation (WMO-No. 8-III)[32].

Automated Weather Stations and Marine Station:

- The sensors should be well calibrated to report accurate data;
- Real time transmission of observation (targeting for hourly data);
- Establish an automated data transmission for global data exchange via GTS/ WIS2.0;
- Continuously monitoring of station status and operations;
- Provide and monitor mobile network status for data communication;
- Provide and monitor LAN for servers' communication and data integration;
- Fail-safe systems in place, such as power back-up to ensure system uptime

Upper air Station:

- Real time transmission - target balloon launch 2 times a day;
- Establish/automate data transmission for global data exchange;
- Continuously monitoring of station status and operations;
- Provide and monitor LAN for servers' communication and data integration;
- Fail-safe systems in place, such as power back-up to ensure system uptime

[32] Guide to Instruments and Methods of Observation (WMO-No. 8)

For marine stations, a tender specification[33] is being developed by the WMO, GBON task team. Recommendation for a potential marine station in Bangladesh will be provided upon completion of the WMO specification.

Preliminary maintenance plan for existing and improved/new stations, including calibration practices

BMD currently lacks calibration and maintenance practices for its AWS network. Their capacity is limited to conventional observation networks. BMD has recently (2023) acquired calibration systems including climate chamber, pressure generator, barometric pressure chamber, a field calibrator and a portable rainfall calibrator. This means that BMD has laboratory calibration capabilities for air temperature, humidity and air pressure, and the ability of on-site mobile check for AWS. At present, BMD still lacks the ability of laboratory calibration for wind speed, wind direction and precipitation. This should be considered during the SOFF investment phase.

Mazzak Inter Trade, BMD's vendor for AWS infrastructure, is now managing the AWS network till May 2025. Transitioning for BMD and being able to operate, manage and maintain the AWS system is crucial, and as such the transition planning should be initiated promptly. This includes addressing managerial aspects, new technology or capacity, skill level, and implementation costs. It is necessary to establish a set of comprehensive maintenance and guarantee operation systems to ensure the quality of the observation system, which includes necessary equipment, new technology, available skill levels, personnel capability, and financial support. The transition planning should consider all components of change.

Preliminary costs of servicing and maintaining AWSs systems can greatly exceed their initial cost and as such the AWSs networks should be designed to have the greatest possible reliability and maintainability. Observing sites, instruments and sensors should be maintained regularly to maintain the quality of observations throughout the station's lifetime. The frequency and timing for preventative maintenance, corrective maintenance and adaptive maintenance should be determined by BMD and should satisfy WMO's guide to Instrument and Method observation requirements (WMO-No. 8).[34] It is essential that BMD puts in place a maintenance plan that details all the functions necessary and to arrange them so that costs are minimised without adversely affecting performance. The modular structure of many modern AWSs allows maintenance to take place in the field or at regional and national centres. BMD has previously received support and training from the regional instrument centre RIC-Tsukuba in Japan.

Regular calibration of metrology systems and instruments is also crucial for maintaining national standards. Guidelines on calibration routines, recommended frequencies, types and indicators of metrological standard instruments, personnel capacity, and training capability to BMD to ensure they meet international or national standards have been provided by the peer reviewers in the technical specification of the BMD AWS (annex I).Capacity Building/Training in meteorological Metrology has also been tailored for BMD at CMA RIC-Beijing and BMD during SOFF investment phase and budget estimates included in the SOFF Expenditure Estimate for Bangladesh (annex II). CMA RIC-Beijing has provided meteorological metrology training services to a number of countries, particularly in Southeast Asia, and conducted numerous WIGOS international training workshops. The CMA RIC-Beijing has plans to assist the SOFF initiative. As a result, BMD may now use the resources of regional centres like the RIC-Beijing to have access to various training and comparison opportunities in order to improve its meteorological equipment calibration capabilities through regional collaboration.

[33] Task Team on GBON implementation (TT-GBON)

[34] https://library.wmo.int/idurl/4/41650

Some general maintenance and calibration recommendations:

- Cleaning of sensors once per month
- Routine inspection, preventative and maintenance – quarterly
- Monitoring of operations to trigger immediate maintenance and replacement of parts and/or preventative and corrective maintenance during the quarterly service
- Calibration of sensors as guided by manufacturer and system requirements (after EoL, and upon failure).[27] Replacing sensors as per the company manual and types of sensors.

General recommendation 3.1:

- BMD requires training on the system operation and maintenance of AWS, including calibration practices.
- Can be nice if BMD will immediately have a transition plan with Mazzak. BMD needs to independently maintain their station network from June 2025.

3.2. Design of the ICT infrastructure and services

Detailed description of the BMD's ICT Infrastructure and services design relevant for GBON is provided in annex III of this report. BMD's manual/conventional observations, SYNOPs are generated and manually entered for exchange through GTS every 3 hours and submitted globally through the New Delhi RTH. At present, no SYNOPs from the AWSs are generated.

The AWSs use GPRS for communication and the data are transmitted to a separate server, installed by Mazzak Inter-Trade, in the server room at Storm Warning Centre (SWC) in Dhaka. The PolarisWEB[35], a web-based remote data collection platform installed at the SWC is mainly used for AWS data visualisation. The AWS data is therefore not yet well integrated into a Data Management Software System or into the operational production tools for the operational forecasters (e.g. Diana, CDMS). Integration of the AWS data through the Data Management Software System and further down the value chain is an urgent matter and of high priority for SOFF. Currently, there is an hourly data transmission, but it is configurable to adjust the temporal resolution to e.g. every 5 or 15 minutes. Hourly temporal resolution is sufficient for future transmission to GTS/WIS 2.0. The planned infrastructure interface at BMD for integration of AWS data is provided in Figure 4.

[35] https://www.siapmicros.com/wp-content/uploads/2022/12/PolarisWEB-ENG.pdf

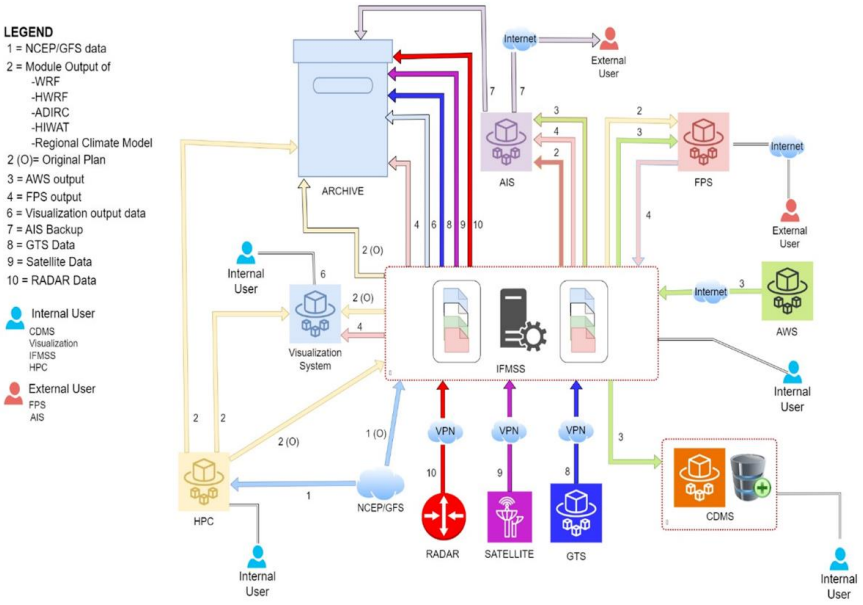

Fig 4: The planned infrastructure interface at BMD

The radiosondes were established in 2007, using iMet-4 (USA) - Frequency 403 MHz (Dhaka) and Frequency 402 MHz (Sylhet). The data transmission is using GPS Technology (collecting data up to 30 hPa). Details on the technical specification of the GPS radiosonde is included in annex I.

The full data processing and transmission chain from an observing station and to a final Climate Data Management System (CDMS) should be performed through a reliable ICT infrastructure. Hence, urgent development and skilled IT specialists for the increased data processing and management capabilities are critical for BMD and the sustainability of the SOFF projects.

At present, data exchange at BMD is not yet compatible with WMO Information System 2.0. The WIS 2.0 is the latest framework for WMO real-time data sharing. WIS2 node is the WIS 2.0 component that provides data and associated metadata. WIS2 node replaces the GTS Message Switching System and shares data from an HTTPS service and sends notifications to MQTT subscribers. Figure 5 shows a flow chart of the planned IP Network Structure for the GTS/WIS Systems at BMD.

General recommendation 3.2:

- BMD requires training and skilled IT specialists for the increased data processing and management capabilities, including to make the data exchange become compatible with WIS 2.0.
- Need to design an effective data flow architecture,
- Automation of data transmission

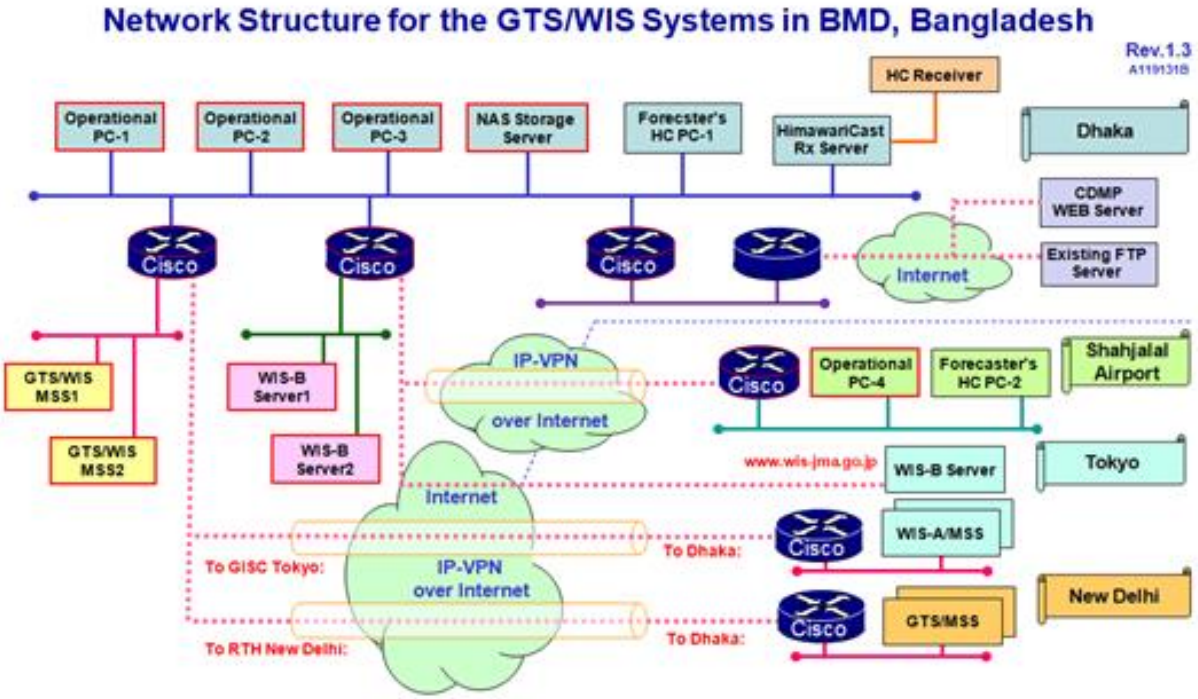

Fig 5: GTS/WIS system in BMD

3.3. Design the data management system

Short-term data storage and access through the services and protocols required by applications for national and international operational activities

Organisational datasets management throughout the entire value chain including data ingestion, data quality control and assessment, storing, metadata management, data retrieval and visualisation require significant consideration to ensure the reliability and accuracy of observations. Short-term data processing, monitoring, storage and access through the services and protocols will depend on the capabilities and viability of the data management system and in-house capacity. Until the acquisition of CLIDATA CDMS recently, BMD has not had a systematic data archiving system. Observations from their manual stations received at the SWC in Dhaka were archived as individual files manually, and then entered into the available Network-attached storage (NAS). Thus, no other data except from manual stations is currently being archived.

The features of the CLIDATA database management system including automatic collection of AWS observations, generating products, creating metadata and archive information will be explored during the SOFF investment phase. This is in addition to Open CDMS[36] CLIMSOFT. For BMD benchmarking other Met Services that have successfully integrated their AWS observations

[36] https://www.opencdms.org/

into the CLIDATA CDMS can be advantageous. This will however still necessitate capacity development both in numbers and skills.

Acquisition of data to and from WIS/GTS, WIS 2.0 and other national or international sources required for operational activities

The first step of the data management is the stage from observation station to the data acquisition and status monitoring server for short-term data storage, exchange and access by various data processing and data transmission systems such as the GTS and WIS2 Box [37] [38]. These requirements are included in the Technical Specification for the BMD Observation Network and the ICT Infrastructure specification documents annexed in the report.

It is recommended that all future BMD national and international data transmission processes should be based on the WIS2box software and synchronised to the national CDMS. The data delivery component functionality should include:

- Proper data discovery (both observational data and metadata)
- Data ingested should be stored in WMO format and in the right locations for long term preservation and delivery
- Data delivery and publication services should be based on open spatial standards (e.g. the Open Geospatial Consortium (OGC), Web Map Service Interface Standard (WMS), the International organisation for Standardization (ISO) 19100 series or the Open-source Project for a Network Data Access Protocol (OPeNDAP))

The second step is data management and archiving in a Climate Data Management System (CDMS):

- Data from observations are most likely to be of ascii or tabular format. For data exchange through WIS2Box, the AWS will be configured to push/send data through relevant protocols (FTP/ MQTT) to the WIS2Box cloud server for further transmission as BUFR-messages.
- The current CLIDATA system is not yet in use or understood in handling automatically generated and transmitted data. The recommendation is to understand, upgrade and start using the CDMS (CLIDATA) for enhanced transmission of the AWS data and data from the manual/conventional observation stations.
- The supplier is expected to provide the software for managing the data from the stations. This includes details of the station itself (metadata) and its current operating status in terms of power and efficiency of sensors and parts. For ease of access and interpretation, the software is recommended to have an API service or other interface that will be able to identify a unique station and display and provide all the required data and metadata through BMD's CDMS.

Data delivery to the national CDMS

[37] https://community.wmo.int/en/activity-areas/wmo-information-system-wis/WIS%20Core%20Components
[38] https://community.wmo.int/en/GTS_WIS2_Transition_Guidance

Currently BMD has a licence of a Climate Database Management System, CLIDATA[39], by a commercial provider until the end of 2025 (will most likely be extended) for processing and archiving of climate data. As listed on their website, CLIDATA is Oracle based and provides data acquisition, quality control, calculations, reports, and maps generating.

The CLIDATA makes use of a mix of dedicated and public network services, Transmission Control Protocol/Internet Protocol (TCP/IP), which may include encryption. Some main features:

- Collects observations, generate products, create metadata and archive information;
- Assign user role;
- Maintain and expose a catalogue of services and information;
- Authorise access to information by users;
- Deliver information to users (internal and external);
- Manage system performance.

BMD has limited capability in the use and understanding of CLIDATA and to perform structured procedures regarding data quality management to which the SOFF project can be of benefit. The CLIDATA system architecture and the system for data quality control should be well understood by the relevant personnel at BMD. The CLIDATA should be customised as the single endpoint for storing and retrieving observations and metadata at BMD. The quality control system should be able to meet the needs of both the institute and external users of observational data. On data access, procedures that govern data access, especially for international operations as required in SOFF, should be in place as well as a clear understanding of the policies for the provision of BMD's data. It is crucial that sufficient funding, training and human resources through SOFF are in place to ensure a sustainable capacity at BMD throughout the whole data value chain.

Use of open-source technologies and open protocols (e.g. OpenCDMS[40] and CLIMSOFT[41])is recommended to ensure sustainable and reliable operation, maintenance, and development throughout their life cycles and beyond. The OpenCDMS software is expected to be available by 2025. CLIMSOFT is an existing free open-source climate data management system developed by and for NHMSs of developing countries, and is supported by WMO, the UK Met Office, University of Reading, and others. An open-source software should be considered as an alternative and/or backup as the Climate Database Management System (CDMS) at BMD.

Discovery and descriptive metadata management

With regards to metadata management, two complementary types of metadata are required:

- Discovery metadata; used for relevant data discovery, access and retrieval. They describe who did what, where and when, how to access data and potential constraints on the data
- Descriptive metadata: enables data values to be interpreted and discovered in context. They help connect users to the data and provide important context about the data discovered.

The routines on metadata are essential to ensure resilience and continuity of the full data processing chain. AWS and instrument metadata are currently being collected and will be fully integrated into the CDMS. BMD has not yet implemented a well-structured metadata

[39] https://www.clidata.cz/

[40] https://www.opencdms.org/

[41] https://climsoft.org/

management system for the AWS data in compliance with the GBON requirements. BMD should aim to meet the WIGOS Metadata standards (WMO, 2019)[42] and possibly include additional information into the description of the stations in the CDMS if lacking. Ideally, the database should include the ten categories of WIGOS metadata identified. Site metadata which includes station or platform identifiers, geographical location (lat, lon, and altitude) should be carefully revised. This should also be reflected in the OSCAR website.

Photographs can be used to provide description of the observation site and its surrounding area. This can be done annually during the scheduled station inspection to facilitate description of influences of cities, topography, land use and coverage on observations. In the end, BMD should have an observational metadata system that covers all the GBON stations including their site/location, observation practices and instrumentation per site, calibration and inspection reports, site layout, condition, site exposure and details of all changes during the station's lifetime.

The recent discovery metadata standard for the WIS2.0 platform by the "WMO Core Metadata Profile (WCMP) Version 2[43]" defines the content, structure, and encoding for the WCMP.

Monitoring of data, processing and services

Monitoring of data, processing and services will depend on the capabilities and viability of the CDMS system and in-house capacity. Guidelines on Surface Station Data Quality Control and Quality Assurance for Climate Applications (WMO-No. 1269)[44] provides recommendations when designing a monitoring system. Automatic data quality control techniques are recommended sub-hourly to hourly AWS data with further checks. Even then, the data quality and assurance system at BMD should be adapted to fit to the local meteorological environment and to the local technical set-up and needs. Procedures applied whether manual or automated in the entire data life cycle should be well determined with a long-term perspective.

BMD needs sufficient funding to have in-house climate data management specialists with geoscientific knowledge on observations data and data quality control and IT expertise for daily and scheduled maintenance of the database system. The CDMS[45] specification provides additional information useful for the BMD data management team.

General recommendation 3.3:

- BMD requires sufficient funding, training and human resources through SOFF to ensure a sustainable capacity at BMD throughout the whole data value chain.
- BMD requires a data management software system for all observation data collection, processing, data quality, displaying and archiving (including backup)
- The CDMS (CLIDATA) architecture and system need to be well understood by relevant personnel at BMD for data transmission of all the observation data
- An open-source software should be considered as an alternative and/or backup as the Climate Database Management System (CDMS) at BMD

[42] WIGOS metadata standard, (WMO-No. 1192)

[43] WMO Core Metadata Profile (WCMP) Version 2

[44] Guidelines on Surface Station Data Quality Control and Quality Assurance for Climate Applications (WMO-No. 1269)

[45] Climate Data Management System Specifications

3.4. Environmental and sustainability considerations

Significant environmental effects result from surface observation networks, infrastructure, and their operations. To support the implementation of GBON, the WMO Commission for Observation, Infrastructure, and Information Systems (INFCOM) is dedicated to fostering the creation and adoption of economically viable approaches and technologies that are environmentally and operationally sustainable. The environmental sustainability of observing systems and methods should therefore be integrated into all stages of the weather, water, and climate monitoring value chain, from planning and procurement to decommissioning the observing system location at BMD.

At present, BMD has made some strides in environmental impact considerations when installing their new automatic observing network. Alternative power supply sources (solar panels) are installed alongside all AWS. In addition, BMD uses hydrogen gas for operational upper-air balloon observations which is more environmentally friendly and sustainable.

Further, BMD will as much as possible strive to have significant environmental consideration for their network design and operation to achieve GBON requirements, including:

a. Development and use of specifications that consider environmental sustainability for procurement of measurement instrument equipment to meet the GBON requirements. This includes;
    i. Ensuring the environmental management accreditations of potential vendors is considered before procurement process
    ii. investigating innovative technologies that would improve the environmental sustainability of current observing practices
b. Integration of sustainability considerations for the management of operations of GBON stations, including installation, calibration, and maintenance
    i. Before choosing a new location for an observation system, factors including geographic accessibility, the transportation of goods and services, installation logistics, operating costs should be considered.
    ii. Before granting construction permits, environmental assessments may be required to ensure compliance with national or local laws and regulations.
    iii. For calibration and maintenance, use of hybrid vehicles should be considered to reduce emissions and costs. Additionally, having scheduled preventive maintenance and calibration plans will potentially also increase the lifecycle of the sensors. Having contact personnel in remote stations with capabilities for simple maintenance check e.g. changing of batteries, will reduce the number of corrective field visits that can be avoided.
    Enhancing capacities for remote system diagnostics and alarms crucial to minimise maintenance trip.
    iv. Continued focus on training and capacity building. Increased and improved capacity of BMD staff (through training) will ensure dependency on local contractors.
c. Careful material selection for the development, shipping, and day-to-day operations of GBON stations, with a focus on developing and using reusable instruments and sustainable methods of observation (e.g., elimination of single-use plastics).
    i. Continued use of hydrogen gas for operational weather balloon observations

ii. The quantity of physical waste generated during day-to-day operations and maintenance of observing systems, including used lubricants, and malfunctioning instruments, should be monitored and disposed of in a sustainable manner.
iii. To reduce their negative impacts on the environment, observation systems that can include hazardous components should be disposed of appropriately.

Module 4. GBON Human Capacity Development Module

4.1. Assessment of human capacity gaps

BMD's current staffing estimate (March 2024) is 673 personnel. 17% of the workforce consists of women, while 83% are men. Corporate support staff includes those working with administration roles e.g. accountants, HR, secretaries.

28 of the present capacity has technological capabilities to maintain and manage the weather observation infrastructure, which includes instrument and station maintenance, calibration and maintenance, network monitoring, and ICT system administration. The current capacity is not optimal to maintain the total observation infrastructure at BMD especially with the recent increase in automated station network. BMD's capabilities and capacity must be enhanced to ensure sustainability of GBON infrastructure. Table 6 shows an overview of BMD's personnel across various professional fields as of March 2024, including their gender and educational backgrounds, as reported by the human resources department. 13% of the total workforce have a higher education. To be more competent to deliver the required meteorological services and play other relevant roles in national development relevant to GBON, BMD needs the requisite policy, guidance, resources, and training, including re-structuring of their organization structure to include more workers with relevant training for AWSs and UA observations. Emphasis is put on the need for IT personnel to run the climate database and data flow infrastructure that is lacking at the department. Recent years have seen BMD increase its automatic observation network. AWSs employ different electronics and infrastructural technologies than the conventional manned stations that BMD is familiar with. Maintenance and calibration of such technology should include training for those responsible for automatic weather observation. To implement an automatic weather monitoring system, it is important to train or hire experienced staff who understand AWS operations. BMD is in dire need for dedicated staff to handle their AWS including data management throughout the entire value chain to the Global NWP centres in real-time, from the statistician to the climate database managers and IT experts.

In Bangladesh, all government employees are hired through the Bangladesh Civil Service (BCS) recruitment procedure. As a result, any BMD employee recruitment must be approved by the GoB. Hiring into BMD as a government worker has been particularly slow, with a recruitment freeze in place since 2016. The long-term freeze has increased the burden on existing employees, as well as an ageing workforce that is not replaced when they retire. As of March 2024, almost 73% of BMD employees were over the age of 40. To recruit and retain professionals, the government must remove employment restrictions and create robust solutions that meet the demands of BMD. Nonetheless, initiatives are underway to expand the human capacity at BMD, as seen in Table 7. When employing new staff, BMD should prioritise individuals who can handle BMD's automated weather system infrastructure, which includes data quality control, maintenance, and calibration. The emphasis should be on ensuring BDM has a dedicated staff of IT specialists. An updated organogram is also available (Bengali).

Table 6: BMD staff with information on education and gender - As of March 2024

	Headquarters	Regional Centres	Education (number of staff with BSc or higher)	Gender
Corporate support	50	253	12	Women: 100 Men:203
Meteorologist/ Climatologists/ Researchers	15	40	55	Women:11 Men: 44
Meteorological technicians	44	258	12	Women: 5 Men:297
Engineer/IT	2	**9**	11	Women: 1 Men:10
Hydrologists	0	0	0	Women: Men:
Hydrological technicians	0	0	0	Women: Men:
Others	1	1	0	Women: 0 Men:2
Total	**112**	**561**	**90**	**Women:117** **Men:556**

Table 7: Total post in the newly approved organigram at BMD

Description of Post Number of post	Present	Created	Total
Meteorological Post			
1 Director General	-	1	1
2 Director	1	3	4
3 Deputy Director	6	13	19
4 Meteorologist	41	11	52
5 Assistant Meteorologist	58	32	90
6 Sub Assistant Meteorologist	42	27	69
7 Met Assistant	142	-	142
8 Met Observer	286	24	310
9 Assistant Met Observer	117	-	117
Sub-Total	**693**	**111**	**804**
Engineer/ Technical Post			
1 Superintendent Engineer	1	-	1
2 Executive Engineer(electronic)	3	1	4
3 Executive Engineer (Mechanical)	1	1	2
4 Sub-Divisional Engineer (electronic)	8	6	14
5 Sub-Divisional Engineer (Mechanical)	2	3	5
6 Assistant Engineer(electronic)	15	8	23
7 Assistant Engineer(Mechanical)	3	3	6
8 Sub-Assistant Engineer(electronic)	46	2	48
9 Sub-Assistant Engineer(Mechanical)	9	2	11
10 Sub-Assistant Engineer(civil)	2	-	2
11 Electronic System Supervisor	43	-	43
12 Mechanical System Supervisor	15	-	15
13 Electronic System Operator	94	-	94
14 Mechanical System Operator	24	-	24
15 Electrician	3	-	3
16 Carpenter	2	-	2
Sub-Total	**271**	**26**	**297**
General Post			
1 Account Officer	2	7	9
2 Security Officer	1	-	1
3 Store Officer	1	1	2
4 Administrative Officer	2	7	9
5 Accountant	3	6	9
6 Steno typist cum Computer operator	1	-	1
7 Caretaker	1	-	1
8 Upper Division Assistant	7	7	14
9 Stenographer cum Computer operator	6	12	18
10 Storekeeper	3	-	3
11 Store Assistant	2	-	2
12 Office Assistant come Computer typist	25	5	30
13 Driver	10	-	10
14 MLSS	77	10	87
15 Security Guard	35	-	35
16 Gardener	2	-	2
17 Cleaner	4	-	4
sub-Total	**182**	**55**	**237**
Total	**1146**	**192**	**1338**

4.2./4.3 Design capacity development activities for technical staff and senior management

Table 8 shows the technical staffing capacity for the GBON station operations at BMD. The personnel listed in the table already work at BMD. Table 7 also indicates the total positions in the newly approved organigram at BMD for new hires, which will increase BMD's capacity. They are all expected to be financed by the GoB, BMD. Recommendations are thus for training within the SOFF framework, to fill the capacity gaps for technicians, experts, and management to maintain and operate the weather observing infrastructure. Only training of personnel is requested from SOFF.

BMD does not have a dedicated ICT system and operation unit aligned for successful implementation of GBON compliance. The capacity of field technicians for instrument and station maintenance including calibrations is currently only limited to manually operated stations. As a result, and along with the newly acquired AWS, it is recommended that BMD gets a tailored training and capacity development plan with clear objectives aligned to sustainability of GBON stations. As already mentioned, BMD can benefit from having consideration in the projected recruitment to include personnel that can oversee the adopted automated weather system infrastructure, including the management for the climate database, at BMD.

The current state at BMD necessitates additional qualified personnel who will be responsible for maintenance of the GBON observation network ICT networks for operation, maintenance, and sustainability of the infrastructure. The planned recruitment should therefore give priority to hiring on qualified personnel key for GBON stations operations. It is also recommended that the Standard SOPs for the observational network's deployment, maintenance, calibrations, and quality control should be developed and made available.

Recommendation on training activities and recruitment for technical staff relevant for GBON stations operation is provided in the Technical Specification for Automatic Weather Stations annexed in the report.

Table 8: Personnel for GBON stations operations at BMD

Personnel	Task	Available at BMD	Education & Credentials	Analysed Gaps
Network management planning specialists/ Communication Engineer	Including those who work in service, incident, change and process improvement management, and life-cycle support	02	N/A	• No Separate ICT Division • Manpower – need develop certified personnel in network management

Personnel	Task	Available at BMD	Education & Credentials	Analysed Gaps
Field technicians (system operators or system observers)/ Inspector	Technical tasks of maintenance, repair, and upgrades to the meteorological system	08 including technicians in regional offices	meteorological instruments technicians trained at BMD with the WMO inspector Course. "Basic Instructional Package for Meteorological Technicians Inspector Course" for 2 months.	• Basic electrical-electronics training on meteorological instrument and sensors • AWS training on installation, maintenance, configuration and maintenance • Regular Hands-on Training on calibration of different meteorological instruments • Meteorological workshop management training • Manpower – need additional trained meteorological instrument technicians. • No calibration experts for AWS
Operational support 24/7	From the IT service desk to log field site, communications, or server failures to ensure repairs are affected in a timely manner.	0	N/A	• No Separate ICT Division. We are getting limited service through annual maintenance contacts (AMC) from vendors for our operational support. • Manpower – need additional It service desk personnel's
IT Specialists/Meteorologist/Engineer	Supporting data ingestion, QA/QC functions, storage and the flow of data and products to forecast models	07	4 years BSc Hons & 1 Yr MSc	• No Separate ICT Division. • Though we do not have IT specialist Few of our officials are engaged for the tasks.
Specialists / data scientist/ Meteorologist	analyse, interpret, and apply AWS information	02	4 years BSc Hons & 1 Yr MSc Degree in Atmospheric Physics, Meteorological Science	• No Separate ICT Division. • Training on the use of database system (CLIDATA) • Training on application and use of WIS 2.0 and GTS • Training on metadata management • Training on managing AWS stations data • No database administrator
Engineers	AWS installation, configuration, maintenance, calibration and overall management	04	Electrical and Electronics Engineers	• State of the art AWS training on installation, configuration, calibration and maintenance • Training on QMS on activities and services • Manpower – need additional trained Electrical-Electronics Engineers
Managers/Engineer	Manage the data acquisition and station infrastructure activities Administer and manage the whole ICT functions of the Institute	02	Degree in Atmospheric Physics, Meteorological Science, EEE, Computer science & Eng,	• No Separate ICT Division • Short term capacity building in managing stations and meteorological infrastructure • Capacity building in ICT infrastructure management and configuration

Personnel	Task	Available at BMD	Education & Credentials	Analysed Gaps
	Coordinate the existing 5 Regional Inspection Centre Lead the whole activities related to stations management and data acquisition at the regional levels		Mechanical Engineering	• Experience sharing with similar meteorological organization of well-established and developed nations
Port Meteorological Officers (PMO)	Provide an operational marine forecasting and warning service; Supply data to end users.	01		
Senior management/ Meteorologist/ Engineer	Responsible for overseeing the overall data management regime at the institute, its design, implementation and administration throughout the organization. Responsible for the provision of strategic and operational leadership in SOFF planning and implementation Inspect the data to day activities of data, ICT and station infrastructure offices and give direction to them in order meet the Institute's goals and objectives Approve the annual plan of station administration, data management and ICT offices Assign experts and managers to design, craft and implement development projects Give direction to managers to incorporate the needs of the government in their areas of focus Ensure in collaboration with relevant government organization and Ministry of Water and Energy the safe operation of conventional and AWS stations and the like	02	Electronic and Electrical Engineering (EEE), MSc in Atmospheric physics, Meteorology or PhD in Meteorology and related fields	• Proper management training/ courses, including data administration and management functions; • Capacity building and training on modern database and information system and ICT technologies • Project management and implementation • Experience sharing with similar meteorological organization of well-established and developed nations • Short course in leadership and managerial skills

General recommendation:

- For GBON compliance, focus should be on increasing capacity and capabilities of staff at BMD. The provided analysed gaps show where most is needed including operation and maintenance of AWS. Continuous capacity gaps analysis should be conducted periodically.
- Design an effective climate database management system in line with the capabilities of BMD staff.
- Proactive recruiting policy for the sustainability of the institute's capacity and capabilities while eliminating negative effects of extended vacancies.
- Minimal dependent on external consultants
- Initiate project management training
- Sufficient skilled ICT manpower is recommended for the sustainability of the system.

4.4. Gender and CSOs considerations

Gender

The Bangladesh Government has made efforts to encourage women participation in various fields and have reserved a 10% quota to increase participation of women in the civil service. According to the 2021 Bangladesh Bureau of Statistics (BBS) report[46], the percentage of female officials in Public Administration was 20% and in field office was at 23%. While progress has been made in a variety of disciplines, women representation still appears to be far behind.

At BMD, the proportion of women engaged in various fields is significantly lower (17%) compared to men (83%). Women make up far less than 5% of the workforce in scientific, technical, and information and communication technology (ICT) disciplines. It is therefore highly recommended that women be given priority when SOFF is implemented in Bangladesh in order to boost their representation. Furthermore, the planned recruitment of staff at BMD should focus on enhancing gender balance through the development and implementation of a gender equality strategy in accordance with the WMO gender action plan[47]. BMD would particularly benefit from having strategies and mechanisms to integrate gender mainstreaming into their service provision and have them implemented. Organized seminars, training and workshops on the benefits of gender equality and gender-responsive climate services can be beneficial. The gender equality strategy has been successful in the SAREPTA project between BMD and MET Norway where there is currently a 50:50 male to female participation.

BMD is expected to implement the SOFF gender action plan, which mandates that all GBON National Contribution Plans contain gender considerations in order to promote female equality and empowerment. It is anticipated that women will engage in capacity-building initiatives and consultations at a 50% rate during the SOFF investment phase. Table 9 lists the various gender consideration tasks that SOFF has recommended be completed as part of its investment efforts

[46] Gender-Based Employment and Wage in Bangladesh
[47] WMO's gender plan action

in BMD. A financial strategy for allocating resources toward women's empowerment and gender equality will be incorporated into the SOFF framework throughout the investment phase.

Table 9: Gender considerations for SOFF activities in BMD

Activity	Indicator
Deliver capacity building activities on gender-sensitive topics in the context of SOFF operations	● Report on technical capacity building workshop at BMD on gender sensitive topics to mainstream the government strategies and development plans on gender concerns
Conduct a gender assessment analysis as part of the human capacity assessment (including areas as gender discrimination, harassment, gender balance etc.) and provide recommendations accordingly.	● Reports on the gender assessment analysis, highlighting findings and recommendation on affirmative action to bridge the gap where necessary
Organise stakeholder engagement workshops/consultations including, where possible, civil society organisations (CSOs) focused on women's empowerment	● Further stakeholders' engagement activities that involve CSOs focused on women' empowerment recommended in the National Contribution Plan
Promote gender equality by establishing minimum thresholds for female participation in SOFF-related activities	Ideally, women should represent at least ● 50 %[48] of all participants in SOFF-related and supported trainings ● 50 % of all participants in SOFF consultations, planning workshops, etc. ● 50 % of staff for operating and maintaining GBON stations ● 50 % of decision-making and project management positions where applicable BMD should set up affirmative action plan to improve women representation from the current 17 %to at least 30% during the initial SOFF period

[48] In cases where it is not possible to meet this threshold a strong justification should be provided.

Civil society organisations (CSOs)

CSOs play an important role in transforming global agendas into national ones in Bangladesh. BMD actively works with CSOs, particularly on the effectiveness of early warning systems and climate change policy. BMD recently held a heat wave alert meeting with Dhaka North City Corporation on February 25, 2024, to produce a micro zoning map of Dhaka City Corporation to help BMD forecast and respond to heat waves more effectively. In addition, BMD organises the Monsoon Forum twice a year, with RIMES serving as a facilitator, to inform civil society organisations on the forthcoming seasonal forecast. BMD also collaborates with Bangladesh Red Crescent Society (BDRCS) in the event of weather disasters.

In February 2024, BMD and MET Norway hosted a SOFF stakeholder meeting in Dhaka, Bangladesh. The meeting brought together many players across Bangladesh's meteorological value chain, including government ministries, UN agencies, media organisations, NGOs, CSOs and academia. The purpose was to generate debate and consultations that would lead to future engagements with BMD, especially with CSOs and private institutions, focusing on the sustainability of observation networks. The workshop was an excellent start in raising awareness about BMD exercises and how they might be supplemented. A meeting report is presented in Annex IV. During the workshop, a side event was held between the peer advisors and the World Bank BWCSRP project leadership to ascertain the complementarity of the SOFF Project at BMD. Some of the recommendations in this report are based on feedback from the meeting.

It is proposed that additional consultation platforms that foster collaborative communication and interaction with CSOs be expanded and maintained on a regular basis in order to improve collaborations that benefit the long-term operation of SOFF project. CSOs can contribute to these collaborations by facilitating public awareness about BMD's services and their relevance to communities, as well as promoting stakeholder and user participation through grass-roots workshops. BMD can also actively partner with CSO on participatory scenario planning on the use of BMD's weather forecast and alerts for disaster response.

Module 5. Risk Management Framework

Table 10: SOFF risk management framework in Bangladesh

Operational risks	Analysis of risks	Actions for mitigating the risks	Monitor and evaluate risks following implementation of mitigation actions
Inflated budget	Costs in general (equipment, general expenses etc) could rise, as well as exchange rates. Planned budget may fail to accomplish the project targets **Risk level is high.**	Allocate contingency budget that considers the yearly inflation rate based on detailed analysis of past situations.	Follow up the use of contingency budget in case of inflation and the general rise in costs
City development (urbanisation expansion) and potential station obstruction	City administration may plan to build infrastructure and buildings close to an AWS. This could interfere the data quality and create a different microclimate **Risk level is high.**	Strengthen awareness to the local community of the importance of AWS exposure. Regular update of the metadata to ensure observation data quality.	Receive regular reports from the observers and regional office administration of the status of the AWS.
Staff skills and turnover	Due to budget constraints and limited human capacity, staff may lack the necessary skill to undertake specific tasks. Employees and key personnel may move on to other organisations or businesses in search of better salary. **Risk level is high.**	Allocate sufficient resources for training and make sure that enough people are trained Good working environments. Put in place incentive mechanisms for key staff under SOFF	Regular reports of the human resource capability

Implementation delays	Slow implementation and delays in procurement, installation and capacity building & training activities **Risk level is high.**	Collaborate with IE, peer advisors and neighbouring SOFF countries in order to speed up the activities	Receive regular status reports from IE
Infrastructure and technical challenges	AWS and in-house infrastructure, communication, unstable power supply, operational vehicles, insufficient internet, vandalism **Risk level is medium.**	Sufficient allocated budget to upgrade infrastructure elements should be in place. Make sure backup solutions are in place (redundancy)	Regular status reports

Module 6. Transition to SOFF investment phase

The initiatives outlined in Bangladesh National Gap Analysis and this National Contribution Plan will serve as the foundation for developing the Investment Funding Request Proposal. The peer advisors collaborated with the beneficiary BMD to develop the SOFF Investments estimates proposal (Annex II) and the activities required of BMD throughout the implementation phase. The implementation entity, IsDB, will refine the funding request proposal based on feedback from the reports and inputs from the peer advisors, and the BMD.

Summary of GBON National Contribution Plan

Components	Recommended activities
Module 2. GBON business model and institutional development	1. BMD collaborates with several governmental institutions in Bangladesh but will benefit from better formulation of existing relationships with formal agreements that are mutually beneficial. Partnerships and collaborations with private sectors should be initiated and strengthened to maximise synergies between SOFF activities in Bangladesh. Especially with academia that can serve as a national hub for training and staffing.
	2. Strengthen sub-regional collaboration, especially regarding capacity building training, calibration practices and seek common solutions to common challenges. This could contribute to sustained compliance to GBON strategy both in Bangladesh and across the region.
	3. While a fully public business model (government-owned and government-operated networks) is the best recommendation for BMD, enhancing engagement with private stakeholders through workshops and forums can encourage future engagements and support.
	4. Consider engaging with the Civil Aviation Authority of Bangladesh (CAAB) to develop a plan for aviation cost recovery to support ongoing funding to BMD.
	5. Engagement with Bay of Bengal initiative for Multi-sectoral Technical and Economic Cooperation (BIMSTEC) especially with regards to development of marine stations services in BMD.
	6. BMD does not currently have a strategic plan. The current strategy plan for creating and strengthening observation networks is viewed solely as a procurement document. It is therefore critical that BMD develop and implement an operational strategic plan that is aligned with the national strategic plan. The strategic plan should be updated on a regular basis while closely aligning it with national policies and strategies.
Module 3. GBON infrastructure development	1. Implement the Bangladesh National Gap Analysis and recommendations in this National Contribution Plan to achieve complete GBON compliance, particularly by automating the data transmission system for global exchange via WIS 2.0.
	2. Prioritise expanding BMD personnel capacity by training and/or the recruitment of experienced IT professionals for increased data processing and management capabilities, particularly making data exchange compliant with WIS 2.0.
	3. Establish a transition strategy with Mazzak because BMD will need to autonomously operate, manage, and maintain their AWS station network and data management throughout the whole data value chain beginning in June 2025.

	4. Establish and implement a calibration and maintenance plan.
	5. Consider an open-source data management system as an alternative and/or backup as the Climate Data Management System (CDMS) at BMD.
	6. Plan procurement of one marine station once the GBON tender specifications for marine stations from the WMO are finished.
	7. Explore the proposed recommendation on Environmental and sustainability considerations in their observing networks, infrastructure and operations plan to reduce their environmental impacts
Module 4. GBON human capacity development	1. Only 13% of the present BMD workforce (673) holds a higher degree. To be more competent in providing the necessary meteorological services and other essential roles in national and international development related to GBON, BMD must restructure its human capacity to incorporate more personnel with suitable training and competence. Emphasis should be placed on the department's lack of IT skills and people committed to research and climatology. Training in system operation, inspection, and maintenance of AWS, as well as calibration techniques, will be advantageous.
	2. The evaluated human capability gaps in Table 8 should be considered and addressed. BMD should prioritise increasing the capacity and capabilities of its staff, as well as conducting continuous capacity gap analysis, including training to establish skilled IT specialists for increased data processing capabilities, including making data exchange compatible with WIS 2.0.
	3. Implement a proactive recruiting policy to ensure the institute's sustainability while mitigating the negative consequences of extensive vacancies. This will reduce dependence on external consultants.
	4. Implement the SOFF gender action plan and promote gender equality by establishing minimum thresholds for female participation with affirmative actions to bridge the gap between female and male staff, especially for technical staff.
Module 5. Risk Management	Regularly update the SOFF Risk Management Framework and put the recommended steps into action. For the successful implementation of SOFF, emphasis should be placed on personnel skills and turnover risk, which is considered as extremely high.
Module 6. Transition to SOFF investment phase	Transition to be implemented in collaboration between the SOFF operation partners in Bangladesh with support from WMO/SOFF secretariat following approval of the National Contribution Plan report.

Annexes

Annex I: Technical specification of the BMD observational network[49]

Annex II: SOFF Expenditure Estimate for Bangladesh

SOFF Investments and activities needs for BMD				
Human and Institutional				
Activity	**Quantity**	**Frequency**	**Unit cost ($)**	**Total cost ($)**
Partnership				
1. Conduct face to face meetings with selected private sector and CSOs on support on operations of and M&E for SOFF and GBON compliance of other stations at BMD	1	4	2,000.00	8,000.00
2. Organise stakeholder engagement workshops/consultations including, where possible, civil society organisations (CSOs) focused on women's empowerment	1	3	2,000.00	6,000.00
3. Consultative regional and national workshops	1	3	10,000.00	30,000.00
Sub Total				**44,000.00**
Institutional Capacity				
1. Develop institutional capacity for ICT and System Management (targeting officers)	4	1	5,000.00	20,000.00
2. Upgrade the Server/ Communication room (Computers, network devices, air-conditioning, power outlets, cabling, UPSs etc)	1	1	20,000.00	20,000.00
3. Upgrade climate database management system (CDMS - CLIDATA) with licence to integrate all AWS data	1	1	10,000.00	10,000.00
4. Create back-up climate database management system (CLIMSOFT) - open source	1	1	10,000.00	10,000.00
5. Develop BMD capacity on OSCAR/ WDQMS (targeting officers) (travel, accommodation and tuition)	4	1	5,000.00	20,000.00
Sub Total				**80,000.00**

[49] Technical specification of the BMD observation network

Human Capacity				
1. Capacity building local training in ICT/ Network management (targeting officers) for 5 days	4	1	1,500.00	6,000.00
2. Capacity building Local training in Programming Language for 5 days	10	1	1,500.00	15,000.00
3. Capacity building Local training in Electronics/ Electrical engineering (targeting officers) for 5 days	5	1	1,500.00	7,500.00
4. Tailored training in maintenance and calibration of automated monitoring systems for 5 days	4	1	1,500.00	6,000.00
5. (a)Tailored training in meteorological metrology, theory training on routine elements of meteorology, and guidance on metrology programs based on AWS value transfer and traceability. - 10 day training at CMA, for 10 personnel (5 elements, totaling 10 people.) - Cost: Includes all costs of travel to and from BMD's personnel, as well as all costs for the Chinese side to host this event.	10	1	5,000.00	50,000.00
5. (b)Standards and business process learning on wind speed and direction, and precipitation : Using CMA's wind tunnel, and precipitation standards and other equipment. complete operational practices, complete sensor calibration, data processing, uncertainty assessment, complete calibration conclusions and metrological reports. - 5 day training at CMA, targeting 4 Personnel: 4 calibrators - Cost: All costs for the Chinese side for this event..	4	1	2,000.00	8,000.00
5. (c) Calibration and business process learning (temperature, humidity, barometric pressure parameters): operate with BMD's existing calibration system, complete sensor calibration, data processing, uncertainty assessment, complete calibration conclusions and metrology reports. Provide suggestions for BMD metrology business quality system construction, business quality assurance program establishment, and overall business operation. - 5 day training at BMD includes 4 CMA experts. - Cost: Including round-trip travel of CMA personnel and all expenses for teaching.	4	1	10,000.00	40,000.00
6. Tailored trainings in Upper air O & M and analysis (travel, accommodation and tuition) for 5 days	2	1	7,000.00	14,000.00
7. Capacity building training on WIS2Box data exchange and administration	5	2	1,500.00	15,000.00
8. Tailored capacity building training in use of Climate Data Management Systems (CLIDATA, CLIMSOFT), including QC (travel, accommodation and tuition) for 5 days	4	1	10,000.00	40,000.00
Sub Total				**201,500.00**
Acquisition and Installation of Infrastructure				
Activity				

AWS Improvement				
1. Annual Maintenance Contract (AMC) for the AWS for 3 yrs, Including two operations persons for maintenance and quarterly preventive maintenance	1	1	291,000.00	291,000.00
2. Internet subscription for operations of CDMS/ servers and AWS communication in place	2	1	70,000.00	140,000.00
3. Conduct routine servicing and calibration of AWSs (DSA, travel, parts, materials)	2	4	2,500.00	20,000.00
4. Routine management of server systems for data access/exchange (Power, UPS, air-cons, cleaning)	1	1	20,000.00	20,000.00
5. Procure necessary AWSs spare parts for 3 yrs	10	1	25,000.00	250,000.00
6. Rework the sites for AWS installation (fencing, security enhancement, base strengthening, etc)	5	1	1,105.00	5,525.00
7. Conduct awareness at installation sites for routine maintenance and cleaning of AWSs mast.	1	3	350.00	1,050.00
8. Develop SOPs for O&M for AWSs and other automated monitoring systems	1	3	475.00	1,425.00
9. Upgrade of GTS/ WIS2Box data exchange systems (server, backup)	1	1	185,000.00	185,000.00
9. Upgrade of ICT and Data management System	1	1	100,000.00	100,000.00
10. Integrate AWS data into the upgraded CDMS –(practical orientation of officers)	4	1	400.00	1,600.00
Sub Total				**1,015,600.00**
UPPER AIR Station Improvement				
1. Procure upper air station accessories (balloons, gas, radiosondes)	1	1	200,000.00	200,000.00
2. Undertake security enhancing measures at the site (fencing, security enhancement, base strengthening, etc)	1	1	1,465.00	1,465.00
3. Develop and test SOPs for O&M of Upper air station	1	5	475.00	2,375.00
4. Integrate Upper air data into the upgraded CDMS	1	4	1,000.00	4,000.00
5. Conduct awareness at installation sites for routine maintenance and cleaning of Upper air station	1	1	350.00	350.00
Sub Total				**208,190.00**
Operation, Maintenance and Monitoring of Operations				
Calibration Lab Improvement				
AutoRainfall CalibrationLab				
Auto Rainfall Calibrator ARC100 -P	1	1	49,230.80	49,230.00

Software Rainfall calibration system	1		7,402.00	7,402.00
Display screen - Display the calibration data	1		1,230.70	1,230.70
Rainfall calibrator's stand -Place the rainfall calibrator	2		2,307.69	4,615.38
Online training -and installation guide	1		2,829.00	2,829.00
Freight cost	1		7,402.00	7,402.00
Sub Total				**72,709.08**
Sustained compliance				
AWS				
1. Internet subscription for operations of AWS communication in place for 3yrs	1	2	2,700.00	2,700.00
2. Hosting subscription for operations AWS communication for 3yrs	1	1	1,050.00	1,050.00
3. Conduct routine servicing and calibration of AWSs (DSA, travel, parts, materials)	1	4	5,000.00	20,000.00
4. Routine management of server systems for data access/exchange (Power, UPS, air-cons, cleaning)	1	4	3,000.00	12,000.00
Sub Total				**35,750.00**
Upper Air Station				
1. Internet subscription for operations of CDMS/ servers and AWS communication in place	1	3	900.00	2,700.00
2. Conduct routine servicing of UA station	1	3	400.00	1,200.00
3. Exchange hourly data globally through GTS/WIS2Box	1	4	1,000.00	4,000.00
4. Annual O&M cost, labour cost per site and annual consumable cost (2 launches per day)	1	2	200,000.00	400,000.00
5. Spare parts	1	2	5,000.00	10,000.00
Sub Total				**417,900.00**
Total for all Outputs				**2,075,649.08**

Annex III: ICT Infrastructure Specification at BMD[50]

[50] ICT Infrastructure Specification at BMD

Annex IV: Report on the SOFF Stakeholders Workshop in Dhaka-Bangladesh[51]

MINISTRY OF DEFENCE
BANGLADESH METEOROLOGICAL DEPARTMENT

REPORT ON
SYSTEMATIC OBSERVATIONS FINANCING FACILITY (SOFF) STAKEHOLDERS WORKSHOP

JOINT ACTIVITY WITH THE NORWEGIAN METEOROLOGICAL INSTITUTE AND CHINESE METEOROLOGICAL ADMINISTRATION

Author: Razia Sultana (BMD)

February 2024

[51] Report on SOFF Stakeholder Workshop 28 Feb 2024

Introduction:

Bangladesh Meteorological Department (BMD) seeks for support from the World Meteorological Organization (WMO) facilitated by the systematic observations financing facility (SOFF). The goal of the project is to ensure sustained compliance with the Global Basic Observing Network (GBON) regulations, which will contribute to improved weather and climate forecasting products in order to ensure the regular and continuous availability of observation data globally. In terms of the frequency of reporting observations and meteorological parameters being observed, SOFF will ensure that Bangladesh has GBON compliant observation stations. These observations are important for the effective operations and output from numerical weather modelling centres that are part of the Global Data-processing and Forecasting System of WMO. SOFF will also lead to better local forecasts that is a foundation for the UN Early Warnings for All.

BMD is supported by the Norwegian Meteorological Institute (MET Norway) as the Peer Advisor, China Meteorological Administration (CMA) as co-peer Advisor, and IsDB Dhaka as the implementing entity. As a part of the SOFF Readiness phase, a stakeholders' workshop was jointly organized by Bangladesh Meteorological Department (BMD) on Thursday 28th February 2024 at Hotel Sarina, Banani, Dhaka in collaboration with the Norwegian Meteorological Institute (MET Norway).

The workshop was attended by different stakeholders including government ministries, departments and agencies, the media, academia, development partners and civil societies. The 60 stakeholders present were from different climate related sectors such as agriculture, fisheries, disaster risk management, energy, water resource management, telecommunications and transport, as well as from intergovernmental regional organisations. The overall objective of the workshop was to consult with stakeholders on the status of weather and climate services provided by the BMD from the stakeholders' perspective and to bring together relevant stakeholders across the meteorological value chain to facilitate dialogue and consultations that will maximise synergies between SOFF activities in BMD and other stakeholders. Output from the workshop will contribute to the BMD's Country Hydromet Diagnostic report under the SOFF programme.

The Workshop Presentations and Group Work:

Md. Azizur Rahman, Director of the Bangladesh Meteorological Department and the day's chairman officially launched the workshop. In his introductory remark, he introduced the background of SOFF and underlined its importance for Bangladesh, and concluded by acknowledging the participants of the workshop and in particular those from MET Norway.
Dr. Hans Olav Hygen, Project Manager of Capacity Building Projects for the SAREPTA project[52] at MET Norway, presented his opening remarks on SOFF. He also commented on how well the MET Norway team has collaborated with BMD for over a decade to support and boost BMD's

[52] https://bistand.met.no/en/Bangladesh

development of weather and climate services. Dr. Guo Jianxia expressed her gratitude and gave her thoughts for how CMA may support BMD while preparing NCP and CHD for SOFF activities. Mr. Robiul Islam, Project Management Specialist at IsDB, represented IsDB Bangladesh. Mr. Robiul, the implementing entity's representative, also made a few remarks. Ms. Elinah went on to explain how SOFF will help to accelerate the collection and international exchange of highly essential surface and upper air observation in compliance with international standards, thereby closing the weather and climate data gaps and improving the quality and timely provision of weather forecasts, early warning and climate services.

Presentations were made on

(i) Introduction to GBON and Present Status of Bangladesh by Md. Abdul Matin of BMD
(ii) Introduction to SOFF (what it is; Bangladesh SOFF status) by Elinah Khasandi Kuya of MET Norway,
(iii) Global Meteorological Observation and Forecast Service in CMA by Ms. Guo Jianxia of CMA
(iv) The country hydromet diagnostics by Dr. Teferi Demessie of MET Norway.
(v) Human Capacity Development of BMD by Dr.Shameem Hassan Bhuiya of BMD
(vi) ICT infrastructure and services of BMD by Razia Sultana of BMD
(vii) Data management system of BMD by S M Quamrul Hassan of BMD
(vii) Potential implementation challenges by Tor Ivar Mathisen of MET Norway

Groups assignments followed during which the stakeholders were divided into three groups to discuss the following discussion points:

- **Engagement of stakeholders in the service delivery**

  Can BMD provide new or better service tailored to your needs as a stakeholder?
  - What services do you need first and foremost from BMD in your line of work?
  - What can BMD provide and/or improve?
  - How/where would you like to access those services?
  - If you could pick one service that would make a big difference for you, what would it be?
- **Dissemination of the forecasts and warnings**
  - Do you think BMD is effective in reaching out to users and stakeholders?
  - How can improved cooperation between sectors enhance better dissemination to the public?
  - What is needed to enhance such cooperation?
- **Country Hydromet Diagnostics can help identify the gaps, challenges and opportunities for BMD;**
  - In your opinion, where are the highest priorities for support at BMD

Group Discussions

The groups' discussions were presented and summarised as follows:

Engagement of stakeholders in the service delivery

- In general BMD provides a good and effective service to the users and stakeholders. However, there is a concern from few stakeholders with limited awareness of the services. They can also benefit more from services and products that are tailored to specific sectors. Service agreements and increased coordination between BMD and stakeholders was recommended.
- Point location forecasts are needed in order to provide additional information at subregional and community level (and not only on a regional level).
- More accurate 7-10 days (medium range) forecasts are needed. Some stakeholders from Roads and Highway and Tourism sector ask for 3 hourly forecast
- More use of probabilistic forecasts (extended use of the ensemble system) might be beneficial
- More detailed sub-seasonal and seasonal forecasts are needed for agricultural planning purposes. Weather index regarding agriculture / crop yield can add more significant weather information.
- An API-service from BMD would be very beneficial, where the users can retrieve the data they need themselves from BMD (e.g. for a "lat/lon" point forecast)
- Make better use of nowcasting (such as availability of real time observations, weather radars etc)
- Easier access to historical observation data for analysis and reanalysis purposes
- Development of a warning app for natural hazards (such as coastal cyclones): Potential collaboration between the CPP and BMD?
- On new and better services, platforms for engagement and research were recommended as means of improving the understanding of users' needs of weather and climate data.
- Services needed by stakeholders included timely and more accurate weather information, (ii) improved micro-scale services for insurance to check claims, and (iii) improved and automated means of data and information access.

Dissemination of the forecasts and warnings

- Recommendations on improved cooperation to enhance dissemination of weather and climate information included
    - cooperating with the media (community radios, hosts of media platforms, extension services partners (agriculture, fisheries) as means of disseminating information, improve visibility to media and administration, tailored website
    - parliamentarians as means of lobbying for more funds and
    - the local communities who need timely and accurate disseminated information
- In order to enhance the cooperation, groups recommended (i) campaigns and awareness programs can be included.
- Image with map for forecast of different regions of Bangladesh- color map easier to understand for illiterate people.
- Designing projects that are more inclusive, establishing relevant working groups, SOPs for engagement and adherence to policies and strategic frameworks.
- Observed challenges to sustainable weather and climate services included (i) use or adoption of technologies for communication and dissemination (mobile and internet services specially social media), (ii) inadequate capacity to provide information in several

local languages, (iii) vandalism and high cost of monitoring equipment and, (iv) limited knowledge at all levels. Recommendations include improving coordination, data sharing and assurance of data quality, procurement of sensible equipment, etc.

Opportunities for PPP (Public-Private-Partnership)

- Proposed recommendations for PPP included partnerships in data management (repositories) for hydromet, partnerships with media for subsidised rates to information dissemination, and mobile service providers on utilisation of technologies.
- Also recommended are the partnerships with institutions to identify value addition needs for demanded weather and climate services to enable cost recovery operations, and to also undertake the cost-benefit analysis of climate services and use in justifying for resources needs.

Way Forward:

Appreciating the contributions and recommendations that were made by stakeholders, there is a need for continued unilateral and multilateral engagements with potential partners in order to realise the sustainability of weather and climate services. There is potential for partners to help with managing stations and ensuring their G-BON compliance. BMD will need to be engaging partners actively.

Annex I: Meeting Program

Systematic Observation Facility Financing Stakeholders Meeting

28 February 2024, Hotel Sarina, Banani, Dhaka, Bangladesh

Time	**Theme/Activity**	**Responsible**	**Facilitator**
09:30-10:30	Registration		BMD
10:30-10:40	Opening Remark	Md. Azizur Rahman Director, BMD	
10:40 -10:50	Introduction to GBON and Present Status of Bangladesh	Mr. Abdul Matin, Sr. Communication Engineer	
10:50 -11:00	Introduction to SOFF (what it is; Bangladesh SOFF status)	MET Norway (Elinah Khasandi Kuya)	MET Norway/CMA
11:00-11:15	**Coffee Break**	**Hotel**	
11:15-11:30	Country Hydromet Diagnostics status	MET Norway (Elinah Khasandi Kuya)	
11:30-11:40	Standard Calibration Infrastructure	Tor Ivan/Ms. Guo/others	
11:40-11:50	ICT infrastructure and services	Razia Sultana	
11:50-12:00	Data management system	SM Quamrul Hassan	
12:00-12:10	Human Capacity Development	Dr Shameem Hassan Bhuiya	
12:10-12:20	Project Risk Analysis	Peer team/Elinah will decide	
12:20-12:30	Discussion /Q&A	SOFF BMD SOFF Peer CoPeer Team	
12:30-1:30	Lunch Break		
1:30-4:00	Role of Stakeholders in SOFF and sustainability of met & climate services *Hosting of monitoring systems *Communication *GBON compliance *co-benefiting (e.g tailoring of products, data sharing, real-time access)	Group work/Plenary Led by MET Norway (Elinah Khasandi Kuya)	
4:00	Closing Remarks	Ahmed Arif Rashid	

participant list

Annex II: Photo gallery

SOFF Bangladesh peer advisory team at Hotel Sarina, Banani, Dhaka, Bangladesh (from left, Teferi Dejene Demissie, Tor Ivar Mathisen, Elinah Khasandi Kuya, Guo Jianxia, Yang Shunan, Bian Zeqiang)

Introductory remarks by Dr. Hans Olav Hygen (MET Norway)

SOFF Bangladesh team at the BMD – Dhaka offices (from left, Yang Shunan, Bian Zeqiang, Guo Jianxia, Elinah Khasandi Kuya, Teferi Dejene Demissie, Razia Sultana and Abdul Matin)

Site Visits at Dhaka Meteorological Station

Upper air observations at Dhaka Meteorological Station

Site visit at BMDs calibration laboratory

Report completion signatures

Peer Advisor signature
Kristiansand, 08.08.2024

Roar Skålin, Director General, MET Norway

Beneficiary Country signature
11.8.2024

Md. Azizur Rahman, Director,
Bangladesh Meteorological Department

WMO Technical Authority signature