COUNTRY HYDROMET DIAGNOSTICS

Informing policy and investment decisions for high-quality weather forecasts, early warning systems, and climate information in developing countries.

June 2024
Bangladesh Peer Review Report

Reviewing Agency: Norwegian Meteorological Institute and China Meteorological Administration

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Norwegian Meteorological Institute

China Meteorological Administration

IsDB البنك الإسلامي للتنمية Islamic Development Bank

SOFF Systematic Observations Financing Facility

WORLD METEOROLOGICAL ORGANIZATION

Alliance for Hydromet Development

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Authorisation for release of this report has been received from the Peer Reviewing Agency and the Country NMHS as of June 2024.

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Acknowledgements

The peer advisory team extends its heartfelt appreciation to the Bangladesh Meteorological Department SOFF team. Special thanks to Abdul Matin, Razia Sultana, and S M Quamrul Hassan for their involvement, experience, and detailed insights into BMD throughout consultations and the compilation of this Country Hydromet Diagnostics report. The SAREPTA Bangladesh team in MET Norway led by Hans Olav Hygen is also appreciated for their additional insight into BMD and their contribution to the development of this report.

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List of acronyms and abbreviations

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
BCC	Beijing Climate Centre
BCCSAP	Bangladesh Climate Change Strategy and Action Plan
BCS	Bangladesh Civil Service
BCWC	BIMSTEC Centre for Weather and Climate
BDRCS	Bangladesh Red Crescent Society
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
BUFR	Binary Universal Form for the Representation (of meteorological data)
BWCSRP	Bangladesh Weather and Climate Services Regional Project
BWDB	Bangladesh Water Development Board
CAAB	Civil Aviation Authority of Bangladesh
CAP	Common Alerting Protocol
CCNP	Cisco Certified Network Official
CDMS	Climate Database Management System
CHD	Country Hydromet Diagnostics
CMA	China Meteorological Administration
CPP	Cyclone Preparedness Programme
CSO	Civil Society Organisation
CWC	Central Water Commission
DAE	Department of Agricultural Extension
DMC	Disaster Management Committees
DDM	Department of Disaster Management
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
ECMWF	European Centre for Medium-Range Weather Forecasts
FFWS	Flood Forecasting and Warning Centre
FFGS	Flash Flood Guidance System
FTP	File Transfer Protocol
GBON	Global Basic Observing Network
GFS	Global Forecast System
GHG	Greenhouse gases
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
IBF	Impact Based Forecasting
ICAO	International Civil Aviation Organization
ICIMOD	International Centre for Integrated Mountain Development
ICT	Information Communication Technology
IE	Implementing entity for SOFF
IIRS	Indian Institute of Remote Sensing
IMD	India Meteorological Department
IMDMCC	Inter-Ministerial Disaster Management Coordination Committee
INGOs	International non-governmental organisation

INFCOM	WMO Commission for Observation, Infrastructure, and Information Systems
IOC	Intergovernmental Oceanographic Commission
IP	Internet Protocol
IRI	International Research Institute for Climate and Society
IsDB	Islamic Development Bank
ISO	International Standardisation Organisation
ISRO	Indian Space Research Organisation
JICA	Japan International Cooperation Agency
JMA	Japan Meteorological Agency
JRC	Indo-Bangladesh Joint Rivers Commission
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
MHEWS	Multi-hazard Early Warning System
MoA	Ministry of Agriculture
MoDMR	Ministry of Disaster Management and Relief
MoTT	Ministry of Transport and Tourism
MoU	Memory of Understanding
MQTT	Standard based messaging protocol (machine to machine communication)
MTBF	Medium Term Budget Framework
NCOF	National Climate Outlook Forum
NDC	Nationally Determined Contributions
NDMC	National Disaster Management Council
NDRCC	National Disaster Response Coordination Centre
NEOC	National Emergency Operation Centre
NGOs	Non-Governmental organization
NMHS	National Meteorological and Hydrological Services
NOAA	National Oceanic and Atmospheric Administration
NPDM	National Plan for Disaster Management
NSDS	National Sustainable Development Strategies
NWP	Numerical Weather Prediction
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
SAREPTA	Institutional Support and Capacity Building for Weather and Climate Services
SDG	Sustainable Development Goals
SOFF	Systematic Observation Financing Facility
RCC	Regional Climate Centre
RCOF	Regional Climate Outlook Forum
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
SOD	Standing Order on Disaster
SOPs	Standard Operating Procedures

SPARRSO	Bangladesh Space Research and Remote Sensing Organization
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
WMC	World Meteorological Center
WMS	Web Map service
8FYP	Eight Five Year Plan

Executive Summary

The Bangladesh Meteorological Department (BMD) is the authorised government body in Bangladesh responsible for all meteorological activities including maintenance of the country's network of surface and upper air observatories, radar and satellite stations system. BMD is also a crucial player in providing weather and climate services, including achieving international meteorological responsibilities.

The peer review assessment of BMD provides a high-level strategic assessment of the organization, its working environment, and its contribution to high-quality meteorological, climate, hydrology, and environmental services and warnings. BMD has demonstrated areas of strengths such as availability of institutional governance systems (Meteorological Act, 2018) as well as extensive coverage of observation infrastructure. However, there are significant gaps that demand immediate attention, particularly for Global Basic Observing Network (GBON) compliance in SOFF as part of the UN Early Warnings for All. Addressing the shortcomings within the ongoing SOFF project, as well as the recommendations made in this report, will significantly improve BMD's CHD maturity score. The maturity level of BMD across the ten elements (Figure 1) in this peer-review process is 2.7. Key areas that require immediate action include:

1. Human capacity and capabilities constraints: The capacity and technical capabilities of BMD personnel, especially those with scientific and ICT technologies (ICT), are generally lacking. The evaluated human capability gaps revealed that BMD lacks a dedicated team for research, climatology and IT. BMD also has an elderly workforce and no proactive recruitment policy. Gender disparities are also evident at BMD and require specific consideration.
2. Financial constraints: While the GoB's budget allocation consistently meets most BMD's budgetary needs in terms of salaries and operating costs for BMD's observation infrastructure, some logistical constraints limit BMD's ability to maintain its observation infrastructure (calibrations and quality assurance of the observational network) as well as meet regional and global duties for the growing demand for meteorological services. Budgetary and logistical constraints should be addressed because they limit BMD's ability to provide weather and climate services, as well as the Early Warnings for All (EW4ALL) initiative.
3. Departmental strategic, operational and risk management plan needs: BMD currently lacks a strategic plan document that outlines the department's strategic operations and goals for the short, medium, and long term. There is also no risk management plan in place, which reduces operational efficiency among leadership and personnel. These documents are critical for the organisational effectiveness of BMD.
4. Maintenance of the observation network gaps: As of 2023, BMD had expanded its automatic observation network to cover 80% of the entire network, in addition to new calibrating facilities. Critical gaps were however observed in BMD’s ability to maintain these observation networks. SOPs for calibration, maintenance and quality assurance of these automatic systems were also found to be generally lacking, compromising the sustainability of observation systems.
5. ICT infrastructure services and data management requirement: The lack of adequate skilled IT specialists to meet the increased data processing and management needs limits BMD organisational datasets management capabilities across the entire value chain. The viability of the recently acquired CDMS system is further jeopardised by a

lack of in-house capability. Prioritised expansion of BMD personnel capacity by training and/or the recruitment of ICT personnel is highly recommended.

6. User interactions and stakeholder involvement at BMD is somewhat weak and would benefit from partnerships and formal SOPs. Mechanisms for national governance at BMD need to be strengthened to facilitate collaboration with various stakeholders including in hydrology and climate services. The establishment of a National Framework for Climate Services (NFCS) or other efforts between key stakeholders in the country to formalise the working relationship can be beneficial. User interface platforms that include representation from all actors, particularly at the grassroots level, are also valuable.

Figure 1. Maturity level scores for BMD based on the CHD Methodology

Element	Maturity level score
1. Governance and institutional setting	2
2. Effective partnerships to improve service delivery	3
3. Observational infrastructure	3
4. Data and product sharing and policies	2
5. Numerical weather prediction model and forecasting tool application	3
6. Warning and advisory services	3
7. Contribution to climate services	3
8. Contribution to hydrology	3
9. Product dissemination and outreach	3
10. Use and national value of products and services	2

Chapter 1: General information

Introduction

Bangladesh is located in South Asia (between 20.57ºN to 26.63ºN and 88.02ºE to 92.68E) Figure 1. It is surrounded by India on the West, North and Northeast, Myanmar on the Southeast and the Bay of Bengal on the South. Bangladesh is one of the largest deltaic countries in the world characterised by low-lying plains, river deltas, and a network of numerous rivers (230), including Ganges (Padma), the Brahmaputra, and the Meghna. Bangladesh geographical location exposes the country to subtropical monsoon climate regime. The extensive coastline of Bangladesh (about 720 km) along the Bay of Bengal makes the country exposed to extreme natural disasters such as cyclones. The Great (Bhola) Cyclone of 1970 in Bangladesh remains the deadliest tropical cyclone ever recorded and one of the world's deadliest humanitarian disasters. Bangladesh has an approximate total landmass of 147,570 sq. km. The population of Bangladesh stood at 173.8 million in January 2024[1], with about 80% of them living in rural areas.

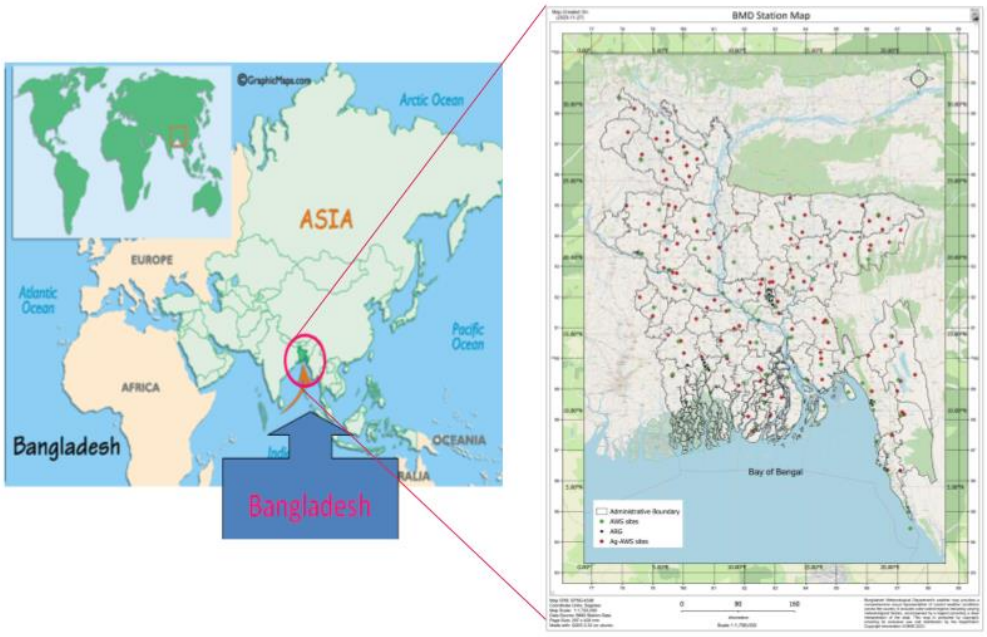

Figure 1. Location map of Bangladesh (left) and distribution of existing surface automatic weather stations (right). (Source BMD, 2024)

The climate of Bangladesh is categorised as sub-tropical monsoon, characterised by wide seasonal variations in rainfall, moderately warm temperatures, and high humidity Figure 2.

Winter Season (December-February)

In Bangladesh, the Winter Season lasts from December to January and February. Winter brings short days and lengthy nights. This is the coolest season. This season in the country brings frigid air, with temperatures dropping as low as 5°C to 8°C, while the average temperature here in winter is 15°C to 20°C. January is often the coldest month of the year.

[1] https://datareportal.com/reports/digital-2024-bangladesh

The winter season in Bangladesh is extremely dry, accounting for about 2% of total annual rainfall. Bangladesh is a tropical country. So, winter here is more moderate than in higher latitudes. A chilly air stream moves eastward and enters Bangladesh at its northwestern corner. Cold spells and foggy days are prevalent throughout this season. Tetulia recorded the winter's lowest temperature of 2.6°C on January 8, 2018. During this season, the prevailing air mass is dry at midday. Humidity trends do not show that the air is dry in the morning or late afternoon. This is because continuous evaporation occurs from multiple rivers, lakes, and natural watersheds on clear sunny days, and evaporated moisture manifests itself as high humidity throughout the chilly hours of late evening and morning. This finally aids in the production of mists/fogs during the late night and early morning. The influence is especially noticeable in the Gangetic Central and Coastal Districts.

Pre-Monsoon Season (March-May)

The pre-monsoon season occurs when the northerly or northwesterly winds of the winter season gradually shift to the southerly or southwesterly winds of the southwest monsoon or rainy season. During the beginning of this season, the winds are neither strong nor consistent. However, as the season progresses, wind speed and direction become more persistent.

Pre-monsoon is the hottest season, with high temperatures and thunderstorms/Kalbaishakhi. April is Bangladesh's hottest month, with average temperatures ranging from 27°C in the east and south to 31°C in the west-central region. Summer temperatures in the west can reach 40°C or more. This season accounts for around 19% of the total annual rainfall. The average temperature throughout the summer months ranges between 23 and 30 degrees Celsius. The northern and northwest districts see the highest temperatures, which range from 41 to 45°C. The rest of the country has high temperatures ranging from 38 to 41°C. This season is also notable for cyclogenesis in the Bay of Bengal. Some depressions may intensify into cyclonic storms that travel north-westward at first before recurving north-eastward toward the shores of Bangladesh and Myanmar. Some of these storms can reach the severity of an Extremely Severe Cyclonic Storm or Super Cyclone and are accompanied by storm surges.

Monsoon Season (June–September)

The 'Southwest Monsoon' season runs from June to September. The Southwest Monsoon period is the rainy season in the Indian subcontinent. During this period, the entire country receives about 71% of its rainfall.

The monsoon season begins in late May and lasts until early June, beginning in Bangladesh's south-east. It brings more compact cloudiness, high humidity even during the day, and frequent rains, as well as a reduction in temperature, which falls to 30/32 °C during the day but remains high at night, around 25 °C. Rains are more abundant throughout Bangladesh's coastal region, particularly in the south-east, but also in the north-east, near India's Himalayas. July has the highest average rainfall in the country, with August coming in second. The monsoon is less vigorous in western Bangladesh, where annual rainfall ranges from 1,500 to 1,600 mm, with the highest total in July.

The southwest monsoon typically begins on June 2 in the country's coastal districts and spreads across the entire country by June 14. The season is characterised by heavy to very heavy rain and cloudy skies. The northeastern, southern, and southeastern areas receive

more rainfall than the central, western, and northwestern districts. With the arrival of the monsoon, summer extreme temperatures drop significantly across the country. Although the mean temperature decreases by only one degree and the maximum temperature falls by 2°C to 5°C across the country, except in coastal districts where it drops by 5°C to 6°C. Tropical depressions and storms originate in the Bay of Bengal throughout the season and move north-westward over India, occasionally crossing the shores of Bangladesh. However, storms rarely reach hurricane status during this season.

Post-Monsoon Season (October–November)

In Bangladesh, the post-monsoon season runs from October to November. This is the transitional season from summer monsoon to the winter. The southwest monsoon begins to exit from the country in early October and continues until the end of October. During this season, the surface wind is extremely weak and changeable. Rainfall drops significantly in October and November, and the Dry spell begins over the country. This time accounts for about 8% of the country's total annual rainfall. The average temperature decreases from 28-29°C in September to 25-26°C in October and 23-25°C in November. The highest maximum temperature rarely exceeds 29.0°C, and the lowest minimum temperature never falls below 10.0°C in the country. During this season, tropical cyclones form over the Bay of Bengal and move west, then north-west, and occasionally northeast, affecting the Bangladesh coast. Some of the storms this season have the potential to become hurricanes.

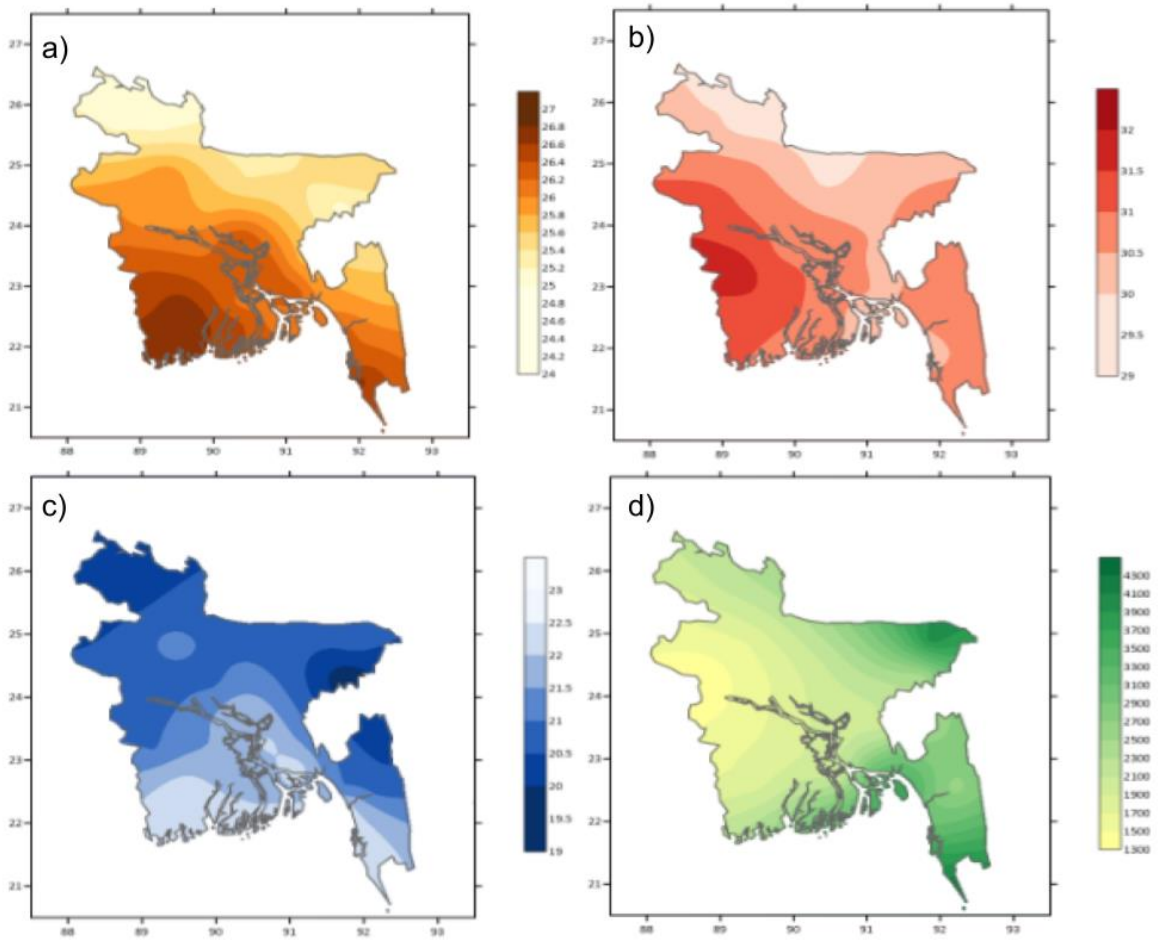

Figure 2. Spatial patterns for (a) minimum, (b) maximum, (c) mean, and (d) precipitation for the normal period 1991-2020. (Source BMD, 2024)

CHD methodology

This Country Hydromet Diagnostics (CHD) report is a peer-to-peer, standardized review of the Bangladesh Meteorological Department (BMD) operating environment as well as their contribution to high-quality weather, climate, hydrological and environmental information services and warnings prepared as part of the Systematic Observations Financing Facility (SOFF) project in Bangladesh This report has been prepared as a result of a peer-peer review of BMD by the Norwegian Meteorological Institute (MET Norway) and the Chinese Meteorological Administration (CMA) as peer advisors with some collaboration from Islamic Development Bank (IsDB) in-country focal point as the implementing entity.

The diagnostics supplement the SOFF's Global Basic Observing Network (GBON) National Gap Analysis report and the GBON National Contribution Plan reports for Bangladesh. It aims at highlighting where additional focus and support are needed in BMD, based on defined maturity levels for each of ten critical elements of the hydromet value cycle. This in turn will inform policy and investment decisions, particularly investments pertaining to the hydromet services in Bangladesh.

The CHD will therefore create a strategic level assessment across ten elements (Figure 3), with peer review serving as the overall approach. To carry out the peer-to-peer review, the Norwegian Meteorological Institute (MET Norway) adopted a variety of methods, including two in-person consultation sessions (one of which was an in-country stakeholder meeting), questionnaire and weekly online meetings held during the peer-review process (Annex 1) to peer-review BMD. WMO guidance material and survey data as well as various published documents and online content were also employed.

The findings of the peer review are summarised in this report and maturity level for each of the ten elements of the meteorological value cycle assigned including description of each component describing critical capacity gaps and recommendations for improvement. The highest possible maturity level is five. The findings will strongly enhance BMD's development especially in support of better hydrometeorological services in Bangladesh.

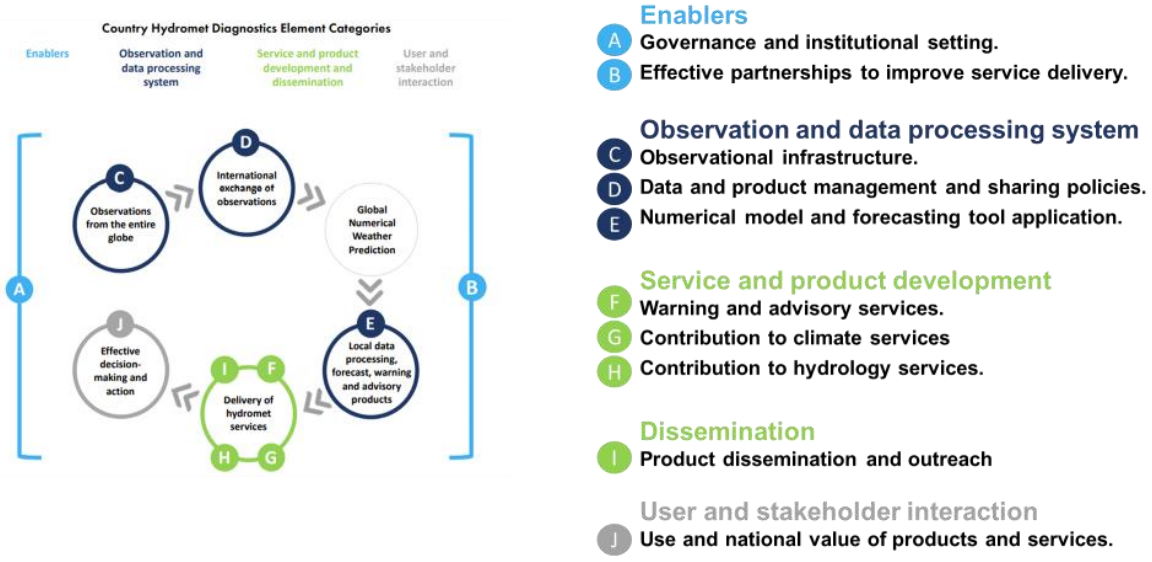

Figure 3. Main elements of the hydromet value chain (A-J) that are evaluated in this Country Hydromet Diagnostics (CHD) report

Chapter 2: Country Hydromet Diagnostics

Element 1: Governance and institutional setting

1.1 Existence of Act or Policy describing the NMHS legal mandate and its scope

The Bangladesh Meteorological Department (BMD) is a government organization working under the administrative control of the ministry of defence of the government of Bangladesh. The department's legal mandate and scope is provided by the BMD's Meteorological Act, 2018 (Act No. XXVIII of 2018)[2]. The act described the functions and duties of BMD as the only organisation having the jurisdiction to conduct meteorological services and related activities in Bangladesh. The primary areas of responsibility of BMD as provided in the act include:

I. **Provision of meteorological services**, including but not limited to: -
   A. Monitoring and collection of all meteorological data
   B. Conducting basic research on weather and climate
   C. Operating and maintenance of meteorological observatories, radars and all infrastructure under its mandate

II. **Mutual cooperation**
   A. by providing expert opinion, information and data to concerned ministries, divisions, departments, agencies, interested stakeholders, research institution and agencies as per the prescribed rules and regulations
   B. Exchange of information and data related to meteorological services with national and international organisation as per the national needs and international liability
   C. Preparing and providing astronomical information.
   D. Provide notification as to observation, forecasts and timely warnings

III. **Meteorological forecast and warnings**
   A. Issuing forecast and special notifications for use of the public, agriculture, tourism and for safe movement of vessels, ships and aircrafts

IV. **International communication, coordination and representation**
   A. Coordination with the regional associations and technical commission of WMO
   B. Representing Bangladesh in international level as to exchange of information, data and meteorological services

Other responsibilities of BMD are outlined on BMD website[3]. However, the denied responsibilities are limited to forecasting services. It would be beneficial for BMD to make the public aware about its additional areas of responsibility. This could be a catalyst for future collaborations.

In addition to provision of meteorological services, as part of its core function of mutual cooperation, BMD shares responsibilities with other ministries and departments in a number of areas primarily with regards to hydrology and agrometeorology. Hydrology is a shared responsibility between BMD, the Flood Forecasting and Warning Centre (FFWC) of Bangladesh and the Bangladesh Water Development Board (BWDB). BMD offers rainfall

[2] Meteorological Act, 2018

[3] https://live8.bmd.gov.bd/p/About-Us/

data, forecasts/warnings, radar and satellite image for the operation of flood forecasting and warning systems in addition to severe weather forecasts. Agrometeorology is a shared responsibility with the Department of Agriculture Extension (DAE). BMD has a mandate to share seasonal forecasts with DAE. These relationships were formalised under the Bangladesh Weather and Climate Services Regional Project (BWCSRP)[4], a recent world bank (WB) supported projects where BMD has the mandate to share seasonal forecasts with DAE.

BMD also shares its data, information (forecast, warnings) and expert knowledge with several other organisation and ministries in Bangladesh including and not limited to the Ministry of Agriculture (MoA), Ministry of Transport and Tourism (MoTT) , Department of Disaster Management (DDM), the Civil aviation Authority of Bangladesh, (CAAB), Bangladesh Inland Water Transport Authority (BIWTA), Ministry of Fisheries, Ministry of Livestock, Ministry of Health, Bangladesh Television, Bangladesh Betar (Radio), print and electronic media, Life Insurance Companies and also NGOs and INGOs.

Aviation services: BMD is the only meteorological authority in Bangladesh as per ICAO Annex 3. BMD provides aviation weather services to both the public and military. BMD provides both observers, forecasters, and technicians at their five national and three international airports.

Multihazard Early Warning System (MHEWS): The Ministry of Disaster Management and Relief of the Government of the People's Republic of Bangladesh bears primary responsibility for disaster risk management. This ministry plays an important role in developing policies, laws, and regulations, as well as taking the required steps to plan, implement, and monitor disaster risk management programmes. The MHEWS in Bangladesh is governed by the Standing Orders on Disaster (SOD) 2019[5]. Bangladesh is one of the most disaster-prone countries in the world and as such SOD was formulated to inform all concerned about their roles and responsibilities at every stage of disaster risk management. Each ministry, division, department and agency prepares its own detailed work plan to perform its responsibilities and functions efficiently as specified in the Standing Orders. In addition, the National Disaster Management Council (NDMC) and the Inter-Ministerial Disaster Management Coordination Committee (IMDMCC) coordinate disaster-related activities at the national level. Coordination at division, district, and other lower levels is coordinated by the respective Disaster Management Committees (DMC). There also exist other plans in Bangladesh relevant for Disaster Risk Management (DRM) including the National Plan for Disaster Management, NPDM (2021-2025)[6] listed in module 2.4 of Bangladesh National Contribution Plan report.

As provided in the standing order, BMD is mandated with provision of early warnings and alert messages of major meteorological hazards including tropical cyclones, storm surges/coastal floods and heatwaves for risk reduction and preparedness strategies. The FFWS and the BWDB will perform duties relevant for hydrological hazards including flood risk assessments.

BMD actively participates in cross-border exchanges of warnings with India. The Central Water Commission (CWC) of India shares warnings/information with Flood Forecasting & Warning Centre (FFWC) during monsoon season for floods watch. There is also cross-border

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

[5] Standing Orders on Disaster 2019

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

exchanges between BMD and the Regional Specialized Meteorological Centre (RSMC)[7] New Delhi on warnings and information for cyclonic disturbances over Bay of Bengal especially during the tropical cyclone season. The cooperation between 13 countries through the WMO/ESCAP Panel on Tropical Cyclones[8] programme helps to ensure that there is no loss of life and damage caused by tropical cyclones in the Bay of Bengal region. In addition, the Indo-Bangladesh Joint Rivers Commission (JRC)[9] is a bilateral agreement for sharing of flood forecasting information on major rivers during the monsoon.

Summary and comments for Element 1.1

The Bangladesh Meteorological Department (BMD) is a government organization under the Ministry of Defence of Bangladesh, responsible for providing meteorological services and related activities in the country. The BMD's legal mandate is provided by the Meteorological Act, 2018, which outlines its primary areas of responsibility.

BMD also shares responsibilities with other ministries and departments in hydrology and agrometeorology, such as the Flood Forecasting and Warning Centre (FFWC) of Bangladesh and the Bangladesh Water Development Board (BWDB). It also shares its data, information, and expert knowledge with several other organisations and ministries in Bangladesh.

BMD is the only meteorological authority in Bangladesh, providing aviation weather services to both the public and military. The Ministry of Disaster Management and Relief bears primary responsibility for disaster risk management, and the BMD is mandated to provide early warnings and alert messages of major meteorological hazards for risk reduction and preparedness strategies. BMD actively participates in cross-border exchanges of warnings especially with India.

1.2 Existence of Strategic, Operational and Risk Management plans and their reporting as part of oversight and management.

At present, BMD has no strategic plan which is aligned with the national strategic plan as well as the WMO plan formulated to accomplish the department's strategic activities and goals in the short-, medium- or long-term periods.

There however exists a focussed write-up document[10] that BMD developed with a general aim to improve and modernise its infrastructure as well as the forecasting and warning system. This document is regarded as a kind of a detailed procurement plan and was not approved by any higher authority. In it six approaches are listed that may enable BMD to accomplish some of the department's goals. The approached as listed in the document are: -

1. Reviewing past development policies (last five years), strategies, programmes and projects of the sectors/sub-sectors
2. Lesson learned/best practices evolved from past developments interventions and key constraints faced. These should also include appropriateness of institutional framework and human resource needs and capabilities

[7] Regional Specialized Meteorological Centre (RSMC) for Tropical Cyclones over North Indian Ocean
[8] WMO/ESCAP Panel on Tropical Cyclones
[9] Indo-Bangladesh Joint rivers Commission (JRC)
[10] BMD's Eight Five Year Plan (8FYP) 2021 - 2025.pdf

3. Development objectives and targets for the Eight Five Year Plan (8FYP) of the ministry/division drawn from the constitutional obligation, election manifesto of the government, vision 2041, BDP 2100, National Sustainable Development Strategies (NSDS), Sustainable Development Goals (SDG) and other national and international commitments
4. List of policies/programs/projects/action for achieving the targets of the 8FYP including year wise indicative costs within the available framework of the Medium-Term Budget Framework (MTBF)
5. Institution mechanisms for monitoring the progress of 8FYP implementation and indicators
6. Suggest mechanism for improving implementation capacity of the Ministry/Division for policy programmes /projects/actions

The Eight Five Year Plan (8FYP) (FY 2021 - 2025) development and objective targets were determined with a view to address the global changing climate as well as the GoB vision 2041. The main objectives of the plans include,

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

The key targets to achieve the objectives are

1. Train all officers and staff of BMD to enable them have essential skills including to perform their duties in IT-enabled work environment by 2041
2. Establish AWOS, AWS, Moored Buoy, Supercomputer, meteorological equipment in order to expedite the data collection and dissemination in real time bases throughout the country by 2021
3. Cover the whole country under doppler radar coverage by 2023

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 are:

- 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

While we were informed that there is no action plan or an implementation plan operationalizing the strategic plan at BMD. There is progress towards modernising the station network and infrastructure as detailed in the Bangladesh GBON National Contribution Plan Report. As of 2023, BMD had increased its AWS network including calibration facilities.

Under JICA's "Strengthening the capacity of weather and climate services" project, BMD will develop a strategic medium-long-term plan that will be linked with both the national strategy plan and the WMO plan. Reviewing past development policies, strategies, programmes and projects of the sectors/sub-sectors in BMD including achievement of key targets in the E8FYP can be beneficial in formulating the strategic plan.

BMD also has no risk management plan in place and at the time of writing the report there were no plans to implement such plans in its operations. It is therefore highly recommended that BMD actualize the formulation of a strategic plan as intended through the JICA coordinated project. A risk management plan should also be formulated to enable BMD to maximise the probability of success or reaching organisational goals.

Summary and comments for Element 1.2

BMD currently lacks a strategic plan aligned with the national and World Meteorological Organization (WMO) plans to achieve its strategic activities and goals. However, a focussed write-up document aims to improve infrastructure and forecasting systems. The document includes six approaches to achieve BMD's goals, including reviewing past development policies, lessons learned, development objectives, and the Eight Five Year Plan (8FYP). Key targets include training officers and staff, establishing AWOS, AWS, Moored Buoy, Supercomputer, and meteorological equipment, and covering the country under doppler radar coverage by 2023. Priority interventions include infrastructure development of meteorological observatories, strengthening marine weather forecasting, modernising meteorological training institutes, and modernising meteorological workshops and laboratories. BMD has made progress towards modernising its station network and infrastructure, and under JICA's "Strengthening the capacity of weather and climate services" project, it will develop a strategic medium-long-term plan linked to both national and WMO plans. Reviewing past development policies, strategies, programs, and projects can help formulate the strategic plan. A risk management plan is recommended to maximise the probability of success or reaching organisational goals.

1.3 Government budget allocation consistently covers the needs of the NMHS in terms of its national, regional, and global responsibilities and based, among others, on cost-benefit analysis of the service. Evidence of sufficient staffing to cover core functions

The overall annual budget for BMD in the fiscal year 2022-2023 was approximately 8.7 million USD (Table 1). Budget-wise, the principal areas of responsibility (mandate) include operating and maintaining meteorological infrastructure costs (42%), staffing costs (51%), and other capital expenditures (7%). Over the past 3-5 years, there has been an increase in government budgets for BMD. The operating budget for the fiscal year 2023-2024, for example, is around 9.5 million USD.

Cost recovery sources of funding to BMD is mainly from data (processing cost), recycled newspaper sale, and selling of outdated computers and other electronic components which accounts for less than 1 % of the department's budget. The CAAB does not share turnover related to provision of aviation services with BMD. BMD provides both observers, forecasters, and technicians at five national and three international airports located at CAAB premises. A well-defined cost recovery model between BMD and CAAB can be beneficial. BMD has in the past received development assistance from international funding agencies including the recent World Bank BWCSRP supported hydromet development project (2016-2024) to strengthen Bangladesh’s capacity to deliver reliable weather, water, and climate information services and improve access to such services by priority sectors and communities. Through the project BMD has increased its observational infrastructure. Other internationally funded projects have helped BMD mainly on staff capacity development as well as for improving observation infrastructure. Additionally, BMD has received in-kind grant development assistance through the JICA RADAR project for the improvement of meteorological radar systems in Dhaka and Rangpur. The tower construction of Rangpur Radar Station is currently

completed. This was granted through the donors/vendors/contractors, Japan Radio Company[11]. BMD does not receive funding from commercial activities.

As a government entity, the complete funding for all BMD operations during the fiscal year 2022-2023 came from government budget allocations. The budget frequently meets the organization's needs for BMD, particularly in terms of consistently providing salaries and operating costs for BMD's observation infrastructure, as well as offering regular and special courses for meteorological staff to increase human capacity competency. However, multiple challenges were observed, especially with regard to meeting its regional and global duties. For GBON compliance, for example, increasing the observational reporting cycle with transitioning to new observation technologies, as well as meeting the growing demand for meteorological services, has been a challenge for BMD due to a lack of capacity and competences among existing workers. This can be easily improved during the SOFF project.

BMD's budget allocations do not reflect a cost-benefit analysis of their services. There has been no research into the social and economic benefits of weather, climate, and water services in Bangladesh. Such studies would benefit BMD, particularly in increasing partnerships ready to invest in weather and climate services in Bangladesh.

Table 1. BMD's annual budget vs Actual Financing for the year 2022/2023.

Budget	Budget for for fiscal year 2022-2023 (in USD)	Actual financing for fiscal year 2022-2023 (in USD)
Expenditures		
Capital expenditures	596 590,92	620 021,96
Total operating costs	3 074 759,51	3 662 609,27
Staff costs	3 693 107,82	4 431 349,17
	7 364 458,25	**8 713 980,40**
Income		
Basic funding from government department/ministry	7 364 458,25	8 713 980,40
Turnover related to provision of aviation services or other cost recovery sources (please name)	17 073,00	29 834,55
Development assistance Weather and Climate Services Regional Project 2016-2024[12,13]	*19 674 309,00*	*24 547 000,00*
JICA RADAR project 2016-2025[14,15]	---	*16 688 500,00*
Special account Provision of specialised meteorological, hydrological, agrometeorological, or other information	-	-
TOTAL	**7 381 531,25**	**8 743 814,95**

[11] https://www.jrc.co.jp/en/

[12] Bangladesh Weather and Climate Services Regional World Bank Project (BWCSRP) Component A

[13] This is the total budget in BWCSRP Component A to BMD during the project duration (2016-2024). It does not impact the total actual financing for fiscal year 2022-2023

[14] https://www.jica.go.jp/Resource/bangladesh/english/activities/activity14_01_08.html

[15] In-kind grant to BMD through donors vendors/contractors, (Japan Radio Company)

Summary and comments for Element 1.3

The Bangladesh Meteorological Department (BMD) has an annual budget of approximately $8.7 million for fiscal year 2022-2023, covering operating and maintaining meteorological infrastructure costs, staffing costs, and other capital expenditures. The budget has increased over the past 3-5 years, with an operating budget of around 9.5 million USD for fiscal year 2023-2024. BMD's cost recovery sources include data processing costs, recycled newspaper sales, and selling outdated computers. The Bangladesh Aircraft Authority (CAAB) does not share turnover related to aviation services with BMD. BMD has received development assistance from international funding agencies, including the World Bank BWCSRP hydromet development project, and in-kind grant assistance through the JICA RADAR project. The budget meets BMD's needs, but challenges remain, such as meeting regional and global duties and meeting the growing demand for meteorological services.

1.4 Proportion of staff (availability of in-house, seconded, contracted- out) with adequate training in relevant disciplines, including scientific, technical, and information and communication technologies (ICT). Institutional and policy arrangements in-country to support training needs of NMHS.

Table 2 provides an overview of BMD's personnel across various professional fields as of March 2023 including their gender, age, and educational backgrounds. At the time BMD had a total of 673 personnel comprising 117 women (17%) and 556 men (83%). Women account for less than 5% of the workforce in scientific, technical, and information and communication technology (ICT) disciplines. The proportion of staff with a higher education (bachelor's degree or higher) is 13% of the total workforce. During the writing of this report, five of the total staff at BMD went into retirement.

In Bangladesh, all staff working in government institutions are employed through the Bangladesh Civil Service (BCS) recruitment process. The GoB thus must approve any recruitment of staff at BMD. Hiring into BMD as a government worker has been extremely slow, with a recruiting freeze since 2016. The lengthy freeze has exacerbated the burden on existing employees over time, as well as an ageing workforce that is not replaced when they retire. As of March 2024, more than 90% of BMD employees are over the age of 45. To recruit and retain staff, governments must eliminate employment barriers and provide robust solutions that match the needs of each institution. Nonetheless, efforts are being made to increase the human capacity at BMD. An updated organigram (in Bengali) has been approved for new recruitment as provided in Annex 5. This will improve BMD's capacity by 14% for meteorological positions and 9% for technical posts. It was thus recommended that while hiring new staff in accordance with the approved organisational structure, consideration be given to experts capable of maintaining BMD's newly adopted automated weather system infrastructure, including data quality control, maintenance, and calibration. Focus should also be on enhancing gender balance through the development and implementation of a gender equality strategy in accordance with the WMO gender action plan[16]. In the future, when developing BMD's organisational structure, careful thought should be given to ensuring that a highly valuable, relevant skill set is sought after, with an emphasis on expanding technical and scientific knowledge at BMD.

[16] WMO gender action plan

The capacity and technical capabilities of staff at BMD including those with scientific and information and communication technologies (ICT) for GBON station operations (instrument and station maintenance at site, Calibration and maintenance at the workshop, Network monitoring and ICT system operations) is generally lacking. BMD's capabilities and capacity must be enhanced to ensure sustainability of GBON infrastructure.

To be more competent to deliver the required meteorological services and play other relevant roles in national, regional and international developments, especially that which is 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 and expertise. Emphasis should be put on the needs for IT expertise and staff dedicated to research and climatological studies that is lacking at the department. BMD is purely a meteorological institute with no hydrological functions hence has no hydrological staff.

Based on the assessment of human capacity gaps at BMD in the SOFF GBON National Contribution Plan, 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.

At present, BMD has no special assessment of staff competency. BMD however has a training policy for its meteorological staff members. There are two types of training programs including Basic Instructional Package for Meteorologists (BIP-M) and the Basic Instructional Package for Meteorological Technicians (BIP-MT). BMD offers both regular courses i.e

- BIP-MT Pre-Initial Meteorology course 02 Months
- BIP-MT (Entry-Level) Preliminary Meteorology course 06 Months
- BIP-MT (Mid-Level) Meteorology course 09 Months
- BIP-M Meteorology course 1 Year

and special Course i.e.

- BIP-MT Inspectors course 02 Months
- BIP-MT (Mid-Level) Assistant's Refresher course 04 Months
- BIP-M Forecaster's Refresher course 06 Months

BMD has institutional arrangements for capacity building with mainly regional and international institutions. BMD collaborates with several countries in the region and has both regular training and occasional/need based training. BMD actively collaborates with several institutes India on capacity building training including the Space Application Centre - ISRO [17], the Indian Institute of Remote Sensing (IIRS) for Remote Sensing and Geographic Information System (RS-GIS)[18], the RSMC-IMD[19]. Additionally, BMD participates in South Asian Climate Outlook Forum (SACOF) which is usually coordinated through the Regional Climate Centre (RCC) RAII region, in Pune India. BMD also collaborates with the Japan Meteorological Agency (JMA) and Japan International Cooperation Agency (JICA), the China Meteorological Administration (CMA), Korea Meteorological Administration (KMA) for diverse capacity building training. BMD is also a member of several intergovernmental regional organisations including Regional Integrated Multi-Hazard Early Warning System for Africa

[17] https://www.sac.gov.in/Vyom/

[18] https://www.iirs.gov.in/

[19] RSMC for Tropical Cyclones over North Indian Ocean

and Asia (RIMES)[20], Asian Disaster Preparedness Centre (ADPC)[21] , International Centre for Integrated Mountain Development (ICIMOD)[22], and the South Asia Hydromet Forum (SAHF) IV. 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. On an international level, since 2013, BMD has on-going capacity building training with the Norwegian Meteorological Institute (MET Norway) for Weather and Climate Services. The project (SAREPTA[23]) main focus is on using 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).

On a national level, BMD has recently entered into a formal agreement[24] for two primary objectives. The first is for "Support to capacity building at the Department of Meteorology, University of Dhaka". This arrangement was launched as part of the World Bank's BWCSRP initiative, which aimed to strengthen meteorological information services and early warning systems. The second objective of this agreement is to "develop academic exchanges and cooperation in teaching and research" in order to promote human resource and research activities that are mutually beneficial between the two institutions.

Table 2: BMD staff with information on age, education, and gender - As of March 2024

	Age group	**Head quarters**	**Regional Centers**	**Education (number of staff with BSc or higher)**	**Gender**
Corporate support /Management	< 20 20-29 30-39 40-49 >50 years	0 1 11 40 47	0 1 0 0 0	12	Women:22 Men:78
Meteorologists	< 20 20-29 30-39 40-49 >50 years	0 0 6 15 22	0 0 4 4 2	55	Women: 10 Men:43
Engineers/IT	< 20 20-29 30-39 40-49 >50 years	0 0 2 2 5	0 0 1 1 0	12	Women: 01 Men: 10
Meteorological technicians	< 20 20-29 30-39 40-49 >50 years	0 5 38 59 52	0 1 113 143 98	11	Women: 84 Men: 425

[20] https://www.rimes.int/

[21] https://www.adpc.net/igo/?

[22] https://www.icimod.org/country/bangladesh/

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

[24] 20190324_DU-MoU_Signed

Hydrologists	NA	NA	NA	NA	NA
Hydrological Technicians	NA	NA	NA	NA	NA
Researchers/ Climatologists	*	*	*	*	*
Total		**305**	**368**	**90**	**673**

*Meteorologists work informally in research and climatological services.

Summary and comments for Element 1.4

As of March 2023, Bangladesh Meteorological Institute (BMD) had 673 personnel, with 117 women (17%) and 556 men (83%). Women account for less than 5% of the workforce in scientific, technical, and information and communication technology (ICT) disciplines. The government must approve recruitment for BMD, and the recruitment freeze since 2016 has exacerbated the burden on existing employees. As of March 2024, over 90% of BMD employees are over the age of 45.

The capacity and technical capabilities of staff at BMD, including those with scientific and ICT technologies (ICT) for GBON station operations, are generally lacking. To ensure the sustainability of GBON infrastructure, BMD needs requisite policy, guidance, resources, and training, including re-structuring their organization structure. Emphasis should be placed on IT expertise and staff dedicated to research and climatological studies.

BMD has no special assessment of staff competency, but it has a training policy for its meteorological staff members. The institute offers two types of training programs: Basic Instructional Package for Meteorologists (BIP-M) and Basic Instructional Package for Meteorological Technicians (BIP-MT). BMD has institutional arrangements for capacity building with regional and international institutions.

1.5 Experience and track record in implementing internationally funded hydromet projects as well as research and development projects in general.

BMD has implemented or benefited from several internationally funded hydromet projects as well as research and development projects including:

Bangladesh Weather and Climate Services Regional Project BWCSRP (2016-2024)[25]: A World Bank supported hydromet development project involving 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, BMD has increased its observational infrastructure to including

- 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

Based on the project report, some of BMD staff have also benefited from capacity development as a result of the project. However, from discussions with BMD, the capacity received is not yet sufficient for operation and maintenance of the new infrastructure, and SOFF will better complement the project.

Improvement of Meteorological Radar System in Dhaka and Rangpur[26]: This is a JICA supported radar project. Since 1988, Japan has been contributing to improving the weather forecast service in BMD through establishment of meteorological radars, improvement of weather analysis & forecasting system and capacity buildings. All 5 meteorological radars in BMD were established through the JICA, and those in Dhaka and

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

[26] https://www.jica.go.jp/Resource/bangladesh/english/activities/activity14_01_08.html

Rangpur were completed in 2000 and 1999 respectively. With a view to also upgrading radar systems in Dhaka and Rangpur, Japan has undertaken detailed design of these radar systems.

The Project Duration is July 2016 - June 2025 and total budget 1955700000 BDT. Presently Dhaka (Joydebpur) Radar is in operation and Construction of Rangpur Radar Tower is also completed. RADAR at Rangpur station will be operational by March 2025. By June 2025 the project will be completed.

Strengthening the Capacity of Weather and Climate Services project: This is a JICA project. Duration of this project is from January 2024 to June 2027. Total cost of this project is 267300000 BDT. The major goal of this project is to improve Surface observation, RADAR maintenance, RADAR products, Improvement of operational forecast, Satellite image analysis, Forecast guidance, Regional NWP System, Seasonal forecasting, Climate change Projection, Dissemination of Meteorological Information and Medium- Long Term Strategic Plan.

Support of the GEO-KOMPSAT-2A Receiving and analysis System in Bangladesh" Project: This is a technical cooperation project of the government of Korea. Initially the duration of this project was from December 2020 to December 2021. Due to the COVID 19 situation, this project was finally officially handed over in January 2024. The estimated cost of this project was 220000000 BDT. Overall goal of this project was strengthening resilience and adaptive capacity to climate related hazards and natural disasters in Bangladesh. Development partner of this project was the Korea Meteorological Administration (KMA).

SAREPTA project by MET Norway (Norad)[27]**:** Since 2013, MET Norway has worked with BMD to provide Institutional Support and Capacity Building for Weather and Climate Services. The project's main focus is on using 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). Also included are the digitalization and organising of observation data, as well as the use of meteorological, climate, 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) and the Changing Climate of Bangladesh (2024) based on the weather observations in Bangladesh. This support is well aligned with SOFF especially on the benefits of data analysis, visualisation and verification

Summary score and recommendations for Element 1

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

BMD's maturity level on "Governance and Institutional Setting" is assessed **Level two** on the CHD scale reflecting "*Effort ongoing to formalise mandate, introduce improved governance, management processes and address resource challenges.*"

Recommendations:

- To better clarify the duties across the many governmental departments and private actors, governance acts, policies, and strategies must be updated and well-coordinated.
- Formulate and implement an operational strategic plan aligned with the national strategic plan.
- Formulate/Implement a risk management plan to enable BMD to maximise the probability of success and accomplishing its organisational goals
- Re-evaluate cost-recovery funding arrangements with the CAAB
- Conduct cost-benefit analysis studies on BMD's services to demonstrate the socioeconomic worth of meteorological and climate services.
- Percentage of staff with higher education (bachelor's degree or higher) is significantly low at BMD. BDM should prioritise regular recruitment of highly qualified staff.
- BMD could benefit from better documented training procedures and policies for all personnel.
- Initiate a plan to increase capacity and capabilities of staff at BMD. Sufficient skilled ICT manpower is highly required and recommended.
- 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.
- Develop specific expertise at BMD staff including research and climatology.
- BMD should focus on projects that directly address their needs

Element 2: Effective partnerships to improve service delivery

2.1. Effective partnerships for service delivery in place with other government institutions.

As the only government organization with the authority to carry out all duties related to meteorological services in Bangladesh, BMD partners and provides services to key sectors in the country including, but not limited to:

- Ministry of Agriculture, Department of Agricultural Extension (DAE)
- Bangladesh Water Development Board (BWDB)
- Department of Disaster Management (DDM) (Interactive Voice Response, 1090)
- Cyclone Preparedness Programme (CPP)
- National Broadcasting Agency (Bangladesh Radio, Bangladesh Television)
- Bangladesh Sangbad Songstha (BSS)
- Ministry of Health.
- Ministry of Fisheries
- Ministry of Livestock
- Ministry of transport and tourism
- Media

BMD mainly offers forecasting, warnings and alert services to these organisations. Recently under the BWCSRP, a WB supported hydromet development project, a Memorandum of Understanding (MoU) was established between BMD, DAE and BWDB on third party data sharing, and for cooperation in generating quality hydro-meteorological data on a common platform in support of improved weather, water, climate and early warning services for Bangladesh. Detailed information on these partnerships can be found in section 1.1.

No other organization or entity, other than the BMD, may make notifications about meteorological observation forecasts and warnings. Other government ministries and organisations, on the other hand, are free to utilise and modify the BMD forecast as they like.

Summary and comments for Element 2.1
BMD is the only provider of meteorological services in Bangladesh. Despite the lack of formal agreements, BMD has formed strong collaborations in critical industries such as agriculture, water resources, and broadcasting. Formal agreements include a Memorandum of Understanding with DAE and BWDB for third-party data exchange.

2.2. Effective partnerships in place at the national and international level with the private sector, research centres and academia, including joint research and innovation projects.

There are no formal or mutual **service delivery** agreements between the BMD and other private sectors. There are also currently no privately owned providers of meteorological observations and data services, and no legislation exists to address private sector engagement in information delivery in Bangladesh. However, during disasters, several NGOs and INGOs are called upon to deliver information.

For the **Operation and maintenance of networks**, Mazzak Inter Trade[28], a private company enlistment with the Ministry of Defence was contracted with installing, maintaining, and operating all of the new AWS infrastructure deployed at BMD as part of the BWCSRP Project. There is a maintenance contract with the supplier until May 2025 when BMD should take over the project. All radars at BMD are/were installed as part of the JICA project. BMD has five radar stations, one of which, Joydevpur, has recently been installed and is operational around the clock. Another new RADAR at the Rangpur station will be operational from March 2025. The remaining three RADARs have reached the end of life (average sixteen years). RADAR data from stations is transmitted to the Storm Warning Centre (SWC) via VSAT link. There is a maintenance contract with the supplier (Japan Radio Company (JRC).

With regards to **observational data**, as previously stated, BMD has formal agreements with DAE and BWDB on third party data sharing. Other private entities[29] can also acquire meteorological observations from BMD because its data is publicly available but shared at a government determined fee (processing cost) through BMD's data portal service[30].

BMD participates in several multi-sector consultative platforms including:

- Regional Integrated Multi-Hazard Early Warning System for Africa and Asia (RIMES), Asian Disaster Preparedness Centre (ADPC) and the International Centre for Integrated Mountain Development (ICIMOD)
- National Climate Outlook Forum (NCOF) and Regional Climate Outlook Forum (RCOF)
- see also section 7.1 and 10.1

Frequent stakeholder meetings, such as that convened by BMD in February 2024 in collaboration with the peer advisory (see Annex IV, NCP report), was a good starting point for addressing the private sector's needs on how to strengthen interactions and collaborations among stakeholders.

BMD works in partnership with several academia and research institutions both at national and international level. They include Khulna University, Khulna University of Engineering and Technology (KUET), Dhaka University, Bangladesh Space Research and Remote Sensing Organization (SPARRSO) and DAE. Recently under the BWCSRP, an MoU was signed with the University of Dhaka's Department of Meteorology to expand meteorological information services and early warning systems, as well as to develop academic exchanges and cooperation in teaching and research. Under the BWCSRP project there is a research and operational applied part where 25 students from different universities were engaged with forecasters' research work. Few papers from the students were published in BMDs Journal[31]. At the international level, the BMD collaborates with various institutions including,

- The Norwegian Meteorological Institute (MET Norway) - SAREPTA project
- Korea Meteorological Administration (KMA)
- UK Met Office
- Japan International Cooperation Agency (JICA)
- IRI International Research Institute of Columbia University (IRI)
- see also section 1.5

International research activities are mostly externally funded and proposed by funding institutions.

[28] Mazzak Inter-trade

[29] BMD's Data Users' List.

[30] https://dataportal.bmd.gov.bd/

[31] https://live8.bmd.gov.bd/p/Publications

Summary and comments for Element 2.2
BMD has no formal or mutual service delivery agreements with other private sectors, and there are no privately held meteorological observation and data service providers. There are contracts with suppliers for the operation and maintenance of AWS and weather radars. BMD participates in multi-sectoral consultative platforms for early warning and disaster risk management, as well as various international climate and weather service programs.

2.3. Effective partnerships in place with international climate and development finance partners.

BMD collaborates with a number of international climate and development funding partners (including JICA and the World Bank) on a variety of initiatives, both past and present. As part of the WB, Bangladesh Weather and Climate Services Regional Project, BMD expanded its observational infrastructure in 2023, adding 35 new AWS, 3 AWOS, 125 Agricultural AWS, 65 ARG, 7 Hydrogen gas generators, calibration facilities, and a Climate Data Base Management System (CDMS). Section 1.5 provides a detailed summary of several more initiatives.

Summary and comments for Element 2.3
An overview of partnership can be found under section 1.5.

2.4. New or enhanced products, services or dissemination techniques or new uses or applications of existing products and services that culminated from these relationships.

Several services and products have been delivered as a result of these collaborations and partnerships, including website, BMD weather APP, MultiFAX, social media (WhatsApp, Facebook, Twitter), BMD Current weather APP, mail, Interactive Voice Record (IVR), and Telephones.

The network infrastructure has been enhanced (see the GBON NGA and NCP reports on Bangladesh).

Summary score and recommendations for Element 2

BMD's maturity level on "Effective partnerships to improve service delivery" is assessed **Level three** on the CHD scale reflecting *"Moderately effective partnerships but generally regarded as the weaker partner in such relationships, having little say in relevant financing initiatives".*

Recommendations:

- Establish better formulated formal partnerships with the private sector that are mutually beneficial
- Establish a transition strategy with Mazzak Inter trade such that BMD is in a position to autonomously operate, manage, and maintain their AWS station. BMD should also investigate the feasibility of autonomously operating and maintaining radar stations. This demands capacity-building initiatives.
- Strengthen the relationships with the academia with formal agreements
- Strengthen sub-regional collaboration
- Develop strategies to strengthen their position in project finance decision-making and resource allocation. BMD should ensure that externally funded projects align with their strategic development plan and available capacity.

Element 3: Observational infrastructure

3.1. Average horizontal resolution in km of both synoptic surface and upper-air observations, including compliance with the Global Basic Observing Network (GBON) regulations.

BMD operates about 315 observation stations of varying classes. There are 58 manual (synoptic) observatories, 61 are AWS, 125 agricultural AWS, 65 automatic rain gauge stations and 6 upper air stations. All the country's manual synoptic and AWS stations are installed at the same location. Through the WB BWCSRP project, BMD acquired several new automatic observation stations in 2023. The horizontal resolution of the manual synoptic surface stations are 50 km and 157 km for the upper air stations.

All of the 58 manual synoptic stations observe and transmit data every 3 hours to the GTS, and 15 of these stations are GBON designated stations. The newly installed AWS stations transmit hourly data to BMD using GPRS, but the data is not integrated for data transmission to the Global NWP centres in real-time. Nine of the AWSs (4%) are currently not operable. For GBON compliance the ICT infrastructure and services at BMD need to be re-designed for complete data processing and data transmission (hourly) from the observing stations to the Global NWP centres in real-time through WIS 2.0.

Five of the six upper air stations only have one sounding per day. The upper air station in Dhaka is transmitting 2 soundings per day and is designated as a GBON station. For GBON compliance observed data needs to be available more than 80% in the WDQMS monitoring system at least 80% of days. This is however not the current situation for the station in Dhaka. Data exchange internationally in real-time needs improvement such that complete sounding is received for GBON compliance.

There are no marine observations in Bangladesh's Bay of Bengal exclusive economic zone, although SOFF (GBON National Gap Analysis) has recommended funding for one marine station (SLP, SST). The primary shortcomings in BMD's ability to monitor priority hazards (tropical cyclone and storm/coastal flood) are a lack of buoy monitoring and a surge gauge.

Regarding specialised alerts for different hazards, BMD monitors variables important to all hazards, with the exception of riverine floods, which are handled by the Flood Forecasting and Warning Centre (FFWC) under the Bangladesh Water Development Board. The following main gaps have been identified in BMD's capacity to monitor priority hazards in Bangladesh:

- Lack of monitoring capacity and capabilities for observation of relevant additional variables including marine observations (SLP, SST)
- Lack of observation stations (storm surge gauges)
- Lack of cyclone model for tropical cyclone monitoring
- Insufficient automation of the observation network
- Insufficient (near-)real-time access to observation data
- Lack of monitoring capacity
- General insufficient data quality control practices
- Lack of adequate remote sensing data for heat wave observation
- Lack of lightning data (though BMD has plan for lightning network)
- Lack of comfort heat index

Summary and comments for Element 3.1

The coverage of surface and upper air stations in Bangladesh is quite good, and a lot of AWSs have been installed during the last few years. None of the stations are GBON compliant, because only data every 3 hours from the manual stations are transmitted through GTS. Data from the AWS is not integrated for real-time transmission to Global NWP centres. And the GBON upper air station has some data availability issues. To comply with GBO) standards, the ICT infrastructure and services at BMD need to be redesigned. BMD also has a lack of marine observations in Bangladesh's Bay of Bengal exclusive economic zone

3.2. Additional observations used for nowcasting and specialised purposes.

BMD obtains and shares observational data particularly during tropical cyclone seasons. Forecasters collect hourly observations and communicate them with neighbouring nations, and BMD also receives warning information from RSMC-India, such as cyclone tracking data (speed and position). BMD also provides rainfall observations to FFWC and DAE. BMD only transfers data from manual stations to GTS. AWS are not currently included for data sharing, but they will be made available through SOFF.

Bangladesh has five weather radars, one of which is newly installed. Each radar has a 400 km radius. Currently, there are no radar composites. BMD network also includes a lightning detection network of eight sensors. All sensors are optimised, however owing to internet issues, they are not always performing optimally (going online). Maintenance issues also arise as a result of a shortage of manpower.

In addition, BMD has access to satellite data via HimawariCast (see Section 4.3).

Summary and comments for Element 3.2
Additional observations at BMD are weather radars, lightning data and satellite data.

3.3. Standard Operating Practices in place for the deployment, maintenance, calibrations and quality assurance of the observational network.

BMD currently lacks calibration and maintenance practices for its AWS network. Their capacity is limited to conventional observation networks, and they lack trained personnel that are responsible for maintenance and calibration of the automatic weather stations. 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.

Until May 2025, Mazzak Inter Trade is contracted with installing, maintaining, and operating all of the new AWS infrastructure deployed at BMD as part of the WB BWCSRP project. BMD needs a transition plan with Mazzak so that BMD can independently maintain their station network from June 2025. BMD also requires training on the system operation and maintenance of AWS, including calibration practices.

BMD mainly receives support and training on calibration from RIC-Tsukuba in Japan and from India, but this support is not periodic due to capacity issues. Instruments are usually sent to RIC-Tsukuba for calibration every two-three years, but financial resources are limited. BMD hopes to expand its collaboration with RIC-Beijing in China. As a result, BMD lacks specified standard operating procedures (SOP) for deploying, maintaining, calibrating,

and ensuring the quality of its observation network. BMD requires a more frequent and sustainable calibration plan. Budgetary and logistical constraints should also be addressed.

As for a national governance mechanism within the WIGOS framework, BMD currently does not have such a mechanism established. BMD has an Oscar/Surface National Focal point; however it is not clear to them how the WIGOS governance mechanism works.

Furthermore, there is no established national process in place for acting on quality problem information received from the WMO Information System (WIS) Data Quality Monitoring System (WDQMS). More training is required and the communication between the departments needs to be strengthened.

Summary and comments for Element 3.3
BMD needs SOPs and training on calibration and maintenance of their automatic stations. BMD has designated personnel responsible for WIGOS data quality management systems and OSCAR coordination, but more training is needed and also improvement of internal coordination.

3.4 Implementation of sustainable newer approaches to observations.

A national WIGOS implementation plan has not yet been adopted at BMD. BMD has an expert member at the RA II WG-I Expert Team on Regional WMO Integrated Global Observing System (WIGOS) Implementation (ET-WIGOS). But there is a lack of capacity (number of people and knowledge capacity) to develop and implement newer approaches to observations.

The SOFF readiness phase is a positive step toward enabling BMD to meet the National WIGOS Implementation Plan (N-WIP) for sustainable innovative newer approaches to observations. The Bangladesh GBON NGA and NCP reports (2024) outlined the infrastructure, as well as the human and institutional capability, required to meet a progressive aim for GBON compliance, including the continued operation and maintenance of the national observation network. The SOFF investment funding request presented in the NCP report addressed the highlighted needs for the long-term viability of BMD observation networks, but further support from other stakeholders, including the GoB, regional and international partners, would be beneficial.

Summary and comments for Element 3.4
BMD has not yet adopted a national WIGOS implementation plan. Both human capacity and knowledge capacity need to be improved to develop and implement newer approaches to observations. The SOFF readiness phase is a positive step towards meeting the National WIGOS Implementation Plan for sustainable innovative approaches to observations

3.5. Percentage of the surface observations that depend on automatic techniques.

Out of the total 315 surface stations, approximately 80% are automatic stations, and 20% are conventional manual stations. During the last 5 years, 225 new automatic stations (35 AWS, 125 Agricultural AWS, 65 Automatic Rain gauges) have been deployed. Data is delivered in real-time using GPRS to BMD headquarters, currently hourly for AWS and every 3 hours for manual stations. BMD has not yet migrated to WIS 2.0 for data transmission, and only synoptic manual stations are exchanged in real-time internationally to the global NWP centres through GTS.

BMD recently acquired a CDMS (CLIDATA) through the WB BWCSRP project for quality control, archiving, and exchange of observational data. However, BMD has operational challenges such as a lack of training and up-to-date ICT infrastructure. The current local archiving system is limited to data from their manual station, where data is manually archived as individual files before being uploaded to the available network-attached storage (NAS).

Summary and comments for Element 3.5
Although autonomous stations account for 80% of surface observations, data from these stations are not transmitted in real time via GTS or WIS 2.0. in real time. The ICT infrastructure has to be enhanced, and personnel require the necessary training.

Summary score and recommendations for Element 3

BMD's maturity level on "Observational Infrastructure" is assessed **Level Three** on the CHD scale reflecting "*Moderate network with some gaps with respect to WMO regulations and guidance and with some data quality issues"*

Recommendations:

- Implement the national WIGOS implementation plan. BMD lacks the capacity to develop and implement new observation approaches. Implementation of SOFF's GBON national contribution plan will enable BMD fully GBON compliant surface and upper air stations
- Build and strengthen the capacity of BMD staff for AWS operations, maintenance, and calibration. Training and human resources are also necessary for data management across the entire data value chain, including the use of the CDMS.
- Prepare SOPs for calibration, maintenance and quality assurance.
- Develop proper maintenance and management plan of existing station network through e.g. scheduled preventive maintenance and calibration plans to lengthen the life cycle of sensors.

Element 4: Data and product sharing and policies

4.1. Percentage of GBON compliance – for how many prescribed surface and upper-air stations are observations exchanged internationally. Usage of regional WIGOS centres.

BMD has 15 surface and one upper air GBON designated stations in OSCAR/Surface. None of these stations are GBON compliant. Observations from all BMD's manual surface stations (58) and four upper air stations are exchanged internationally via the Global Telecommunication System (GTS) through the New Delhi (India) Regional Telecommunication Hub (RTH) every three hours for the surface stations, two times per day for the GBON upper-air station and once per day for the other upper-air stations. None of their station's data has been migrated to WMO Information System (WIS) 2.0, nor are they using WIS2.0 protocols to transfer data. BMD uses the Global Information System Centre (GISC) in Tokyo. BMD has no greenhouse gases (GHG) stations, and neither is monitoring of GHG parameters under its mandate in Bangladesh.

Summary and comments for Element 4.1

BMD has 15 surface and one upper air GBON designated stations in OSCAR/Surface, but none are GBON compliant. Observations are exchanged internationally via GTS every three hours for the surface stations and twice a day for the GBON upper air station. BMD has not yet migrated to data sharing using WIS 2.O protocol.

4.2. A formal policy and practise for the free and open sharing of observational data.

At present, there is no national WMO Integrated Global Observing System (WIGOS) partnership agreement in place for integration and open sharing of observations data from BMD or other sources in Bangladesh. At BMD, there is no specific document governing data policies and practices. The framework for provisions of observational meteorological data is provided in BMD's Meteorological Act, 2018 No. XXVIII. The act establishes national legislation governing the responsibility for measuring and reporting weather observations, as well as mutual interaction, including data exchange, with national and international organisations in accordance with national requirements and international liabilities. BMD has this official jurisdiction. The climate division, which oversees meteorological data management, is required to share observational data at a government-determined fee. The Meteorological Act prohibits the use, distribution, dissemination, and publication of meteorological data for reasons other than those listed. BMD data is thus openly available but shared at a cost (processing cost) through BMD's data portal service[32]. It would be advantageous for BMD to have a specific data governance policy document.

As detailed in Bangladesh GBON National Contribution Plan, BMD has not had a systematic data management plan including quality control, archiving and sharing of the observation data. This was exacerbated by lack of capacity and capabilities to manage the growing observation data from their increasing observational network. With the recent procurement of Climate Database Management System (CDMS), CLIDATA, training and recruitment of skilled IT specialists was identified as one of the measures to ensure increased data

[32] https://dataportal.bmd.gov.bd/

processing and management capabilities at BMD. There however exist agreements and interagency protocols for data exchange of monitoring systems and baseline data that necessary to produce data products for all five priority hazards (Tropical cyclone, Storm surge/Coastal flood, Riverine Floods, Thunderstorms/Squall lines and Heat wave), although that the agreements and protocols are only available in part. BMD has formal agreements with DDM, BDWB, DAE established recently under the World Bank BWCSRP hydromet development project (2016-2024)

Summary and comments for Element 4.2

Bangladesh Meteorological Department (BMD) lacks a national WMO Integrated Global Observing System (WIGOS) partnership agreement for data integration and open-sharing. The Meteorological Act, 2018 No. XXVIII provides the framework for meteorological data provision, but BMD lacks a systematic data management plan. The lack of capacity to manage growing observation data is exacerbated by the increasing observational network. BMD has recently procured a Climate Database Management System (CDMS) but has no trained IT specialists to improve data processing and management capabilities.

4.3. Main data and products received from external sources in a national, regional and global context, such as model and satellite data.

BMD has a PC based system to receive satellite data from CMACast, GEO-KOMPSAT-2A (GK2A) and receiving stations for HimawariCast. The system for HimawariCast is illustrated in Figure 4

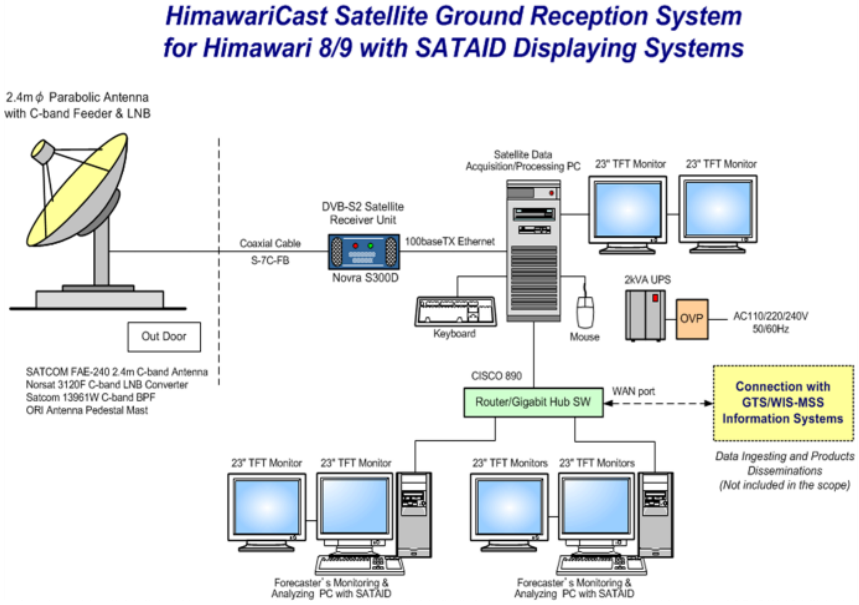

Figure 4: HimawariCast Satellite Ground Reception System at BMD

BMD uses a variety of satellite products to monitor and interpret the priority hazards in Bangladesh, such as tropical cyclones (TC), storm surge/coastal flooding, thunderstorms/squall lines, and heat waves. BMD personnel have also been trained in remote sensing data access and interpretation, mostly for TC, storm surge, and thunderstorms in China, India, and Japan.

Different communication systems are used to access data and products from different sources. Satellite images are retrieved via the parabola antennae at BMD and the internet is also used as backup. Radar data is collected using the Very Small Aperture Terminal (VSAT), whilst Automatic Weather Stations (AWS) observation data is collected using the mobile internet general packet radio service (GPRS) via sim card. The Internet is used to transmit data from manual stations and Numerical Weather Prediction (NWP).

BMD enjoys good internet stability at their HQ/national meteorological centre (NMC). The bandwidth available at BMD varies. Under the BWCSRP hydromet development project BMD has a I GB bandwidth connection and the connectivity for GTS and GISC Tokyo is 200Mbps and 350Mbps respectively. The upload and download bandwidth speed ranges from 92-684 mbps. BMD uses mostly internet connectivity to access data and products from World Meteorological Centre (WMC)/ Regional Specialized Meteorological Centre (RSMC). The level of BMD access to products provided by global and regional centres in the past 2 years has improved. BMD however is also interested in accessing data from CMA regional forecast product, CMA-meso model, and regional model from India.

The BMD is interested in many aspects regarding the data accessing from both satellite and model. They include

- upgrade the existing CMACast reception system and receive data from FY2A.
- The MicroWave (MW) channel data from CMACast reception system
- Global model output data for medium range, monthly/seasonal as well as Sub-seasonal to Seasonal (S2S) forecast.
- Capacity building on the use of Meteorology Information Comprehensive Analysis Process System (MICAPS), Satellite Weather Application Platform (SWAP), and on lightning, thunderstorm prediction.
- Local Installation of the GRAPES-MESO model, GRAPES-Typhoon model and Storm surge and ocean state forecast model
- Regional Climate model from India

Summary and comments for Element4.3
BMD uses a PC-based system to receive satellite data from various sources, including CMACast, GEO-KOMPSAT-2A, and HimawariCast. BMD monitors priority hazards like tropical cyclones, storm surges, and heat waves. BMD personnel are trained in remote sensing data access and interpretation. Communication systems include satellite images, radar data, and the internet.

Summary score and recommendations for Element 4

BMD's maturity level for "Data and product sharing and policies" is assessed as **Level two** on the CHD scale reflecting "*A limited amount of GBON compliant data is shared internationally. The existing data sharing policies or practices or the existing infrastructure severely hamper two-way data sharing*".
More precisely, data is exchanged internationally, but none of it complies with GBON. There are no national data sharing policies or practices. Because various infrastructures (Parabola Antennae, VSAT, mobile internet) have been employed to retrieve data for various observations, the most significant obstacles are likely to be a lack of long-term strategic plans at the national scale.

Recommendations:

- Develop and implement a national policy on the exchange of meteorological, hydrological and climatological data and products.
- Update current international exchange stations to be compliant with GBON and increase the number of data sharing stations.
- A system for the quality controlling, archiving and sharing of the observation data is highly recommended.
- Continue communications with the meteorological departments of China, India, and other nations that have satellite or model data that is of interest to BMD.
- Review current data sharing policies and develop a data governance policy document.
- Could be beneficial for Bangladesh to have GHGs stations for Greenhouse Gases observations in the region

Element 5: Numerical model and forecasting tool application

5.1. Model and remote sensed products form the primary source for products across the different forecasting timescales.

BMD actively utilises forecast products from various World Meteorological Centres (WMCs) and Regional Specialized Meteorological Centres (RSMCs) to support its service delivery. Numerical weather prediction (NWP) products used for forecasting at BMD come from both local limited area data (LAM) and global models. BMD uses global model outputs from ECMWF, the Global Forecast System (GFS) of NOAA, JMA-GSM Model, and India Meteorological Department (IMD) operational GFS output. The WRF model is run as a Limited-Area Model (LAM) specifically for Bangladesh using their own resources. BMD has their own meteorological forecaster workstation and forecast production website where the model products can be shown.

BMD relies on many model outputs and remote sensing products to forecast at various timescales, including nowcasting, daily, medium range, extended range, sub-seasonal, monthly, and seasonal. The primary satellite products in use are the HIMAWARI from JMA, the FY 4 series satellite from CMA, the GK-2A from South Korea, and the METEOSAT from MET Norway. BMD uses several products (charts) from various models, including gridded data in GRIB, GRIB2, and NetCDF formats from various centres (ECMWF, NCEP and IMD). Sometimes the products in use are in text format, such as cyclone information.

All products from ECMWF are obtained by BMD through the internet twice a day (00 and 12 UTC). For GFS of NOAA, BMD has access to the model output data twice a day (00 and 12 UTC) through the internet. BMD can download and use the data of the Global Spectral Model output of JMA on a regular basis twice a day (00 and 12 UTC). The IMD operational GFS model output is pushed to the BMD's ftp server once a day (00 UTC). NWP model output data, observations and satellite data is visualised as charts, soundings, cross sections and time series with the Diana[33] open-source software from MET Norway.

BMD can post-process model outputs and use them as guidance for forecast generation. BMD staff are trained in different centres including RSMC New Delhi, India, RSMC Tokyo, Japan, Tokyo Climate Centre (TCC), Japan, RCC, Pune, India for the aim of accessing and using WMCs/RCs products and guidance for forecasting hazards. Since 2012, BMD staff have benefited from capacity development including use of NWP model output using the Diana open-source software from MET Norway. During the last few years, the number of products and the number of producing centres both increased for BMD, so access to the products widened a lot.

Summary and comments for Element 5.1

BMD actively uses prediction products from several World Meteorological Centres (WMCs) and Regional Specialized Meteorological Centres (RSMCs) to help deliver its services. In BMD, the WRF model runs on its own resources. BMD receives several products and data from various sources and methods, making it challenging to use. They may need to create an integrated system to deal with all of the model data. BMD's access to products given by global and regional centres has strengthened over the last two years. However, they may require additional training to improve their items and create their own model.

[33] https://github.com/metno/diana

5.2. a) Models run internally (and sustainably), b) Data assimilation and verification performed, c) appropriateness of horizontal and vertical resolution.

BMD has run their own WRF regional model since 2010, which covers the Bangladesh domain (13.5 -31.0 °N and 80.0 - 100.0°E), with horizontal resolutions of 18 km and 9 km. Since March 2024, BMD started to run WRF regional models with 3 km horizontal resolution. However, BMD does not perform any data assimilation for their model, but they have some plans to do the assimilation. Forecast verification is going on in BMD. BMD releases forecasts and warnings based on deterministic NWP guidance.

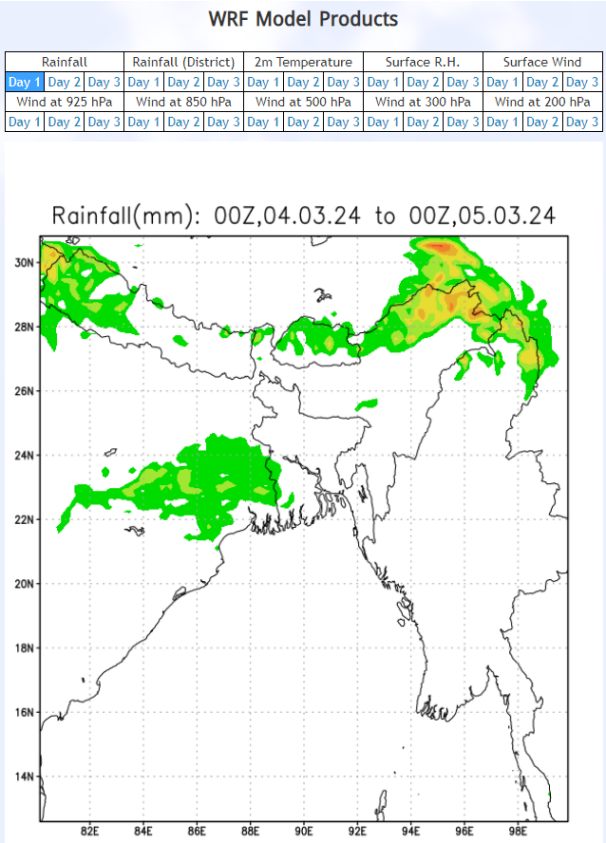

Figure 5: Example of WRF model product from the BMD website

Summary and comments for Element 5.2
BMD has its own WRF regional model that covers the Bangladesh domain with horizontal resolutions of 18 km and 9 km. However, BMD does not undertake any data assimilation for their model; they may require further training to do so.

5.3. Probabilistic forecasts produced and, if so, based on ensemble predictions.

Currently, BMD does not release forecasts and warnings based on probabilistic NWP. BMD however uses ARWpost[34] package to read the WRF output and Python programme and other software for post processing of other model output. BMD has good computing facilities for post processing, but capacity development is needed along with sufficient skilled manpower.

Summary and comments for Element 5.3
BMD has the capacity to post-process NWP, but requires capacity development and skilled manpower. They have not released probabilistic NWP forecasts or warnings yet.

Summary score and recommendations for Element 5

BMD's maturity level for "Numerical model and forecasting tool application" is assessed as **Level three**, on the CHD scale reflecting "*Prediction based mostly on model guidance from external and limited internal sources (without data assimilation) and remotely sensed products in the form of maps, figures and digital data and cover nowcasting, short and medium forecast time ranges*".

Gaps

- BMD lacks the resources to run models more frequently, as well as the abilities required to increase WRF skills and do data assimilation. Some meteorological features and disaster weather, particularly strong convective weather such as thunderstorms and lightning, have poor predicting ability.
- BMD does not provide probabilistic forecasts.
- BMD can receive a variety of numerical forecasting model results, but the sources and methodologies differ, and some models do not provide data. At the same time, there is a scarcity of integrated application systems that support numerous numerical models.

Recommendations

- Basic training in weather forecasting across time scales, as well as the use of ensemble forecasts, is required. Supporting real-time observations for nowcasting and expanding length with global model data.
- Establishing a data assimilation system is critical for model development and forecasting purposes.
- Create a multi-model integrated application system to process multiple models of data and generate products. Improving model data use and giving additional application references for forecasting and service, such as multi-model comparison, forecast modification, service product production, and so on.
- Establish research collaboration for NWP development, including post-processing, data assimilation, and verification.

[34] https://ruc.noaa.gov/wrf/wrf-chem/tutorial_arwpost.htm

Element 6: Warning and advisory services

6.1. Warning and alert service cover 24/7.

The warnings and alert services of BMD are available on a 24/7 basis. There is a multi-hazard early warning system (MHEWS) in place in Bangladesh governed by the Standing Orders on Disaster (SOD) 2019, see element 1.1. Several institutes in Bangladesh including BMD, FFWC and DDM are involved with the guidance of the Ministry of Disaster Management and Relief according to SOD.

BMD has monitoring and forecasting systems for multiple hazards occurring simultaneously or cumulatively over time in some instances. For example, when a tropical cyclone affects Bangladesh, BMD may predict TC, heavy rainfall, strong wind, landslide, flood, and even storm surge simultaneously. Drought and heatwave hazards may also happen at the same time. In addition, BMD has a disaster calendar for extreme meteorological events in Bangladesh Figure 6. Bangladesh in collaboration with Japan have created an online platform[35] dedicated to increasing awareness on how to be safe in the event of natural disasters.

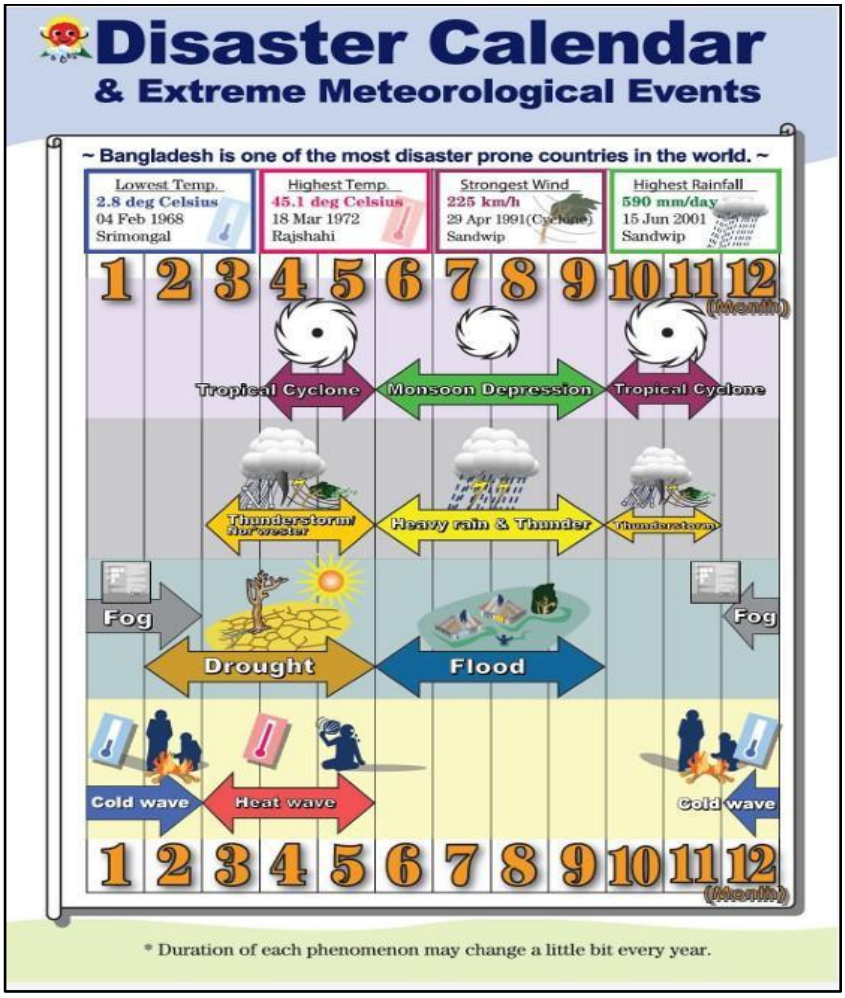

Figure 6: Disaster calendar for extreme meteorological events in Bangladesh

[35] http://www.saveyourself-bangladesh.com/

There are MHEWS warnings for potential cascading impacts in BMD. This may include frequent short rain episodes, dengue fever, and malaria. However, currently Impact Based Forecasting (IBF) is not sufficient, especially for severe weather induced hazards. It is not yet clear how many people per 100,000 are covered by early warning information in Bangladesh. The early warning information can however cover many people in Bangladesh in different ways. In case of cyclone, more than 78,000 volunteers are in place for early warning over the coastal area. Moreover, the lead time of the warning information depends on the type of events. For thunderstorms the lead time is very short, sometimes that may be just an hour, while for cyclones, the lead time can reach 72 hours.

Summary and comments for Element 6.1

Bangladesh's Disaster Management Department (BMD) provides 24/7 warnings and alert services. The Multi-hazard Early Warning System (MHEWS) is governed by the Standing Orders on Disaster (SOD) 2019. BMD monitors and forecasts multiple hazards simultaneously or cumulatively over time, such as tropical cyclones, heavy rainfall, strong wind, landslide, flood, and storm surge. The BMD also has a disaster calendar for extreme meteorological events. Bangladesh collaborates with Japan to create an online platform for safety during natural disasters. The number of people covered by early warning information is not yet clear.

6.2. Hydrometeorological hazards for which forecasting and warning capacity is available and whether feedback and lessons learned are included to improve warnings.

BMD issues warnings for extreme meteorological events in Bangladesh including tropical cyclones, storm surge, heavy rainfall accompanied with flood warnings, heat and cold waves, thunderstorms, and landslides.

BMD currently lacks a mechanism for evaluating its MHEWS performance, as well as feedback mechanisms for verifying warnings. The department hopes that this can be initiated during the SOFF project. DDM monitors and evaluates MHEWS/Disaster Risk Reduction in Bangladesh. As such, BMD only analyses forecast verification. This is still not practised consistently at BMD.

In Bangladesh, BWDB is responsible for the early warning for hydrological operation. This is part of a national MHEWS as provided in Bangladesh's Standing Orders on Disaster (SOD) 2019. There are generally no feedback mechanisms in place to verify warnings in BMD. The MHEWS checklist[36] identifies important features of early warning systems, including main components and actions, to which national governments, community organisations, and partners from all sectors can refer when designing or evaluating early warning systems.

There exists a mechanism for the co-design and/or co-production of tailored products and services at BMD within the RSMC framework during extreme weather events. BMD uses guidance products provided by the RSMC-IMD[37]. BMD also participates in South Asian Climate Outlook Forum (SACOF), which however is not well established for sector engagement in co-production and tailoring of climate services. Such can also be a forum for

[36] Multi-hazard Early Warning Systems: A Checklist

[37] Regional Specialized Meteorological Centre (RSMC) for Tropical Cyclones over North Indian Ocean

feedback sharing from different users for service delivery improvement. BMD offers tailored services including agro-met Bulletin, fleet forecast, inland and riverport bulletin and route forecast for special movement. BMD issues an agro-met bulletin once a week and disseminates this bulletin to farmers and specially to DAE for further advisory. Fleet forecast is delivered every 12 hours for the ocean-going vessels. And, inland and riverport warnings are delivered every 12 hours for the river ports. BMD issues route forecasts for VVIP and VIP movements on demand. BMD has aviation services too, such as TAF, SIGMET, Aerodrom F/C, route F/C. METAR and SPECI report, Aviation Warning, Domestic and international Flight Folders.

BMD does not use Flash Flood Guidance System for issuing flash flood warnings because FFGS is not a mandate of BMD. In Bangladesh, the FFWC[38] manages issues related to flooding. BMD maintains a warning and forecast archival system for most priority hazards under their mandate. There is a hardcopy archive for every warning and forecast including the

- Special Weather Bulletin (SWB) for tropical cyclone
- Daily Weather forecast
- Heatwave warning
- Coldwave warning
- Kalbaishakhi "Nor'wester" Warning

Summary and comments for Element 6.2

BMD issues warnings for extreme weather events such as tropical cyclones, storm surges, heavy rainfall, flood warnings, heat and cold waves, thunderstorms, and landslides. However, BMD lacks a mechanism for evaluating its MHEWS performance and feedback mechanisms for verifying warnings. The department hopes to initiate this during the SOFF project.

6.3. Common alerting procedures in place based on impact-based services and scenarios taking hazard, exposure and vulnerability information into account and with registered alerting authorities.

BMD has not yet adopted Common Alerting Protocol (CAP) format for the delivery of warnings. However, the process establishing a threshold for risks is ongoing. In 2023 as part of the SAREPTA capacity building project by MET Norway, there was an introduction classification of weather alerts with focus on temperature (heat waves) and rainfall. Demonstration of plotting according to thresholds in the visualization tool (Diana) was also undertaken. Further training on CAPs format will be beneficial including adopting the WMO CAP[39].

Standing Orders on Disaster[40] provides detailed Standard Operational Procedures and actions at Alert/Warning Stage. For example, as provided in the SOD, BMD is expected to: -

Promote the warning signals for each stage at the fixed times given below with the coordination of the Ministry of Disaster Management and Relief (in case of cyclone):

- Alert: Before 24 hours;

[38] http://www.ffwc.gov.bd/

[39] https://alertingauthority.wmo.int/authorities.php

[40] Standing Orders on Disaster 2019

- Warning Signal: At least 18 hours before;
- Danger Signal: At least 10 hours before.

Send these warning messages to the control rooms of the National Emergency Operation Centre (NEOC) and National Disaster Response Coordination Centre (NDRCC) of the Ministry of Disaster Management and Relief (MoDMR), Department of Disaster Management (DDM), Cyclone Preparedness Programme (CPP) and Bangladesh Red Crescent Society (BDRCS);

After issuing any alert/warning, BMD disseminates these to the concerned/registered authorities and stakeholders through fax, email and WhatsApp directly in addition to all centres of Bangladesh Radio and Television.

Impact-Based Forecasts (IBF) and warning services are yet to be fully established at BMD. Forecasters have not been trained on the principles, methods and application of impact-based forecasting (IBF). BMD however is looking to establish sector wise IBF. Due to the absence of a good impact dataset over Bangladesh, BMD has no access to impact information and post-disaster analytics from key stakeholders. Additionally, BMD has no capacity to use hazard, exposure and vulnerability information as an input into the development of warning products. Through German Redcricent, RIMES and BBS, some of these datasets have been mentioned but according to BMD, they are not good enough to be incorporated into IBF.

BMD lacks a hazard-specific impact model. Software methods for generating impact-based forecasts and alerts are lacking. BMD provides hazard-based information, but DDM takes the effort to decrease risk based on SOD.

Summary and comments for Element 6.3
BMD has not yet adopted the Common Alerting Protocol (CAP) format for warnings, but is working on establishing a risk threshold. BMD also lacks a good impact dataset and software methods for generating impact-based forecasts and alerts. Further training on CAP format and standard operational procedures is needed.

Summary score and recommendations for Element 6

BMD's maturity level for "Warning and Advisory Services" is assessed as **Level three** on the CHD scale reflecting *"Weather-related warning service with modest public reach and informal engagement with relevant institutions, including disaster management agencies."*

Gaps

- Impact Based Forecasting (IBF) is inadequate, particularly for severe weather-related hazards. Not all disaster weather in Bangladesh is reliably forecast, and early warning services remain insufficient. Lack of resources for operating EWS infrastructure and dissemination channels.
- BMD is currently facing a shortage of capacity and human resources to operate and develop contemporary early warning systems.

Recommendations to strengthen warning services and to achieve objectives of the Early Warning for All Initiative by 2030:

- The availability and utilisation of existing technical facilities should be further enhanced in order to build a more reliable and timely warning service. Technical help and capacity building are required to achieve this.
- To increase the efficiency of early warning production and information dissemination, a forecast analysis and early warning system for diverse dangers is required. This system can aid in speedy data processing, product generation, and data sharing.
- Impact-Based Forecasting (IBF) should be enhanced.
- The CAP format for generating and disseminating weather warnings has to be operationalized.
- Early warning for severe convective weather, such as thunderstorms and lightning, needs to be enhanced, including the use of satellite data and the development of monitoring systems.
- Improving the use of satellite and remote sensing data for monitoring meteorological and hydrological conditions will be beneficial.
- More lead-time for the warnings is required: some stakeholders require more time to mitigate the effects of catastrophe weather; some homes are dispersed and lack enough infrastructure, making it harder to reach the public with warning information.
- Cooperation with DRR authorities must be strengthened and made more regular including establishing an annual user survey.
- Improve last-mile information transmission using digital means.
- More training in forecasting and early warning systems is needed.

Element 7: Contribution to Climate Services

7.1. Where relevant, contribution to climate services according to the established capacity for the provision of climate services.

In assessing the climate service capabilities in Bangladesh, several key aspects have been examined.

Governance: At the time of writing BMD has no official governance platforms or mechanisms, such as MoU's or any engagement in NFCS, to ensure coordination for climate services. However, some coordination efforts are ongoing with other national institutions and stakeholders to enhance climate service delivery and contribute to national adaptation planning.
For instance, BMD has a mandate to share seasonal forecasts with the Department of Agricultural Extension (DAE). This relationship was formalised under the Bangladesh Weather and Climate Services Regional Project[41], a recent World Bank (WB) supported project.

BMD is also engaged in the National Climate Outlook Forum (NCOF), particularly ahead of the monsoon season. Through the NCOF platform, BMD in collaboration with other sectors, have engaged in co-production of tailored climate services. Important feedback is also shared at these forums for service delivery improvements.

Coordination efforts between BMD and the Ministry of Disaster Management and Relief during disaster risk management have been governed by the Standing Orders on Disasters (SOD) from 2019.

Basic Systems:
Observing networks: BMD operates a network of about 314 observation stations of varying classes. There are 58 manual (synoptic) observation stations, 61 automatic weather stations (AWS), 125 agricultural AWS, 65 automatic rain gauge stations and six 6 upper air stations. The spatial coverage of the observation network is good, but the ICT infrastructure for the complete data processing and data transmission of all the observation data (including AWS data) needs to be improved, where SOFF will support.

Data and data management system: The full data processing and transmission chain from an observing station to a final and operational Climate Data Management System (CDMS) is not in place at BMD. Hence, urgent development and skilled IT specialists for the increased data processing and management capabilities are critical for BMD. Implementation of Bangladesh's GBON National Contribution Plan through SOFF will be of great benefit.

The observation data is not open, but customers may purchase observation and climate data from BMD. To purchase data, a fill-in form from a data portal service (https://dataportal.bmd.gov.bd/) is available. BMD has to prepare the data manually for the customers upon the request. The cost depends on the amount of data and customer (for instance cheaper for students).

Monitoring and forecasting systems: An efficient monitoring of the data is dependent on the capabilities and viability of the data management system and BMD in-house capacity. The BMD CDMS (CLIDATA) is not yet integrated into the data processing chain and is not

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

supporting the overall data monitoring and the forecasting systems. Observations from the manual/conventional stations are archived as individual files manually, and then entered into the available Network-Attached Storage (NAS).

User Interface: Sufficient mechanisms, tools and systems that allow climate services users and providers to interact, to ensure co-production and tailoring of services for decision support and feedback are still not fully in place at BMD.
Through the NCOF, there are some mechanisms established, including face-to-face meetings and digital user engagement. There is also some co-production in place with various Departments (Agriculture, Health, Water development Board etc), coordinated and supported by RIMES (The Regional Integrated Multi-Hazard Early Warning System for Africa and Asia).

Provision and application of Climate Services: BMD has established some provision and application of Climate Services, which is slowly expanding in the right direction.

Bangladesh has a quite dense observation network, which provides a good foundation for the two published climate reports; Climate of Bangladesh (2016) and the Changing Climate of Bangladesh (2024). These are available online at BMD and contain decision relevant information digested by BMD and MET Norway. The information in these two reports may be used as a foundation to generate e.g. climate monitoring products for Bangladesh to relevant stakeholders. Ahead of the reports, a lot of work and emphasis have been conducted on digitization, preparation and quality control of observation data.

BMD offers tailored climate services to key sectors, such as Health, Water, Agriculture (food security), Disaster Risk Reduction and Energy (nuclear power plants etc).

BMD has also started to publish a Seasonal Climate Summary (as a newsletter) containing climate data and verification of the previous seasonal forecast.

Monitoring and evaluation of the socio-economic benefits: BMD currently lacks a structured mechanism for monitoring and evaluating the socio-economic benefits of Climate Services in Bangladesh.

The Ministry of Disaster Management and Relief conducts studies of crop monitoring with weather information input from BMD.

It is recommended for BMD to conduct impact studies to provide evidence for the socio-economic value of weather and climate services, as a start for internal and in-house use.

Capacity Development: There are some technical advisory services and training available at BMD to address capacity development needs for climate services provision and use.

As part of the 'Sarepta Project' (capacity building project between BMD and MET Norway), training and development of climate services such as climate monitoring is planned. However, the current priority is on the future climate. There is still a significant gap between the needs and the current capacity, especially on data management.

Relevant capacity building and collaborative efforts for Climate Services at BMD are conducted also by other organisations, such as RIMES (Regional Integrated Multi-Hazard Early Warning System), JICA (Japan International Cooperation Agency), KOICA (Korea International Cooperation Agency) etc.

Data Rescue: Data from the manual/conventional observation stations are digitised and archived (with a backup-system), allowing for identification of weather and climate hazards over a long time series. Since a CDMS at BMD is not yet functional, the data from the automatic weather stations (AWS) are not archived. A functional data management system at BMD (including a CDMS) will make the data sharing more efficient.

There is also a World Bank (WB) initiated project for data rescue at BMD, but all details are not yet clear.

Summary score, recommendations, and comments for Element 7

BMD's maturity level for "*Contribution to Climate Services*" is assessed as Level 3: "*Essential Capacity for Climate Services Provision*".

Recommendations:

- Strengthen the national governance mechanisms at BMD to ensure coordination of climate services, such as NFCS or other efforts
- Improve the observation data management (archiving, quality control, CDMS), monitoring, and forecasting systems through SOFF. Urgent development and skilled IT specialists for the increased data processing and management capabilities are critical for BMD.
- BMD to enhance their capacity to offer tailored climate services to key sectors and customers
- Establish mechanisms (start internally for in-house use) to monitor or evaluate the socio-economic benefits of climate services.
- Ensure that all user interface platforms have representation of all actors, particularly on the grassroot level

Element 8: Contribution to hydrology

8.1. Where relevant, standard products such as quantitative precipitation estimation and forecasts are produced on a routine basis according to the requirements of the hydrological community.

Bangladesh Water Development Board (BWDB) and the Flood Forecasting and Warning Centre (FFWC) under the Ministry of Water Resource in Bangladesh are responsible for operational hydrological services including collection of hydrological data, hydrological forecasting and water resource assessment activities. BMD coordinates with these institutes in Bangladesh in operational hydrology mainly on the provision of meteorological observations and NWP model output (rainfall product from WRF model) relevant for hydrological services.

Summary and comments for Element 8.1
The Bangladesh Water Development Board and Flood Forecasting and Warning Centre are responsible for operational hydrological services, including data collection, forecasting, and water resource assessment, coordinating with these institutes.

8.2. SOPs in place to formalise the relation between Met Service and Hydrology Agency, showing evidence that the whole value chain is addressed.

At present, there are no formal SOPs in place in Bangladesh that formalises the work relationship between the sections of Meteorology and Hydrology. BMD however provides various services to the BWDB and the FFWC as stipulated in the Meteorological Act, 2018. Additionally, recently under the WB BWCSRP Project BMD entered a formal MoU with BWDB on 3rd party data sharing. Initiatives such as the National Framework for Climate Services (NFCS)[42] that are absent in Bangladesh would be very relevant in the coordination of activities between the meteorological and the hydrological services, hence improvement of service delivery. Bangladesh has a flood management plan established under the Ministry of Water Resource, FFWC.

Summary and comments for Element 8.2
Bangladesh lacks formal SOPs for Meteorology and Hydrology work relationships, but BMD provides services to BWDB and FFWS. A MoU with BWDB on 3rd party data sharing is under WB BWCSRP Project. Initiatives like NFCS could improve service delivery. Bangladesh has a flood management plan.

8.3. Data sharing agreements (between local and national agencies, and across international borders as required) on hydrological data in place or under development.

[42] https://wmo.int/sites/default/files/2023-06/NCFS-Factsheet.pdf

The Bangladesh Water Development Board (BWDB) is responsible for facilitating hydrological data sharing agreements between local and national organisations, as well as across international borders.

Summary and comments for Element 8.3
BWDB) facilitates hydrological data sharing agreements between local and national organisations, as well as across international borders.

8.4 Joint projects/initiatives with the hydrological community designed to build hydrometeorological cooperation.

The BWCSRP project, a recent World Bank (WB) financed hydro-project, consists of four components, including a component on strengthening meteorological information services implemented by BMD and a component on strengthening hydrological information services and early warning systems implemented by BWDB. Through the project, a formal agreement on data sharing has been established. More effort is needed to build and strengthen hydrometeorological collaborations, particularly to promote co-design and co-production of services in the whole value chain.

Summary and comments for Element 8.3
The BWCSRP project, a World Bank-financed hydro-project, focuses on strengthening meteorological information services and early warning systems, establishing data sharing agreements, and promoting co-design and co-production of services throughout the value chain.

Summary score and recommendations for Element 8

BMD's maturity level on Contribution to Hydrology is assessed as **Level three** on the CHD scale reflecting "*There is a moderately well-functioning relationship between the meteorological, hydrological and water resources communities but considerable room for formalising the relationship and SOPs.*"

Recommendations:

- Establish specific SOPs to formalises the work relationship between the sections of Meteorology and Hydrology in Bangladesh
- Strengthen hydrometeorological collaborations, particularly to promote co-design and co-production of services across the whole value chain.

Element 9: Product dissemination and outreach

9.1. Channels used for user-centred communication and ability to support those channels (for example, does the NMHS operate its own television, video or audio production facilities? Does it effectively use cutting-edge techniques?).

BMD uses a variety of communication channels to ensure that its weather products and services are effectively disseminated. BMD communicates through print and electronic media, social media (WhatsApp, Facebook), fax, e-mail, and the internet, which includes the BMD website. The website is used to distribute various forecast products and other weather-related information at varying intervals. Satellite and radar products, for example, are uploaded every half-hour. NWP products are issued twice a day, aviation forecast products are issued every hour, and agro-met forecast products are issued weekly. Other channels, such as phone, email, and FAX, are typically issued twice every day, particularly when disasters warnings are issued. Other social media platforms, such as WhatsApp and Facebook, are utilised to disseminate the forecasts and alerts as they are issued. BMD does not run its own radio/television studio. Warnings are disseminated at the regional and/or local levels in Bangladesh in coordination with the DDM, as specified in the SOD. BMD has meteorological administrators up to the divisional level who serve on disaster management committees and can issue warnings to the public and other end users at these levels.

Summary and comments for Element 9.1
BMD has a variety of means for effectively disseminating its forecasting product, including a website, phone, fax, email, and social media (Whatsapp, Facebook, etc.). There are additional procedures in BMD for disseminating alerts at the regional and local levels. However, there is no dedicated radio/TV studio for producing and broadcasting weather forecasts.

9.2. Education and awareness initiatives in place.

BMD has collaborated with Non-Governmental Organisations (NGOs) and International Non-Governmental Organisations (INGOs) on education and awareness efforts. In addition, BMD signed a Memorandum of Understanding with the University of Dhaka's Department of Meteorology to expand meteorological information services and early warning systems, as well as to develop academic exchanges and cooperation in teaching and research. As part of the World Bank's BWCSRP effort, BMD held 42 seminars at various schools, farmers' markets, and grassroots communities.

Summary and comments for Element 9.2
BMD collaborates with NGOs, INGOs and universities for education and awareness initiatives.

9.3. Special measures in place to reach marginalised communities and indigenous people.

Under World Bank (WB) finance, BMD hosted 42 seminars from Bangladesh Weather and Climate Services Regional Project (BWCSRP) Component A project at different schools, farmers, grassroot level communities.

Summary and comments for Element 9.3
The BMD has already implemented certain initiatives to reach out to marginalised populations and indigenous people. However, there is a necessity to establish conventional collaboration with the community in science popularisation or weather warning.

Summary score and recommendations for Element 9

BMD's maturity level on "Product dissemination and outreach" is assessed **Level 3 on** the CHD scale reflecting "A moderately effective communication and dissemination strategy and practices are in place, based only on in- house capabilities and supported by user-friendly websites."

Recommendations:

- Consider establishing a radio/tv studio or forming formal collaborations with existing local radio/tv studios to produce and broadcast weather forecasts, therefore increasing visibility and the societal benefit of early warnings.
- Try to foster closer communication with the various communities, primarily through "information agents" such as local government officials and community leaders. These agents should be taught to interpret and translate meteorological information for their communities.
- Facilitate stakeholder and user participation through grass-roots workshops to increase institute visibility and work to improve tailored solutions to the specific needs and challenges of different communities.

Element 10: Use and national value of products and services

10.1. Formalised platform to engage with users in order to co-design improved services.

BMD currently lacks a structured framework for engaging with users in order to promote co-design and co-production of services. BMD engages users by hosting roaming seminars with agriculture specialists and farmers, attending disaster-related meetings with high-level officials, and conducting surveys among the general public. These operations are often ad hoc, with unclear outcomes. However, some reports in Bangla are usually generated.

BMD actively participates in a multi-sector consultative platform, including the Monsoon Forum, which is organized by the Regional Integrated Multi Disaster Early Warning System (RIMES) twice a year. BMD also organises the National Climate Outlook Forum. The Bangladeshi government normally funds this twice a year, in partnership with RIMES who provide logistical support. All BMD stakeholders participate in these forums and provide feedback. The reports from these forums are available on BMD website[43,44] . BMD also attends the South Asian Climate Outlook meeting (SACOF), a regional climate outlook meeting hosted by RCC in Pune, India, twice a year. Additionally, BMD forecasters attend the South Asian Hydraulic Conference Forum (SAHF) once a week. Different organisations in Bangladesh organise/convene cross-sector discussions. BMD sometimes takes the lead, but other organisations, such as the DAE, BWDB, DDM, RIMES, ICDDRB, STEP, IFAD, and universities, become the primary organisers.

The National Disaster Management Council (NDMC)[45] in Bangladesh was established to provide policy guidance on disaster risk reduction and emergency response management. The Council is multi-sectoral and inter-disciplinary in nature, with governmental, commercial, and civil society participation from all relevant bodies within the country, including representation from the UN. The NDMC Council convenes at least once each year. The NDMC has a Disaster Management Committee at each administrative level (Zilla, Upazila[46], Union, District[47]). BMD has representation up to the divisional level, and they are participants on these disaster management committees. The main communication channels between these sectors are mainly through WhatsApp and email.

At present, the services provided by BMD mainly include, agricultural meteorological services, aviation services, climate services (including online climate data purchase, one month and three-month climate outlook), weather services (including daily weather forecast and alarm services, mobile forecast services to Bangladeshi dignitaries, and astronomical services). BMD also provides Sea Bulletin, Fisherman Forecast, and Fleet Forecast.

In 2022, the Strengthening Forecast-based Early activities in Cyclone Prone Coastal Regions in Bangladesh (STEP) project supported communities in Bangladesh's coastal districts to integrate anticipatory and early activities, as well as preparedness measures. On October 25, 2022, the Sitrang cyclone struck Bangladesh's coastline. The majority of supported households involved in agriculture, fishery, cattle, and poultry took anticipatory or early

[43] https://live6.bmd.gov.bd/p/Outlook-for-ASO2023

[44] https://live6.bmd.gov.bd/p/Outlook-for-JAS2023

[45] National Disaster Management Council (NDMC)

[46] Upazila Disaster Management Council (NDMC)

[47] District Disaster Management Council (NDMC)

activities on their own, with considerable outcomes in reducing loss and damages. Details of the project are available in the report[48].

Summary and comments for Element 10.1
Although BMD does not have a formal or routine framework for co-designing and improving services with users, it actively participates in a multi-sector consultative platform and communication with its users and important meteorological service stakeholders. To further improve, a platform for interaction with users, stakeholders, and other departments can be developed in order to implement independent user satisfaction.surveys

10.2. Independent user satisfaction surveys are conducted, and the results used to inform service improvement.

BMD conducted user satisfaction surveys under various initiatives, targeting diverse communities. The feedback they receive frequently culminates in a report. Based on the input, BMD has worked to improve its services. For example, if farmers prefer to receive forecasts and warnings through a specific media channel, BMD prioritises that medium. However, BMD currently does not undertake frequent assessments and reports on the accuracy and timeliness of its services. It is crucial for BMD to regularly assess the accuracy and timeliness of their services to ensure that they effectively meet the user needs. BMD provides bilingual (Bangla, English) predictions and alerts but lacks a multilingual assessment mechanism.

Summary and comments for Element 10.2
There appears to be no clear and consistent approach or mechanism for BMD to drive service improvement based on user feedback data. It is vital to thoroughly study user feedback data and improve BMD's grasp of consumer requirements. Meanwhile, create a plan and system for regular service assessment, measurement, and evaluation.

10.3. Quality management processes that satisfy key user needs and support continuous improvement.

BMD's Quality Management System (QMS) implementation is generally lacking. BMD has limited and uncertified QMS only for the provision of meteorological service, for example in climate data management without using any standard tool. In terms of international air navigation, BMD has a separate division dedicated to evaluating aviation forecasts and managing quality. There thus lacks a QMS for its aviation services in Bangladesh. BMD currently does not have a plan in place for the full adoption of QMS. The comprehensive implementation of QMS, as well as the certification and documenting of SOPs, are critical to guaranteeing the quality and efficacy of climate and meteorological services.

Summary and comments for Element 10.3
BMD generally lacks any intervention for the Quality Management System (QMS)

[48] A rapid assessment of the effectiveness of early action measures during Cyclone Sitrang in November 2022

implementation. There is a need to improve existing QMS and adopt certification, also strengthen training and use of standardized tools.

Summary score and recommendations for Element 10

BMD's maturity level for "Use and National Value of Products and Services" is assessed as **level two** on the CHD scale reflecting "*Service development draws on informal stakeholder input and feedback.*"

Recommendations:

- Set up a formal platform to improve user engagement and stakeholder involvement.
- Establish a system for reviewing, measuring, and evaluating their services on a regular basis in order to improve their accuracy and timeliness, including sector-specific assessment surveys.
- Continuously participate in or organise national or regional forums and seminars, which may require ongoing government financing.
- Carry out quality management system certification.
- Create a comprehensive and practical quality management system implementation plan for expanding the implementation.
- Improve training and use of standard tools.

Annex 1 Consultations (including experts and stakeholder consultations)

To carry out the peer-review with BMD and stakeholders for this Country Hydromet Diagnostics (CHD) report, country information was obtained through:

1. A **questionnaire** on each element was developed based on the indicators provided in the CHD EW4All data inventory and review sheet for Bangladesh. The questionnaire was shared and filled up by the EMI-SOFF team based on consultation with different internal and external experts and stakeholders based on the review question.
2. The peer advisors conducted two in-person consultation sessions during the peer-peer review process:
    a. The first consultation session was held in Dhaka, Bangladesh in November 2023. The session was a kick-off meeting to introduce SOFF to BMD staff and focus was on SOFF GBON Gap Analysis during which some of the information acquired was relevant for the Country Hydromet Diagnostics report.

    BMD experts: Md. Abdul Matin, Razia Sultana, Quamrul Hassan
    Peer-reviewers: Elinah Khasandi Kuya, Kristine Gjesdal, Tor Ivar Mathisen

    b. NCP and CHD SOFF stakeholders meeting in Dhaka, Bangladesh in February 2024. The stakeholder workshop was organized in collaboration with MET Norway's SAREPTA project and brought together 60 stakeholders from different government stakeholders and CSOs across the meteorological value chain in Bangladesh. The meeting report annexed in the NCP report provides more information.
    BMD SOFF experts: Md. Abdul Matin, Razia Sultana, Quamrul Hassan
    MET Norway: Elinah Khasandi Kuya, Tor Ivar Mathisen Teferi Dejene Demissie,
    CMA: Guo Jianxia, Yang Shunan, Bian Zeqiang

3. Bi-weekly and Weekly meetings were scheduled and held whenever possible with the SOFF team at EMI, peer-reviewers and the implementing entity (UNDP) to discuss the progress of SOFF reporting, including the CHD report.
   BMD SOFF team: Md. Abdul Matin, Razia Sultana, Quamrul, Md. Shameem Hassan Bhuiyan
   MET Norway: Elinah Khasandi Kuya, Tor Ivar Mathisen, Hildegunn V. Dyngeseth Nygård
   CMA: Guo Jianxia, Yang Shunan, Bian Zeqiang, Peng Jie, Kang Jiaqi, Wang Jia, Chi Xiaozhu
   Implementing entity (IsDB): Olatunji Yusuf, Nasser Yakubu

4. Peer-advisors and designated SOFF staff at BMD have also been in email correspondence and charts regarding different issues and data sharing of additional information throughout the report writing.

Annex 2 Urgent needs reported

The recommendations presented in each chapter for elements 1-10 are critical steps for improving BMD services and raising the department's maturity score to a higher level. The following recommendations are evaluated as those requiring immediate attention in addressing the critical needs listed in the executive summary:

1. To address the human capacity and capabilities challenges, BMD needs to prioritise developing their employee's capacity through training and recruitment of qualified personnel with relevant skills needed by the institute. A proactive recruiting policy will ensure the institute's long-term viability while limiting the negative consequences of extensive vacancies. Gender action plan that includes affirmative actions to bridge the gender gap between female and male employees will be useful. Restructuring the department's organisational structure to match growing technological (more automated weather system infrastructure) demands can also benefit BMD.
2. To achieve its financial goals, BMD should strive to improve their financial decision-making and resource allocation strategies to allocate their financial resources efficiently and effectively to optimise department performance and meet their strategic development goals and targets.
3. BMD should develop and implement an operational strategic plan that is aligned with the national strategic plan, as well as a risk management plan, in order to maximise the probability of success in accomplishing its organisational goals in the short, medium, and long term.
4. The long-term viability of the observation infrastructure network is dependent on the calibration and maintenance strategies employed. Implementation of the proposed recommendation in the NCP and this report should be considered, including the development of SOPs for the calibration, maintenance, and quality assurance of BMD's automatic systems.
5. ICT infrastructure services and data management systems require immediate attention. Organisational dataset management throughout the entire value chain, including data ingestion, quality control and assessment, storage, and a real-time data transmission system for global exchange via WIS 2.0, is lacking, and BMD must prioritise improving its personnel capacity in order to comply with GBON. The capacity for numerical model and forecasting tool applications should be addressed, including the development of a multi-model integrated application system capable of processing numerous data models and generating products.
6. User interactions and stakeholder involvement at BMD should be strengthened, including the formation of partnerships with formal SOPs. Implementing the National Framework for Climate Services (NFCS) can help to formalise key stakeholders' working ties. Improvements to MHEWS projects, the Common Alerting Protocol, and SOP implementation for systematic disaster response is recommended.

Annex 3 Information supplied through WMO

- WMO Global GBON gap Analysis
- WMO Monitoring System Data
- WMO EW4All Rapid Assessment for Pillar-2
- WMO Hydrology Survey
- Data from Checklist for Climate Services Implementation

Annex 4 List of materials used

In addition to the WMO guidance materials, data and information, reviewed reports, database, websites and documents referenced are linked by each chapter/element in the report.

Annex 5 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**