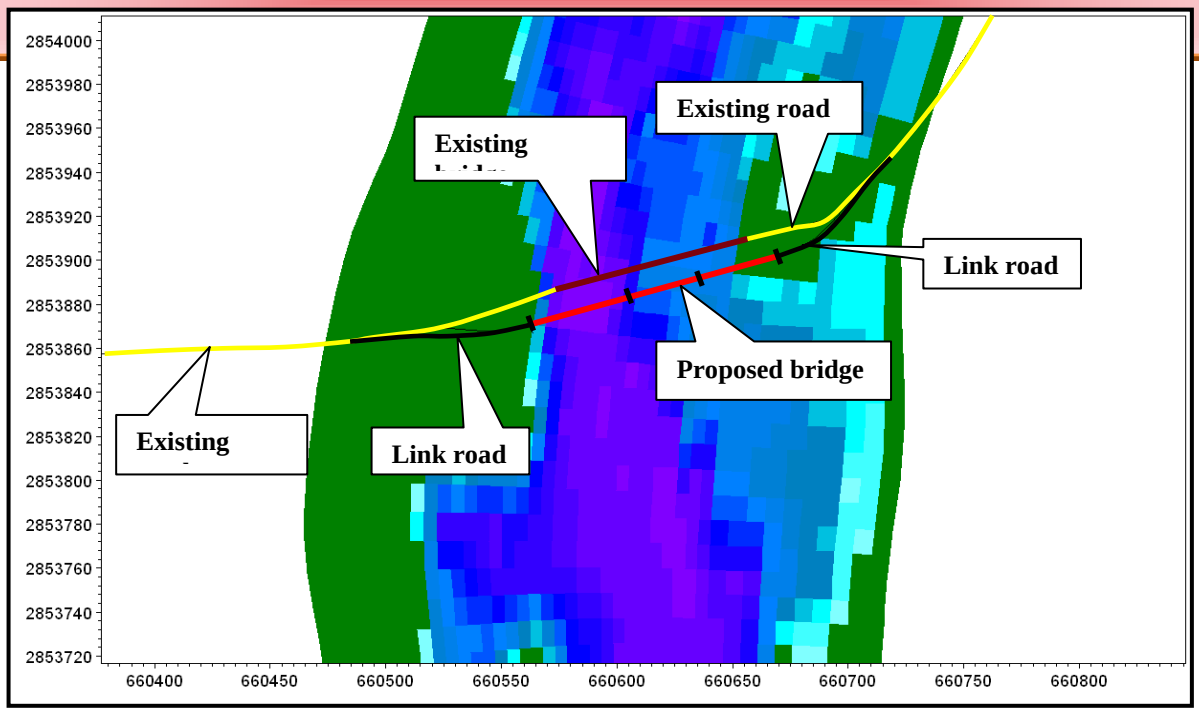
Annual Report

2017-2018 Serial No. 45/17-18



J U L Y 2017 - J U N E 2018

RRI
River Research Institute

RIVER RESEARCH INSTITUTE, FARIDPUR
Ministry of Water Resources
Government of the People's Republic of Bangladesh

Water Resources Minister, Secretary and DG RRI & BWDB and other high Officials in a meeting at MoWR

Water Resources Secretary, IHE expert , DG RRI and DC Faridpur in a meeting at RRI Conference room.

River Research Institute

Annual Report

Serial No. 45/17-18

JULY 2017 - JUNE 2018

Published in November 2018

RIVER RESEARCH INSTITUTE
Faridpur, Bangladesh

Contents

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RRI, Faridpur.

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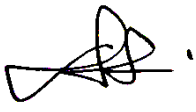
RIVER RESEARCH INSTITUTE
Faridpur, Bangladesh.

Editorial Note

The annual report is a reflection of all activities of a financial year of an institute or organization. River Research Institute publishes an annual report every year focusing on its functions and activities in the bygone fiscal year. In order to accomplish this task an Editorial Committee and an Advisory Committee are formed at the end of the every fiscal year. Accordingly, the annual report of the fiscal year 2017-18 has been prepared by the Editorial Committee with the assistance of the Advisory Committee. It is done based on the annual activities carried out by different directorates of River Research Institute during the fiscal year 2017-18. This report briefly highlights the background, objectives and findings of different physical and mathematical model studies and basic and applied research works. It also focuses on testing of various engineering properties of soil, concrete, water quality, sediment samples etc. Moreover, this report contains the staff development, financial management, projects with revenue received, future trend etc. which will assist to provide useful information to the organization and individuals working in the water sector.

The Editorial Committee likes to express its sincere thanks and gratitude to Chief Advisor Mr. Arun Chandra Mahottam, Director General (in-charge) of RRI for his valuable direction, suggestion, assistance and back-up in publishing this annual report. The committee earnestly recognizes the guidance provided by the advisors for making this annual report informative and comprehensive.

The committee is also grateful to the relevant personnel who extended their efforts and co-operation in preparing and publishing this report in time. Any valuable comments and suggestions regarding improvement of this report from among readers will be highly appreciated.



Engr. Pintu Kanungoe
Convener
&
Chief Scientific Officer
RRI, Faridpur.

Engr. Md. Alauddin Hossain
Executive Editor
&
Principal Scientific Officer
RRI, Faridpur.

Minister
Ministry of Water Resources
Govt. of the People's Republic of Bangladesh

Message

I am highly delighted to know that the Annual Report 2017-2018 of River Research Institute (RRI) is being published. As a statutory body under the Ministry of Water Resources, RRI has been providing remarkable services to the nation in its field of activities.

RRI has been established with distinct mandates to play a vital role in water sector by providing technical assistance to government and non-government organizations concerned in managing rivers and developing vast water resources of the country. As a riverine country with about 700km coastal line, the economic prospects of Bangladesh are largely dependent on sustainable development of its water resources and effective management of water related disaster risks. Since its establishment RRI has been putting its best efforts to support water resources development activities undertaken by the Ministry of Water Resources. I am very happy to know that RRI has also extended its services to support development activities of other ministries of the Government of Bangladesh. The institute has already proven its capability of providing sound technical solutions to different water related problems by means of physical and mathematical modeling. I am quite hopeful that the institute's roles in water sector for achieving sustainable development goals will continue to be vital in the future.

Finally, I congratulate the editorial committee for their painstaking efforts in preparation and publication of the annual report.

I wish it gets the deserved attention.

(Anwar Hossain Manju, MP)

State Minister
Ministry of Water Resources
Govt. of the People's Republic of
Bangladesh

Message

It is a pleasure for me that River Research Institute (RRI) working under the Ministry of Water Resources is going to publish its Annual Report 2017-2018. So far, the contribution of the institute to overall development and management of vast water resources of the country is remarkable.

Bangladesh being mostly a flat deltaic country with its unique geographic location is prone to different water related disasters. At the same time, the country has bright economic prospects by utilizing its precious water recourses in a sustainable manner. The Government of Bangladesh has already formulated a number of plans and policies for sustainable development and management of its surface and ground water resources and taken initiatives for restoration of its lost or dying rivers and wetlands. So far a number of projects have been implemented to mitigate flood, arrest bank erosion, reduce sedimentation and ensure water supply for dry season irrigation. As a prominent organization in water sector, RRI has contributed much for successful planning, design and implementation of many a project. I am really happy to see that RRI is constantly putting efforts to update its technologies and develop its manpower to meet the ever increasing demand for improved service quality to achieve sustainable development goals.

I would like to extend my warmest and most sincere thanks to the editorial committee for their conscientious efforts in preparation of the RRI annual report. I am hopeful that this report will provide the water sector professionals with good insight about the functions and activities of the institute.

(Muhammad Nazrul Islam, Bir-Protik, MP)

Secretary
Ministry of Water Resources
Govt. of the People's Republic of Bangladesh

Message

I take immense pleasure in expressing best wishes to River Research Institute (RRI) on the publication of its Annual Report 2017-18. The role of the institute in water sector is significant as far as overall national economic development is concerned. I am very happy to know that the performance of the institute in discharging its responsibilities is up to the mark so far.

RRI traces its origin to Hydraulic Research Laboratory which was established in 1948. The institute was established in 1973 under the Bangladesh Water Development Board. In July 1990 it was made a national autonomous organization. Since its establishment RRI has been playing a vital role in providing planning and design support to different water resources development projects undertaken by the Government of Bangladesh (GoB) by using physical modelling technology. In order to meet the increasing demand of quality services, RRI has adopted the use of mathematical modeling tools since 2007. So far RRI has proven its capability of providing important technical assistance in implementation of a number of pride projects of the country by using both physical and mathematical modeling technologies.

As a flat deltaic country with its unique geographic location Bangladesh is prone to different water related disasters. Sustainable development and management of its vast water resources together with effective management of disaster risks are challenging tasks for water sector professionals. Decreasing dry season flow, deterioration of river dependent ecosystems, increasing sedimentation, unabated bank erosion and flooding are some burning issues that need to be addressed properly to achieve sustainable development goals. I am confident that RRI would continue to play a vital role in contributing to water resources development projects undertaken by the Ministry of Water Resources. I expect that RRI would focus more on basic and applied researches to come up with effective solutions to cope with the challenges in view successfully.

I would like to express my sincere thanks and appreciation to the editorial committee of RRI for their conscientious efforts in preparation of the RRI annual report.

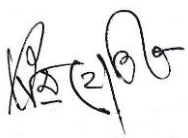
(Kabir Bin Anwar)

Message from the Director General

River Research Institute (RRI) is a statutory public organization working under the Ministry of Water Resources, Government of the People's Republic of Bangladesh. It has been putting its efforts in providing technical support to different development initiatives undertaken by the Ministry of Water Resources. Side by side it also provides technical assistance to different development activities of other ministries. During 2017-2018 fiscal year, RRI provided hydraulic design support for sub-structure and river training works of the proposed Bangabandhu Railway Bridge over the Jamuna River by conducting three separate physical model studies. Besides, RRI conducted physical model study for sustainability of Buriganga River Restoration Project. A mathematical model study intended for hydro-morphological and environmental impact assessment of the Derai-Sullah Road in Sunamganj district was undertaken which is now underway.

A multiyear Bamboo bandalling project aiming at bank protection and land reclamation was commenced in this fiscal year. Another multiyear project named Institutional Development and Capacity Building (IDCB) was also commenced in this year. Among the completed applied research in this fiscal year include Hydro-morphological Study of the Mahananda River in Bangladesh with Focus on Problems and Possible Solutions and Laboratory Based Study using Physical modeling on River Bank Erosion Control using Concrete Block Mats and Placed Concrete Blocks with Filter on the Arial Khan River Bank at Madaripur District. Moreover, two important researches funded by GoB were undertaken in this fiscal year. Geotechnical Research Directorate of RRI conducted various tests on physical and engineering properties of soil, quality of construction materials (cement, brick, MS rod, sand, concrete block and cylinder), sediment characteristics and water quality of the rivers etc. The testing results have been used for planning and design of hydraulic structures like bridge, groyne, barrages, sluice gate, drainage channels, irrigation canals, sluices, closures etc. The main activities of Administration and Finance Directorate comprise of the overall administration of RRI, accounts and audit, estate, library, public relation and photography and establishment. In addition, the directorate is responsible for operation and maintenance of all physical facilities in RRI.

Finally, I hope this annual report will provide the reader with good insight about the functions and activities of RRI during the fiscal year 2017-18. Sincere thanks are due to editorial committee and others who have contributed for the publication of this annual report.

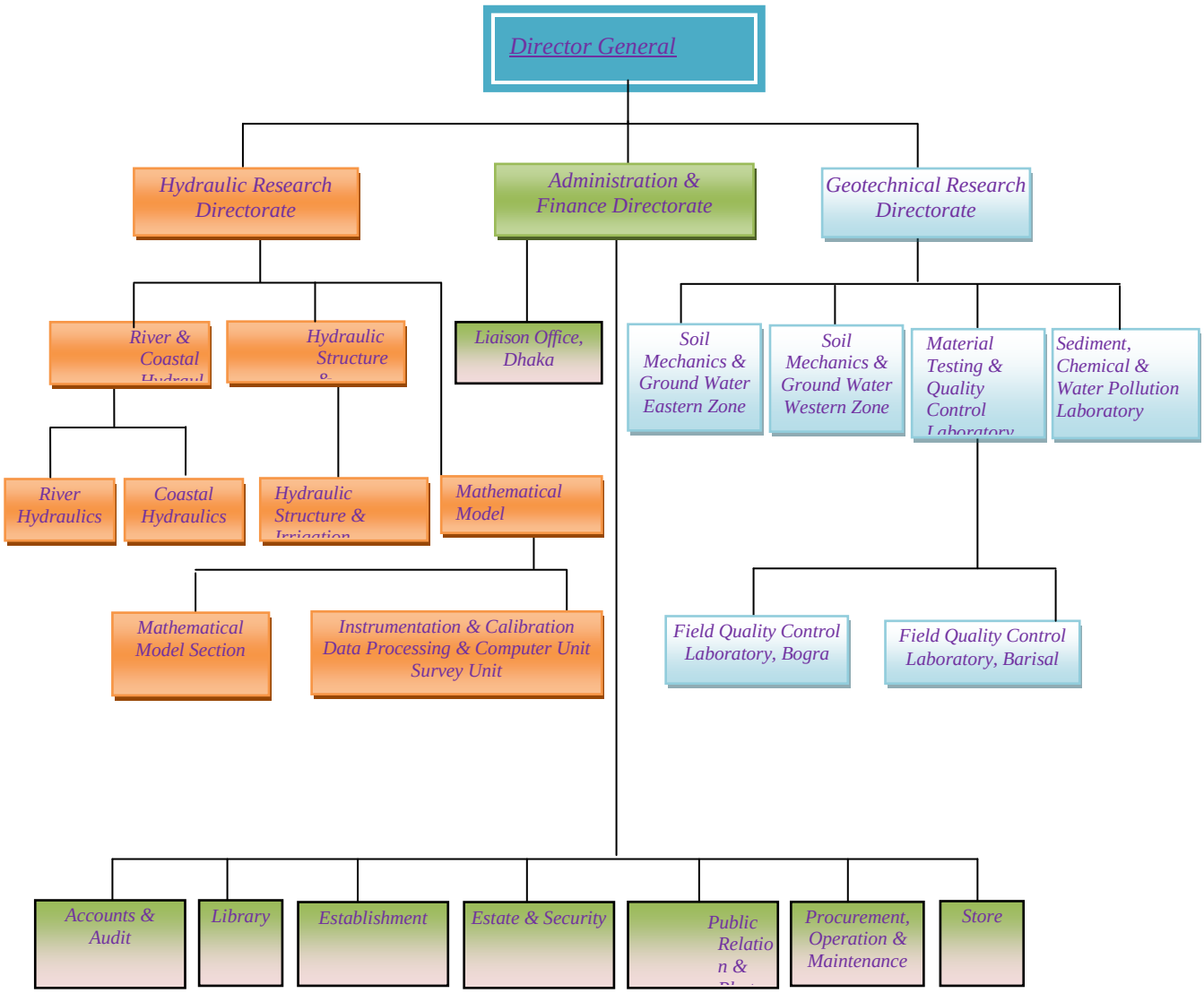


(Arun Chandra Mahottam)
Director General (in-charge)

BOARD OF GOVERNORS OF RRI
(As on November 2018)

1. Hon'ble Minister Ministry of Water Resources Government of the People's Republic of Bangladesh.	**Anwar Hossain manju**	**Chairman**
2. Chairman Zilla Parishad, Faridpur.	**Md. Lokman Hossain Mridha**	**Member**
3. Hon'ble Member of Parliament Nominated by the Government.	**Md. Abdur Rahman, MP** Faridpur-1.	**Member**
4. Secretary Ministry of Water Resources Government of the People's Republic of Bangladesh.	**Kabir Bin Anwar**	**Member**
5. Secretary Ministry of Shipping Government of the People's Republic of Bangladesh.	**Abdus Samad**	**Member**
6. Vice Chancellor Bangladesh University of Engineering & Technology (BUET), Dhaka.	**Prof. Dr. Saiful Islam**	**Member**
7. Director General Bangladesh Water Development Board (BWDB), Dhaka.	**Engr. Md. Mahfuzur Rahman**	**Member**
8. Water Resources Engineer / Scientist.	**Prof. Dr. Umme Kulsum Navera** WRE, BUET.	**Member**
9. Water Resources Engineer / Scientist.	**Bodrun Nahar** Director General,WARPO	**Member**
10. Director General (in-charge) River Research Institute Faridpur.	**Arun Chandra Mahottam**	**Member-Secretary**

Administrative Structure of River Research Institute



CITIZENS CHARTER

RIVER RESEARCH INSTITUTE

Sl. No.	Name of the service
1	Providing consultancy services for viable technical solutions to the problems related to river bank erosion, flooding, drainage and irrigation.
2	Assisting in development of water resources by devising appropriate technological solutions for maintaining river flow, use of surface and ground water, environmental protection and reducing salinity.
3	Testing and assessment of quality of soil, sediment, water as well as materials used for construction of water infrastructures for water resources development and river management.
4	Conducting applied research on river management, sediment control of river, coast and estuary management etc. using physical and mathematical modeling technology and publishing the research results in report form as well as in periodicals and journals.
5	Field level implementation of research outcomes in limited form to assess its effectiveness.
6	Conducting basic research to develop understanding of river and coastal processes for the sake of applied research works.
7	Taking up problem oriented research and studies as to decrease in dry season flow of the rivers, sedimentation in river bed, loss of navigability of rivers, increase in flooding, long-term water logging etc. to furnish the outcomes to the planners and decision makers.
8	Taking up projects for capacity building of the institute as well as human resource development and conducting joint venture multi-disciplinary studies.
9	Determining the physical, chemical and engineering properties of sediment along with various chemical properties of surface and ground water such as arsenic, iron, calcium, magnesium, sulphate, carbonate, potassium, salinity, etc.

1 GENERAL INTRODUCTION

River Research Institute (RRI) is a national research organization in Bangladesh. It is working as a statutory public authority under the Ministry of Water Resources (MoWR), Government of the People's Republic of Bangladesh. RRI has a Board of Governors (BoG) comprising ten members chaired by the Hon'ble Minister, MoWR, Government of the People's Republic of Bangladesh which reviews and evaluates the activities of RRI and approves important proposals so that it can run with all its activities properly. Director General is the Chief Executive of the institute and responsible for implementation of the decisions approved by the BoG. The activities of RRI are conducted by three directorates namely, Hydraulic Research, Geotechnical Research, and Administration and Finance.

RRI is set up with a view to devising plans and actions to develop water resources in a sustainable manner to meet the development needs of Bangladesh. Since its establishment RRI has been conducting multi-disciplinary and problem oriented tests and researches in the field of River Hydraulics, Hydraulics of Structure and Irrigation, Coastal Hydraulics, Soil Mechanics, Material Testing and Quality Control, Sediment Technology, Hydro-chemistry, Geo-chemistry and Instrumentation. The results of such tests and research are playing a vital role in providing information and recommendations regarding different water resources development plans and interventions.

RRI has been conducting physical modelling in the field of water resources since its establishment. Since 2009 RRI has also been involved in mathematical modelling. Physical and mathematical modelling tools are complementary to each other. Both physical and mathematical model have been proved to be very essential for sound engineering judgments to find out solutions for different water resources development projects. In view of this RRI has adopted hybrid modelling approach by using physical as well as mathematical modelling to improve the understanding of different water systems which may lead to safe and less expensive solutions for engineering problems. RRI has the mandate for conducting hydrodynamic and morphological study of the river mainly to derive and verify the design parameters of any hydraulic structures, bank protection and river training works.

During fiscal year 2017-18, the following seven studies were carried out at RRI, of which first five studies have already been completed and last two research studies are going on at present fiscal year. Besides these seven studies, four multiyear pilot projects for bank erosion mitigation, land reclamation and maintain navigation route using Bamboo Bandalling structures and one multiyear Institutional Development and Capacity Building project (IDCBP) are underway. Short description of four model studies appear in section 2 entitled "ACTIVITIES OF THE INSTITUTE" and that of on-going & completed research works, IDCBP and pilot projects is furnished in section 3 entitled "RESEARCH AND DEVELOPMENT ACTIVITIES".

- **Physical Model study for Supporting Design of the Proposed Bangabandhu Railway Bridge upstream of Existing Bangabandhu Multipurpose Bridge over the River Jamuna**
- **Physical Model Investigation to study the Effectiveness of New Dhaleswari River Off-take Structure to support the Design Work of the Buriganga River Restoration Project**
- **Hydrological and Morphological study for proposed Kaharol Road (Z-5007) under Dinajpur Road Division**
- **Laboratory Based Study using Physical modeling on River Bank Erosion Control using Concrete Block Mats and Placed Concrete Blocks with Filter on the Arial Khan River Bank at Madaripur District**

- **Hydro-morphological study of the Mahananda river in Bangladesh with focus on problems and probable solutions of dry season flow scarcity**

- **Investigation of geotechnical reasons for bank failure on Daulatdia and Paturia side of Padma River of Bangladesh (on-going).**

- **Development of Suitable Technologies for Removal of Manganese from Ground Water in Household, Community and Municipal Levels (on-going).**

A view of a meeting attended Mr. Anwar Hossain Manju, MP, Hon'ble Minister, Ministry of Water Resources and Chairman of the Board of Governors (BoG) of RRI along with Secretary, MoWR and DG, RRI

RRI has conducted four in-house training and four seminars in 2017-2018 fiscal year for skill development of its scientists and engineers as well as all officials. Details description of in-house training is summarised in section 4 entitled "HUMAN RESOURCES DEVELOPMENT".

As per requirements of different clients, some proposals have been submitted for model studies and correspondence with the relevant organization is going on. A large number of soil, water, sediment and construction material samples are received from different projects of Bangladesh Water Development Board (BWDB) and other organizations. These samples are tested with the sophisticated laboratory equipment of RRI as routine works of Geo-technical Research Directorate. The results and findings are sent to the project authorities concerned. In addition, the operation and maintenance activities of office and residential buildings, roads, rest house, vehicles, water supply system, sewerage system, power distribution system including power generator etc. are routinely done.

A view of model visit made by Water Resources Secretary, IHE experts, DC Faridpur along with RRI DG and RRI Officials.

A view of knowledge and experience sharing meeting in presence of DG (in charge) Mr. Arun Chandra Mahottam (Deputy Secretary), Director Hydraulic Research Dr. Engr. Md. Lutfor Rahman, Director Geotechnical Research (in charge) Mr. Engr. Swapan Kumar Das and President, save the river movement, Bangladesh.

Qualified and trained personnel are very much essential to meet the objectives of RRI and to maintain its standard to the international level. For this purpose a number of officials have already been completed their higher studies and obtained training in the related fields at home and abroad. Many others are expected to be trained in the near future.

At present RRI has shortage of junior officers to undertake more responsibilities. For this reason recruitment of junior officials is under consideration. The existing manpower is, however, well experienced and well trained in the field of hydraulic, geotechnical and environmental engineering. Detailed list of existing administrators, scientists, supporting and managerial officers is shown in Annex-I. List of abbreviations is shown in Annex-III.

RRI has also been publishing journal named 'Technical Journal' yearly since 1991. RRI's technical journal got recognition in 2000 by ISSN - International Centre, 20, rue Bachaumont, 75002 Paris - France and its serial has been registered as ISSN 1606-9277 with key- title: Technical journal - River Research Institute, abbreviated key – title: Tech. J. - River Res. Inst. Multidisciplinary research activities and case studies of different water resources projects are published in the journal.

RRI undertakes sports and cultural activities and observes all national days. RRI officials and staffs along with their families take part spontaneously in the sports and cultural activities. In addition, RRI takes part in different world and international days such as "world water day" and different national program taken by the government such as National Development Fair (Jatio Unnayan mela), Information Fair (Tottho mela) etc. Some photographs showing celebration of national days, RRI/model visits by dignitaries and memorable moments for RRI officials appear in Annex-II.

Participation of RRI in National Development Fair 2018 and Information Fair 2018

2 ACTIVITIES OF THE INSTITUTE

The Directorates of Hydraulic Research and Geo-technical Research execute the research activities of this institute. The Administration and Finance Directorate is accountable for the overall Administration and Financial activities of RRI and works for its development. The activities of different directorates are briefly described below:

2.1 HYDRAULIC RESEARCH DIRECTORATE (HRD)

The Hydraulic Research Directorate has three divisions such as (i) River and Coastal Hydraulics (ii) Hydraulic Structure and Irrigation and (iii) Mathematical Model. These three divisions carry out studies and research work in the field of flood control and drainage, river training and bank protection, coastal engineering, hydraulic structure *a*nd irrigation etc. by means of physical and mathematical modelling along with other laboratory testing and studies. This directorate is well equipped with physical and mathematical modelling facilities.

Physical modelling is an authentic tool, which can be used confidently to verify the effectiveness of any structural intervention in the river by reproducing the natural phenomena of river hydro-morphology at a reduced scale. The causes of any river engineering problems are identified and its mitigation measures are investigated through physical modelling. Local scour, 3-dimensional flow phenomena like eddy and vortex, morphological processes and developments etc. are possible to reproduce well in physical model.

The important design parameters such as local scour around the structure, flow field, maximum velocity, appropriate location, dimension and orientation of hydraulic structures, spacing between groyne/spur like structures etc. can also be obtained by physical modelling. The physical process/phenomena, which are not possible to describe well by empirical formula and mathematical expression, can be easily reproduced precisely in physical modelling. Moreover, the real phenomena that are happening in the field are only possible to visualize by physical modelling.

Necessity of Physical Modelling

River models are important for the prediction of future developments in river morphology and the management of the natural processes in an integrated way to the benefit of the people. Physical

modelling technique is used for the solution of the problems that may occur during the ongoing construction of bridges, river training works and other hydraulic structures and also for the future maintenance of the same against the critical hydrodynamic and morphological conditions. Physical models are necessary for the following specific reasons.

- To understand the prevailing river condition
- To determine the most suitable option for river training
- To determine the effects of hydraulic structures on existing flow pattern and river morphology
- To determine the effectiveness of the proposed works
- To find out the most suitable design parameters for hydraulic structures
- To predict future changes in the river morphology
- To ensure sustainable development of water resources through detailed investigations.

Physical Modelling facilities at RRI

Indoor model Area

Dimension	:	100mx30m (effective space 70mx23m)
Pump capacity	:	800 l/s (maximun)
Sand depth in the covered shed model bed	:	0.7-0.8 m
D50 of sand	:	0.10mm

Outdoor model Area

Dimension	:	125mx40m (Three beds)
Tilting flume	:	23.98mx0.76m
Pumping capacity	:	800 l/s (maximum)
Sand depth in the open air model bed	:	0.5 -0.6 m
D50 of sand	:	0.15-0.18mm

Other available facilities include various measuring instruments, tide generator, wave generator, sediment feeder, power generator, workshop etc.

Important Physical model studies conducted at RRI and achievement in the past

So far, more than two hundreds of Physical model studies of different projects have been conducted by Hydraulic Research Directorate since 1948. Some of the important Physical model studies carried out at RRI is as follows:

Name of the project	Year of completion	Objectives of the Physical modelling
Bangabandhu Railway Bridge Project	2018	To determine the local scour around the proposed Bangabandhu Railway Bridge pier and to check the efficacy of the existing RTW with proposed railway bridge pier.
Buriganga River Restoration Project	2018	To finalize the layout of the off-take structure such as guide bund, intake canal and sedimentation basin in order to get required discharge in Dhaleshwari River.

Name of the project	Year of completion	Objectives of the Physical modelling
Laboratory Based Study Using Concrete Block Mats to control River Bank	2018	To determine the cost effectiveness and sustainability of Concrete Block Mats compared to traditional method of river bank protection
Paira Bridge Project	2016	To finalize the type, location, dimension and hydraulic design parameters of the proposed river training works
Ganges barrage project	2013	To finalize the location, effectiveness and design parameters of the proposed barrage.
Padma multipurpose Bridge project	2013	To check the efficacy of river training structure.
3rd Karnaphully bridge project	2006	To decide the effectiveness and design parameters of bridge piers.
Gorai river restoration project	2001	To find out the suitable options for sustainable measures.
Bangabandhu multipurpose bridge project	2000	To find out the efficacy of river training structure and to solve instantly arising any difficulties during the period of erection.
Paksey roadway bridge project	1996	To verify the efficacy of river training structure.
Silt trap model for Teesta barrage project	1994	To finalize the effectiveness and design parameters of the barrage component.

Mathematical Modelling

At the present time, mathematical modelling tool is being widely used all over the world for research and studies in the field of water resources engineering. It has become an important tool for decision support in planning and management of water resources and sustainable water infrastructure development. In many cases mathematical modeling is complementary to physical modeling to arrive at sound engineering judgment as to planning, design and implementation of water infrastructure projects. In view of this fact, the GoB has equipped RRI with mathematical modeling facilities (MIKE Series) to enhance its quality of works. It is expected that RRI will play a vital role in water sector as well as in other related sectors to make the water resources development cost effective and sustainable. It can be mentioned here that RRI has already completed a number of mathematical model studies from 2009 to till. RRI has conducted a numbers of mathematical model studies which is mentioned in below. At present, one mathematical model study entitled "Topographical, Hydrological and Morphological Study using mathematical model for Madanpur-Dirai-Sullah (Dirai-Sullah Portion) Road under Sunamganj Road Division during the year 2018-19 is underway. Another mathematical model study entitled "Hydrological and Morphological Study for Proposed Kaharol Bridge over the river Punarbhaba River at 11th K.M. of Birganj-Kaharol Road (Z-5007) under Dinajpur Road Division, Dinajpur " has recently been completed in the financial year 2017-18 as per agreement signed between RRI and RHD (Roads and Highways Department).

Important Mathematical model studies conducted at RRI in the past

- Detail Engineering Design of Kurigram Irrigation Project (South Unit),
- Wazed Miah Bridge project in Rangpur District
- Road Bridge over the Banar River on Mymensingh-Goffargaon-Toke Road in Mymensingh District
- Road Bridge over the Kalni River in Habiganj District.
- Road Bridge over the river Lohalia at Boga in Patuakhali District.
- Pagla-Jagannathpur-Raniganj-Aushkandi Road Project in Sunamganj District.
- Road Bridge at Nalua-Baherchar over the river Pandab-Paira in Patuakhali District.
- Road Bridge over the Monu River in Moulvibazar District.

Recently Mathematical model studies conducted at RRI

- New Sachna-Golakpur Road under Sunamganj Road Division.
- Proposed Sonahat Bridge over the river Dudhkumar under Kurigram Road Division.
- Proposed Kaharol Bridge over the river Punarbhaba River under Dinajpur Road Division.
- Improvement of Nikli – Soharmul - Karimganj Road & Gunnodhor GC -Mojlishpure GC Road under Rural Infrastructures Development Project of Kishorgonj District of LGED.

2.1.1 Model Studies Conducted by HRD in 2017-2018 fiscal year

A) Physical Model Investigation for Sustainability of the Buriganga River Restoration Project

The Buriganga is the main river flowing beside Dhaka, capital city of Bangladesh. Over the last several decades the flow of Buriganga, Turag, Shitalakkha and Baluriver has been reduced drastically. As a consequence, the water quality of the river Buriganga has been severely deteriorated due to insufficient river flow, solid waste, tannery and disposal of contaminant effluent from different types of industries. In addition, continual growth of population and consequent increased human interventions in the river and floodplain have severely affected the flow regime leading to loss of navigability of the once famous inland navigation route between Dhaka and Narayanganj. Under this circumstance, Bangladesh Water Development Board (BWDB) has undertaken a project entitled "Burigarrga River Restoration Project (BRRP)" with a view to ensure sufficient flow in the river Buriganga by diverting flow from the Jamuna through the New Dhaleshwari river. In order to achieve this end large scale dredging at the New Dhaleshwari off-take together with structural interventions have been envisaged as a means for augmenting the dry season flow of the Buriganga river. It was a key finding from the comprehensive feasibility study and mathematical modelling conducted by Institute of Water Modelling (IWM), Dhaka. Afterwards BWDB decided to conduct a physical model study to investigate the sustainability of BRRP and to come up with a plan and design of structural interventions in the form of guide bund and sediment basin. Physical model also aims to verify the performance of off-take structures including sediment basin as proposed by BWDB. The tentative layout of the sedimentation basin (1500m × 1500m) as initially supplied by the BWDB is shown in **Figure 1**. The sediment will be deposited into the sedimentation basin due to reduction of velocity and thereby silt laden water entering from the Jamuna river will be trapped and eventually silt free water will enter into the New Dhaleswari river. The deposited sediment will be disposed of periodically by maintenance dredging. This will ensure sufficient flow in the New Dhaleswari river that will eventually augment the flow in the Buriganga river. As a result, it will reduce the severity of water pollution in the river Buriganga.

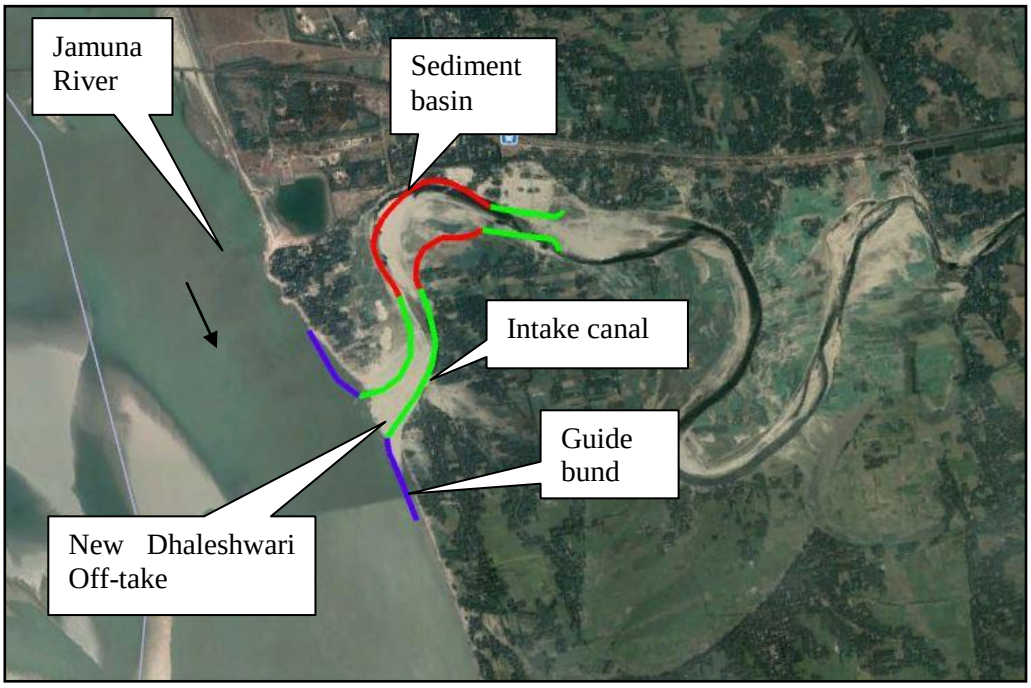


Figure 1. Tentative layout of the sedimentation basin

It is revealed from the previous studies that sediment management at the off-take is a must to ensure round the year connection between the New Dhaleswari and its parent river, the Jamuna. At present Jamuna river flow enters into the New Dhaleahwari river during monsoon but more or less no water flow situation occurs during dry season. Therefore, continuous monitoring and maintenance dredging together with capital dredging will be required to ensure desired dry season flow into the New Dhaleshwari river. In addition structural measures at the off-take will be needed to keep the off-take position stable and to guide the flow to the distributaries. Moreover, sediments that enter into the New Dhaleahwari river should be allowed to settle at a specified location to facilitate maintenance dredging and to let more or less sediment free water to enter into the river system. The planning and design of appropriate structural measures at off-take needs decision support by physical model investigation.

In order to simulate the existing hydro-morphological processes of the river an overall distorted morphological model was constructed at RRI which covers about 5km of Jamuna river extending from 3km upstream to 2km downstream of the New Dhaleswari off-take. The model has also included about 10 km reach of the New Dhaleswari river from the off-take. Partial width of Jamuna river (more or less 2km) and whole width of New Dhaleshwari river have been reproduced in the model. The horizontal scale is 1:200 and vertical scale is 1:55 used in model.

A total of eight tests including calibration test have been conducted to carry out the investigation. The first application test is base run (without project condition) while the other application tests have been conducted with proposed interventions in place. The model has been calibrated for dominant discharge (**Figure 2**) and the same discharge has been considered for application tests. Two application tests have been conducted for Jamuna discharge corresponding to its low water level of 6.08mPWD at the New Dhaleshwari off-take. Test conditions of the subsequent tests have been decided based on understanding gained from the prior test results. It has been done through interactive communication between RRI and BWDB i.e. taking feedback from the BWDB engineers concerned.

Some of the important findings from the model study are:

(a) The proposed interventions at the off-take in the form of guide bunds, intake channel, sedimentation basin and exit channel (shown in **Figure 1)** could be a solution of the existing problem if properly planned and implemented with provision for long-term monitoring and maintenance dredging.

Figure 2. A view of calibration test run

(b) Model results suggest that targeted flow augmentation of the New Dhaleshwari river is possible with the proposed interventions at the off-take and dredging as per design. However, river channel downstream of the interventions has also to be dredged to a level of 0mPWD with sufficient width for smooth passage of dry season flow. The extent of such dredging should be determined based on field data as in the model study only 10km stretch of the New Dhaleshwari river has been reproduced (**Figure 3**).

(c) Implementation of the proposed structural interventions with dredging only within the interventions as per design will increase the flood discharge through the New Dhaleshwari river. Discharge of the New Dhaleshwari river corresponding to the dominant discharge of the Jamuna river will be more than two times higher compared to that in base condition. However, this increased discharge is not sufficient enough to lower the bed level of the downstream channel to a level to allow for smooth conveyance of targeted dry season flow.

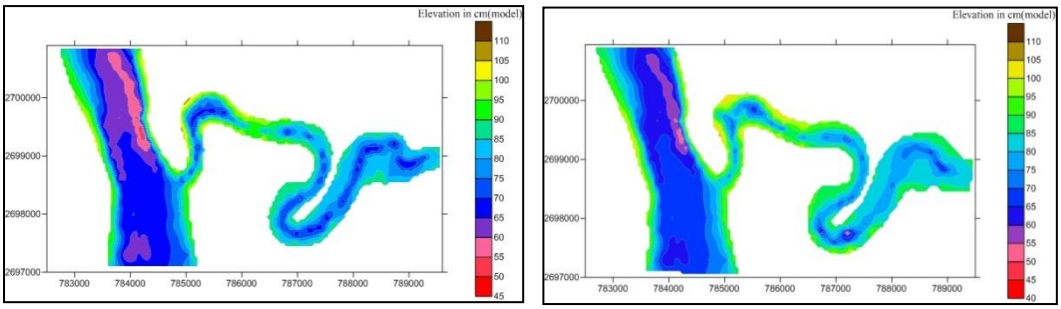


Figure 3. Comparison of bed level in Test T7

(d) Dredging within and beyond the intervention area will cause fourfold increase in the New Dhaleshwari discharge corresponding to the dominant discharge of the Jamuna river compared to base condition.
(e) Due to increased flood discharge and consequent increased flow velocity bank erosion potential may increase in the entire New Dhaleshwari river system particularly at the bend locations. In order to cope with this situation outer bank of the eroding bends may be stabilized by undertaking appropriate bank protection measures.

B) Physical model study for supporting design of the proposed Bangabandhu Railway Bridge over the river Jamuna

Bangladesh is a riverine country having three major rivers namely the Ganges, the Meghna and the Jamuna. The Jamuna river, which is the mightiest of the three and which ranks as the fifth largest river in the world in terms of volumetric discharge and the highest silt carrying river in the world. The construction work of Bangabandhu Bridge Project started in October 1994 and opened to traffic on 23 June 1998. The length of the bridge is 4.8 km and lengths of west and east guide bunds are 3.26 km and 3.07 km respectively. The guide bunds direct the river into a single channel under the bridge. The original width of the river at the bridge location was 10km. For the construction of the bridge this length was reduced to 4.8 km by closing the west channel. The main objective of the construction of the Bangabandhu Bridge was to establish a strategic link between the east and the west region of Bangladesh, to integrate the country by generating multifaceted benefits for the people, promoting better inter-regional trade and economic and social development. It enables quick movement of goods and passenger traffic by road and by rail across the Jamuna river. In addition, its facility promotes transmission of electricity, transfer of natural gas and integration of telecommunication links. For further enhancement of the capacity and to overcome the loading restriction of Bangabandhu Bridge, it would be necessary to go for construction of a parallel Bangabandhu railway Bridge, dedicated to railway, while the existing the Bangabandhu Bridge could carry road traffic only.

The bridge is located on the strategic Asian Highway and the Trans-Asian Railway which, when fully developed, will provide an interrupted international road and railway link from S.E. Asia to N.W. Europe. The roadway bridge is quite capable to connect the Asian Highway. But the existing Rail Track Bed over the Bangabandhu Bridge is not enough to link to the Trans-Asian Railway. Under this circumstance, Bangladesh Railway, Government of Bangladesh has undertaken a Project entitled "Construction of Bangabandhu Railway Bridge over the river Jamuna" which will be located 300m upstream of the existing Bangabandhu Bridge. An agreement between RRI and DDC Ltd. is signed on 28 May, 2017 to conduct the physical model study for supporting hydraulic design of the proposed Bangabandhu Railway Bridge over the river Jamuna.

As per agreement, three models have been studied. These are West Guide Bund (WGB) model, East Guide Bund (EGB) model and Flume model. WGB and EGB models are sectional model. The sectional model encompasses a certain river reach upstream and downstream of proposed railway bridge with partial width of the Jamuna river. Here real bathymetry has been used. Detail model study for WGB and EGB has been done to assess bridge-to-bridge pier and bridge-to-revetment interaction with existing Bangabandhu Bridge and proposed Bangabandhu railway bridge piers and also to determine local scour around the tip of EGB for present as well as for likely future worse condition. On the other hand, in the flume model, arbitrary plain bathymetry has been used. Flume study is done to investigate the extent of maximum local scour, its shape and its location at different severe flow condition around the pier. About 3.0 km length and partial width of the Jamuna river including tentatively 1.5 km upstream and 1.5 km downstream of the proposed rail bridge is reproduced in the WGB model (**Figure 1**) . It is an undistorted model having horizontal and vertical scale 1: 100. Model bed and bank are composed of fine sand having d_{50} of about 0.085mm. About 3.5 km length and

partial width (30% of flow line) of the river including 2.0 km upstream and 1.5 km downstream of the proposed bridge is reproduced in the EGB model (**Figure 1**). It is also an undistorted model having horizontal and vertical scale 1:130. Model bed and bank are composed of fine sand having d_{50} of about 0.17mm. For both sectional models (WGB and EGB) maximum flood discharge of 100-year, 200-year and 500-year return period is taken into account to investigate the model with two different model discharge conditions. One is Froudian discharge and the other is scour discharge for scour development. Froudian discharge provides the flow pattern and velocity field as a whole and the scour discharge focuses on the scour simulation and sediment transport. Each test of the model continues about 16-20 hours until a dynamic equilibrium scour is reached. In the WGB and EGB model, two calibration tests (T0-1 and T0-2) and 6 (six) application test runs (T1-T6) are conducted. The flume study has been conducted to investigate the extent of maximum local scour, its shape and its location under different severe flow conditions around the pier. This study was conducted in a sand bed flume inside a model shed at RRI. The flume was filled with fine sand of D_{50} = 0.085 mm to reproduce the local scour precisely in the laboratory. The total length of the flume from the discharge measuring weir to the tail gate was 34.0 m and the width of the flume was 4.0 m and 1.3 m sand depth. The scale used in Flume model is 1:80. This flume consists of mobile bed and fixed bed. The length of the mobile bed was 21.0 m and it exists in between upstream and downstream fixed bed portions. With this model set-up 3 (three) tests (T0-1, T0-2 and T-1) were conducted.

Three different models i.e. WGB, EGB and Flume Model are constructed to meet the objectives as mentioned in the ToR. After calibration of the three models, different application test runs were conducted with various test scenarios.

The following conclusions have been made for supporting design of the proposed Bangabandhu Railway Bridge:

(a) The change in velocity to the existing bridge and at the Guide Bund due to the proposed bridge is not observed in WGB model. The WGB model is constructed with sectional width. Moreover different model technique is adopted to create severe condition in the model. So aggradation and degradation tendency as a whole is not possible to report. Scour and deposition both observed irregularly in the WGB model and it was due to the different tested flow conditions and planforms. The modified design of the revetment is found to have worked effectively as observed in the WGB model.

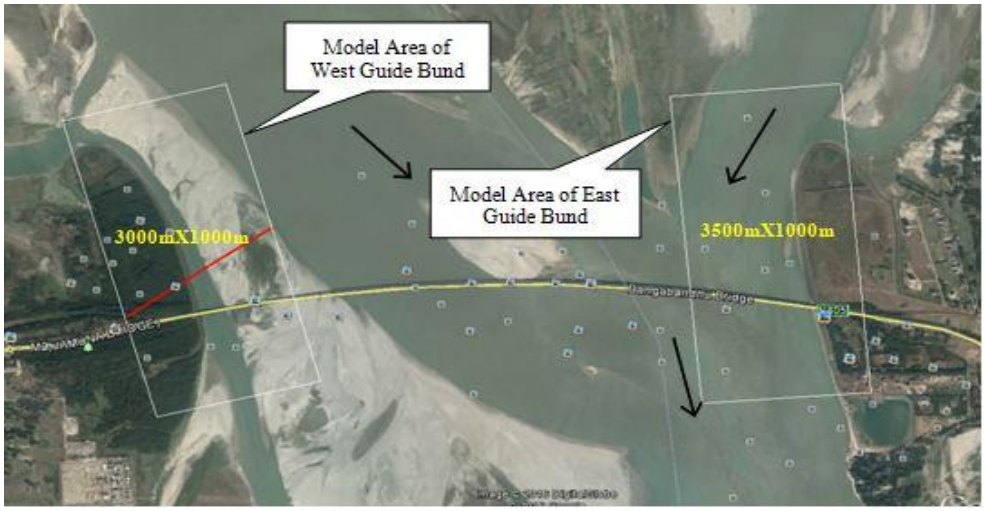


Figure 1. Sectional Model areas for West & East guide bund

(b) In worse condition i.e. at different approach flow condition and 500yr return period discharge, total 39.10m (-35.10 mPWD) scour including 6.0m general scour is found at tip of EGB which is located at (784046.06 mEasting, 2702643.15 mNorthing). The scour bed level after run is shown in **Figure 2**

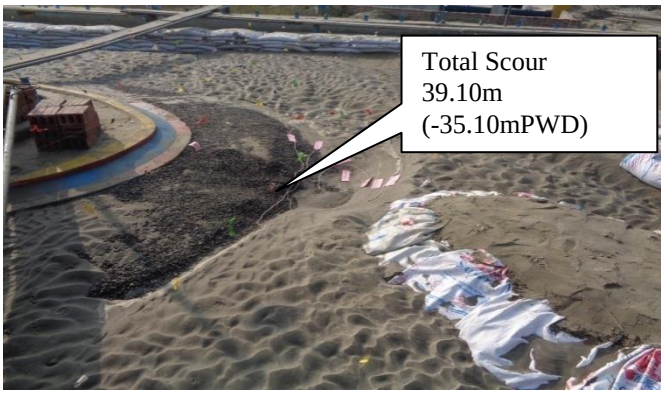


Figure 2. Maximum scour around the tip of EGB for test T6

(c) From the test results of Flume study, it is concluded that among different test alternatives, different piers experienced different scour. Maximum net scour observed from the model tests was 19.40m (-27.40 mPWD) and it occurred at proposed bridge Pier-1(Pier-19 in prototype). It was observed from the recent velocity profile in model that the upstream velocity was lessening slightly due to the sediment deposition. Furthermore, the test results showed that less scour was occurred around existing roadway bridge piers as compared to the proposed railway bridge piers since proposed piers created more turbulence. The key points of the test findings are given hereafter.

- Maximum net scour around the existing Bridge pier was found to vary within 3.20 m (+0.8 mPWD) to -10.20 m (-18.20 mPWD)
- Maximum net scour around the proposed Bridge pier was within the range of 2.60 m (+1.4 mPWD) to -19.40m (-27.40 mPWD)
- Maximum point average velocity around the Bridge pier was varied from 1.77 m/s – 5.5m/s
- Maximum proto velocity at 0.8d around proposed bridge piers ranges from 4.14 m/s to 4.52 m/s
- Maximum longitudinal extent of local scour at upstream side varies from 27 m to 28 m while at downstream side ranges from 155.0 m to 163.0 m
- Deposition observed at d/s of proposed bridge and u/s of existing bridge section

C. Laboratory Based Study Using Physical Modelling on River Bank Erosion Control Using Concrete Block Mats and Placed Concrete Blocks with Filter on the Arial Khan River Bank at Madaripur District

The Arial Khan river is a distributary of the Padma river. The river maintains a meander channel throughout its course and is erosional in nature. A number of settlements have already been destroyed due to severe river bank erosion of Arial Khan river and the process is continuing. Bangladesh Water Development Board (BWDB) has taken measures to save these areas using conventional method. Concrete block mats and placed concrete blocks with filter are the

developments of conventional loose concrete block placement and loose concrete block dumping. Here the effectiveness will be more and expenditure will be decreased.

Similar type of work has not done yet in Bangladesh and abroad. The idea and technique have been developed by Manob Hitoishi Sangstha (MHS). So, it is felt that there is a need for the development of economical and environment friendly approaches. From approximate technical and financial analyses, it is found that river bank erosion control using concrete block mats and placed concrete blocks with filter are the best effective substitute and much cheaper than the conventional loose concrete blocks placement and dumping for the control of river erosion. The technical and financial aspects of newly proposed protective measure through "Laboratory Based Study using Physical Modelling on River Bank Erosion Control using Concrete Block Mats and Placed Concrete Blocks with Filter on the Arial Khan River Bank at Madaripur District" has been explored by River Research Institute (RRI).

Making contact with the concerned water resource specialists of different organizations in Bangladesh for the long time from 1989 to 2014 it is concluded that the proposed new river bank protective measure using concrete block mats and placed concrete blocks with filter can be applied to the bank of river after model test at RRI. The test can be done in the laboratory for a location along the bank of river in low, medium and high flow condition. Under this backdrop, a study was undertaken by RRI to carry out the study mentioned above and an agreement was signed between RRI and BWDB on 6th June, 2016.

The overall objective of the study is to evaluate and determine the performance of concrete block mats and placed concrete blocks with filter in river bank erosion control compared to conventional methods. The study area is at the bend of Arial Khan river at Ramarpole near Mollarhat bazar under Kalkini upazila of Madaripur district. Here the river is very dynamic and has a shifting tendency. Devastating bank erosion occurs at the right bank of it.

The river reach about 1.0 km length (0.5 km upstream and 0.5 km downstream of centre line of bend) and average width about 133m is reproduced in the model. It is an undistorted model and the scale used in the model is 1:30. The model is setup in the outdoor model bed (60mX40m) of RRI. After calibration of the model, different application test runs are conducted with different test scenarios and CBM bank protection work using low, medium and high flows. The CBM protective work is reproduced in the model covering a reach of about 168m along the Right Bank of the river.

Figure 1: Placement of CC blocks during low flow in the model

Figure 2: Model is under running condition with oblique flow

Figure 3: Scour pattern in the vicinity of CBM and oblique char

Figure 4: Additional Secretary of MoWR visiting the model at RRI

The study results show that the effectiveness of the proposed concrete block mats is not so attractive compared to the traditional method as a whole, though the cost is relatively less. The construction of concrete blocks, filter placement under water, block placement through the wire etc. are found to be very complex in the model. But in nature it might be more complex. The construction of proposed bank protective structure might be very difficult to implement in the field and it is time-consuming and needs special working technology to construct in the field.

D. Hydrological and Morphological Study for Proposed Kaharol Bridge over the river Punarbhaba River at 11th K.M. of Birgonj-Kaharol Road (Z-5007) under Dinajpur Road Division, Dinajpur

Road Division, Roads and Highways Department, Dinajpur has planned to construct a roadway bridge over the Punarbhaba river at 11th KM on Birgonj-Kaharol road which is a zila road (Z-5007). At present there is a 110m long bailey bridge over the Punarbhaba river at Kaharol bazar. The bridge is suitable only for lightweight vehicles. In order to establish smooth roadway communication between Kaharol Upazila Head Quarter and other important towns and growth centers in Dinajpur district a new bridge over the Punarbhaba river is of immense importance. The existing bailey bridge over the Punarbhaba river at Kararol bazar is serving important purpose of roadway communication. However, this bridge is not suitable for serving the purpose of RHD zila road and thereby, has to be replaced by a new bridge for further expansion of RHD road network to the north, south and west of the Kaharol upazila head quarter.

Under this backdrop RRI has conducted a mathematical model study for the proposed bridge under an agreement signed between RRI and RHD mainly to provide planning and hydrological and hydraulic design support to bridge project. In order to conduct the study necessary hydrological data of the Punarbhaba river, satellite image of the study area and other relevant information have been collected. A field survey campaign has been conducted to collect the recent bathymetric data of the river, bank line data, nearby road alignment data, water level and sediment data etc. A two-dimensional model covering an extent of about 17km of the Punarbhaba river has been developed using modelling software MIKE21C. The developed model is then applied for investigation of hydraulic performance of four different bridge and approach road alignment options under different return period discharges including design discharge. Taking all relevant issues in view into account Option-3 and Option-4 have been considered as the suitable alignment for bridge and link road.

However, after stakeholder consultation Option-4 has been recommended for implementation (**Figure 1**). The extent of lateral migration potential of the river at this location is less due to presence of another bridge in the immediate upstream.

The hydrodynamic simulations of different return period discharges show similar velocity distribution pattern along the cross-sections at and in the immediate upstream and downstream of the proposed bridge location. The design discharge for the bridge has been estimated as 976.93m^3/s and based on the design discharge and other relevant issues in view appropriate minimum length for the bridge has been determined as 112m. The model simulations with different return period discharges have been conducted with bridge in place to see the effects of bridge constriction caused by bridge piers, abutments and approach roads on existing hydraulics at and around the bridge. It is found from the simulation results that the bridge causes local increase in flow velocity around the bridge piers and to some extent upstream and downstream of the same but has negligible effects on the water level upstream compared to the base condition. It means with the selected bridge opening free passage of flood flow will not be hampered. The velocity field at and around the proposed bridge for 100 year discharge with proposed bridge in place is shown in **Figure 2**.

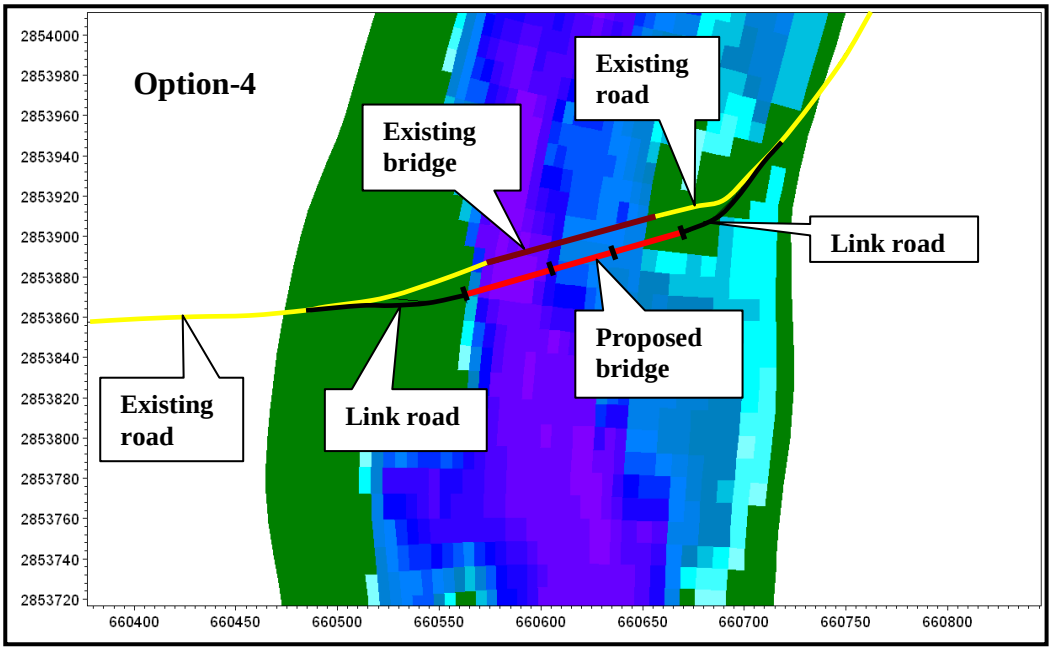


Figure 1: Proposed alignment of the bridge and approach road over the Punarbhaba river under Option-4

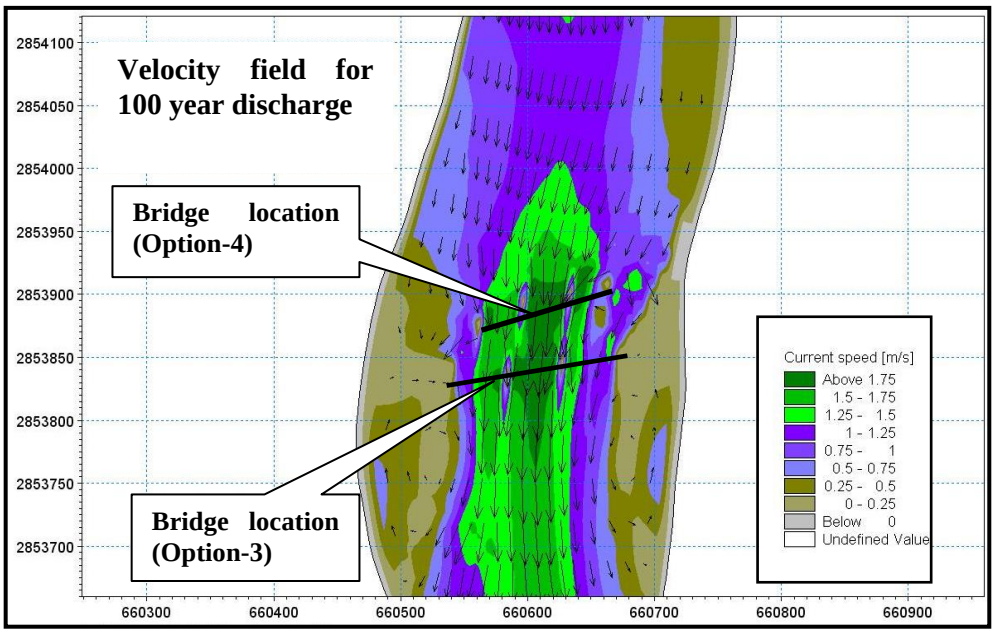


Figure 2: Velocity field at and around the proposed bridge location for 100 year discharge with proposed bridge in place

The study has come up with different hydrological and hydraulic design parameters of bridge, approach road, approach embankment slope protection works and bank protection works namely length and orientation of the bridge, design discharge and design water level, formation level of approach road, bridge deck level, minimum scour level at bridge piers and abutments, bridge span arrangement, design velocity for bank protection works etc.

2.1.2 Ongoing Model Study at RRI

A) Physical Model Study for Padma River Dredging Management in Jajira and NariaUpazilla under Shariatpur District

Shariatpur, a southern district of Bangladesh is bounded by the Padma, Meghna, Kirtinasha and Arial Khan river. The Padma carries immense volumes of water and constantly shifting its main channel due to the emergence of chars (sand bars) and islands at different locations of the river near Jajira and Naria upazilla in Shariatpur district. Apart from these, it has been eroding vast areas on one bank due to the collective effects of huge current, wave, tidal influences and upstream torrents. Consequently, important roads, educational institutes, healthcare facilities, hat-bazars, farmlands and many other public and private establishments have been grabbed by the river. The outer (concave) bank of the river is gradually advancing towards the country side and the bend is becoming gradually sharper. This process of bank erosion is typical to the Padma and other major rivers of Bangladesh. To address the problem, Bangladesh Water Development Board (BWDB) accomplished a feasibility study in 2012 with the help of BETS -one of the leading consultancy firms in Bangladesh. Besides, a technical committee was formed in 2015 by BWDB to investigate the issues. The present scheme is proposed in light of the recommendation made by the technical committee and accomplished feasibility study of BWDB.

The Kundeshwar, Sureshwar Launch Ghat Terminal, Darbar Sharif and Chandipur bus stand area are vulnerable to massive erosion of the Padma river. According to local people, about 1-2 km land area and 5-6 numbers of educational institutions have been engulfed by the river over the course of the last 10 years. As a consequence, erosion affected people have been compelled to take shelter elsewhere losing their ancestral homes. Furthermore, education is hampered and hence, poverty is intensified in that region making the people unhappy, upset and frustrated.

On the other hand, shallowness-induced poor navigability has been hampering traffic on the water route along Sureshwar due to high sediment load. Ferry services on the route have been interrupted due to navigability problem, stranding hundreds of water vessels of mostly transporting goods. Dredgers of Bangladesh Inland and Water Transport Corporation (BIWTC) were in operation to remove the sand, however, due to storing currents of water in the river the work could not be done well. The suffering of passengers travelling on the route knows no bounds. As a result, the normal plying of the ferries on the route is necessary as early as possible. Sand and silt will be dredged out from the bed of the river to make the river route navigable along Sureshwar. The required amount of silt will be removed wherever it is necessary to restore the navigability on the route. A proper dredging design with appropriate method will help maintain its navigability and protection technique will overcome those glitches and make the route more remunerative and sustainable. This will smoothen the plying of passenger launches, cargos and other water vessels.

Physical modelling is an important tool to support the design of appropriate dredging options and strategies. RRI is the sole institute in this country that has vast experience in conducting physical model studies of different river engineering projects. It is, therefore, awarded with physical model study for Padma river dredging management and a contract agreement was signed between BWDB and RRI at Faridpur on 26th June 2018. The overall objective of the physical model study is to investigate the efficacy of dredging options, strategies and spoil disposal plan along Sureshwar and neighbouring areas under Jajira and Naria upazilla in Shariatpur district and to investigate the hydraulic and morphologic effects of the dredging in relation to changes in flow field, sedimentation and river bank erosion.

The model has been constructed in an open-air bed having dimension 100m $\times$ 80m.The outdoor facilities of RRI have been used for setting up the model. Primarily the model extent should cover the tentative river reach about 36km between Mawa and Chandpur together with a tentative river stretch about 15km of the Upper Meghna and about 5km of the Lower Meghna starting from the confluence**.** The tentative length and depth scale is selected as 1:600 and 1:80 respectively.

The study is underway. An inception report has already been submitted to the client. The activities of different modeling approaches are being carried out in full swing. The model bed is formed based on recent field survey data and a test program has been prepared in consultation with BWDB.

Figure 1: Intended areas of dredging in the Padma river

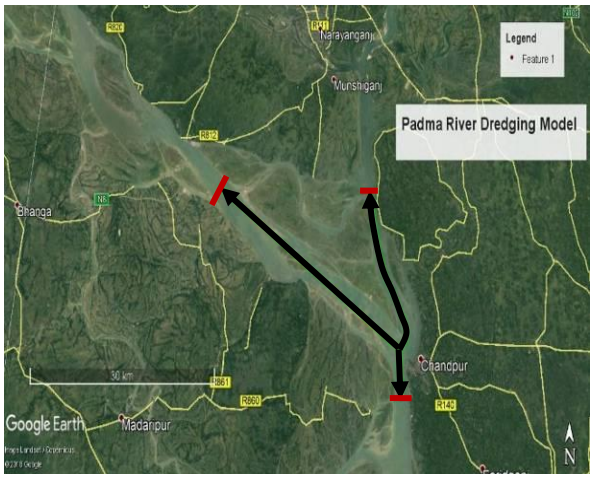


Figure 2: Tentative layout of the overall morphological model

Figure 3: Recent devastating right bank erosion of Padma river in the study area at Naria, Shariatpur.

Figure 4: Dumping of sand bags by BWDB to prevent right bank erosion temporarily at Naria.

B) Preservation and maintenance of the East Guide Bund (EGB) sectional model under proposed Bangabandhu Sheikh Mujib Railway Bridge Construction Project (BSMRBCP) over the river Jamuna.

A physical model study was carried out at RRI as per agreement signed on 28th May, 2017 between RRI and Development Design Consultants (DDC) Ltd. to support the design of the proposed Bangabandhu Sheikh Mujib Railway Bridge Construction Project (BSMRBCP) over the river Jamuna. Under the framework of the study, there were two sectional models and one flume model was constructed at RRI to fulfil the requirements for the design of the Proposed BSMRBCP. Those are namely West Guide Bund (WGB) model, East Guide Bund (EGB) model and Flume model. The scale of WGB, EGB and Flume model was1:100, 1:130 and 1:80 respectively. After calibration of the three models, different application test runs are conducted with various test scenarios. The final report was submitted to the client on 27th March 2018.

Afterwards, a new agreement was signed on 15 May 2018 between RRI and Oriental Consultants Global Company Ltd., Japan-Lead with a view to preserving the EGB model for 18 months with an effect from the contract signed. The preservation and maintenance of the sectional model is

required to carry out the additional test runs during the construction phase. As per agreement, three model layout set-up and test runs of EGB model will have to be performed under 100 and 200-year flood events with the adverse angle of approach for proposed Railway Bridge piers. The sectional model (EGB) encompasses a certain river reach upstream and downstream of proposed railway bridge with partial width of the Jamuna river. As per contract, the methodology as well as the details of the required tests will be provided by BSMRBCP authority when the tests are commissioned. Maintenance work of model bed is done regularly which can be seen from **Figure 1** and **Figure 2.**

Figure 1: Routine maintenance work around the (EGB) model bed

Figure 2: Grass uprooting work at (EGB) model bed

C) Topographical, Hydrological and Morphological Study using Mathematical Model for Madanpur-Dirai-Sullah (Dirai-Sullah Portion) Road under Sunamganj Road Division

Madanpur-Dirai-Sullah road is a district road of Roads and Highways Department (RHD). The road runs through low-lying haor area with complex physical and hydrological settings. Major part of the road construction has already been completed. Dirai-Sullah portion of the road is found to be vulnerable to hydraulic forces namely wave and current. As a result, the constructed road has suffered damage at many locations. Moreover, most of the constructed bridges and culverts are either not yet connected with the road or lost connection with the road due to damage of approach embankments. The road is constructed of locally available soil and at many stretches of the road partial removal of soil from the road embankment sometimes together with part of road pavement is noticeable. Damage of road embankment slope protection works is also noticeable at a number of locations throughout the road. Under this circumstance, Road Division, RHD, Sunamganj has taken up a hydrological and morphological study to address the issues related to road alignment, road structures and road safety under different hydrological scenarios to come with some useful outcomes for successful implementation of the road link between Dirai and Sullah upaazila headquarters. As present waterway communication is the only means of communication for the people there. RRI is given with the responsibility of conducting the study using mathematical modelling technology. A contract is signed between RRI and RHD to this end. The study work is now underway. The present alignment of Dirai-Sullah road is shown in **Figure 1**.

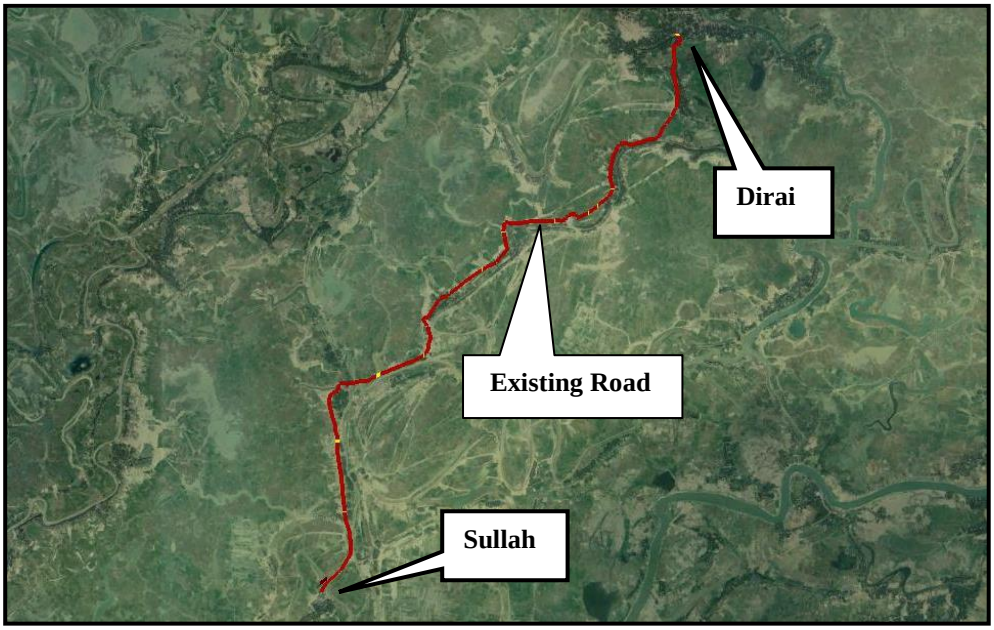


Figure 1: Existing alignment of Dirai-Sullah road

2.1.3 Proposals for Model Study

During the 2017-18 financial year RRI has submitted a number of technical and financial proposals to different clients for physical and mathematical model studies. Besides, RRI is in constant contact with different organizations for taking up studies to address different water related problems and to devise sustainable solutions. Some of the proposed studies have been mentioned hereafter.

- **Hydrological and Morphological Study for design slope protection work of the approach road and river bank protection work of 100.36 meter long Bahadurpur Bridge over at 32+689 km and 111.21 meter long Kernal Khal Bridge at 32+362 km of Ujanchar-Bajitpur-Austogram Road under Road Division Kishoreganj during the year 2017-2018.**
- **Hydrological and Morphological Study of the Brahmaputra River and adjoining are of the river for construction of a bridge at 42nd km Modhupur-Mymensingh Road under Road Division Mymensingh during the year 2018-20192018.**
- **Physical and Mathematical Modelling Study for River Training at the Under Construction Arial Khan Bridge.**
- **Physical Model Study for Construction of Series of T-head Groynes on the Teesta River**
- **Physical model investigation for the protection of right bank of the Jamuna River from Kurnibari to Chandanbaisa at Sariakandi upazilla in Bogra District.**

Figure : A view of meeting at BWDB Circle Office, Bogra in connection with contract agreement of Physical Model Investigation for the Protection of Right Bank of the Jamuna River from Kurnibari to Chandanbaisha at Sariakandi Upazila in Bogra District

2.2 GEO-TECHNICAL RESEARCH DIRECTORATE

Geo-technical Research Directorate comprises of three divisions. These are Soil Mechanics and Groundwater Eastern & Western Zone division (Soil mechanics division), Material Testing & Quality Control division and Sediment, Chemical & Water pollution division. The scope of works and facilities available in each division are described in the following sections.

2.2.1 Soil Mechanics and Ground Water Eastern & Western Zone (Soil Mechanics Division)

Soil Mechanics and Groundwater Eastern and Western Zone of Geo-technical Research Directorate is an utmost important wing of RRI. It has been conducting tests and research work for the determination of different physical parameters of soils which are required for planning and design of the infrastructures of flood control, irrigation, drainage, water development and other development projects. Ground Water Circle (GWC) of BWDB and other organizations explore site and complete their boring and collect soil samples from different project sites in connection with construction of hydraulic structures like bridges, dams, barrages, regulators, weirs, flood control and river training works and other relevant works. Site investigation and boring logs are prepared by them are sent to RRI with collected samples. RRI has developed sufficient laboratory facilities for testing of soil samples received from the clients. The soil samples of these zones are tested with great care by the scientists and trained / skilled soil technicians. Finally, the reports on the tested soil samples are prepared based on field investigation and laboratory analysis of data. The reports focus on the engineering characteristics of the soil samples according to the foundation needs. Then the approved report is sent to the respective clients along with bill. The works executed in connection with soil testing, analysis and publication of reports during 2017-18 have been discussed briefly in this section.

Receiving Procedure of Soil Samples

The disturbed soil samples were collected by driving split spoon sampler and undisturbed soil samples in Shelby tubes by the clients and sent to the Soil Mechanics and Groundwater laboratory of Geo-technical Research Directorate of RRI. A total 1065 no. of disturbed samples from GWC of

BWDB and other organizations in fiscal year 2017-18 were received in the laboratory. All the samples were tested and reports were sent to the respective clients.

Testing of Soil Samples

At first all the soil samples are visually examined in the laboratory and representative samples are selected for necessary testing. Generally, tests are conducted for determining Natural Moisture Content (NMC), Grain Size Distribution, Atterberg Limits, Density (γ), Void Ratio (e), Compression Index (Cc), Unconfined Compressive Strength (q_u), Shear Strength (cohesion c and angle of internal friction Φ), by Direct Shear, Tri-axial Shear with or without pore pressure, California Bearing Ratio (CBR) value and Permeability value etc. As per planned schedule, different tests are performed simultaneously in order to work out all necessary parameters quickly within the shortest possible time. Other necessary soil parameters are also tested according to client's requirements.

Apparatus for determining Specific gravity of soil

Direct Shear testing machine

Electric Sieve Shaker

Undisturbed soil sample ejector

Preparation of Reports

The soil testing reports normally contain the mode of field exploration, laboratory investigation, and summary of test results and range of test values, results of the different tests in tabular form, curves, charts and figures which are essential part of the report. The reports are prepared, published and sent to the clients with a copy to the design office of BWDB. A copy of the report is also sent to the library of RRI for record. A total of 11 no. of soil testing reports are published and sent to the respective clients during the fiscal year 2017-18. The detailed information has been tabulated in **Table 2.2.1**.

Table 2.2.1: List of samples received (project-wise in chart), billed amount and volume of work executed during 2017-18 in Soil Mechanics & Ground Water Division.

Sl No.	Report No.	Name of Division	Name of Project	No. of Sample Received & Tested	Billed amount (Taka)
01	01 (2017-18)		Buriganga River Restoration Project, RRI, Faridpur.	03	
02	02 (2017-18)	XEN, Patuakhali O & M Division, Patuakhali.	Implementation of soil testing and preparation of bore log for the construction of 4 water control structures at polder no. 55/2F under the CCTF project in Bauphal thana.	168	461625
03	03 (2017-18)	XEN, Habiganj O & M Division, BWDB, Habiganj.	Makhalkandi Haor sub project of FCD & development project in Haor Area under Habiganj O & M Division, BWDB, Habiganj.	140	306186
04	04 (2017-18)	XEN, Patuakhali O & M Division, BWDB, Patuakhali.	Soil boring for the Construction of Keshobpur sluice at polder no. 43/2-D and Charmoishadi Sluice at polder no. 55/2-A under "Blue Gold program".	84	146956
05	05 (2017-18)	XEN, Narial O&M Division, BWDB,Narial.	Soil boring for the construction of two pump house under the project " গন্ধর্ব্যখালী পাম্প হাউজে ২টি ও কমলাপুর পাম্প হাউজে ২টি মোট ৪টি পাম্প প্রতিস্থাপন কাজ" .	48	203400
06	06 (2017-18)	XEN, Magura O & M Division, BWDB, Magura.	Soil Boring for the Construction of a regulator under the project "দক্ষিণ-পশ্চিমাঞ্চলীয় সমন্বিত পানিসম্পদ পরিকল্পনা ও ব্যবস্থাপনা প্রকল্প (২য় পর্যায়)" at Boyra.	60	96075
07	07 (2017-18)	XEN, Chittagong O&M Division-II BWDB,Chittagong	Construction of Sea-Dyke for BEZA at Mirer sarai, Chittagong.	252	570225
08	08 (2017-18)	XEN, Chittagong O&M Division-II BWDB,Chittagong	Construction of Sea-Dyke for BEZA at Mirersarai, Chittagong.	308	554944
09	09 (2017-18)	SDE, Jaduboyra Sub-Division, BWDB, Kushtia.	Soil Compaction test for the protective work along the Right Bank of the river of Padma to protect Shelidah Kuthibari of great point Rabindranath Tagore and adjacent area under Kushtia district during year 2015-16 to 2017-18.	2	87600

Sl No.	Report No.	Name of Division	Name of Project	No. of Sample Received & Tested	Billed amount (Taka)
10	17 (2016-17)	XEN, Chittagong O&M, Division BWDB, Chittagong.	Construction of Ichakhali Regulator sluice, Mirsarai, Chittagong.	255 (Received & tested 2016-17)	816997
11	20 (2016-17)	XEN, Cox's Bazar O&M Division, BWDB, Cox's Bazar.	Soil Investigation of the Bank of Bakkhali river in Cox's Bazar to build 4 Nos. 1-Vent & 3 Nos. 2-Vent water control structure.	154 (Received & tested 2016-17)	392782
	Total			1065	3636791

Field Services

In order to assist the quality control of earth works of different projects, RRI sends experienced technicians on deputation to the field in response to the request from the project authority (mainly from BWDB). During the deputation period, technicians are involved in conducting in-situ tests for the ongoing projects. During the fiscal year 2017-18, three trained soil technicians were posted in the different working sites (**Table 2.2.2**).Technicians are deputed in the field for several quality control works such as Field Compaction, Relative Density, Grain Size, Limit, Natural Moisture Content, Hydrometer, Field Quality Control, Loss-on-ignition etc. at different projects.

Table 2.2.2: List of soil Technicians deputed in the field for Quality Control Work in the fiscal year 2017-18

Sl. No.	Name & designation of deputed technicians	Name of division	Working period
1	Md. Nuruzzaman ST-B	Patuakhali O&M Division, BWDB, Kalapara, Patuakhali.	01.07.17 to 30.06.18
2	Md. Abdul Mannan ST-A	Bera O&M Division, BWDB, Bera, Pabna.	01.07.17 to 30.06.18
3	Md. Golam Mostafa ST-B	Cox's bazar O & M Division, BWDB, Cox's bazar.	01.07.17 to 30.06.18

Revenue

During the fiscal year 2017-18 the billing amount for soil tests was Tk. 36.36791 lakh (for detail see **Table 6.2**) and 10% overhead charge on basic pay of the deputed soil technicians to BWDB has been earned. In total Tk. 31.861 lakh (After deducting net Tk. 26.278 lakh) has been received during the fiscal year 2017-18. A total of Tk. 36.284 lakh is remaining outstanding up to June 2018 to different divisions of BWDB.

2.2.2 Material Testing and Quality Control Division

The Material Testing and Quality Control discipline of Geo-technical Research Directorate deals with the determination of physical and engineering properties of concrete and concrete materials normally used for different types of river training works, hydraulic structures and other infrastructures. It also involves 'Laboratory Trial Mix' and computation of concrete mix design to attend particular design strength with materials to be used in the construction works. At present this

discipline has two types of working facilities viz. laboratory oriented testing & research facilities and the other is monitoring & evaluation of construction works by conducting field tests and investigations for quality control of concrete to the ongoing projects.

Universal testing machine used for testing of MSrod, flat bar, concrete cylinder, block etc.

Compressive strength testing machine used fortesting of concrete cylinder, block etc.

Laboratory Activities in 2017-18 fiscal year

During the fiscal year 2017-18, a total of 116 number samples/specimens of cement, sand, shingles/stone chips, bricks, concrete cylinders, MS Rod were received from the different ongoing projects under the different divisions of BWDB and other Govt. and Non-Govt. organizations for conducting tests as specified by the clients. There is a very useful and sophisticated instrument named "The Universal Testing Machine (UTM)" used in the concrete laboratory for testing of MS rod, flat bar, concrete cylinder, block etc.

Category-wise list of samples received from different BWDB Divisions and other organizations during this fiscal year have been given in **Table 2.2.3**. The Division-wise list of sample tested with project name, their billed amount and the recovery amount of the different BWDB Divisions during the fiscal year 2017-18 are shown in **Table 2.2.3**.

Table 2.2.3: Category-wise list of samples received from different BWDB Divisions and other organizations during the fiscal year 2017-18.

Sl. No.	Name of division/Other organization/Field laboratory	Cement	Sand	Stone/ Khoa	Concrete cylinder/Cube	M.S rod	Brick	Total sample
1	2	3	4	5	6	7	8	9
1	Faridpur O&M Division, BWDB, Faridpur.	-	2	2	12	-	12	28
2	Chuadanga O&M Division, BWDB, Chuadanga.	-	-	-	-	30	-	30
3	MadaripurO&M Division, BWDB, Madaripur.	2	4	5	7		-	18
4	MaguraO&M Division, BWDB, Magura.	3	5	3	21	-	-	32
5	ShariatpurO&M Division, BWDB, Shariatpur.	-	-	-	2	-	-	02
6	M/S. ZobaidaKarim Jute Mills Ltd, Faridpur.	-	-	-	6	-	-	06
Total							-	116

Table 2.2.4: Name of the Projects, total no. of samples received and billed amount & recovery amount of different BWDB Divisions and other organization during the fiscal year 2017-18

Sl. No.	Name of division/Other organization/ Field laboratory	Name of project	Total nos. of sample tested	Billed amount (in Taka)	Recovery (in Taka)
1	2	3	4	5	6
1	Faridpur O&M Division, BWDB, Faridpur.	• Re-excavation of Kumar River Project.	28	29850	29850
2	Chuadanga O&M Division, BWDB, Gopalgonj.	• Rehabilitation of GKI Project.	30	17260	17260
3	MadaripurO&M Division, BWDB, Madaripur	• Protection work of Dhaka-Mawa- Bhanga-Khulna National Highway.	18	78075	78075
4	MaguraO&M Division, BWDB, Magura.	• Rehabilitation of GKI Project.	32	82050	82050
5	ShariatpurO&M Division, BWDB, Shariatpur.	• NDR budget project.	02	9600	9600
6	M/S. ZobaidaKarim Jute Mills Ltd, Faridpur.	• Construction of administration building project.	06	5250	5250
		Total	116	222085	222085

Field Services

For quality control of works, a few numbers of trained technicians were deputed in the field in response to the request from the project authority. During the fiscal year 2017-18, 05 (five) number of technicians were deputed in the different work sites of BWDB. List of the concrete technicians deputed in the field for quality control works at different projects have been presented in Table 2.2.5.

Table 2.2.5: List of Concrete Technicians deputed in the field for Quality Control Work.

Sl. No.	Name & designation of deputed technicians	Name of division	Working period
1	Md. Shariful Islam ST-A/CT-A (in charge)	Cox's bazar O&M Division, BWDB.	01.07.17- 30.06.18
2	Md. RezaulKarim MT-B/CT-B(in charge)	Pabna O&M Division, BWDB.	01.07.17- 30.06.18
3	Md. Piarul Islam CT-B	Kushtia O&M Division, BWDB.	01.07.17- 30.06.18

4	Md. Taherul Islam CT-C	Kishoreganj O & M Division, BWDB.	01.07.17- 30.06.18
5	Md. Arif Mahmud CT-B	Chittagong O & M Division, BWDB.	01.07.17- 30.06.18

2.2.3 Sediment, Chemical and Water Pollution division

Sediment, Chemical and Water Pollution division is one of the testing and research discipline of Geo-technical Research Directorate of RRI. There are two laboratories under this division, namely Sediment Technology laboratory and Chemical and Water Pollution laboratory. Test and analysis of various kinds of sediment samples of different rivers of Bangladesh are being carried out in the Sediment Technology laboratory. The test results are used for planning and designing of hydraulic structures like barrages, drainage channels, irrigation canals, flushing sluices, closures etc. Sediment testing results are also used in physical and mathematical model studies. In the chemical and water pollution laboratory, samples of surface and ground water are being analyzed for using water in different purposes.

Figure: Late Syed Anwaruzzaman (Left, expired on 08.09.2018), Principal Scientific Officer, observing the soil samples collected for Hydro-morphological study of the Mahananda river during FY 2017-18.

A. Testing Facilities in Sediment Technology Laboratory

- Determination of sediment concentration by evaporation and filtration method.
- Determination of sediment concentration with soluble salt correction.
- Determination of specific gravity.

- Determination of viscosity.
- Grain size analysis by
  - Wet and dry sieving method
  - Hydrometer method
  - Pipette method
  - Sieve and pipette combined method
  - Sieve and hydrometer combined method

Activities of Sediment Technology Laboratory during 2017-2018 fiscal year

A total number of 536 samples including general suspended sediment, bulk suspended sediment and river bed and bank soil samples were received and tested in the sediment technology laboratory as well as chemical laboratory during the fiscal year 2017-18. The general suspended sediment and bulk suspended sediment samples were collected by the field personnel of 3 (three) measurement divisions under the Surface Water Hydrology Circle-I of BWDB. The samples were collected as a routine work by the Surface Water Hydrology Circle-I of BWDB. The river bed and bank soil samples were collected by research team of Mahananda river research project of RRI for research purposes.

The name of clients and category-wise list of samples tested during the fiscal year 2017-18 has been shown in **Table 2.2.6**.

Table 2.2.6: Category-wise list of samples with the clients

Sl. No.	Name of client	Category of samples	Nos. of samples received & tested
1	Surface Water Hydrology Circle-I of BWDB	General suspended sediment samples	192
2	Surface Water Hydrology Circle-I of BWDB	Bulk suspended sediment samples	121
3	Mahananda River Research of RRI	Bed and river bank material samples	223

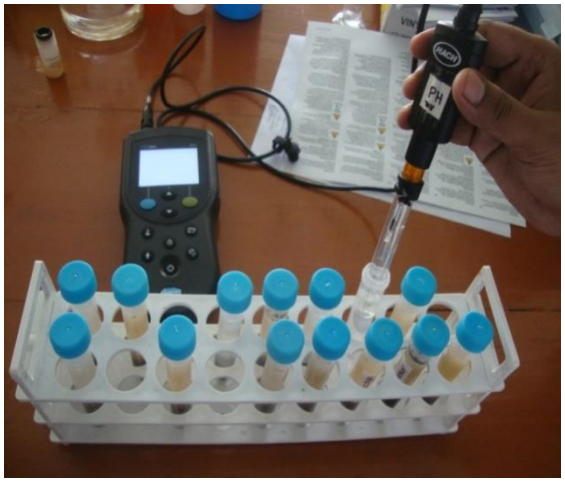
Figure: A view of testing activities for grain size analysis of soil samples.

B. Testing Facilities in Chemical and Water Pollution Laboratory

Chemical and Water Pollution laboratory is well equipped laboratory with modern instruments including Gas Chromatography-Mass Spectroscopy, Atomic Absorption Spectrometer, Spectrophotometer, Portable spectrophotometer, portable multi-parameter meter, Aquaculture testing kit etc. These equipments are designed with cutting-edge technology and are ideal for a wide range of applications including environmental, materials, geological, food safety, clinical and petrochemicals purpose.

Atomic Absorption Spectrometer for detecting heavy metals such as Zn, Al, Pb, B, Cd, Cr,, Mg, Fe, As, Hg etc in soil samples.

Gas Chromatography-Mass Spectroscopy for detecting volatile organic compound in soil and water.



pH measurement of Sediment samples using HACH 30QD multiparameter in chemical Lab.

Incubator used to maintain required temperature of reagents and samples.

'Gas Chromatography Mass Spectroscopy' is used in Chemical and Water Pollution Laboratory for detecting volatile organic compounds, pesticide, insecticide etc. in soil, sediment and water samples. 'Atomic Absorption Spectrometer' is used in this laboratory for determining metals like Na, K, Ca, Cr, Ni, Cu, Mn, Mg, Si, Ba, Fe, Zn, Co, Bi, Cd, Pb, As, Pt, Ag, Al, Sb, Se, Hg, B, Sn, Be, Mo etc. in soil, sediment and water. Hach Spectrophotometer is used to detect substances such as Al, Ba, B, Cd, Cr, Mg, Fe, Cl, C, Ni, Fl, SO_4 etc. in soil, sediment and water samples. Hach portable spectro-photometer is used to detect substances in the field as Hach spectrometer does in the laboratory. Portable Multimeter meter is used to determine pH, EC, TDS, Salinity etc. from the river. Aqua-culture kit is used to measure Amonia, Cl^-, CO_2, Hardness etc. Digital Turbidity meter can be used in this Laboratory to detect turbidity of water samples. Conductivity meter is also available to measure conductivity, total dissolved solid (TDS), salinity of soil and water sample.

The following facilities also exist in the Chemical and Water Pollution laboratory:

- Determination of p^H, electrical conductivity, turbidity, free carbon di-oxide, bi-carbonate, sulphate, chloride, nitrate, sodium chloride, total solid content, hardness, calcium, magnesium, iron, silica, total dissolved solid, dissolved oxygen etc.
- Determination of arsenic.
- Determination of salinity.

Figure: A view of testing activities using Atomic Absorption Spectrometer to detect heavy metals in soil samples at Chemical Laboratory of RRI.

Revenue earned of Sediment, Chemical and Water pollution division

A total of Tk. 2.07 lakh has been billed during the fiscal year 2017-18 for testing of sediment samples. In total Tk. 1.86 lakh has been received in this fiscal year 2017-18 and a total of Tk. 2.67 lakh is remaining unpaid up to June 2018 to different clients of BWDB and other organisation.

2.3 ADMINISTRATION & FINANCE DIRECTORATE

This Directorate consists of several sections namely, i. Establishment, ii. Accounts & Audit, iii. Public Relation & Photography, iv. Library, v. Estate & Security and vi. Store. The other activities include procurement, operation & maintenance of physical facilities.

2.3.1 Activities of Administration & Finance Directorate

The activities of Administration & Finance Directorate include overall administration of RRI, establishment, human resources development, financial management, photography, public relations, internal security, storing of materials, plantation, arrangement of different kinds of training, publications of annual reports, journal, newsletters etc. The approved and existing manpower working in this institute is 257 and 198 respectively. The details of manpower are given in the following table as shown below:

Table 2.3.1: Class-wise approved and existing manpower in RRI

Sl. No.	Class	Approved manpower	Existing manpower
1	1st Class	58	40
2	2nd Class	03	01
3	3rd Class	122	80
4	4th Class	54	57
	Total	257	198

This directorate also collects a number of books both from home and abroad, journals, research reports, newsletter and many other publications every year for library. Many researchers, students and teachers from different institutions use this library for their necessary documents. The total number of reading materials (including books, journal, newsletter reports and publications) is mentioned in Table 2.3.2. and The total expenditure under this directorate during the fiscal year 2017-18 is shown in Table 2.3.3.

Table2.3.2: Total collection of items in the Library

Sl.No.	Description	Collection in 2017-18	Total
1	Books	145	2066
2	Journal	7	2652
3	Reports	42	5432
4	Other publications	77	5200
	Total	271	15350

Table2.3.3: Total expenditure in establishment

Sl. No.	Description	Amount (Tk. in lakh)
1	Officers salary	223.86
2	Staff salary	342.49
3	Allowances	530.03
4	Supply and services	193.32
5	Repair & maintenance	52.22
6	Capital expenditure	28.30
7	Establishment cost by own fund	-
	Totals	1370.22

2.3.2 Other Activities

In addition to the above activities, this directorate also provides technical support services to the other directorates and divisions. This directorate is also responsible for procurement, operation & maintenance, and mechanical & electrical works of physical facilities. The work completed by operation and maintenance, and mechanical and electrical section during the fiscal year 2017-18 is outlined below.

Works executed by Operation and Maintenance (Civil Engineering)

- Repair and maintenance of different offices as well as residential buildings. The repair and maintenance works include stripping of old plaster and replacing by new plaster works, white washing, plastic painting, synthetic enamel painting to window gratings, door polishing, wood work in door frames and replacing of glass panes in window shatters and replacing of doors under establishment budget.
- Purchase & replacing of plumbing materials of different buildings with new ones.
- Purchase of stationery, plumbing, hardware and construction materials for general use as well as model use.
- Cleaning of water tank in all office and residential buildings.

- Cleaning and maintenance of surface drain of RRI campus.

Works executed by Mechanical Section

- Installation, repair & maintenance of pump, motors, tailgates, gate valves, foot valves, model bridges etc.
- Repair and maintenance of mechanical tools.
- Repair, fitting & fixing of grill, window etc at residential and office buildings.
- Repair and maintenance of all the vehicles of RRI.
- Purchase of raw materials for mechanical workshop of RRI.
- Repair and maintenance of photocopy machines, air cooler and refrigerators.

Works executed by Electrical Section

- Purchase of fuel & batteries for generator.
- Routine maintenance of computer, printers, UPS, IPS and other electronic equipments.
- Purchase of computer accessories, electrical materials.
- Purchase of electric wires of different sizes.
- Electrification in model area.

3 RESEARCH AND DEVELOPMENT ACTIVITIES

Research plays a significant role to improve the quality of lives of the people and also the socio-economic development of the country. Quick and effective decision making by proper use of information contributes for upliftment of the society. Researches in the field of hydraulics, geo-technical and environmental engineering carry great importance for the development of water resources of the country. In view of the above mentioned facts, RRI takes up research projects every year. The two directorates of RRI, namely Hydraulic Research and Geo-technical Research conduct research and development activities in their respective fields. These activities are briefly described in this chapter.

Three research works have been conducted in 2017-2018 fiscal year, which of one is completed and other two is being carried out at present fiscal year. Completed research work is "Hydro-morphological study of the Mahananda river in Bangladesh with focus on problems and probable solutions of dry season flow scarcity" under Hydraulic Research Directorate. The other two is entitled "Investigation of geotechnical reasons for bank failure on Daulatdia and Paturia sites of Padma River of Bangladesh" and "Development of Suitable Technologies for Removal of Manganese from Ground Water in Household, Community and Municipal Levels" under Geo-technical Research Directorate. The undertaken three research projects, one development project (IDCB project) and four pilot projects have been briefly described hereafter, respectively.

3.1 THE RESEARCH PROJECT

(A) Hydro-morphological study of the Mahananda river in Bangladesh with focus on problems and probable solutions of dry season flow scarcity

The Mahananda is a natural non-prismatic non-perennial mobile boundary meandering river. It originates in the Himalayas and spills through North Dinajpur, Purnea, Katihar, Maldah and southern parts of Rajshahi, Chapai Nawabganj as well as Natore district in Bangladesh.

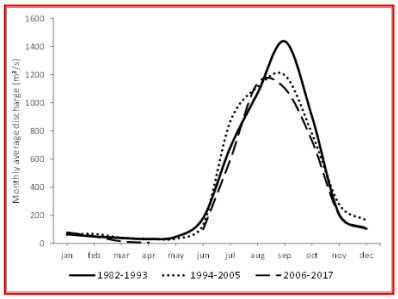
The major towns on the bank of Mahananda within Bangladesh territory are Tentulia, Bholahat, Gomostapur, and Chapai Nawabganj. Entering back into Bangladesh at Gomostapur upazila under Chapai Nawabganj district the Mahananda river travels 36 km through three upazilas namely Gomostapur, Shibganj, Chapai Nawabganj Sadar. The 36 km river reach is very important in terms of agriculture, fishery, groundwater withdrawal for irrigation and drinking purpose, transportation of different goods etc. Uses of river water in various purposes have been limiting gradually due to the shortage of normal flow in the river. However, due to acute shortage of dry season flow agriculture, fishery, ground water use and navigation have been drastically affected with direct consequences on livelihoods and environment. Depletion of groundwater table due to over withdrawal of ground water, arsenic contamination of groundwater and inadequate recharge are some of the conceivable problems. The other problems are lack of year round navigation facility, decreasing fish population, bank erosion and drought. All these problems are believed to be directly related to the dry season flow scarcity of the Mahananda river. Under the above mentioned circumstance and its negative social, environmental and economic impacts River Research Institute has taken up a comprehensive hydro-morphological study on the Mahananda river to identify the issues that are hindering the development and to devise feasible options to address these issues.

The specific objectives of the proposed investigation are as follows:

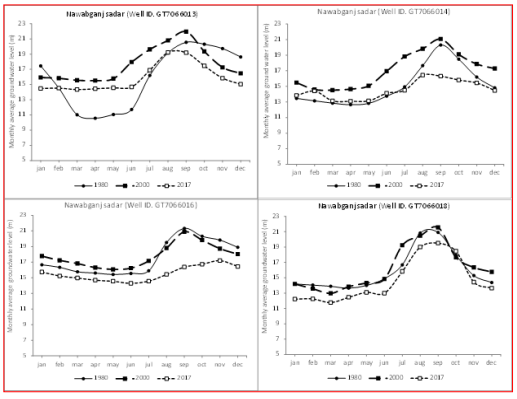
- To assess the past hydro-morphological developments of the Mahananda river and to predict possible future developments;
- To assess the impacts of natural changes and human interventions in the river and floodplain on flow and sediment transport regime;

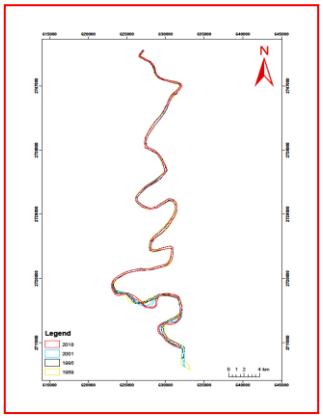
- To determine the relation between depletion of flow and arsenic contamination;
- To determine the trend of ground water level with the change in surface water level within the study reach;
- To analyze the developed options to come up with feasible solutions of the problems.

This investigation has been done based on the data collected from different sources and necessary questionnaire survey from the fields. Planform analysis has been carried out with available time series satellite imageries using appropriate tools. The cross-sectional geometry of the river and its evolution with time has been determined by analyzing the present and historical cross-sections. Historical discharge, water level, groundwater level and rainfall data have been analyzed to identify the trend of change of hydrology of river and its catchment. Probable discharges and water levels have been determined by flood frequency analysis using appropriate methods. Platform parameters have been determined from high resolution (5m) time series satellite images and interrelationships among planform parameters have been established in space and time. Stakeholder consultations were limited to upazila government officials concerned, local union parishad chairmen and members and village people. The methods of stakeholder consultation were meeting and individual interview. Moreover, a questionnaire survey was carried out in 2017 to assess the present socio-economic and environmental status of the study area.



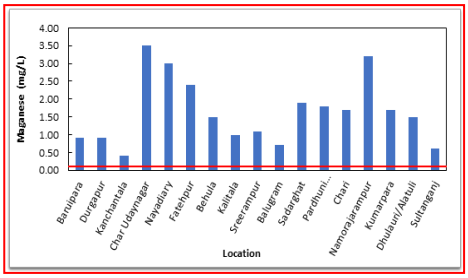
The discharge of Mahananda has been analyzed for the last 35 years. Both the maximum and minimum discharge show a decreasing trend but not significant. The hydrograph of monthly average discharge shows that the recent hydrograph runs much lower than the hydrograph of 1980s, indicates less water is passing through the river. The surface water level shows a decreasing trend and the trend is significant for 1980 to 1995 and 2003 to 2017. Suddenly the water level rises in 1996 and continues for 7 to 8 years within 12.5 to 14 m. After 2004 significant decreasing trend is revealed. Rainfall data for the period of 1980-2015 of the 6 stations have been collected from BWDB. It has been observed from the mean monthly rainfall of all the stations that, in the study area rainfall excess is for the period of May to October and rainfall deficit is for the period of November to April. The trend of rainfall total of all the stations indicate slightly decreasing trend and insignificant. It can be said that rainfall has minimum or no significant effect on dry season flow scarcity. On the other hand, decreasing trend of groundwater table is observed in all stations. Moreover, seasonal variation of groundwater table of 1980, 2000 and 2017 clearly indicates that groundwater table is lowering in this region. The analysis also reveals that groundwater is feeding the river water through base flow during the dry season.





Analysis of morphological parameters has been done from high resolution (5m) time series satellite images and inter-relationships among planform parameters have been established. Sinuosity, meander length, meander belt, channel width, river bank shifting have been calculated for the years 1989, 1995, 2001 and 2017 from satellite images using GIS tools. For all calculations and analyses the river has

been divided into three reach i) Volahat to Gomastapur, ii) Gomastapur to Chapainawaganj Sadar, and iii) Chapainawabganj Sadar to Sultanganj (Padma-Mahanada confluence). From the calculations it has been found that the reach Chapainawabganj Sadar to Sultanganj is more sinuous than the other two. Linear relationship has been found between river width (independent variable) and meander length (dependent variable) with coefficient of determination, R^2 ranging from 0.6743 to 0.8147. Linear relationship has also been found between river width (independent variable) and meander belt (dependent variable) with coefficient of determination, R^2 ranging from 0.6712 to 0.7258. Less migration of river bank has been observed for the upper two reaches in contrast to the lower reach of the Mahanada. There is a much rare U shaped meander in the third reach of the Mahanada. The migration of U shaped meander of Mahananda in the lower reach has been determined 7 to 111 m/year.



Ground water and surface water quality parameters namely As, Mn, pH, total dissolved solid (TDS), dissolved oxygen (DO), electrical conductivity (EC), salinity, resistivity and temperature have been tested at 17 locations situated both on the river and beside the river. From the measured value of arsenic concentration it has been observed that ground water in the study area cross the safe limit set by DoE in five locations namely Baruipara, Kanchantala, Sadarghat, Namorajarampur and Kumarpara. In other places arsenic concentration of ground water was observed within the safe limit of DoE standard. On the other hand arsenic concentrations in the river water were found within the safe limit of DoE standard at all the locations. The values of manganese concentrations in ground water were found to be many times higher than the acceptable limit of DoE standard at all the locations in the study area. For also river water manganese concentrations surpassed acceptable limit of DoE standard at all locations but not higher than that of ground water. The other parameters have been found within the limit of DoE standard.

To assess the socio-economic impact of flow scarcity on river bank community a questionnaire survey has been conducted. The total number of respondent has been 250. Of the total respondent 230 has been male and 20 has been female. While the respondents have been asked whether they affected by flow scarcity 69.60% respondent answered YES, 19.20% answered NO and 11.20% answered the could not say. Draught is found a common natural calamity in the study area as 72.00% of the respondent answered they face draught every year. A variety of solutions of flow scarcity in dry season have been opined by the general people. Of the respondents 21.25% deemed dredging, 55.00% considered increase of water flow at upstream and 15.00% viewed dam/sluice gate as solution.

After field observation, public consultation and data analysis, the following conclusion can be drawn;

(i) The Mohananda is a natural non-prismatic non-perinial mobile boundary meander river
(ii) It is observed from discharge hydrograph that discharge is gradually decreasing, even sometimes no flow in lean period.
(iii) Groundwater level is gradually decreasing.
(iv) The migration of bends of Mahananda river in the lower reach have been counted 7 to 111 m/year.
(v) Meander wave length and meander belt was strongly correlated with the average channel width. It was also observed that the ratio of average meander wave length to average mender belt was gradually decreasing with time.
(vi) Manmade intervention, i.e. about 10 km embankment both in right and left bank are there in Mahananda river.
(vii) Increase population pressure

(viii) Change of cropping pattern

The following recommendation could be considered to get rid of dry season flow scarcity of the Mahanada river

(i) Introduction with upper riparian country in order to have just share of dry season flow may be considered.
(ii) Taking all possible steps to ensure environmental flow in the Mahananda river.
(iii) Implementation of a plan to store monsoon water for subsequent weir in dry season.
(iv) Potential for constructing a barrage within the Bangladesh territory or construction of weirs across the river at a number of locations may be considered.
(v) Feasibility of different interventions for augmenting dry season flow may be studied to decide about appropriate and sustainable solutions of the problem.

(B) Investigation of geotecnical reasons for bank failure on daulatdia and paturia side of padma river of Bangladesh

Bangladesh has predominantly four major river systems-(1) the Brahmaputra-Jamuna, (2) the Ganges-Padma, (3) the Surma-Meghna, and (4) the Chittagong Region river system. The River Ganges originates from the Himalaya Mountains and it is accompanied by three distinct courses of flow, namely its upper, middle, and lower courses. The Ganges River branches into two distributaries, the Bhagirathi and the Padma Rivers. The Padma (Ganges) enters Bangladesh from India near Chapai Nawabganj. But from Chapai Nawabganj to Aricha the Padma is known as Ganges. Ganges meets the Jamuna near Aricha at Goalando and the combined river flow is known as Padma and finally meets with the Meghna near Chandpur and adopts the name "Meghna" before flowing into the Bay of Bengal.

The major part of Bangladesh is on the delta formed by three major rivers Brahmaputra, Ganges and Meghna. The system drains a basin of some 1.76 million sq. km and carries not only snowmelt water from the Himalayas but also runoff water from some of the highest rainfall areas of the world. Over millennia, the sediments carried by the huge discharges of these rivers have built a broad delta, forming most of the large area of Bangladesh and the submerged delta-plain in the Bay of Bengal. These huge sediments are the major sources of formation of 80% soils of the country. The remaining 20% of soils have been formed in Tertiary and Quaternary sediments of hills (12%) and in uplifted Pleistocene terrace (8%).

Regarding soil formation, two distinct conditions occur in Bangladesh: alternating seasonal wet or inundated and dry conditions, as prevalent on most of the floodplain areas, and intermittently wet or moist or dry conditions, as on the upland areas of hills and terraces. This is due to variation of agro climatic parameters in different seasons. The soil formation process differs significantly between floodplain, hill and uplifted terrace.

Riverbank erosion is a common scenario at monsoon in Bangladesh. Almost every year river banks are facing problems like erosion. Devastating flood and excessive rainfall are accelerating the failure process which results in immense damage to river bank, agriculture and infrastructures every year.

Figure: Bank erosion at Daulatdia Ghat, Goalanda, Rajbari (Photo 6 May, 2017)

Riverbank erosion occurs both for hydraulic and geotechnical instability. Geotechnical instability is caused by detachment of more coarse grained layers in any given alluvial bank, by water flowing out of the bank face. Though some researchers already tried to characterize geotechnical properties of soil facing mass failure problem like landslides or containing organic matters, nonetheless it is necessary to know more geotechnical reasons of river bank which can assist the protection works for preventing them from failure. A holistic investigation is necessary to analysis the stability of geotechnical condition of river bank in Daulatdia and Paturia. In this respect, an approach has undertaken with following objectives:

- Knowing geotechnical history and bank failure phenomena
- Geotechnical investigation in the field and the laboratory
- Comparison between the conventional river bank protection work and protection work considering geotechnical aspects
- Recommendations through analysis of geotechnical reasons.

The main objective of the research is to find out geotechnical causes for why bank fails and what type of geotechnical stability needs for preventing the river bank failure. The specific objectives of the study are as follows:

- To determine the geotechnical properties
- To find out the geotechnical reasons for why river bank fails
- Improvement of the conventional river bank protection
- To find out the approach to associate with river bank protection

As a research organization RRI can associate itself with research works relating to river bank failure and its protection. If the study is done through investigation of geotechnical reasons in the selected sides properly it will be easier to find out the ways of protection of failure of bank. The findings of this study may help engineer as a major tool to accomplish bank protection works.

The following methodology should be adopted to reach the objectives.

- Questionnaire survey and image analysis (for selection of sample boring)
- Reconnaissance survey and data collection
- Selection of study area (after field visit)
- Sample collection from different depth for laboratory investigation
- Recording the water table
- Measurement of ground level
- Measurement of hydraulic/hydrologic parameter (water level, velocity/discharge) in-situ

- Sample preparation, laboratory test and their analysis
- Data Analysis (Some correlations will be established)
- Data compilation
- Final Report

The relevant data has been collected from the previous bank protection works and instant data has been collected from the site. The soil testing data will be collected from the laboratory analysis of soil samples which has been collected from the river bank of the study area.

Expected outputs:

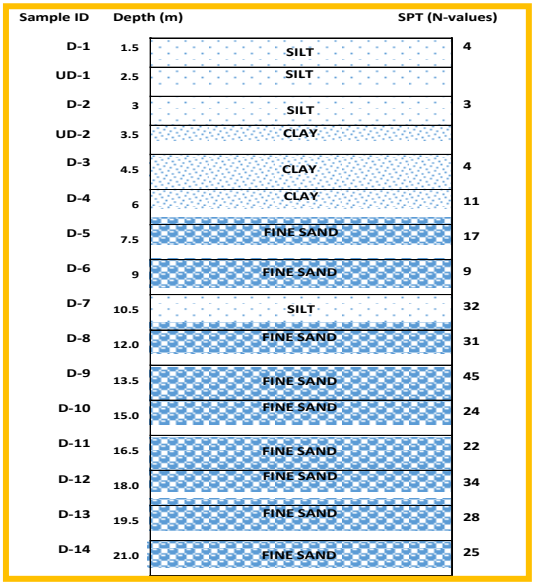
- Soil strength and its other parameters
- Geotechnical reasons of riverbank failure
- Concern to association with river engineering as a tool.

This research study has been undertaken during the fiscal year 2017-2018 and it is expected that it will be completed in the fiscal year 2018-2019. A seminar was held of this research work in June, 2018 at RRI. The following pictures show the field investigation for this research work.

Fig-2

Figure: Sample collection from study area

Figure: Ground Water level Measurement



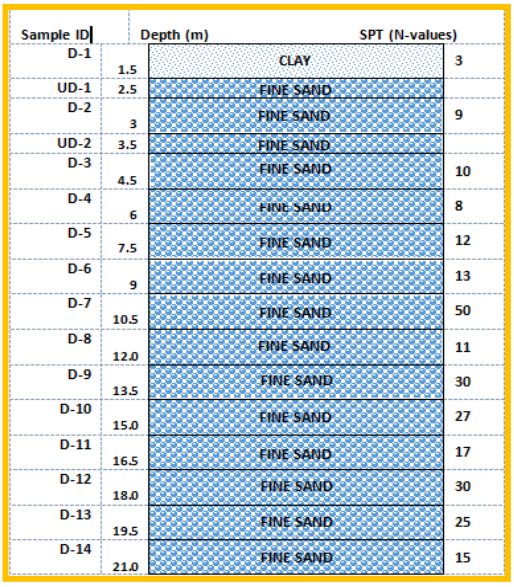


Figure: Showing the illustration of soil layer at Paturia side and Daulatdia side

The on-going laboratory soil tests have been shown in the following figures:

Figure: Determining settlement by Consolidation

Figure: Determining particle size by Hydrometer

(C) Development of Suitable Technologies for Removal of Manganese from Ground Water in Household, Community and Municipal Levels.

Manganese is an element essential to the proper functioning of both humans and animals, as it is required for the functioning of many cellular enzymes (e.g. manganese superoxide dismutase, pyruvate carboxylase) and can serve to activate many others (e.g. kinases, decarboxylases, transferases,hydrolases) (IPCS, 2002). At excessive concentrations manganese can be detrimental to health. Evidence from occupational exposure indicates that manganese can affect neurological function. The World Health Organization (WHO) has a provisional health based guideline value of 0.4 mg/l for manganese in drinking water (WHO, 2004) to protect against neurological damage. The WHO guideline value from consumer acceptability consideration is 0.10 mg/l (WHO, 1993). Bangladesh Standard for manganese in drinking water is also 0.10 mg/l.

Distributions of arsenic and manganese concentrations are not similar in groundwater of Bangladesh. Areas with low arsenic in groundwater have been found to contain high manganese concentrations, and vice versa. Nationwide about 32% of wells, which contain safe level of arsenic (i.e., < 0.05 mg/l) have been found to contain unsafe level of manganese (i.e., > 0.4 mg/l). This would significantly increase the population exposed to unsafe water, beyond that estimated for arsenic alone. Detection of high concentrations of manganese in groundwater has added a new dimension to the already difficult safe water supply scenario in Bangladesh. However, manganese issue has attracted relatively less attention, partly because ground waters high in Mn are often found to be high in Fe as well, and both result in a similar metallic taste (Mondol,2009; ITN-BUET, 2011). In RRI campus, there is only one drinking water tube well, which is thought to be the safe drinking water source in RRI campus and its surrounding areas .Hundreds of people collect water for their drinking purpose (also for commercial purpose) daily from this tube well. A recent test (December,2017) conducted by RRI Study Team showed that manganese concentration of this water (0.7 mg/l) exceeded the Bangladesh drinking water standard for Mn (0.1 mg/l) by seven times and WHO health based guideline value of 0.4 mg/l for manganese in drinking water for protect against neurological damage by about two times.

Considering the aforesaid problem RRI has taken this research project. The major objective of the research project is to develop suitable technologies and design modifications for manganese removal from ground water in household, community and municipal levels. The study was initiated in January, 2018 and the work is in progress in the present fiscal year. The tentative time frame and cost of the research project are two years long and TK 33,00,00.00 (Taka thirty three lakh only) respectively. It is expected that the project will be completed within December, 2019.

3.2 INSTITUTIONAL DEVELOPMENT AND CAPACITY BUILDING PROJECT (IDCBP)

Institutional Development and Capacity Building of River Research Institute (Phase-II)

River Research Institute (RRI) is a national organization in Bangladesh and working as a statutory public authority under the Ministry of Water Resources (MoWR), Government of the people's Republic of Bangladesh. Since its relocation to Faridpur in 1991 from Dhaka, RRI has got a big campus having model sheds, model beds, laboratory buildings, office buildings, workshops, residential colonies for officers and staffs, guest house, auditorium and ancillary structures like roads, utility services. Although these physical facilities have been good enough, nevertheless requires updating and replacement of old equipment to carry out multi-disciplinary research and tests in the field of River Hydraulics, Hydraulic Structures and Irrigation, Estuarine and Coastal Hydraulics, Soil Mechanics, Material Testing and Quality Control, Sediment Technology, Hydro-chemistry and Geo-Chemistry and Instrumentation.

RRI carries out tests, research and consultancy in the aforementioned fields using available testing and modelling facilities. Consultancy works and applied researches are being assigned to RRI by the local and foreign clients. In order to modernize the research facilities, RRI formulated and submitted a Development Project Proposal to the Ministry of Water Resources, Government of the People's Republic of Bangladesh in 2005. That project was approved for three years duration started from FY 2005- FY2008 and it was revised in 2008. But all equipment was not procured in time for many technical causes.

On the other hand, present equipment status is very much inadequate to meet up the present demand of the nation and to perform the activities in accordance with the mandate of RRI. In order to keep pace with modern research trend, more sophisticated instruments are needed. So, for the institutional development and capacity building it is necessary to procure new equipment along with replacement of old machineries, maintenance and construction of new research laboratory and repair of existing old buildings. For the continuation of the development of RRI the ongoing development project proposal was submitted in 2017 and was approved in 2018. The overall objective of this project is to enhance and update of Geotechnical research laboratory facilities as well as physical and mathematical modelling facilities to conduct test and research in the field of water resources engineering in accordance with RRI's mandate. The specific goal of the project is to procure necessary equipment for the overall institutional development and strengthening of RRI research capability as well as to develop human resources. It is also essential to train up RRI scientists to utilize full potential of the sophisticated high-quality instruments. Considering the above mentioned needs, the Government of Bangladesh has approved this development project with a project value of 4762.29 lakh BDT. The duration of the project is from January 2018 to July 2021.

Upon completion of this project, RRI in future will be the leading national Institute to contribute meaningfully to the sustainable Water Resources Development Projects in Bangladesh and RRI will develop itself as a self-earning institute under the Ministry of water Resources. RRI would be in a position to take up all sorts of test and researches pertaining to the overall water resources development of the country. The implementation of the project schemes is in progress in the present fiscal year.

3.3 PILOT PROJECT

River Bank Erosion is a common phenomenon in Bangladesh. Almost, every year, the complicated river network of Bangladesh experiences severe bank erosion all over the country. Changing climate has further aggravated the situation by introducing extreme events such as flash flood, intense precipitation and abnormality in precipitation pattern recurrently. Climate Change driven flash flood and excessive sedimentation in the river bed has caused severe bank erosion in the project locations. Thousands of hectares of agricultural land and household areas are already engulfed by the river bank erosion. Therefore, it is essential to address the bank erosion phenomenon and find out economical, sustainable and eco-friendly way to combat erosion and save life and livelihood of the rural people of Bangladesh. However, flood control , river bank protection and sediment management consume large amount of government expenditure. Considering this issue, RRI has conducted laboratory-based study to investigate the effectiveness of bamboo bandalling structures to protect the river bank erosion and increase of channel navigability. Laboratory based study suggest that, low cost bamboo bandaling structures could be an effective solution to combat bank erosion in small to medium size river having low flow/velocity and less meandering characteristics. Laboratory based research also suggest that:

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- Bandals are less expensive solution for the above mentioned problems over conventional methods.
- Bandals lateral interventions can be extended gradually that can be possible using conventional structures, such as groynes and revetments
- Bandals protect river bank erosion through controlling of river flow
- Bandals increase navigational channel depth
- Bandals reclaim river bank land
- Bandals are eco-friendly

The research-based findings encouraged the River Research Institute to formulate the following two pilot projects in 2016-2017 fiscal year which will be completed during the financial year 2018-2019. The progress of the project (A) up to June 30, 2018 is 93.93 % and the progress of the project (B) is 77.65%. Bandals constructed in the above projects are working effectively by reclaiming land, bank protection and channel deepening.

(A) Pilot Project for the River Bank Erosion of different location in the Jamalpur and Sherpur District.

(B) The Pilot Project of the Bamboo Bandalling Structures for protection from the erosion of the Old Brahmaputra, the Dasani river at Jamalpur Sadar, Mandah and Islampur Upazilla of the Jamalpur District.

The research-based findings encouraged the River Research Institute to formulate the following pilot project (C) to prevent bank erosion in the Rowmari Upazila which situated in the bank of branch channel of Brahmaputra river. The main purpose of the project is to construct 4.9 km Bamboo Bandalling structures in the left and right bank of the branch channel of Brahamaputra river in Rowmari and Fularchar upazila of Kurigram District. The total cost of the project is 200.00 lakh BDT. Bangladesh Climate Change Trust Fund (BCCTF) is financing the project. RRI has taken up the following pilot project (C) in 2017-2018 fiscal year. The implementation of the schemes is in progress in the present fiscal year.

(C) Pilot Project to protect bank erosion and land reclamation in Rowmari and Fularchar Upazila and its surrounding areas under Kurigram district.

(D) The Pilot Project in different areas of Bangladesh using Bamboo Bandalling Structures to reduce river bank erosion, land reclamation and increase navigation.

RRI has taken up a 04 (four) year long (FY 2017-18 to 2020-21) pilot project (D) entitled "The Pilot Project in different areas of Bangladesh using Bamboo Bundling Structures to reduce river bank erosion, land reclamation and increase navigation". It is a GoB funded project with a financial worth BDT 2384.47 lakh. Under this project 47 km bamboo bandalling structures will be constructed at different rivers in seven districts namely Barishal, Khulna, Faridpur, Rajbari, Sirajgonj, Netrokona and Mymensingh. The districts excerpted earlier have tidal, non tidal and flashy rivers. These districts have been chosen so as to examine the effectiveness bandal structures in three types of rivers. The objectives of the project are as follows:

- to reduce river bank erosion;
- to reduce sedimentation in river bed;
- to increase navigational capacity of river;
- to protect environmental and social disaster by hindering river bank erosion;
- land reclamation;
- to develop construction manual for Bamboo Bandalling structures;

The pilot project has a research part comprising of RRI Scientists and consultants. RRI will develop a manual for Bamboo Bandalling structures from the research findings.

Out of 25 packages of (20 Bandalling construction+ 05 hydro-biological survey works), 07 packages have been tendered. Two work orders relating to hydro-biological survey works have been issued to eligible contractor after completing all due processes. Tender evaluation of 05 Bandalling construction packages is being continued. Tender process for other packages will be begun within shortest possible time. A seminar was held of this project in June, 2018 at RRI.

Figure: seminar on "The pilot project in different areas of Bangladesh using Bamboo bandalling structures" held at RRI

4 HUMAN RESOURCES DEVELOPMENT

RRI has been putting special emphasis to human resources development since its establishment in order to achieve its goals as mandated by the Government of the People's Republic of Bangladesh. Scientists and engineers are working at RRI whose efforts are being put with a view to reach the research standard through innovation of new technologies and ideas in the related fields of activities. RRI is a relatively new organisation of this kind of research in the country. As the technologies of the disciplines concerned are fast developing, the necessity of higher studies and advanced on the job training of the research personnel in the academic and research institutions of similar activities at home and abroad (especially in developed countries) has strongly been highlighted in order that it can keep them abreast of the latest development in the related fields of research. Some of the RRI personnel attended higher studies and training program both at home and abroad.

Figure: E-filing management training program where DG, RRI as chief guest along with RRI Officials.

RRI conducted two training programs (each three day long) for skill development of its scientists and engineers during the 2017-18 fiscal year in the month of June, 2018 and these programs were organized under Institutional Development and Capacity Building Project (IDCB-2) for River Research Institute (RRI), Faridpur. The venue for these training programs was RRI conference room. Almost all scientists and officers took part in these training programs. The title of the first and second training programs was "Physical and Mathematical Modeling aspect of all the process in Hydrological Cycle" and "Storm Water Management Modeling (GeoSWMM) " respectively. Prior to this, RRI conducted two in-house trainings (each two day long) for skill development of its all Officers in the month of October, 2017 and February, 2018 and these training programs were organized by RRI and held at RRI in collaboration with a2i project under Prime Minister's Office. The title of these training programs was "Training workshop regarding Innovation in public service" and "e-filing training management".

RRI specialists also took part in trainings organized by different organizations as trainer in the field of river hydraulics and morphology, navigation, hydraulic modelling, bridge hydraulics etc. Besides, some training has been imparted to RRI officials and staffs of different categories on group basis. The name of the persons took part in seminar, conference; workshop and training (out side of RRI) during the year 2017-2018 are mentioned below.

Figure: A view of Training Workshop on Innovation in Public Service where Ex DG, RRI is delivering his speech as chief guest along with Current DG, RRI and Trainers.

Table 4.1: Persons attended in higher studies, seminar, conference, workshop and training in the fiscal year 2017-18

SL. No.	Name & Designation	Name of Course/Seminar/ Workshop	Course Period (Date)
1	Mr. Arun Chandra Mahottam (Deputy Secretary) Director General (In Charge)	EFCC CIP utilization Workshops Ministry of Environment and Forests, Dhaka.	23.04.2018
2	Dr. Engr. Md. Lutfor Rahman Director, Hydraulic Research	Workshop on 37th IAHR World Congress 2017 (International Hydro-Environment Engineering and Research World Congress 2017) Malaysia.	13.08.17 to 18.08.17
		4th International Conference on Ocean Engineering, India.	18.02.18 to 21.02.18
3	Engr. Pintu Kanungoe, Chief Scientific Officer	Rural and Urban Polder Development in Coastal Areas, Yangon, Myanmar.	21.8.17 to 25.8.17
4	Engr. Md. Azizul Haque Podder, Principal Seientific Officer	Flood Control Technology, China.	23.11.17 to 02.12.17

SL. No.	Name & Designation	Name of Course/Seminar/ Workshop	Course Period (Date)
5	Engr. Md. Alauddin Hossain Principal Scientific Officer	National Seminar on "Digital Technology for Transforming Bangladesh into Middle Income Country" organized by Institution of Engineers, Bangladesh (IEB) held at IEB Khulna Center, Khulna.	03.02.18 to 05.02.18
6	Dr. Engr. Moniruzzaman Khan Eusufzai Senior Scientific Officer	e-GP PE User Module Course, Planning Commission, Dhaka.	22.04.18 to 24.04.18
7	Engr. Shailen Kumer Ghosh, Senior Scientific Officer	e-GP PE User Module Course, Planning Commission, Dhaka.	22.04.18 to 24.04.18
8	Engr. Md. Johurul Islam, Senior Scientific Officer	e-GP PE User Module Course, Planning Commission, Dhaka.	22.04.18 to 24.04.18
9	Md. Dulal Bawali, Senior Scientific Officer (In charge)	Public Relations, Media and Communications Techniques. Bangladesh Institute of Journalism and Electronics Media, Dhaka.	24.11.17 to 26.11.17
10	Engr. Md. Tofiquzzaman, Scientific Officer	PPR-2008 and Annual Procurement Planning, Bangladesh Institute of Management, Dhaka.	21.01.18 to 25.01.18
11	Nayan Chandra Ghosh Scientific Officer	e-GP PE User Module Course, Planning Commission, Dhaka.	22.04.18 to 24.04.18
12	Engr. Md. Shahabuddin Scientific Officer	e-GP PE User Module Course, Planning Commission, Dhaka.	22.04.18 to 24.04.18
13	Md. Moniruzzman Scientific Officer	Arc GIS I: Fundamental on GIS, organized by University of Dhaka, Department of Geography and Environment.	18.08.17 to 07.10.17 Every Fariday & Saturday
14	Engr. Md. Nefaur Rahman Scientific Officer	Documentation and Dissemination of Innovation Workshop.	04.10.17 to 08.10.17 25.02.18 to 26.02.18
15	Engr. Taznin Naher Scientific Officer	Arc GIS I: Fundamental on GIS, organized by University of Dhaka, Department of Geography and Environment.	18.08.17 to 07.10.17 Every Fariday & Saturday
16	Engr. Emran Ail Mondal Scientific Officer	EFCC CIP utilization Workshops Ministry of Environment and Forests, Dhaka.	23.04.2018
17	Engr. Bikash Roy Scientific Officer	EFCC CIP utilization Workshops Ministry of Environment and Forests, Dhaka.	23.04.2018
18	Engr. Md. Masuduzzaman Assistant Programmer	Documentation and Dissemination of Innovation Workshop.	04.10.17 to 08.10.17 25.02.18 to 26.02.18
		Microsoft Project Course, National Planning Development Commission, Dhaka.	15.10.17 to 19.10.17
19	Md. Jahangir Alam, Accounts Officer	Effective Budget & Budgetary Control, BIM, Dhaka.	08.10.17 to 12.10.17

SL. No.	Name & Designation	Name of Course/Seminar/ Workshop	Course Period (Date)
20	Md. Hafizul Islam Computer Operator	Basic Financial Management Course, RPATC, Dhaka	11.02.18 to 15.02.18
21	Md. Naymur Rahman Computer Operator	Basic Office Management Course, RPATC, Dhaka	15.04.18 to 03.05.18

Figure: A view of e-filing Management Training Program organized by ICT Cell at RRI with collaboration of a2i project under Prime Minister's Office.

5 FINANCIAL MANAGEMENT

River Research Institute is a national organization having mandate of a statutory Public Authority under the Ministry of Water Resources, Government of the People's Republic of Bangladesh. The annual expenses are being borne by its own income and some grant from the Government revenue budget. The main sources of RRI's own income are revenue received from model studies (physical and mathematical model), and geo-technical testing fee (testing of soil, concrete, water and sediment sample). Detailed budgetary information (income and expenditure) for the fiscal year 2017-2018 and 2016-2017 is given below:

Income and Expenditure account for the fiscal year 2017-2018

Income		**Expenditure**	
Items	Taka (Lakh)	Items (Lakh)	Taka (Lakh)
Government grant	1376.60	Establishment: • Officers salary 223.86 • Staff salary 342.49 • Allowances 530.03 • Supply and services 193.32 • Repair & maintenance 52.22 • Capital expenditure 28.30 • Estab. cost by own fund -	1370.22
Model study	395.51	Model study	260.51
Geotechnical testing fee	31.42	Geotechnical testing	15.60
Others	27.57	Refund of non-expended money	6.38
Total	1831.10	Surplus (+)	178.39
		Total	1831.10

Income and Expenditure account for the fiscal year 2016-2017

Income		**Expenditure**	
Items	Taka (Lakh)	Items	Taka (Lakh)
Govt. grant	1245.00	Establishment: • Officers salary 224.07 • Staff salary 335.71 • Allowances 456.10 • Supply and services 180.17 • Repair & maintenance 36.99 • Capital expenditure 11.96 • Estab. cost by own fund 45.57	1290.57
Model study	274.78	Model study	165.95
Geotechnical testing fee	41.73	Geotechnical testing	20.54
Others	20.47	Refund of non-expended money	-
Total	1581.98	Surplus (+)	104.92
		Total	1581.98

The income and expenditure account for the fiscal year 2017-2018 is presented below as pie chart:

The income and expenditure account for the fiscal year 2017-2018 is presented below as pie chart:

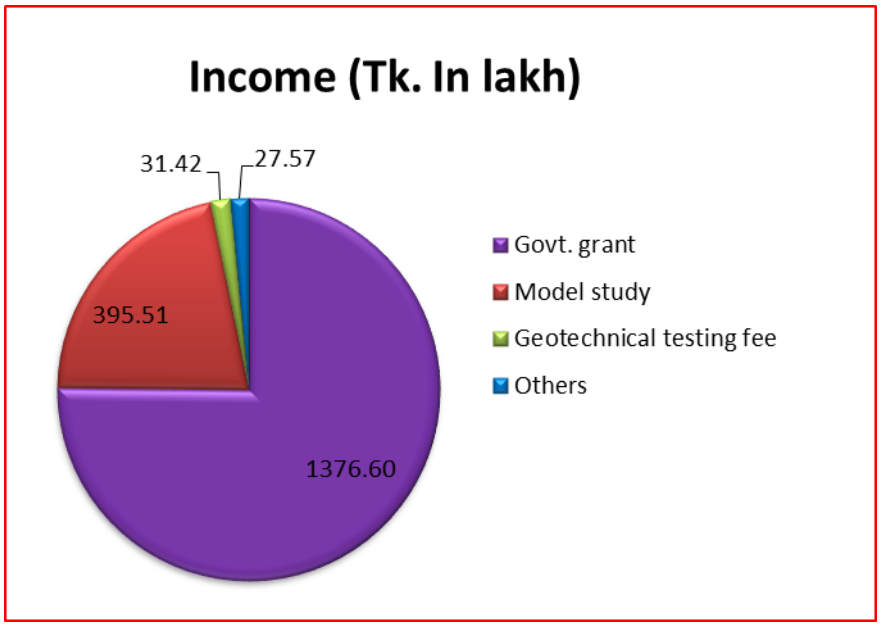


Figure: Income chart for the year ended on June 30, 2018

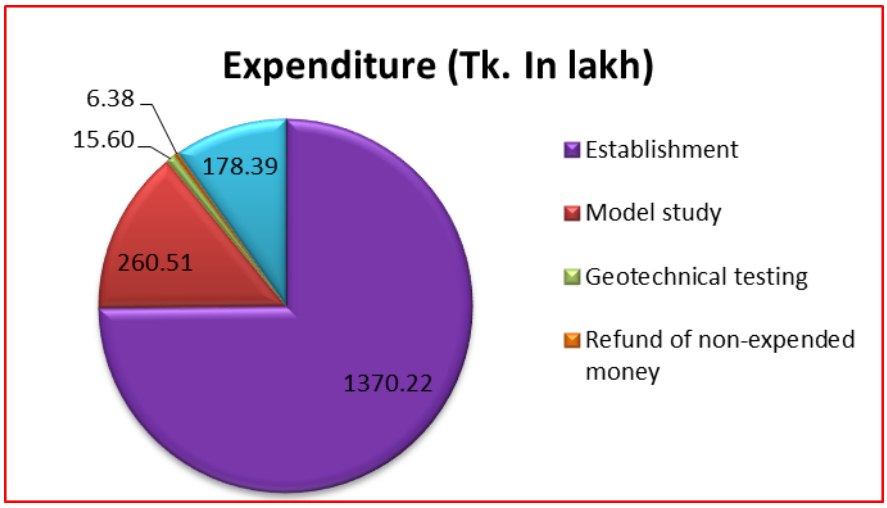


Figure: Expenditure chart for the year ended on June 30, 2018

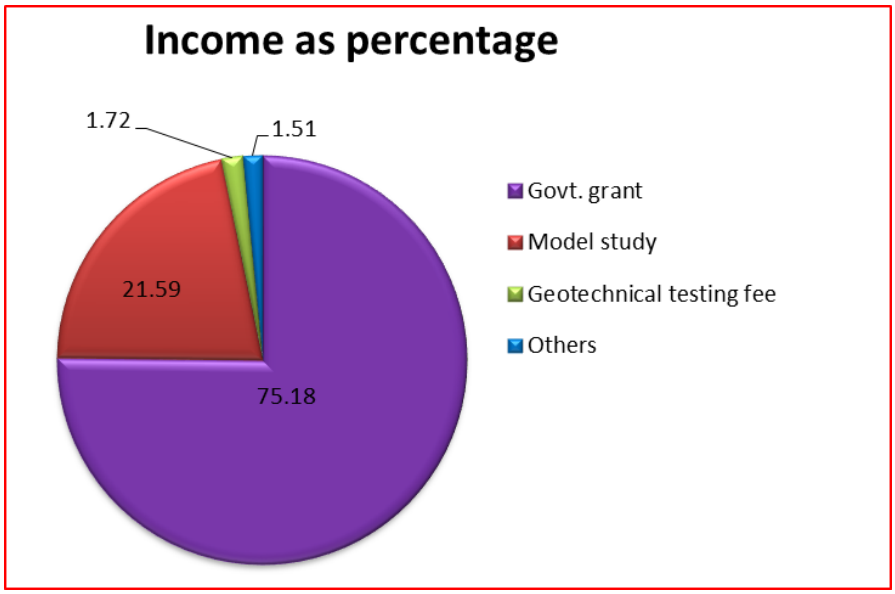


Figure: Chart showing income percentage for the year ended on June 30, 2018

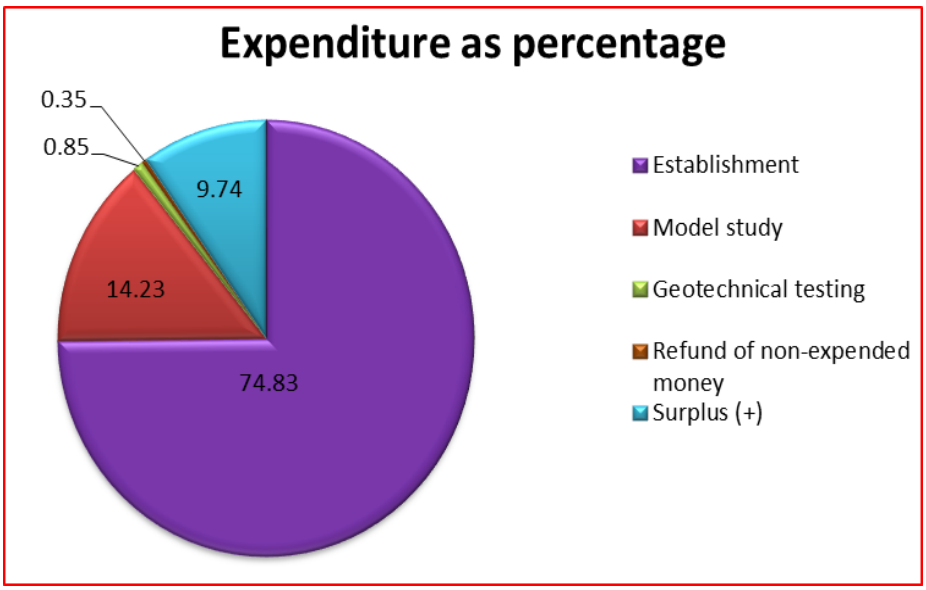


Figure: Chart showing expenditure percentage for the year ended June 30, 2018

The income and expenditure account for the fiscal year 2016-2017 is also presented below as pie chart:

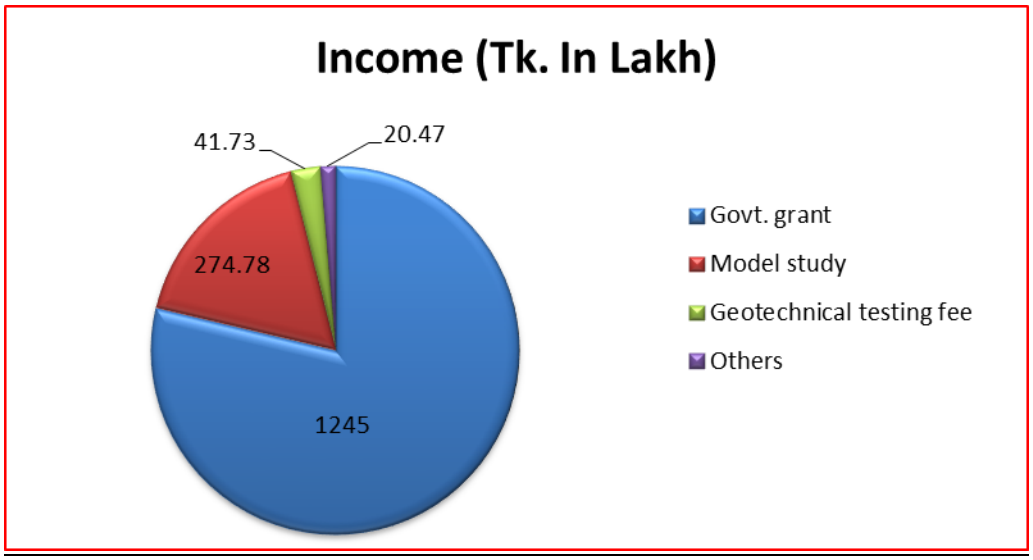


Figure: Income chart for the year ended on June 30, 2017

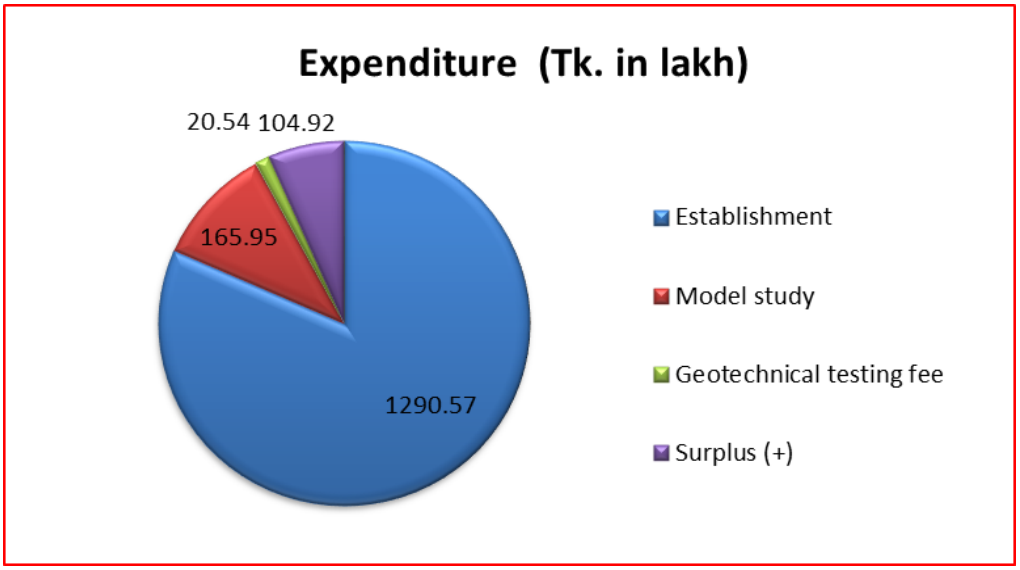


Figure: Expenditure chart for the year ended on June 30, 2017

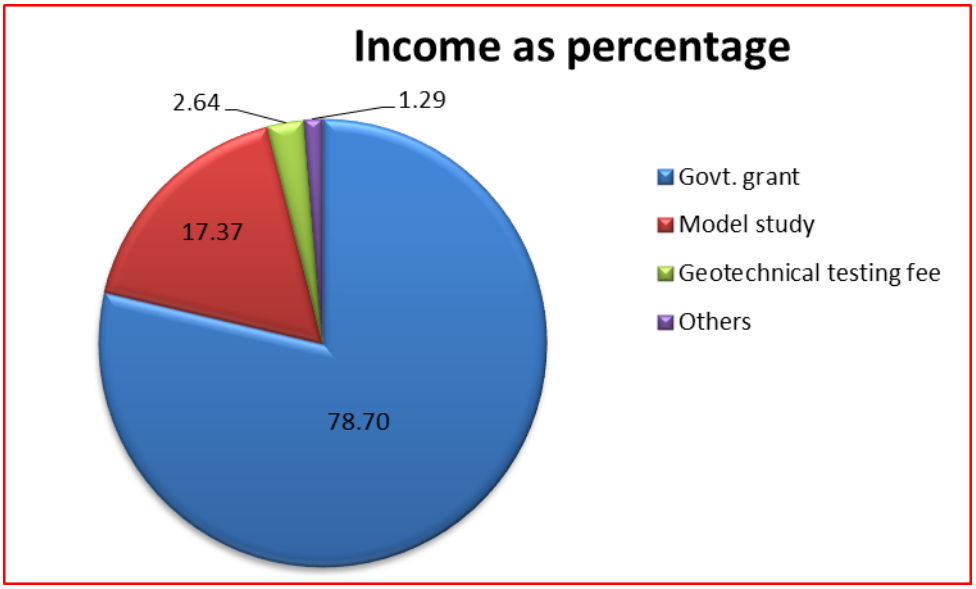


Figure: Chart showing income percentage for the year ended June 30, 2017

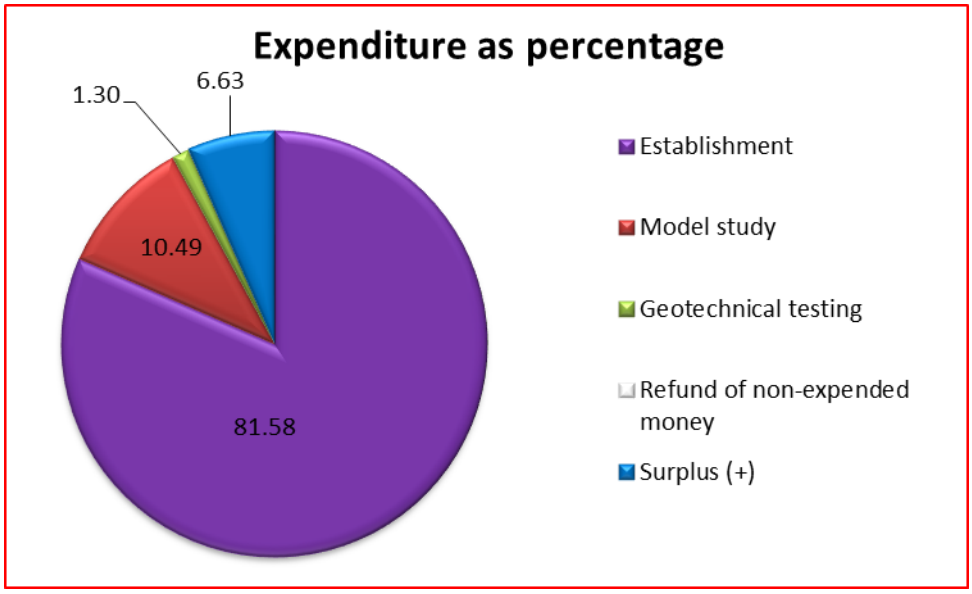


Figure: Chart showing expenditure percentage for the year ended June 30, 2017

Significant features of RRI's income, expenditure and closing balance in recent years (last 5 years) are given below in Table 5.1, Table 5.2 and Table 5.3 respectively.

Table 5.1: Income statement

Sl. No.	Sources of income	Total (Tk. in lakh)				
		2013-2014	2014-2015	2015-2016	2016-2017	2017-2018
1	Model study & geo-technical testing fee	191.25	116.92	71.33	316.51	426.93
2	Govt. grant	700.61	840.00	1071.32	1245.00	1376.60
3	Others	10.97	10.98	22.11	20.47	27.57
Total		902.83	967.90	1164.76	1581.98	1831.10

The above income statement is also presented below as pie chart.

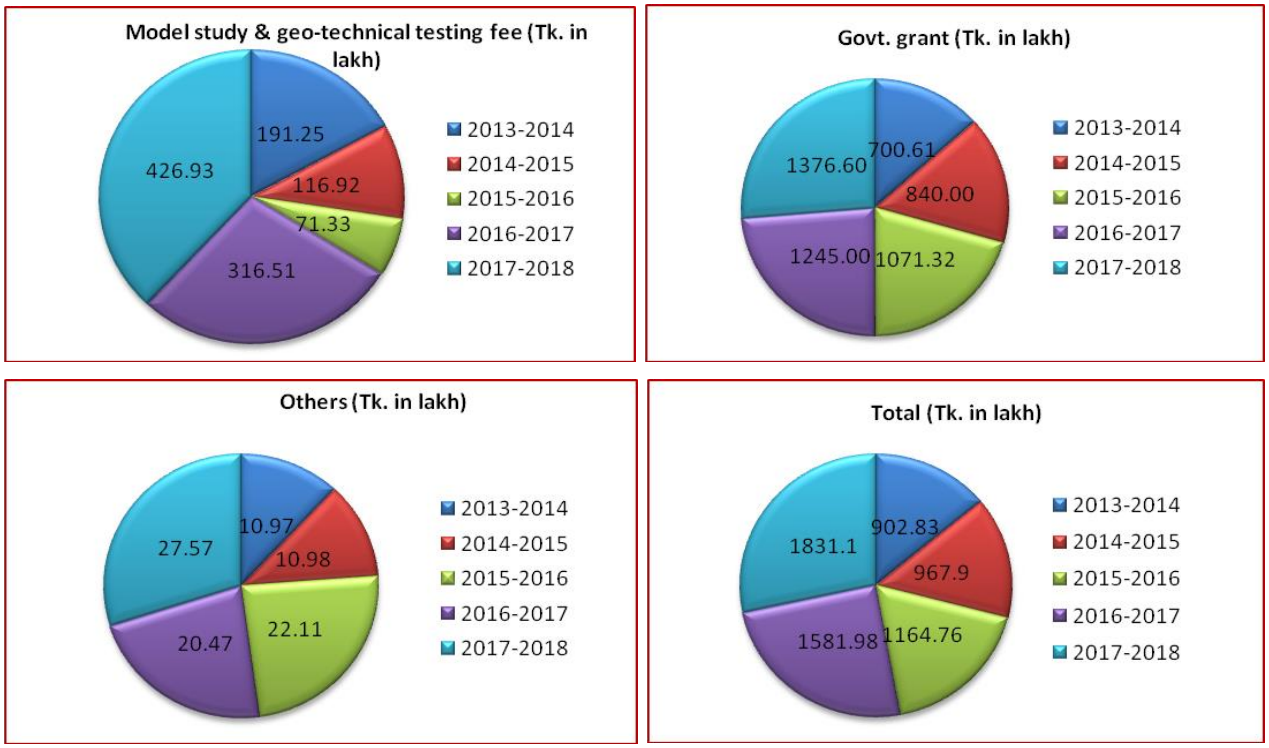


Figure: Income statement chart

Table5.2: Expenditure statement

Sl. No.	Description	Total (Tk. in lakh) 2013-2014	2014-2015	2015-2016	2016-2017	2017-2018
1	Model study and Geo-technical testing.	124.81	67.53	40.08	186.49	276.11
2	Establishment	730.42	835.27	1089.66	1290.57	1370.22
3	Refund of non-expended money	-	4.73	-	-	6.38
Total		855.23	907.53	1129.74	1477.06	1652.71

The above expenditure statement is also presented below as pie chart:

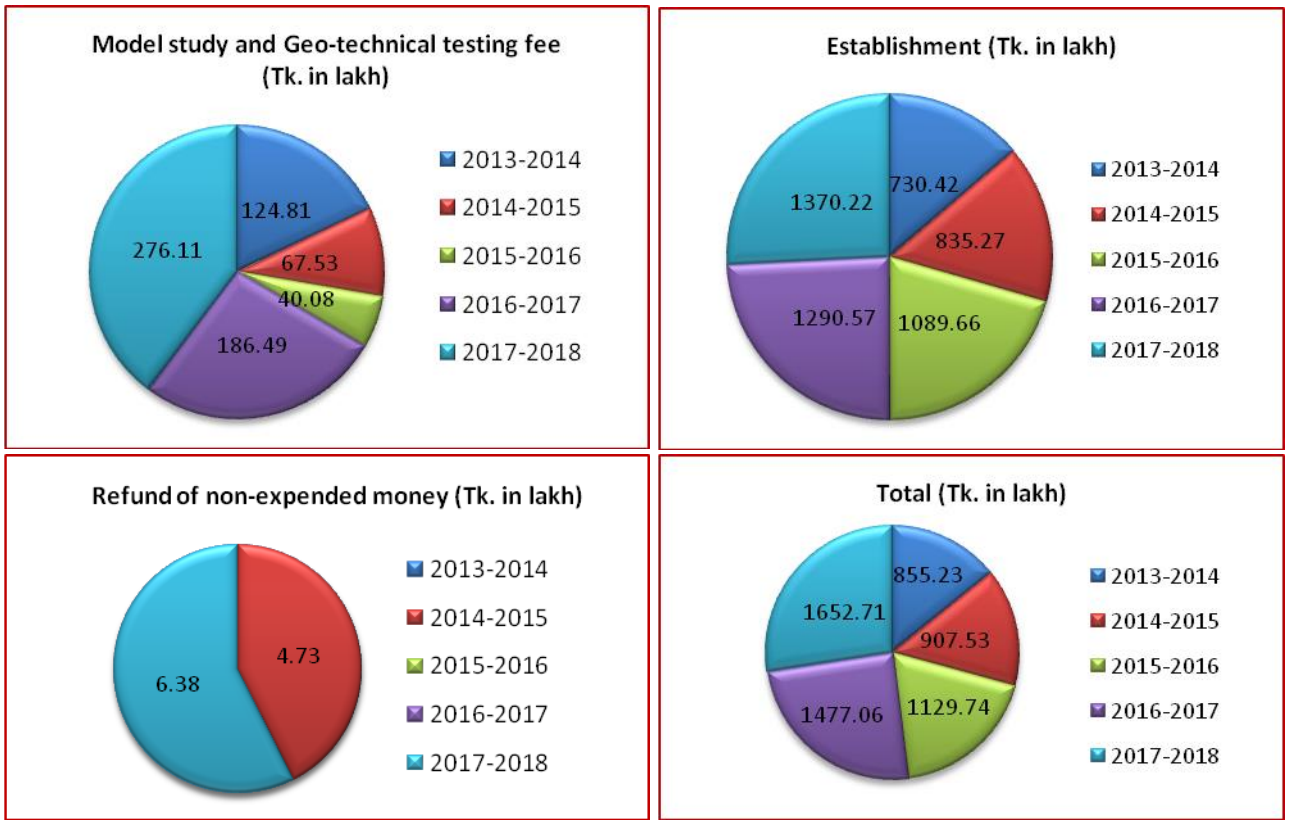


Figure: Expenditure statement chart

Table 5.3: Closing balance

Sl. No.	Description	Total (Tk. in lakh)				
		2013-2014	2014-2015	2015-2016	2016-2017	2017-2018
1	Closing balance on the basis of self income and govt. grant	(+) 47.60	(+) 60.37	(+) 35.02	(+) 104.92	(+) 178.39

NB: (+) indicates surplus.

The above closing balance is also presented below as pie chart.

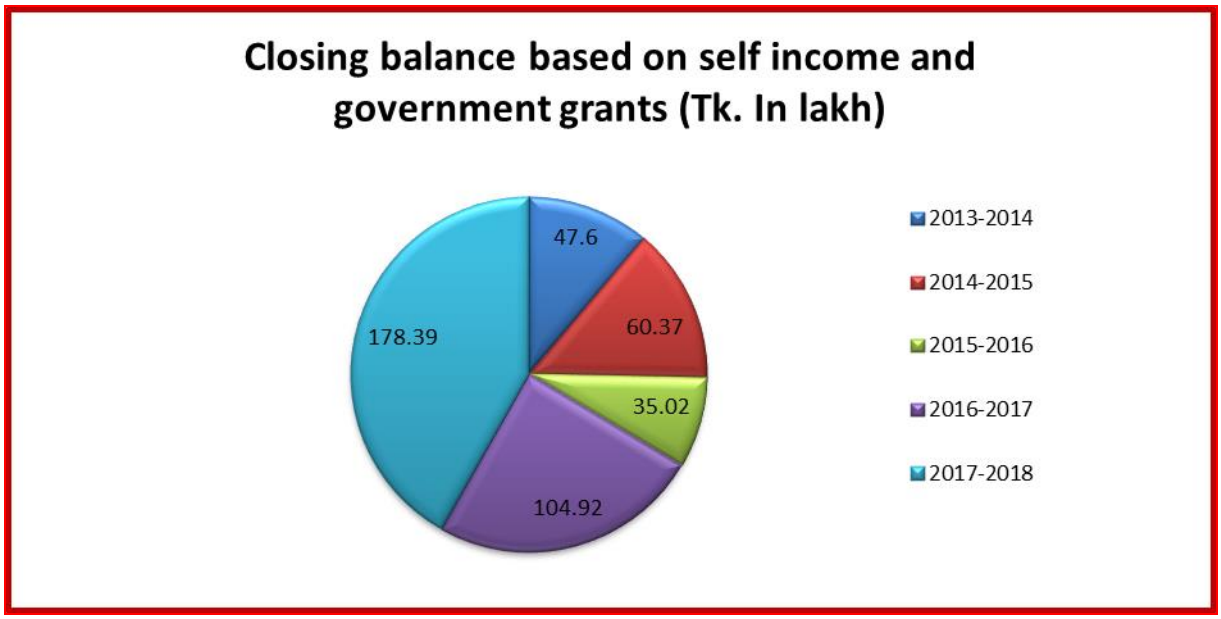


Figure: Closing balance chart

6 INVENTORY OF PROJECTS WITH REVENUE RECEIVED

Here the revenue earned from the model studies completed by Hydraulic Research Directorate and revenue earned from the sample test conducted by Geotechnical Research Directorate is described in the following section.

HYDRAULIC RESEARCH DIRECTORATE

In the fiscal year 2017-18, Hydraulic Research Directorate has received revenue for five physical model studies. Partial money was received against three physical models. The name of the models with estimated cost and money received is shown in **Table 6.1**.

Table 6.1: Name of the models with estimated cost and money received

Sl. No.	Name of the model	Total estimated cost (Tk in lakh)	Money received during 2017-18 (Tk in lakh)	Remarks
1	Physical model study for supporting design of the proposed Bangabandhu Railway Bridge over the river Jamuna	350.00	175.27	Completed
2	Laboratory Based Study using Physical Modelling on River Bank Erosion Control using Concrete Block Mats and Placed Concrete Blocks with Filter on the Arial Khan River at Madaripur	74.73	58.32	Completed
3	Physical Model Investigation for Sustainability of the Buriganga River Restoration Project	95.00	-	
4	Preservation and maintenance of the east guide bund (EGB) sectional model	180.00	-	Ongoing
5	Physical Model Study for Padma River Dredging Management in Jajira and Naria Upazilla under Shariatpur District	199.39	29.11	Ongoing
Total		899.12	262.7	

GEOTECHNICAL RESEARCH DIRECTORATE

During the fiscal year 2017-18, volume of works done and revenue earned by Geotechnical Research Directorate have been shown in Table 6.2.

Table 6.2: Volume of works done and revenue earned during the fiscal year 2017-18

Sl. No.	Name of the discipline	Total nos. of samples tested	Total billed (Tk. in lakh)	Money received (Tk. in lakh)
1	Soil Mechanics & Ground Water Eastern & Western Zone.	Disturbed-1065 Undisturbed-00	36.36791	31.86051
2	Material Testing and Quality Control.	112	2.22085	2.22085
3	Sediment, Chemical and Water Pollution.	536	2.07	1.86
	Total	1713	40.65876	35.94136

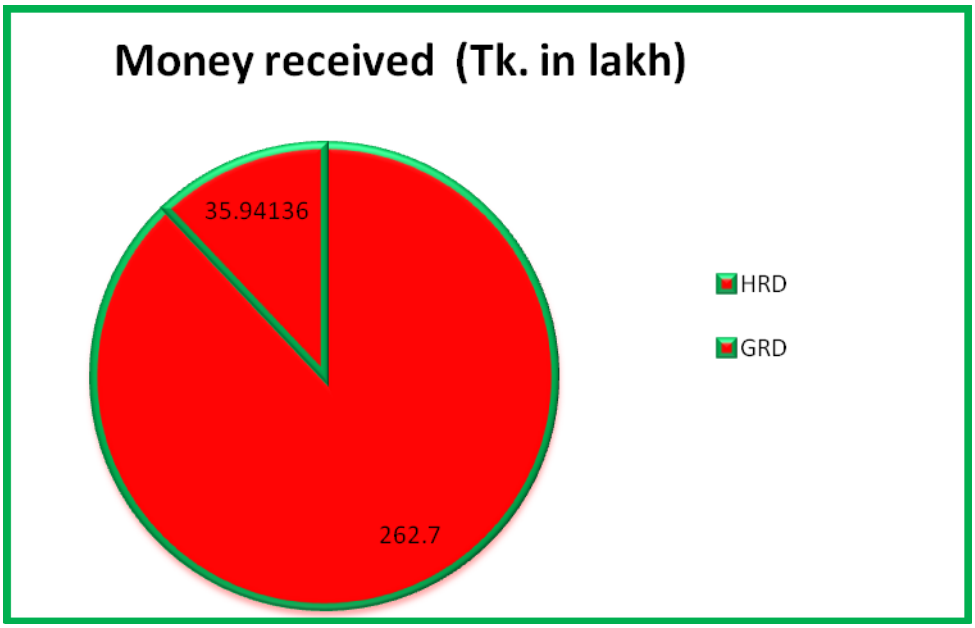


Figure: Money received by HRD and GRD in 2017-2018 fiscal year.

7. FUTURE DEVELOPMENT PROSPECTS

Since its establishment as a national organization with distinct mandates for rendering services to deal with river related problems and to devise economic and sustainable solutions to the problem RRI has been discharging its responsibilities using established facilities and available man power. At the beginning, the main focus was physical modelling and soil and material testing mainly to support planning and design of different water infrastructures and Bangladesh Water Development Board (BWDB) was the main client. With the passage of time physical modelling technology has been applied to address wide range of river related issues namely sediment management at the off-take, river restoration, bridge and barrage hydraulics, river dredging etc. However, the application of physical modelling technology was very limited for tidal and coastal systems due to lack of required modelling facilities. In order to disseminate the study findings RRI has been publishing a technical journal almost every year since 1992. This journal contains research papers of different authors from different organizations on topics related to RRI area of activities. In order to meet the growing need for comprehensive and multidisciplinary studies RRI adopted mathematical modelling technology in 2007 as a tool for conducting model studies side by side physical modelling technology. At the same time a number of RRI engineers and scientists pursued higher education in different disciplines and many of them are trained at home and abroad to enable RRI to carry out multidisciplinary studies. Under an institutional development and capacity building project a number of sophisticated equipment were procured to upgrade testing facilities. However, some facilities are yet to be established to carry out all mandated activities as well as to deal with new challenges and emerging issues in water sector. With this end in view the second phase of institutional development and capacity building project has begun in the financial year 2017-18.

For RRI to function as a pioneering organization in water sector and to cope with the increasing demand of the time in the competitive market; institutional development, instrumentation, sustainable technology and highly trained manpower are very essential to enhance the standard of service to international level. From this point of view the following future development prospects are important to be mentioned:

- Now-a-days, Information Technology (IT) has become a very useful tool for research and studies, sound management and transparent administration in the world. RRI has to encounter this new challenge to meet the demand for quality services.

- RRI has already established a network system by connecting all the activities of this institute. For this RRI has completed all the installations and collected software, hardware and networking components required. By this time, LAN is working at RRI. A complete wing (manpower & logistics) wing will be required to govern the IT sector in RRI.

- Two Material Testing and Quality Control field laboratories at Bogra and Barisal have already been established. A liaison office is situated at 72, Green Road, Dhaka. In the liaison office soil, building materials, sediment & water samples are being received from BWDB and other Govt, Semi-Govt, NGOs and consulting firms. There is system for bringing the collected samples to RRI headquarter in Faridpur within a short period of time to complete the tests in due time. The test results are furnished to the clients in report form to execute the work of the projects in scheduled time. RRI is contemplating to establish field laboratory in all district headquarters of the country to make its services easily available.
- RRI has already established well-equipped Math Model LAB with internet facilities and uninterrupted power supply required to support mathematical modelling. However, existing

facilities need to be expanded and upgraded by purchasing more computers and accessories, installing updated modelling softwares, introducing modelling in new areas and imparting training to the modellers. Some of the needs are expected to be fulfilled under the ongoing IDCB project. It is understood that in order to further expand the RRI mathematical modelling services a full-fledged Math Model LAB has to be established in Dhaka.

- RRI successfully completed the physical model studies of some of the biggest projects of Bangladesh namely Bangabandhu Railway Bridge Project, Paira Bridge Project, Bangabandhu Bridge Project, Padma Multipurpose Bridge Project, Ganges Barrage Project, Gorai River Restoration Project, Arial Khan Roadway Bridge Project, 3rd KarnafullyRoadway Bridge Project, Kushtia Town Protection Project etc. However, due to lack of needed facilities RRI could not do much in physical modelling of coastal systems. Initiatives have already been taken to establish the tidal and coastal modelling facilities and to train scientists in this field.

- RRI may act as a focal institution of its peripheral region to investigate regional water resources problems. A monitoring cell may be established at RRI to monitor the natural hazards like flood, draught, bank erosion, earthquake etc. As a focal institution, RRI may provide consultancy services to the Government, Local Authority of any organizations or may directly advise the beneficiaries to take precautionary measures against those hazards.

- RRI is working in collaboration with BUET and is willing to work with similar foreign institutions like CWPRS (India), DHI (Denmark), Delft Hydraulics (The Netherlands), HR Wallingford (UK), NHC (Canada), SMEC (Australia), LHI (Sri Lanka) etc. Efforts are being made by RRI to start joint venture/bi-lateral study/research projects with these similar international institutions.

- More opportunities should be extended for RRI research personnel for imparting higher studies leading to MS/Ph D degree and other advanced on-job training. There should also have enough scope for RRI officials to participate in the national/international seminar, symposium, congress, workshop etc.

- It can be mentioned here that though RRI is primarily catering the needs for national agencies, with the gradual development of manpower and technology, the institute will fulfil the demands for international bodies and organizations in future.

Figure: DG RRI with RRI Junior Officials at Information Fare in Faridpur District.

Annex I

PERSONNEL OF RRI

List of the Existing Scientific, Administrative and Supporting Managerial Personnel of RRI

(As on November 2018)

Sl. No.	Name of Officer	Designation & Contact Information	Qualification	Photo
1	Arun Chandra Mahottam (Deputy Secretary)	Director General (In charge) mahottam@yahoo.com	M.S.S. (Social Welfare), ISWR, DU, Dhaka	
2	Dr. Engr. Md. Lutfor Rahman	Director (Hydraulic Research) mdlutforrahman10@yahoo.com	B.Sc.Engg. (Civil), BUET, PGD (Env. Water) in UK, M.Engg. (WRE), BUET, Ph. D, DUET; Life F-IEB, M-BCS, M-BAAS, Life M-NOAA, Life M-SH.	
3	Engr. Swapan Kumar Das	Director (In charge) **swapanwre@gmail.com**	B.Sc.Engg. (Civil),Engineering College, Khulna, M.Engg. (WRE), BUET; PGT in IHE, Delft, The Netherlands, India & Canada; F-IEB.	
4	Engr. Pintu Kanungoe	Chief Scientific Officer **pintu_kanungoe@yahoo.com**	B.Sc. Engg. (Civil), BUET, M.Engg. (Hydraulic Engg.), IHE, Delft, The Netherlands; PGT in Nepal, The Netherlands, Myanmar and Indonesia; F-IEB.	
5	Engr. Kazi Rezaul Karim	Chief Scientific Officer **razu6511@yahoo.com**	B.Sc. Engg. (Civil), BUET, PGD (Hydrology), Belgium.	
6	Uma Saha	Principal Scientific Officer **umasaha_65@yahoo.com**	B.Sc. (Hons), M.Sc. (Physics), JU, MBA (MIS), PU; PGT in The Netherlands, Malaysia & India; LM-BPS.	
7	Sheela Rani Chowdhury	Principal Scientific Officer **sheela_chowdhury@yahoo.com**	B.Sc. (Hons), M.Sc. (Physics), RU; PGT in The Netherlands & India; LM-BPS.	
8	Engr. A. K. M. Ashrafuzzaman	Principal Scientific Officer ashrafcebuet89@gmail.com	B.Sc. Engg. (Civil), BUET, M. Engg. (Water Resources), BUET; M. Sc. (Hydrology & Water Resources), IHE, Delft, The Netherlands; PGT in IIT, Roorkee, India, Trained in BPATC; F-IEB.	
9	Engr. Md. Abul Ala Moududi	Principal Scientific Officer moududi80@yahoo.com **moududi78@gmail.com**	B.Sc. Engg. (Agril), BAU, Mymensingh, M. Engg. (WRE), BUET; PGT in IHE, Delft, The Netherlands, Trained in BUET; F-IEB.	

Sl. No.	Name of Officer	Designation & Contact Information	Qualification	Photo
10	Engr. Md. Azizul Haque Podder	Principal Scientific Officer **mdazizul66@yahoo.com**	B.Sc .Engg. (Agril), BAU, M.Sc. (WRS), ITC, The Netherlands; F-IEB.	
11*	Engr. Syed Md. Anwaruzzaman	Principal Scientific Officer anwaruzzaman1968@gmail.com	B.Sc .Engg. (Agril), Gold Medalist, BAU, M. Engg. (WRE), BUET; Trained in IEB, BPATC, RPATC& BIM; F-IEB, M-KIB & MBSAE.	
12	Engr. Md. Matiar Rahman Mondol	Principal Scientific Officer mrmondol68@gmail.com	B.Sc. Engg. (Civil), BUET, M.Sc. Engg. (Civil & Environmental Engg.), BUET, Trained in RPATC; F-IEB.	
13	Engr. Md. Alauddin Hossain	Principal Scientific Officer alauddin_1968@yahoo.co.uk babulala68@gmail.com	B.Sc. Engg. (Agril), BAU, Mymensingh, M. Engg. (WRM), UNESCO-IHE, Delft, The Netherlands; PGT in IRBM (China), Building Flood Disaster Resilience of cities (Nepal), River Delta Planning (Vietnam), PGD in Groundwater Governance (India & Nepal), Trained in e-Govt. Mgt. and ICT (BPATC); Life F-IEB, M-KIB, M-BSAE.	
14	Md. Zahangir Alam	(Deputy Secretary-7869) Deputy Director zalam14bcs@gmail.com	B.A. (Hons), M.A. (History) Jahangirnagar University, Savar, Dhaka	
15	Engr. Gias Uddin Ahmed	Senior Scientific Officer	B.Sc.Engg. (Agril), BAU, Mymensingh; Trained in BPATC.	
16	Dr.Engr. Moniruzzaman Khan Eusufzai	Senior Scientific Officer mzk1973_82@hotmail.com	B.Sc. Engg. (Agril), M.S (IWM), BAU, PhD (Environmental Science), Japan; Post doc (Climate Change), Japan; F-IEB	
17	Dr. Engr. Fatima Rukshana	Senior Scientific Officer frukshana11@gmail.com	B. Sc. Engg.(Agril), M.S (FPM), BAU; PhD (Soil and Environmental Sci.), LTU, Australia; PGT (GIS and Remote Sensing for Water Sector), UNESCO-IHE, The Netherlands; F-IEB, M-ASSI, M-IUSS.	
18	Engr. Shailen Kumer Ghosh	Senior Scientific Officer shailenghosh1967@gmail.com	B.Sc. Engg. (Mechanical) BIT, Dhaka; M-IEB, Trained in BPATC, RPATC, BIM	
19	Engr. Md. Johurul Islam	Senior Scientific Officer johurul1999@yahoo.com	B.Sc. Engg. (Civil), BUET, Trained in BUET, BPATC, RPATC, BIM; M-IEB.	

Sl. No.	Name of Officer	Designation & Contact Information	Qualification	Photo
20	Md. Abul Ehsan Miah	Photographer/ PRO ehsanrubel68@gmail.com	B.S.S RU, Trained in Photography, BPI, Dhaka.	
21	Md. Abu Zafar	Assistant Director	M.A (NU), LLB, Trained in RPATC.	
22	Md. Azmal Hossain Fakir	Librarian azmal1966@gmail.com	B.A (Hons), M.A (Geography); PGD in Library & Information Science, RU; PGT in New Delhi, India; Trained in RPATC.	
23	Nasima Khatun	Personal Secretary to Director General	B.A, NU, Diploma in Computer Science; Trained in RPATC.	
24	Engr. Mohammad Mehedi Hasan	Scientific Officer mhsn.rri.bd@gmail.com	B.Sc. Engg. (Agril), BAU, Mymensingh; M.Sc. (Environmental Engg.), BUET; M.Sc.Engg. (WRE), KU Leuven, Belgium; Trained in RPATC, NAPD; M-IEB.	
25	Md. Dulal Bawali	Scientific Officer dulal.bawali@gmail.com	B.Sc. (Hons), M.Sc.in Applied Physics Electronics and Communication Engineering, Islamic University, Kustia.	
26**	Engr. Md. Zubayerul Islam	Scientific Officer zubi_ageng@ yahoo.com	B.Sc. Engg. (Agril), M.S in Farm Structure, BAU, Mymensingh; M-IEB.	
27	Md. Jahangir Alam	Accounts Officer Jahangir_rri@yahoo.com	B.Com, DU; Trained in RPATC.	
28	Engr. Md. Tofiquzzaman	Scientific Officer tofiqrri@gmail.com	B.Sc. Engg. (Civil), DUET, Gazipur.	
29	Nayan Chandra Ghosh	Scientific Officer ncghosh@rri.gov.bd	B.Sc .(Hons), M.Sc. (Physics), Jagannath University, M.Phil (Physics), BUET, Dhaka; LM-BPS, M-Isabela Foundation.	
30	Md. Moniruzzaman	Scientific Officer mmoniruzzaman@rri.gov.bd	B.Sc. (Hons), M.Sc. (Physics), RU, Rajshahi.	

Sl. No.	Name of Officer	Designation & Contact Information	Qualification	Photo
31	Engr. Md. Shahabuddin	Scientific Officer shahabuddin_61@yahoo.com	B.Sc. Engg. (Civil), DUET, Gazipur.	
32	Engr. Abdullah Al Imran	Scientific Officer imran_0301086@yahoo.com	B.Sc .Engg. (Civil), KUET, Khulna.	
33	Engr. Khondoker Rajib Ahmed	Scientific Officer krahmed147@gmail.com	B.Sc. Engg. (Civil), BUET, Dhaka.	
34#	Engr. Sajia Afrin	Scientific Officer shithi_cecuet02@yahoo.com	B.Sc. Engg. (Civil), CUET, Chittagong.	
35**	Engr. Omar Al Maimun	Scientific Officer maimunduet@gmail.com	B.Sc .Engg. (Civil), DUET, Gazipur.	
36	Engr. Md. Nefaur Rahman	Scientific Officer nefaur25@gmail.com	B.Sc. Engg (Agril), BAU, Mymensingh. M.S. in IWM, BAU.	
37	Engr. Taznin Naher	Scientific Officer tnaher.hrdrri@gmail.com	B.Sc. Engg (Agril), BAU, Mymensingh. M.Sc. (WRD), IWFM, BUET	
38	Engr. Emran Ali Mondal	Scientific Officer emranhossainduet@gmail.com	B.Sc .Engg. (EEE), DUET, Gazipur	
39	Engr. Bikash Roy	Scientific Officer bikashduet60gmail.com	B.Sc .Engg. (ME), DUET, Gazipur	
40	Engr. Sumiya Ferdhous	Scientific Officer sumiya_eee@yahoo.com	B.Sc. Engg. (EEE), CUET, Chittagong.	
41	Engr. Md. Masuduzzaman	Assistant Programmer masud.rri23@gmail.com	B.Sc .Engg. (CSE), DUET, Gazipur	

Sl. No.	Name of Officer	Designation & Contact Information	Qualification	Photo
42	Goswami Bilwa Mongal	Sub-Assistant Engineer	Dip. in Civil Engg., Trained in RPATC & BIM	

* Indicates expired on 08.09.2018 at 1.00 AM (Inna lillahe owa inna illahe owa rajeun)
** Indicates deputation for higher study in abroad
# Indicates deputation within the country

National Day Celebration

Annex II

Placing Floral wreaths at Bangabandhu's Portrait on National Mourning Day 2018

Mournful procession on the RRI Campus on National Mourning Day 2018

DG RRI along with Directors watching drawing competition arranged on the occasion of National Children's Day 2018 and birth anniversary of the Father of the Nation

DG RRI along with Directors distributing prize to the winner of drawing competition on the occasion of National Children's Day and birth anniversary of Father of the Nation

DG RRI along with Directors distributing prize to the winner of drawing competition on the occasion of National Children's day 2018 and birth

A partial view of audience in a meeting arranged in RRI Auditorium on the occasion of victory day 2017

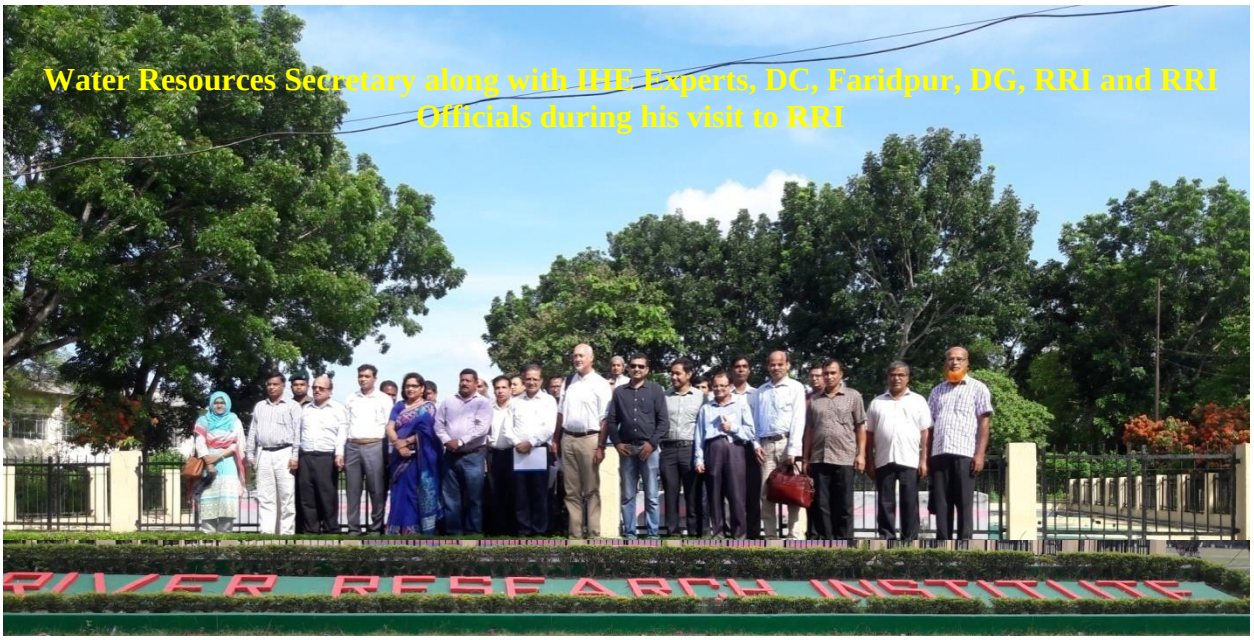
Placing Floral Wreaths at Shahid Minar to pay respect to the Language Movement Martyrs

Procession on the occasion of Language Movement Martyrs Day and International Mother Language Day

Colorful celebration of Bangla New Year 1425 in RRI

Pohela Baishak celebration riding on horse-cart

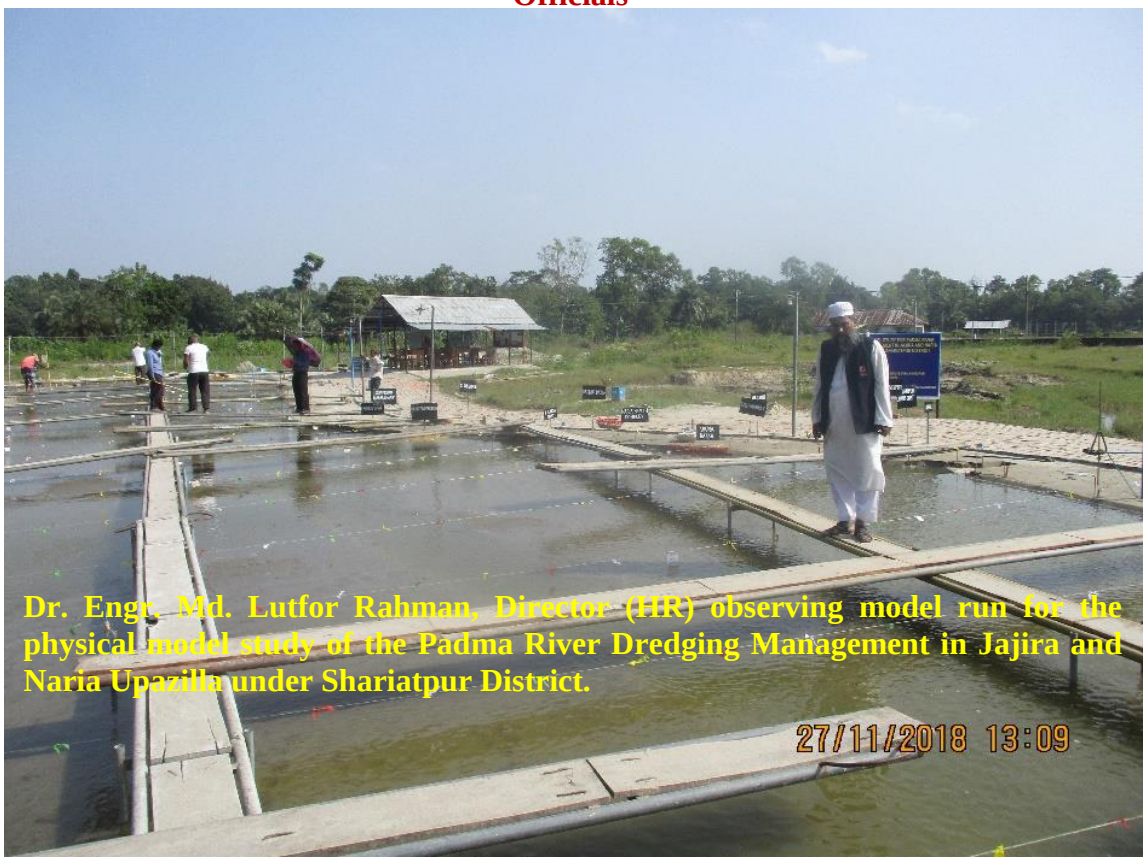
RRI visit



Water Resources Secretary along with IHE Experts, DC, Faridpur, DG, RRI and RRI Officials during his visit to RRI

Water Resources Secretary getting informed about RRI physical model activities during his model site visit

Client of Paira Bridge Model visiting model site along with RRI and BWDB Officials



Dr. Engr. Md. Lutfor Rahman, Director (HR) observing model run for the physical model study of the Padma River Dredging Management in Jajira and Naria Upazilla under Shariatpur District.

Memorable moment (Never-to-be forgotten)

Current DG and former DG of RRI and former President of RRI Primary School on the Sports Day

RRI Officials as well as IHE Alumni with IHE Expert Mr. Michael McClain, Professor of Ecohydrology and Biswa Bhattacharya, Associate Professor of Hydroinformatics during their visit to RRI

DG, Directors and Senior Officials of RRI encouraging a student for winning prize in Essay Writing Competition arranged on the occasion of National Mourning Day 2018

DG, Directors and other Senior Officials of RRI encouraging a student for winning prize in Essay Writing Competition arranged on the occasion of National Mourning Day 2018

Pohela Baishakh celebration in RRI Campus through traditional

RRI participants in a colorful rally with different placards on the occasion of World Water Day 2018 held in Dhaka

DG, RRI with Junior Scientist during Information Fair held at Faridpur Town organized by DC Office.

RRI Officials in a memorable moment during the Training Workshop entitled Innovation in Public Service held at RRI

LIST OF ABBREVIATIONS

Annex III

AD	Assistant Director
ADB	Asian Development Bank
AFPM	Active Flood Plan Management
A & F	Administration and Finance
A & FD	Administration and Finance Directorate
AIT	Asian Institute of Technology
ASTM	American Society for Testing Materials
ASO	Assistant Scientific Officer
ASSSI	Australian Society of Soil Science Inc.
B.A	Bachelor of Arts
BAU	Bangladesh Agricultural University
BCL	Bangladesh Consultant Limited
BCSIR	Bangladesh Council of Scientific and Industrial Research
BIAM	Bangladesh Institute for Administrative Management
BIM	Bangladesh Institute of Management
BIT	Bangladesh Institute of Technology
BIWTA	Bangladesh Inland Water Transport Authority
BIWTC	Bangladesh Inland Water Transport Corporation
BoG	Board of Governors
BPATC	Bangladesh Public Administration Training Centre
BPI	Bangladesh Photographic Institute
BPS	Bangladesh Physical Society
BRRP	Buriganga River Restoration Project
BUET	Bangladesh University of Engineering & Technology
BWDB	Bangladesh Water Development Board
CBM	Concrete Block Mats
CBR	California Bearing Ratio
CC	Certificate Course
CERP	Coastal Embankment Rehabilitation Project
CEGIS	Centre of Environmental and Geographic Information Services
CPT	Cone Penetration Test
CPU	Central Processing Unit
CPTU	Central Procurement Training Unit
CSO	Chief Scientific Officer
CT	Concrete Technician
CUET	Chittagong University of Engineering & Technology
CWPRS	Central Water and Power Research Station
CZEM	Coastal Zone Engineering and Management
DDC	Design Development Consultants Limited
DC	District Commissioner
DD	Deputy Director
DG	Director General
DHI	Danish Hydraulic Institute
DIFPP	Dhaka Integrated Flood Protection Project
Dip.	Diploma
DIFPP	Dhaka Integrated Flood Protection Project

DPP	Development Project Proforma
D/S	Downstream
DU	Dhaka University
DUET	Dhaka University of Engineering & Technology
EC	Electrical Conductivity
EEE	Electrical & Electronics Engineering
EGIS	Environmental and Geographic Information Service
EGB	East Guide Bund
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
ESIA	Environmental impact statement
ENGG.	Engineering
FAP	Flood Action Plan
FCDI	Flood Control, Drainage & Irrigation
F-IEB	Fellow of the Institution of Engineers, Bangladesh
FM	Fineness Modulus
FPM	Farm Power and Machinery
GBSP	Ganges Barrage Study Project
GDP	Gross Development Profit
GHH	Ground Water Hydrology
GIS	Geographic Information System
GO	Government Order
GoB	Government of Bangladesh
GR	Geotechnical Research
GRD	Geotechnical Research Directorate
GRRP	Gorai River Restoration Project
GWC	Ground Water Circle
Hons	Honours
HP	Horse Power
HR	Hydraulic Research
HRD	Hydraulic Research Directorate
HRL	Hydraulic Research Laboratory
IAD	Integrated Agricultural Development
IBAIS	International Business Administration and Information System
ICDDRB	International Centre for Diarrheal Disease Research and Rehabilitation, Bangladesh
IDCB	Institutional Development and Capacity Building
IEB	Institution of Engineers, Bangladesh
IHE	International Institute for Infrastructural, Hydraulic and Environmental Engineering
IIT	Indian Institute of Technology
IMED	Implementation, Monitoring and Evaluation Department
IRD	Integrated Rural Development
ITC	International Institute for Aerospace Survey and Earth Sciences
IUSS	International Union of Soil Science
IWFM	Institute of Water and Flood Modelling
IWM	Institute of Water Modelling / Irrigation and Water Management
IWRM	Integrated Water Resources Management
JOCL	Japan Overseas Consultants Limited.
JU	Jahangirnagar University
KUET	Khulna University of Engineering & Technology
KUL	Katholic University of Leuven

KVA	Kilo Volt Ampere
LA	Laboratory Attendant
LAB	Laboratory
LGB	Left Guide Bund
LHI	Lanka Hydraulic Institute
LLB	Bachelor of Law
LM	Life Member
LOI	Letter of Intent
LT	Laboratory Technician
LTU	La Trobe University
M.A	Master of Arts
M-ASCE	Member of American Society of Civil Engineer
M-BAAS	Member of Bangladesh Association for Advancement of Science
MBA	Master of Business Administration
M-BCS	Member of Bangladesh Computer Society
M-BES	Member of Bangladesh Environmental Society
MC	Main Consultant/Moisture Content
M-IEB	Member of the Institution of Engineers, Bangladesh
MIS	Management Information System
M-JSCE	Member of Japan Society of Civil Engineers
MLSS	Member of the Lower Class Subordinate
M-NOAMI	Member of National Oceanographic and Maritime Institute
MoU	Memorandum of Understanding
MoWR	Ministry of Water Resources
MP	Member of the Parliament
MPA	Mongla Port Authority
MS	Mild Steel
M.S/M.Sc.	Master of Science
M. Phil	Master of Philosophy
NHC	North Hydraulic Consultants Limited
NMC	Natural Moisture Content
NU	National University
NAHRIM	National Hydraulic Research Institute Malaysia
O & M	Operation & Maintenance
OTM	Open Tendering Method
PABX	Public Automatic Branch Exchange
PATC	Public Administration Training Centre
PC	Personal Computer
PD	Project Director
PGD	Post Graduate Diploma
PGT	Post Graduate Training
PhD	Doctor of Philosophy
PLOI	Provisional Letter of Intent
PPM	Parts per Million
PS	Private Secretary
PSO	Principal Scientific Officer
PU	Prime University
PWD	Public Works Department
RAC	Regional Accounts Centre
RDPP	Revised Development Project Proforma
REBRFM	Research on the Effect of Bandalling on River Flow and Morphology

RFQ	Request for Quotation
RGB	Right Guide Bund
RHD	Roads & Highways Department
RPATC	Regional Public Administration Training Centre
RRI	River Research Institute
RTW	River Training Work
RU	Rajshahi University
RUET	Rajshahi University of Engineering & Technology
SAE	Sub-Assistant Engineer
SICT	Support to Information and Communication Technology
SMEC	Snowy Mountain Engineering Corporation
SO	Scientific Officer
SRNDP	Southwest Road Network Development Project
SSD	Submerged Soil Density
SSO	Senior Scientific Officer
SSFCDI	Small Scale Flood Control, Drainage & Irrigation
ST	Soil Technician
SWH	Surface Water Hydrology
SWMC	Surface Water Modelling Centre
TDS	Total Dissolved Solids
ToR	Terms of Reference
TU	Technical University
UGC	University Grant Commission
UK	United Kingdom
UNESCO	United Nations Educational, Scientific and Cultural Organization
UPM	University Putra Malaysia
U/S	Upstream
USA	United States of America
UTM	Universal Testing Machine
WR	Water Resources
WRDP	Water Resources Development Project
WRE	Water Resources Engineering
WRM	Water Resources Management
WR	Water Resources Survey

DG, RRI and other RRI Officials in a colorful rally on the occasion of World Water Day-2018 in Dhaka

RRI's BoG Member Mr. Md. Lokman Hossain Mridha along with RRI DG and other high Officials delivering speech in a seminar held at RRI Conference room

River Research

OBJECTIVES OF RIVER RESEARCH INSTITUTE

The activities of RRI as per Act 53 of 1990 are directed towards the achievements of the following objectives:

- To carry out studies for design supports in river training, river bank protection, flood control, irrigation & drainage works and to conduct research in river engineering, sediment control, estuary and tidal effects by means of physical model.
- To conduct mathematical model studies on river flow & regional flow network, hydrology, surface & ground water utilization and environmental issues with special attention to salinity intrusion & water quality with a view to develop the water resources.
- To perform tests on construction materials required for river training, river bank protection, flood control, irrigation & drainage structures and to inspect & evaluate the quality of the construction works thereof.
- To conduct training program on the above mentioned subjects and to publish reports &periodicals related to technical aspects.
- To advise the Government, Local Authority or any organizations regarding the problems and best approach towards the solution on the above mentioned subjects.
- To co-operate & conduct joint ventured research work with other similar local or foreign organizations.
- To take any necessary steps for performing the above mentioned works.

Contact Address
River Research Institute
Institute
Faridpur-7800, Bangladesh
Bangladesh
Telephone: 880-631-63007
Fax: 880-631-63065
Email:rrib d@yahoo.com
Website: www.rri.gov.bd

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Faridpur-7800,