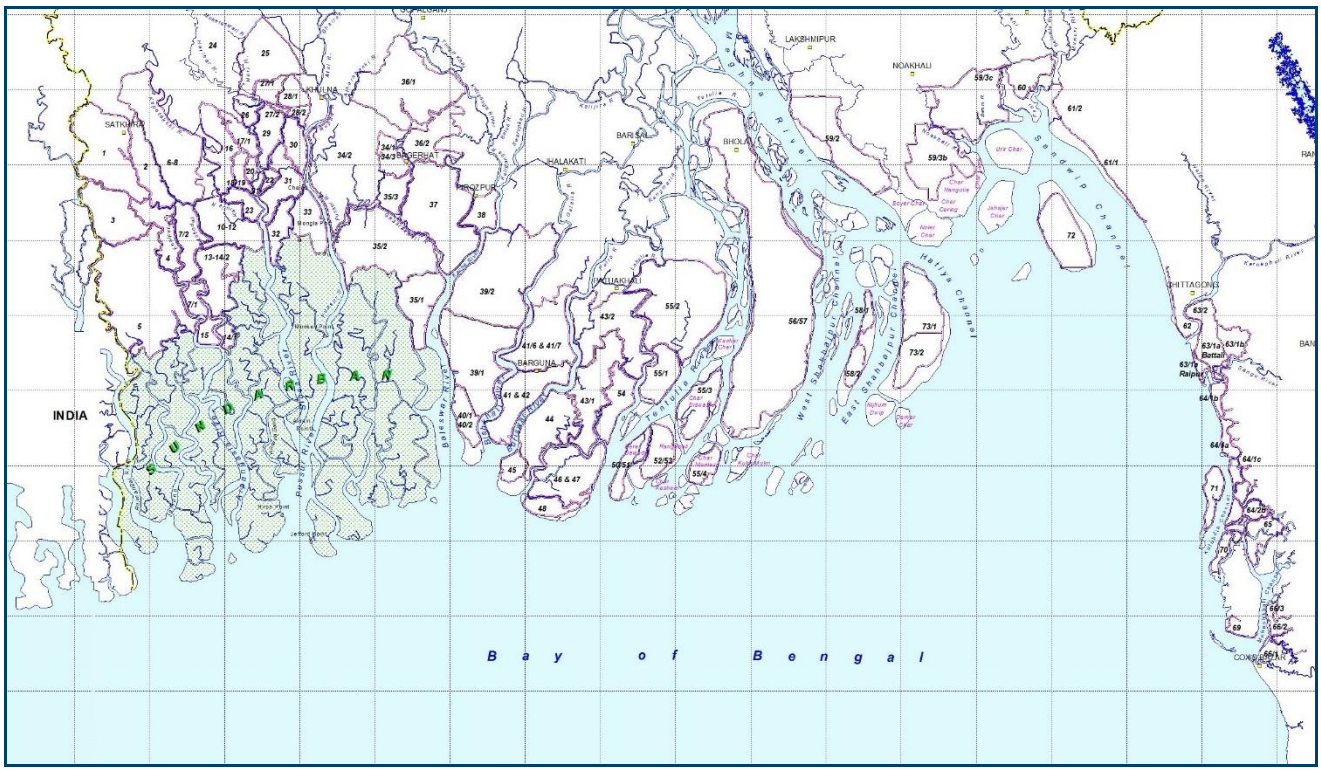
Ministry of Water Resources

Bangladesh Water Development Board

Coastal Embankment Improvement Project, Phase-I (CEIP-I)

Long Term Monitoring, Research and Analysis of Bangladesh Coastal Zone (Sustainable Polders Adapted to Coastal Dynamics)



Technical Report on Improving Data Collection

April 2022

DHI Deltares Enabling Delta Life IWM Water Environment & Climate Columbia University

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Bangladesh Water Development Board
Coastal Embankment Improvement Project, Phase-I (CEIP-I)
Long Term Monitoring, Research and Analysis of Bangladesh Coastal Zone
Office: Flat #3/B, House #4, Road #23/A, Banani, Dhaka 1213, BANGLADESH Phone +880 1307 693299

Memo No: CEIP/LTMRA/0422/160 26 April 2022

Project Management Unit
Coastal Embankment Improvement Project, Phase-I (CEIP-I)
Pani Bhaban, Level-10
72, Green Road, Dhaka-1205

Attn: Mr. Syed Hasan Imam, Project Director

Dear Mr Imam,

Subject: Submission of Technical Report on Improving Data Collection (D-3:9)

It is our pleasure to submit herewith Five copies of the Technical Report on Improving Data Collection (D-3:9). The report comprises 7 chapters and describes the present system including the challenges faced by the hydrological system information monitoring in BWDB, as well as possibilities for improvement in processes of data collection, QA/QC and data dissemination.

The objective of this report is to present an evaluation of the equipment and methods currently in use by BWDB, based on the experience of the Long-Term Monitoring Project, with respect to optimal, sustainable, hydraulic measurements, and to suggest an optimal, sustainable hydraulic measurement strategy with the intent that these instruments and methods will be adopted by BWDB and other agencies like the Bangladesh Inland Water Transport Authority (BIWTA).

Thanking you,

Yours sincerely,

Dr Ranjit Galappatti
Team Leader

Copies: Engineer Mr. Fazlur Rashid, Director General, BWDB
Dr. Zia Uddin Baig, ADG (Planning), BWDB
Dr Kim Wium Olesen, Project Manager, DHI
Ms Sonja Pans, Deltares Project Manager
Mr Zahirul Haque Khan, Deputy Team Leader
Mr AKM Bodruddoza, Procurement Specialist
Ms Swarna Kazi, Sr. Disaster Risk Management Specialist, World Bank

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ACRONYMS AND ABBREVIATIONS

ADCP	Acoustic Doppler Current Profiler
ADG	Additional Director General
BIWTA	Bangladesh Inland Water Transport Authority
BWDB	Bangladesh Water Development Board
BWCSRP	Bangladesh Weather and Climate Services Regional Project
CEIP	Coastal Embankment Improvement Project
DEM	Digital Elevation Model
DG	Director General
EPWAPDA	East Pakistan Water and Power Development Authority
FFWC	Flood Forecasting and Warning Centre
FM	Flexible Mesh
GBM	Ganges, Brahmaputra and Meghna
GPS	Global Positioning System
IWM	Institute of Water Modelling
KJDRP	Khulna-Jessore Drainage Rehabilitation Project
MOWR	Ministry of Water Resources
NGO	Nongovernment Organization
O&M	Operation and Maintenance
QA/QC	Quality Assurance/ Quality Control
RRI	River Research Institute
RTK	Real Time kinematic
SLR-	Sea Level Rise
SSC	Suspended Sediment Concentration
SWRM-	South West Region Model
TRM	Tidal River Management
WL	Water Level

1 Introduction

1.1 Background

The BWDB was formed, in its former identity EPWAPDA, in 1959 to develop recommendations for solving problems of flooding and loss of life, property, and crops. The BWDB was advised to take immediate measures to construct dams, barrages, embankments, drainage systems, irrigation canals, and to negotiate with India the management of water in common rivers. Water resources data collection has been a necessary and critical component of BWDB activities. Data collection supports all management activities and services provided by the Board. With the process of climate change the water resources of Bangladesh will have to be even more carefully recognized and managed.

At present, the measurement, collection, and relay of water resources observations are conducted manually as well as automated. This report describes the existing hydromet information system comprising surface water, ground water, rainfall, and other surface meteorological measurements that are necessary for understanding the prevailing characteristics of water resources in Bangladesh.

An effective water information system for Bangladesh must consider Bangladesh centric factors while weaving in experiences from other solutions developed from around the world. It is completely within reason that an effective water information system can be put in place in Bangladesh, though this will require a thoughtful design as well as a commitment from BWDB.

The Long-Term Monitoring, Research and Analysis of Bangladesh Coastal Zone (Sustainable Polders adapted to Coastal Dynamics) study has been taken by BWDB funded by World Bank to improve and manage the polders successfully in the coming decades and analysing any drawbacks of the existing polders and determining how the coastal polders can be managed in a more sustainable way for the long term. It is important to have a clear understanding of the relation between the functioning of polders and the ever-changing boundary conditions due to the dynamics of the environment.

One of the main Components of this project is the field data collection to set up the mathematical models, and to calibrate and validate them before using them to simulate the full range of possible scenarios including the capacity building in the field of improved data collection methodology in the context of the present state of the art technology. Accordingly, in addition to several scheduled special trainings, official of the BWDB were given hands-on training during data collection programme during this study. The present report describes the present system including the challenges faced by the hydrological system information monitoring in BWDB, as well as possibilities for improvement in processes of data collection, QA/QC and data dissemination.

1.2 Objectives

The objective of this report is to present an evaluation of the equipment and methods currently in use by BWDB, based on the experience of the Long-Term Monitoring Project, with respect to optimal, sustainable, hydraulic measurements, and to suggest an optimal, sustainable hydraulic measurement strategy with the intent that these instruments and methods will be adopted by BWDB and other agencies like the Bangladesh Inland Water Transport Authority (BIWTA).

BWDB (and its predecessor EPWAPDA) have been collecting hydraulic data systematically since 1964. The collected data form an appreciable and professional database that has been used

extensively by different water sector planners, designers, and managers. Still, there is room for modifications and improvements and the key areas for such modifications include:

- Reorganizing the BWDB hydrology offices to reduce jurisdiction area
- Increasing the number of parameters those are presently measured by BWDB.
- Measuring flood discharge at peak stages of the rivers in addition to routine
- Converting water level stations at coast from 3 hourly reading to automatic & continuous reading station.
- Collecting special data needed for different water-sector projects and studies.

Optimization of overall survey techniques is a continuous process, when evaluating each new instruments and methods to be introduced.

2 Institutional and Organizational Analysis and Needs Assessment

All hydrometric and hydrographic measurement under BWDB is carried out under the supervision of the Chief Engineer Hydrology and the four circles under the Chief Engineer of Hydrology.

BWDB is an autonomous organization under the MOWR. There is a 13-member Council that governs BWDB, which is headed by the MOWR. The main function of this Council is to give advice on BWDB policy, planning, and operation. The other members of the Council are the Secretaries of four Ministries, namely Water Resources, Finance, Local Government, and Environment; Directors General of BWDB, and WARPO; two Government-nominated water specialists, one NGO representative, one Chartered Accountant, and two beneficiary representatives.

The Director General (DG) is the Chief Executive Officer of BWDB. There are five wings in BWDB headed by Additional Director Generals (ADG). These wings consist of Administration, Finance, Planning, O&M-1, and O&M-2. Under the ADG for Planning, there are the Chief of Planning, Chief Engineer Design, and Chief Engineer Hydrology.

The organization chart shown in Figure 2-1 presents the organizational chain above the Office of the Chief Engineer, Hydrology, showing the Office of the Chief Engineer Hydrology reports to the Additional Director General, Planning, who reports to the Director General of BWDB. As this Study is directed at upgrading of the hydromet network and services related to the use of this information, this Study focuses on institutional improvements under the Office of the Chief Engineer, Hydrology. The other offices (in orange) are not directly associated with the changes proposed by the Study, and thus are not described in any further detail.

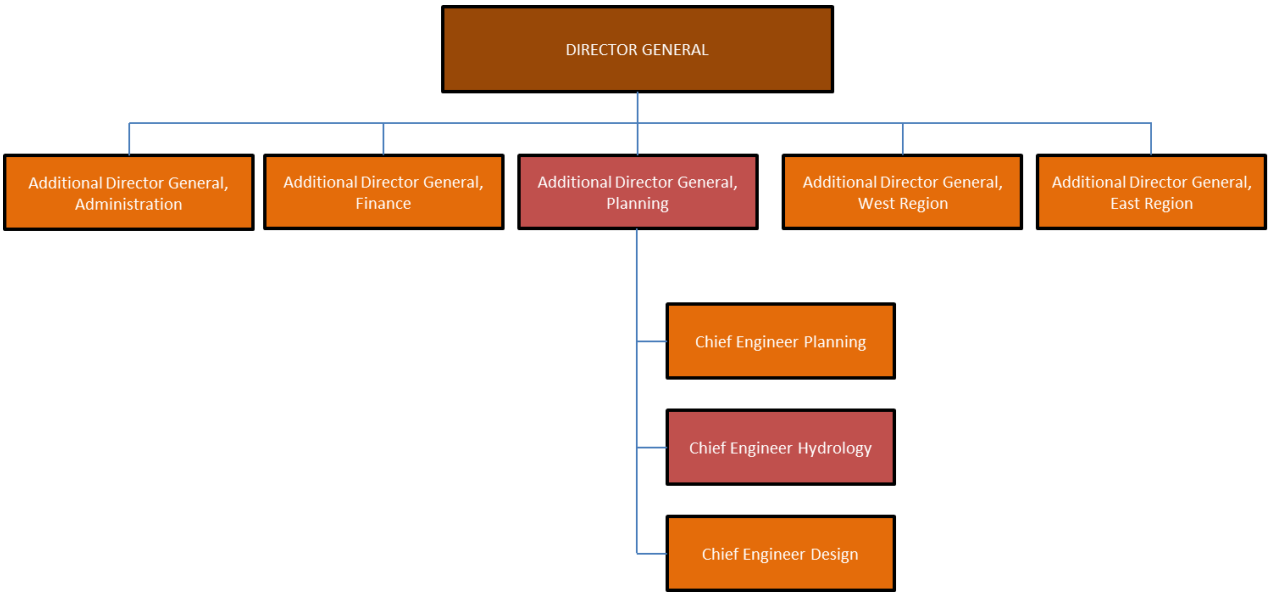

Figure 2-1: Organizational Chain from the Director General, BWDB to the Chief Engineer, Hydrology

The hydro morphological (and/or hydrometeorological) data collection activities fall under the Chief Engineer Hydrology. For this reason, only the organization and staff strength under the Chief Engineer Hydrology is presented. Figure 2-2 shows the current organization structure under the Office of the Chief Engineer, Hydrology, consisting of 4 Circles and the Divisions that are under the respective Circles.

One or many challenges of managing and modernizing water resources data collection is the transition of the capacity of the staff to effectively manage and use of modernized equipment. The number of qualified individuals is available in Bangladesh, but workplace policy compensation and career prospects must improve in order to recruit and retain qualified staff.

With a long history of water resources management that began on or about 1930, BWDB has developed significant institutional strength. The organization under the Chief Engineer Hydrology has the appropriate units already in place for current and for the proposed modernization of the hydromet network, related information system and service-related activities. There will be strengthening of the existing units required to manage a modernized hydromet system which will include re-training existing staff making the performance of activities more efficient.

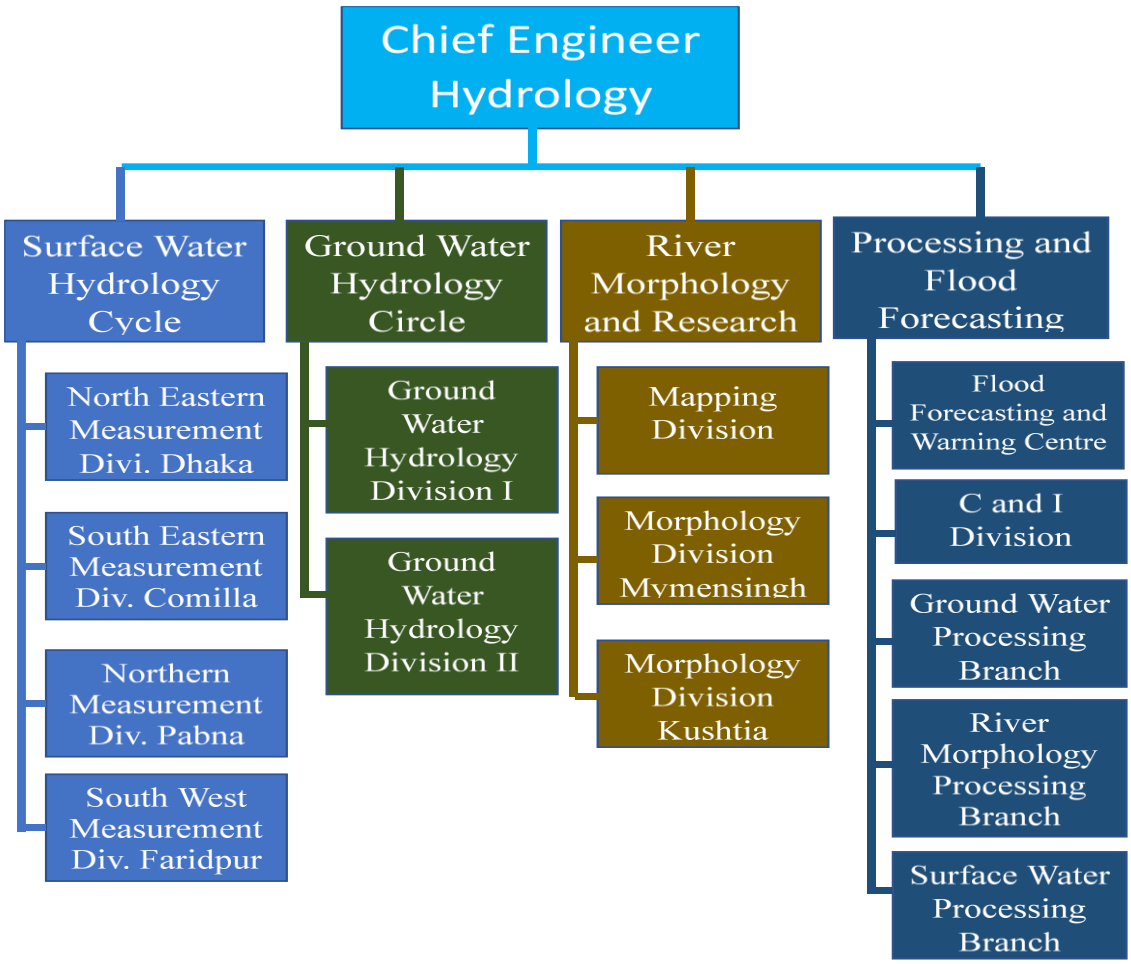

Figure 2-2: Offices under the Chief Engineer, Hydrology

2.1 Surface Water Hydrology Circle

The Surface Water Hydrology Circle performs surface water measurements as well as hydromet observations (rainfall and climate) for the BWDB. The surface water measurements include water level, river discharge, along with measurements of suspended sediment and electro-conductivity.

The Divisional, Sub-Divisional and Sectional offices of the Surface Water Circle are spread throughout Bangladesh utilizing a distributed approach to measurement. The Surface Water Hydrology offices and sub-offices take advantage of shared locations with other entities within BWDB, such as O&M. BWDB O&M has the responsibility of maintaining the vast levee system protecting the population of Bangladesh.

There are four Divisions under Surface Water Hydrologic Circle are as follows:

- North Eastern Measurement Division, Dhaka
- South Eastern Measurement Division, Comilla
- Northern Measurement Division, Pabna
- Southwestern Measurement Division, Faridpur

The Surface Water Measurement Divisions are located in regional locations, with each Measurement Division responsible for stations in the region. Measurements are made by manual observation and include the following measurements:

- Surface water level
- Surface water discharge
- Surface water quality (Salinity)
- Rainfall
- Evaporation
- Climate (Sunshine hours, Relative humidity and temperature)

Modernization of the BWDB hydromet system will cause the Surface Water Hydrology Circle to readjust activities of the gauge readers as well as staff that makes rainfall, evaporation, and climate (state meteorological observations). A real-time HIS will result in the automation of observation, data recording, and data communication, which are three significant activities of the current Surface Water Hydrology Circle.

2.1.1 Northeastern Measurement Division

The Northeast Measurement Division is based in Dhaka and is responsible for three Sub-divisions consisting of Dhaka, Sylhet, and Mymensingh. Figure 2-3 provides an organogram under the North Eastern Measurement Division. The division covers entire north east and north central region (hydrological region) excluding Brahmanbaria District area. It also maintains flow and water level gauge stations at Bahadurabad (Brahmaputra) and Bhagyakul (Padma). The Sylhet Hydrology Sub-Division is in the region of flash floods. Measuring peak floods are really difficult at border stations due to physical condition of the rivers and also uncertainty of flash. To this day, there are no forecasting procedures to predict these flash floods.

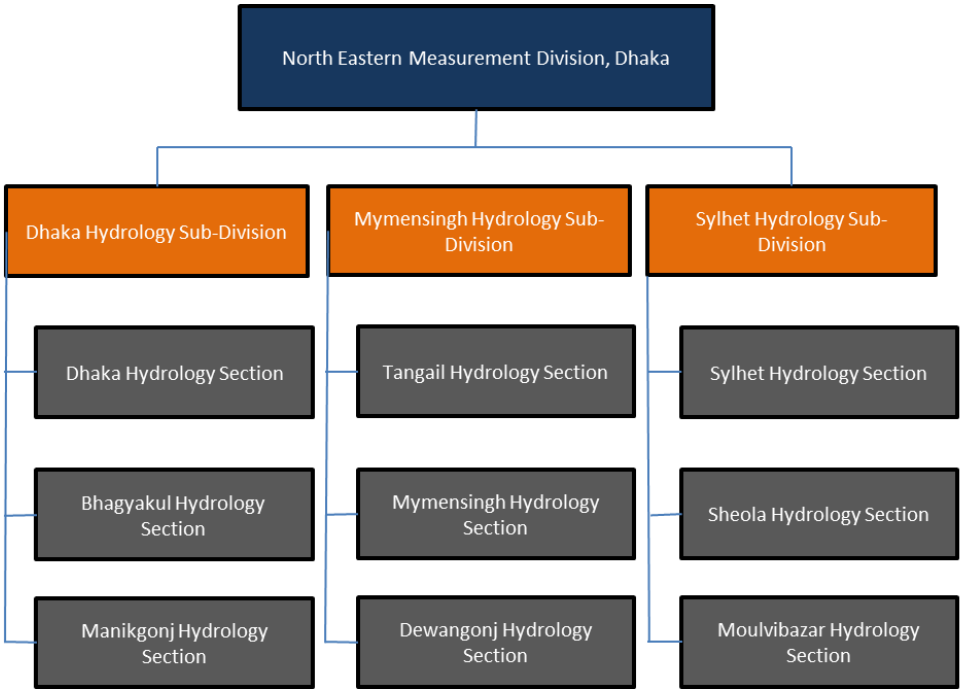

Figure 2-3:Offices under the Northeastern Measurement Division, Dhaka

2.1.2 Northern Measurement Division

The Northern Measurement Division is based in Pabna and has the Sub-Divisions in Pabna, Dinajpur and Rajshahi. The Northern Measurement Divisions is precariously bounded by the Brahmaputra-Jamuna to the East and the Ganges to the West and South. It covers the rivers of Northwest Region. It also conducts measurement at the Hardinge Bridge (Ganges) and Gorai Railway Bridge (Gorai River).

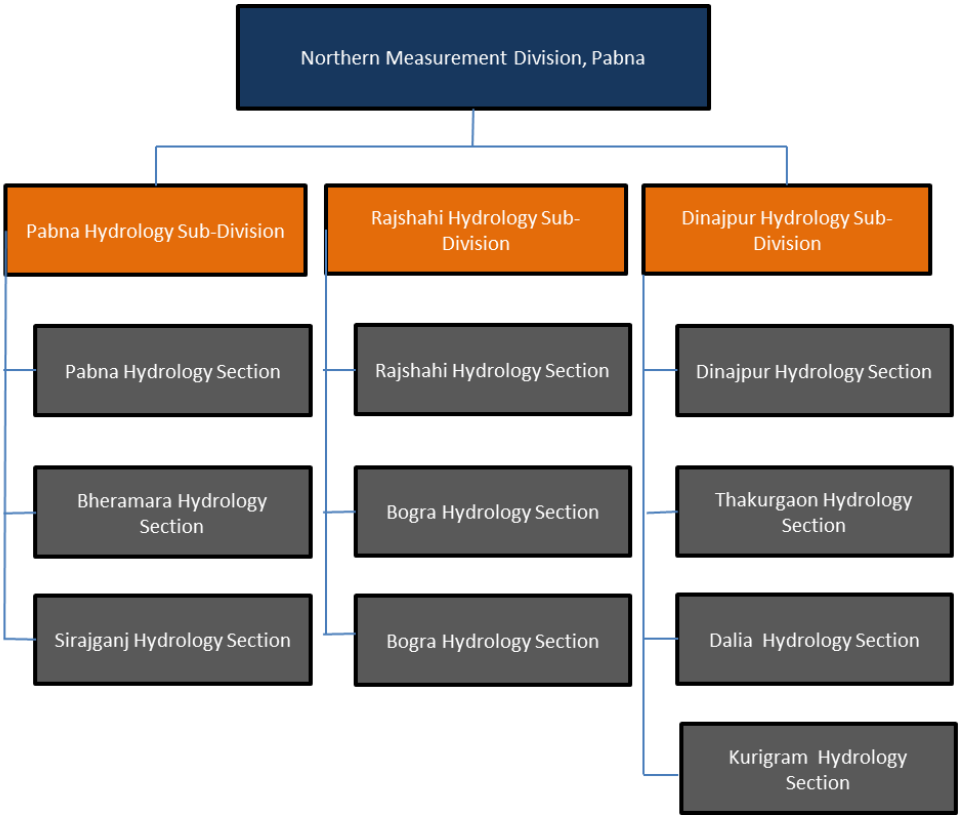

Figure 2-4:Offices under the Northern Measurement Division, Pabna

2.1.3 South Eastern Measurement Division

The South Eastern Measurement Division is located in Comilla. The Comilla, Chittagong, and Brahmanbaria Sub-divisional offices report to the Comilla Divisional Office. The division collects data of Chittagong Division. Most important station under this division is Bhairab Bazar (Meghna).

2.1.4 South Western Measurement Division

The final Division under the Surface Water Hydrology Circle is the Southwestern Measurement Division in Faridpur. The area is largely comprised of tidally influenced rivers, though the transit of the Ganges and the Padma rivers are to the north and east, respectfully. There are four Sub-divisional offices located at Faridpur, Jessore, Barisal and Khulna that report to the Faridpur Divisional Office. It measures flow at Baruria (Ganges/Padma). It measures tidal discharge at Bardia and Khulna.

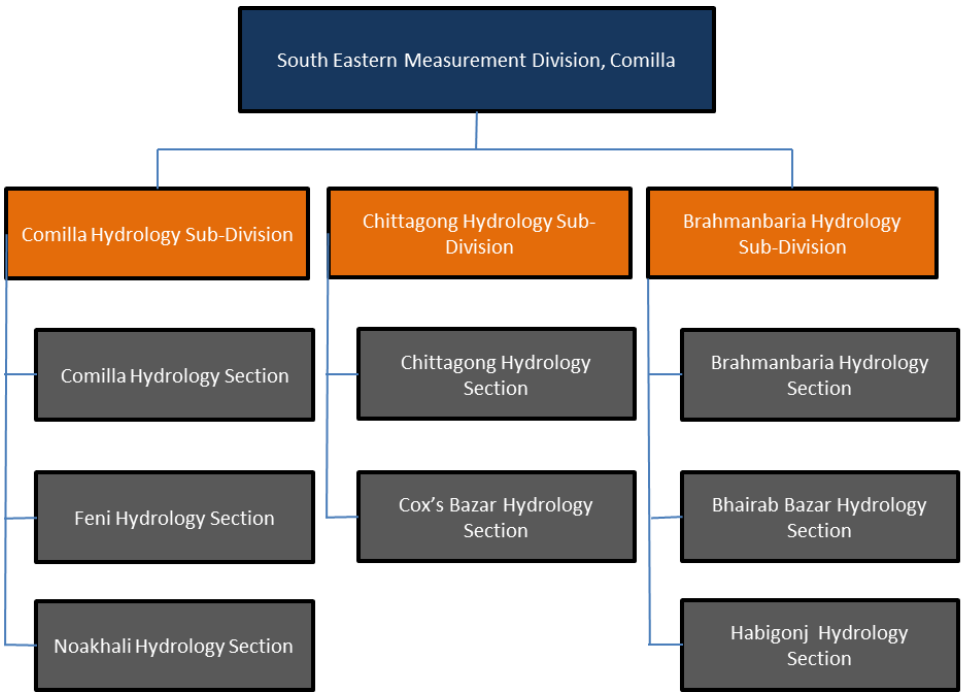

Figure 2-5: Organization under the Southeastern Measurement Division, Comilla

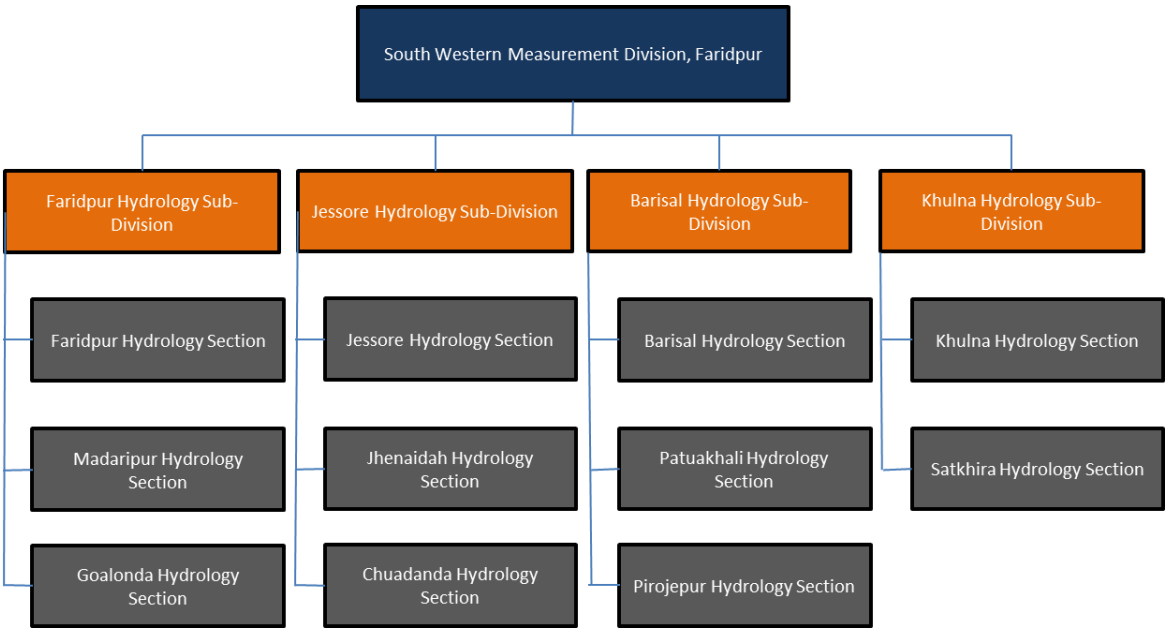

Figure 2-6: Organization under the Southwestern Measurement Division, Faridpur

2.2 River Morphology and Research Circle

The River Morphology and Research Circle characterize the change of river morphology by directly measuring channel cross-sections at regular intervals. River and Channel Morphology needs to be constantly tracked in Bangladesh because of rapid changes in morphology, and the impact of these changes on the environment, and people that inhabit this environment. Bangladesh, being mostly comprised of a massive delta, has a land mass that is redefined with each flood flow. The people and the economy must constantly adapt to these changes. In addition, the prospect of further

changes in morphology spurred by climate change must be carefully studied to build an environment that can demonstrate resiliency to climate change.

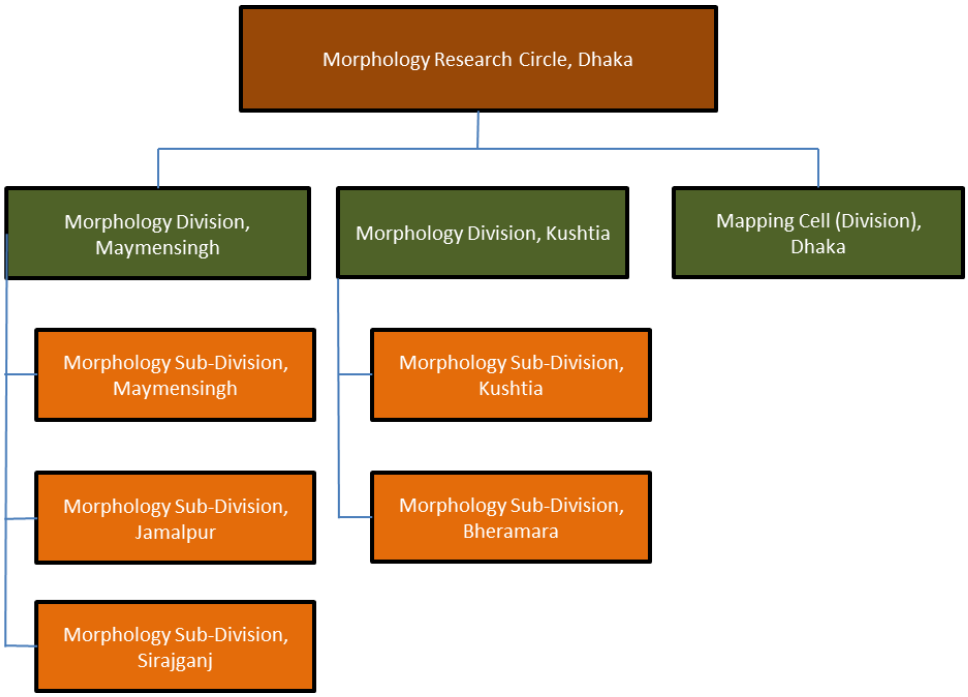

Figure 2-7: Organization under the Morphology Research Circle

2.3 Ground Water Hydrology Circle

The Ground Water Hydrology Circle is one of the four Circles that are under the Chief Engineer, Hydrology. There are currently two Divisions under the Ground Water Hydrology Circle, and both Divisions are based at Dhaka.

The Ground Water Hydrology Circle is dedicated to tracking the changes in ground water as well as ground water quality. Much of the ground water measurement program is performed by contractors. The ground water network includes approximately 1,270 ground water level stations, 117 ground water quality stations, 400 aquifer test sites, and over 5000 borehole lithology sites.

The BWDB utilizes local observers, appointed by BWDB from the local community, to measure ground water once per week. The observers send the data to the Sub-Divisional offices, and eventually this data arrives in Dhaka. The Sub-Division offices are responsible for installation of new wells, repair and maintenance of existing wells, and the quality control check of the measurements made by the contracted observers. They are also responsible for sending the corrected data to higher offices for storage and analysis. Besides monitoring of the water table, the ground water Sub-Divisions also conduct exploratory boring to find aquifers and add to the production of ground water. The Sub-Divisions also collect ground water and sediment samples for chemical analysis as well as to conduct aquifer pump tests to assess the recovery of ground water. Finally, the ground water Sub-Divisions conducts geotechnical investigation for the designing of hydraulic structures for BWDB as well as other national entities.

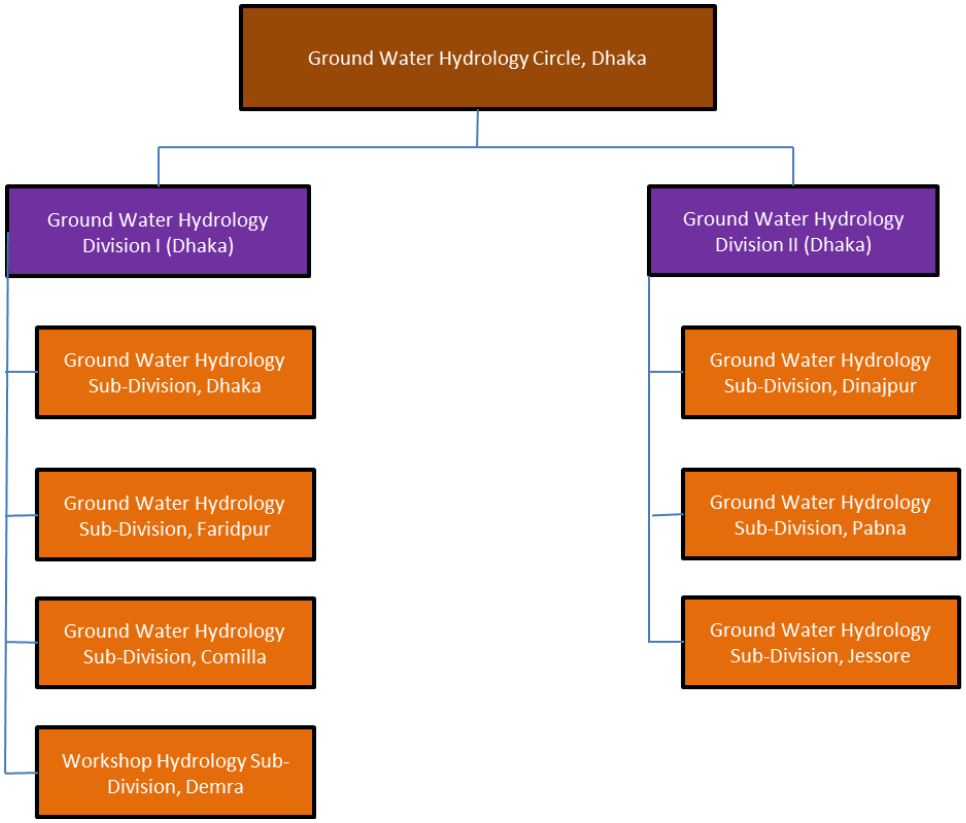

Figure 2-8: Organization under the Ground Water Hydrology Circle

Recently BWDB has installed real time ground water level measurement instrument at 915 locations (out of 1270). The system is in operation now. Currently data is being transmitted from measurement site to BWDB Hydrology Office Server where it is processed and stored in the database. As such, already modern system in place for Ground Water Data Collection in Hydrology

2.4 Processing and Flood Forecasting Circle

The Processing and Flood Forecasting Circle has the task of managing all data collected by the other three Circles. This Circle is also charged with maintaining the Hydrology data base as well as operating the FFWC. Finally, instrumentation maintenance and calibration are also carried out under this circle.

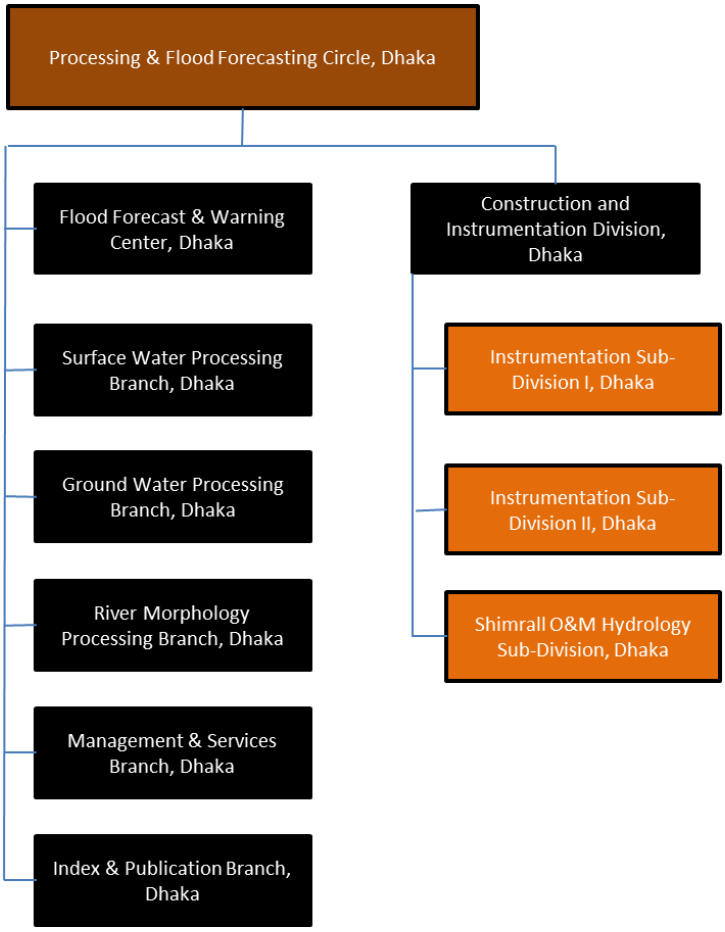

Figure 2-9: Organization under the Processing and Flood Forecasting Circle

3 Hydrological Data collection by BWDB

3.1 Water Level Measurements

Water Level measurements are made from 140 river and 357 gauging locations throughout Bangladesh. The river gauging network is based on a manual system where staff gauges are read daily or more often in the case of stations used by the FFWC. BWDB directly employs 200 regular gauge readers to perform these readings. The remaining stations utilize outsourced gauge readers and are not direct employee of BWDB. 109 of the 357 water level stations are used by the FFWC for input to the forecast models.

A map of tidal and non-tidal surface water stations operated by BWDB is shown in Figure 3-1.

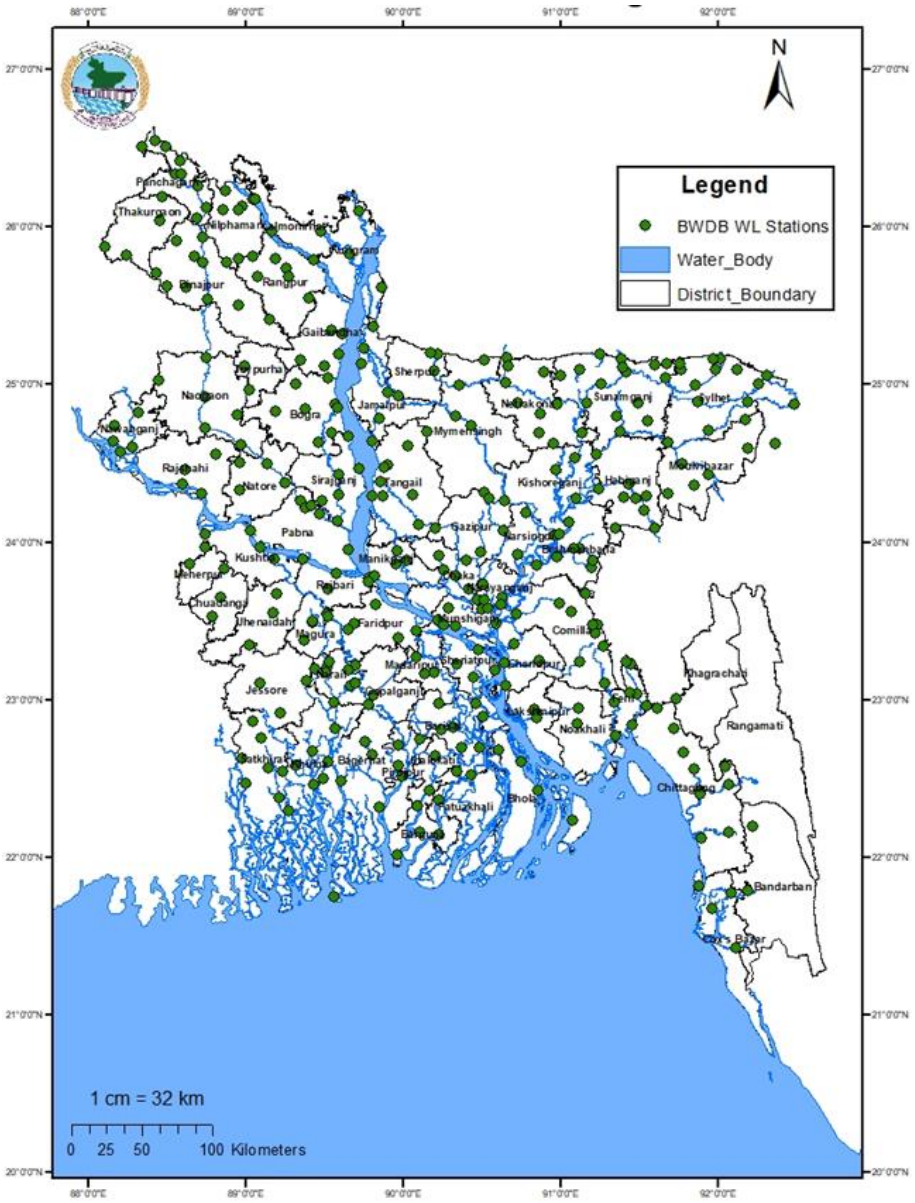

Figure 3-1: Surface water level measurement stations network

The staff gauges are mixture of fixed and portable solutions. The portable staff gauges are relocated with the rising and receding water levels. Every time the staff gauge is moved, the elevation must be re-surveyed from an existing temporary benchmark kept near by the gauges. These temporary benchmarks, are connected from the standard benchmarks, are used which to reduce the time required to perform the survey.

The application of portable staff gauges is a relatively unique solution for water level measurement and borne from necessity and the demands of water measurement in Bangladesh. River channels carved into the flood plain undergo constant change which would cause a problem for any fixed gauging station solution. These factors prohibit the application of a traditional fixed station concept, which is a mainstay of automatic river gauging solutions practiced worldwide. Alternatively, the portable staff gauge solution has proven to be sustainable in Bangladesh. An automated data collection solution for Bangladesh will need to consider both of these challenges when proposing a solution that can be expected to operate in this environment. Recently initiative has been taken up for automating 315 water level gauges under funding from World Bank project BWCSRP. Installation of Radar Gauges on the bridges at 280 locations. Permanent structure will be constructed at 35 locations for mounting the radar where suitable bridges are not available.

Figure 3-2 shows the hydraulic structure mounted and pole mounted structure for automated water level stations.

Figure 3-2: Sample Bridge mounted (left) and Pole mounted Structure (Right)

3.2 Discharge Measurements

BWDB performs discharge measurements at 128 stations of 86 rivers as presented in Figure 3-3. Discharge measurements are performed using a current meter to measure velocities and an echosounder/fishfinder is used to determine the depth of the cross-section. BWDB also uses Acoustic Doppler Current Profiler for conducting discharge observations at selected locations. The main advantages of the ADCP discharge observations is that they require less time, measures river cross section, can be used from relatively smaller boats and does not require anchoring facility.

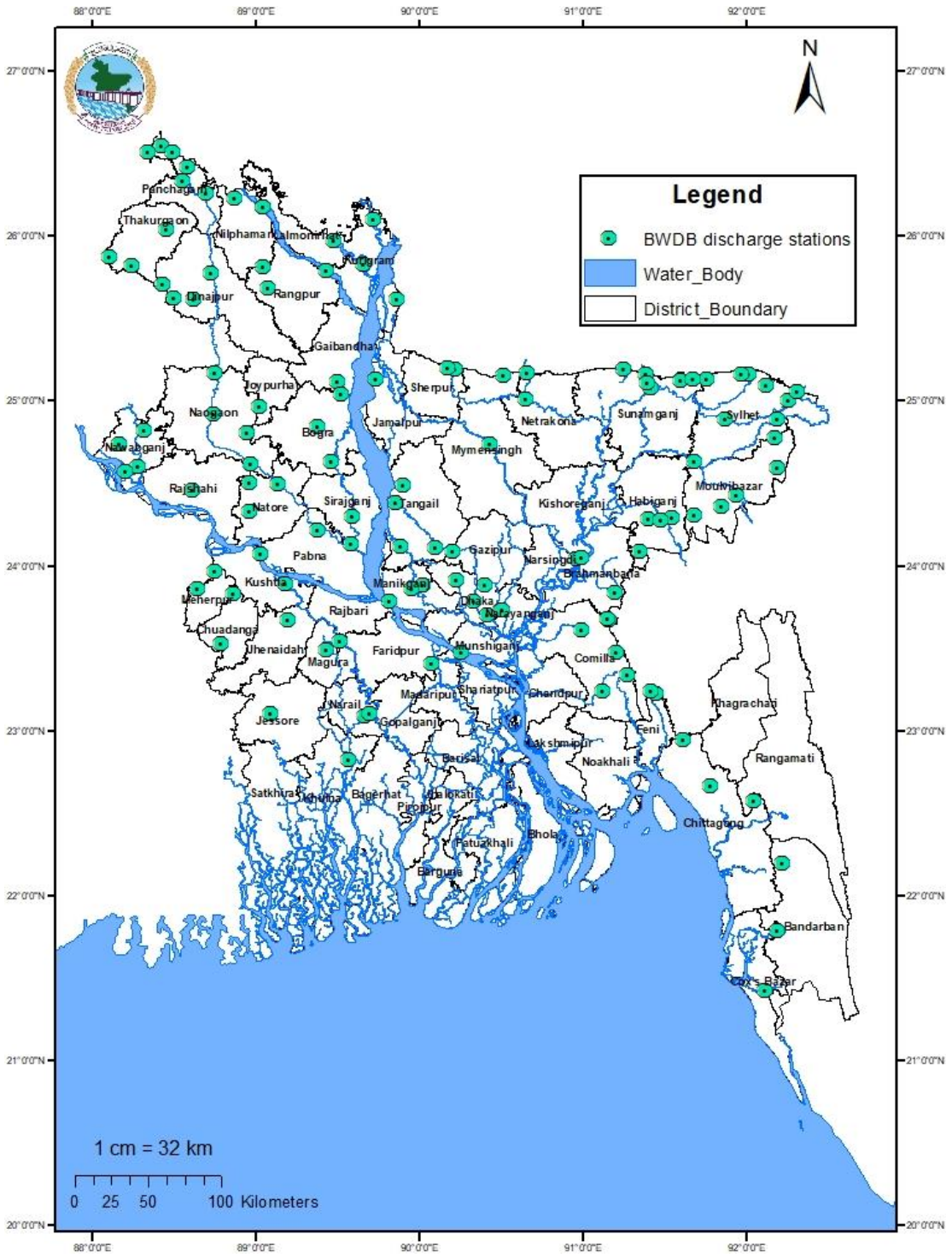

Figure 3-2: BWDB Discharge locations

Figure 3-4: Discharge measurement by BWDB at Bahadurabad

3.3 Suspended Sediment Measurements

BWDB currently measures suspended sediments at 20 stations of 18 rivers. Measurement is being done weekly/Fortnightly during discharge measurement. To collect the suspended sediment sample, BWDB uses a Binckley Silt Sampler. Sediment samples and flow velocity measurements are made simultaneously in a vertical at 0.2 and 0.8 of the water depth in the vertical where the sediment samples are taken in the alternate verticals and the flow velocities are measured in every vertical. The Binckley Silt Sampler is an instantaneous silt sampler which is a horizontal cylindrical sampler having a uniform bore. It is lowered in the water in open conditions and is closed by pulling a wire when it reaches the desired water depth. The volume of sampling is 1000ml at each depth.

The collected samples are allowed to settle the coarse part sediment at the bottom for 100 sec and then the settled part from the bottom is collected in a tube to find the amount of settled sediment per litter volume by dispersion method. Some part of the samples for all verticals of a particular containing finer particle from the top is collected in a bucket which is sent to RRI to calculate the average concentration of the finer sediment of all verticals by filtration techniques. The total sediment concentration for all individual verticals is found by adding the corresponding coarse sediment concentration to the average concentration. After collecting the samples, the water is passed through a funnel to a tube where the (obtained from RRI after analysis). Finally, total concentration id determined in ppm and sediment transport load (kg/s). Figure 3-9 shows the sediment sampling by BWDB using Binckley Silt Sampler at Bahadurabad.

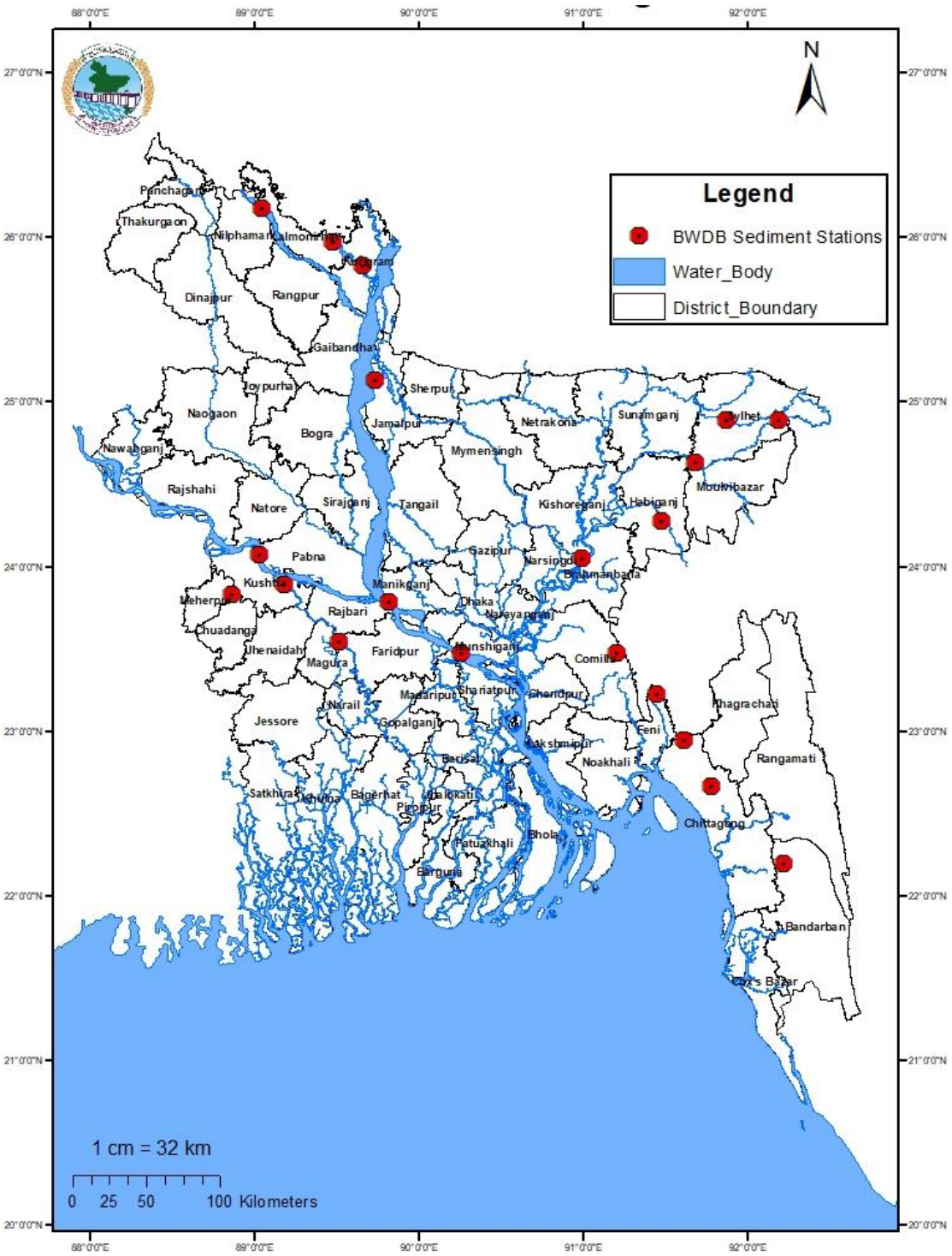

Figure 3-3: Suspended sediment measurement points collected by BWDB.

Figure 3-4: Suspended Sediment Sampling by BWDB at Bahadurabad.

3.4 Laboratory Analysis of sediment samples

Determination of sediment concentration

Suspended sediment samples obtained in the field must be treated in the laboratory for the determination of sediment concentration and particle size. Evaporation, filtration and displacement methods are generally used in laboratories to determine the sediment concentration. The method is chosen on the basis of the quantity and the composition of sediment in the sample and the desired accuracy. BWDB usually send all suspended sediment samples to RRI for analysis.

3.5 Morphological Survey

BWDB conducts morphological survey in different rivers and has developed very good database. They have fixed pillars on both banks of river transects. In the past, they did they survey using conventional method. They used Auto level for surveying dry part of the transect and manual sounding (or Echosounder & Sextant for large rivers) for the water part. However, the work is now being done through outsourcing and Morphology division staffs are not involved in field measurement. The work is executed through GPS, Echosounder and Auto level. BWDB has single beam echosounder, RTK-GPS including professional hydrographic software to carry out the bathymetry survey. They are also in the process of procurement of 4 multibeam echosounders under BWCRSP funded by World Bank.

4 Improved data collection technique

The assessment of the water resources monitoring network managed by BWDB has revealed many gaps. Data from many surfaces water and hydromet stations are only collected once per day. Surface water stations used by the FFWC are observed five times during daylight hours, with no observations occurring in the night-time hours. The detail of flood events, and especially precipitation events is lost with daily rainfall measurements. Short duration, high intensity rainfall can contribute significantly to flooding, especially the occurrence of flash flood. Presently, BWDB does not possess the capability to monitor rainfall duration and intensity occurring within a 24-hour period.

The BWDB surface water, hydromet, and ground water network was designed long ago. Due to change of river conditions and demand for data, existing programme needs modification.

The design and framework proposed in this section suggests the use of Grant funding to improve timeliness and accuracy of hydrological data collection by upgrading the water observation network of BWDB. Reorganization and capacity building is recommended to efficiently manage an automated network that is commensurate for such an important task to all communities in Bangladesh. It is expected that the quality of data collected by BWDB will greatly improve in quality, and such a network can be managed efficiently to keep annual operation costs sustainable. The improvements in data collection will allow water resources information to be processed and used in the decision-making process, and thus improve flood forecasting, early warning, and water supply and safety concerns.

4.1 Consideration for Sustainability

Every country has challenges that must be overcome in the process of the framework and design of a modernized HIS. Bangladesh is no different. Additional funding and institutional changes are very difficult to obtain for BWDB, so the framework and design must take this into consideration. The equipment used in a modernized HIS must be easy to maintain, as well as robust. Security issues, which are prevalent in many countries, are magnified in Bangladesh because of the anticipated lack of resources to replace equipment. A well thought out network will need to consider the secure placement of each and every remote station. Of most concern are the surface water stations, as these stations will be placed in public places. Alternatively, the rain gauge and climate sites are located on private/Government/BWDB property, which is less of a concern when it comes to protecting the equipment from tampering.

A robust modernized HIS will require the specification of very high-quality equipment, that will require occasional preventative maintenance (cleaning), but will be expected to serve BWDB relatively unattended for 10-15 years. The equipment will be easy to operate. For those remote stations that will be located in public areas, like surface water level stations, a thorough survey of the remote stations with precise mounting instructions (location and security considerations) will be required in the procurement document. This is the only way that remote stations can be expected to survive in areas that will draw public attention. Another issue will be periodical replacement of the sensors for continuation of automated system.

4.2 Surface Water Level Stations

The surface water network is already under process of upgradation in BWDB to automatically record surface water level and in some cases, transfer this data automatically to a central data base. From there, data will be analysed and corrected, eliminating artefacts.

The Surface Water Hydrology Circle is responsible for observations at 357 surface stations. The stations will use a variety of surface water level measurement techniques, based on an analysis of site conditions. BWDB has taken programme for automation of 315 stations (Radar Sensor). Among these, 280 stations will be installed on existed bridges of BWDB, RHD and LGED. Remaining 35 stations will be pole mounted. Existing stations cover most part of the country. However, it is necessary to install new stations near the coasts and Hilltract areas (like rivers falling in the Kaptai Lake, upstream reaches of the Shangu and Matamuhuri River).

For the water level data collection or any type of hydraulic measurement, using consistent vertical datum is very important and vital any type of research or studies. Survey of Bangladesh has established Geodetic Benchmark all through Bangladesh except Forest areas with respect to Mean Sea Level datum. It is recommended to consider using the height of control points updated by SOB for the vertical reference for the water level measurements.

4.3 Discharge Measurement Upgrade and Expansion

There are 126 surface river discharge locations. BWDB has already acquired significant number of ADCP for measuring river discharge. These will allow a single crew to perform more measurements over a given period if sufficient logistic like vehicle/transport is provided. Existing current meters can be used in smaller rivers or for backup purposes.

Review of the stations, very few stations are located in the Coastal Zone. It is necessary to include new stations in the Barisal and Khulna Division. Also, it is necessary to establish a new gauging station in the Meghna River downstream of Chandpur.

4.4 Sediment Sampling Network Expansion

Sediment plays vital role in morphological processes of the river system. Current practice is limited to few locations mainly in the upper reaches. It is necessary to initiate sediment sampling at all tidal discharge stations. Number of samples should be sufficient to cover the full tidal cycle.

BWDB existing Water Quality Lab should be equipped with Sediment Testing Facilities. Additional Qualified Staffs for testing water samples should also be appointed.

4.5 Water Quality Testing

BWDB has recently acquired new instruments for water quality laboratory. Presently, all water samples are brought to the lab for testing. However, some of the measurements should be done at site during sampling by field staffs.

5 Training and Human Capacity Building

A well thought out training program is essential to the sustainability a modernized hydrological system. Without an adequate training program, the hydrological information system will either be poorly utilized, fail, or both. BWDB conducts routine training programme for hydrology at Bhagyakul Training Institute using in house resources. The cause for training being ineffective is the content are not very practicable or quite often the wrong people are trained.

Presently, majority of measurement is done by Sectional Officer or lower staffs at field. Sub-Divisional Engineers and above are not very involved with field work and their function is mostly administrative. The data is being processed by separate offices under Processing Circle. Thus, there is a knowledge gap between field staff and data processing staffs.

6 Data Collection & Processing Manual

It is known from interaction that BWDB does not have any manual for Hydro Meteorological Data Collection. The technology is transferred from the training handouts of Senior Staffs during training programme. It is also transferred through person to person at field. For making consistent data collection by all staff, a manual should be prepared. The manual should include following details:

a) Criteria for selection of site for data collection.

b) Data collection frequency/calendar

c) Methodology for data collection of individual parameters.

d) Checking and calibration of survey/lab equipment

e) Standard log sheet for data collection at site

f) Processing methodology of individual data

g) Data Checking for errors using appropriate QA/QC

h) Correction of erroneous data.

7 Conclusion

BWDB is the only agency in Bangladesh established to collect high quality data and provide equally high quality of service. The data collected as well as the services provided are used for all development activities. BWDB has been able to make impressive progress in Flood Forecasting, and especially flood forecasting. With the modernization, they need to train all field and desk staffs to remain updated with changes.

The Design and Framework Study develops a strategy to employ automatic data collection and transmission to bolster the water resources data collection effort, which has remained relatively unchanged over the last 40 years. It is expected that water resources data will be collected more accurately, timely, and efficiently so that decision makers in Bangladesh will have a monitoring network that meets international standards of acceptability.

Some of the key recommendations are as follows:

- Preparation of Data Collection and Processing Manual and practicing the same at site and office
- Regular calibration/checking is recommended for specific equipment.
- Frequent inspection of Senior Officials to ensure data collection is being done as per approved manual.
- The human factor is an important consideration of all type of hydrological measurement. A sophisticated and high-tech methods, which appear attractive, can fail if the equipment and methods are not applied correctly. Therefore, human resources development through training should be continued at all levels.
- Discharge measurements and sediment sampling should be made bi-weekly, weekly, fortnightly or fixed number depending on the different phases of the hydrograph, keeping in mind the needs of the users of the data generated.
- It is necessary to regularly check even primary bench-mark levels in areas when land subsidence has been found to be non-negligible.
- Provision of adequate budget for hydrology.
- Provision of periodic repairing/replacement of sensors/instrument.