River Research Institute

ANNUAL REPORT

2021-22

Providing technical assistance to develop country's water resources in a sustainable manner

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

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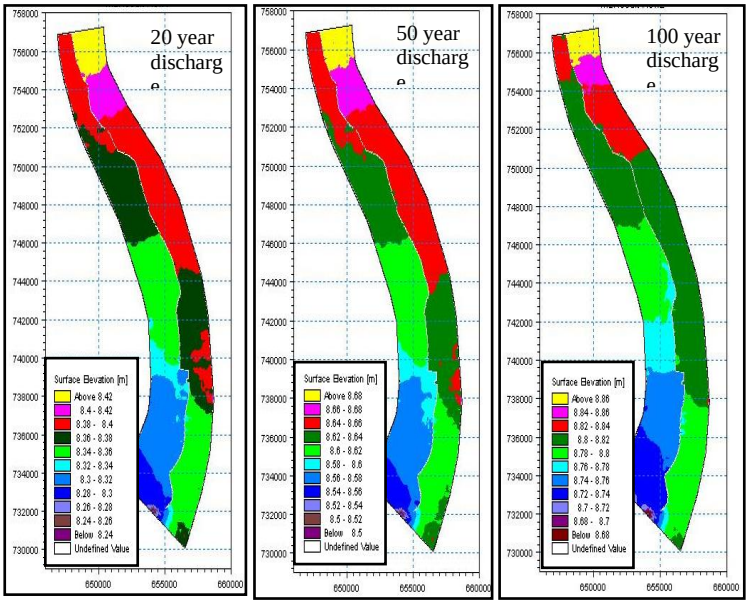
Ganges Barrage Model Study



Mathematical Model Study

Laboratory Investigation

Father of the Nation

Bangabandhu Sheikh Mujibur Rahman

River Research Institute

ANR NO. 49

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EDITORIAL NOTE

The annual report of an institute or organization reflects all activities of a financial year. Same as the previous years River Research Institute (RRI) forms an Editorial Committee to prepare the annual report for the fiscal year 2021-22. This annual report gives an insight into the functions and activities of RRI highlighting the contribution made in the river management and water resources development during the fiscal year 2021-22. The report includes brief description of the findings of physical and mathematical model studies, testing of various engineering properties of soil, concrete, water quality, sediment samples etc. This report also contains the research and development activities, staff development, financial management, projects with revenue received, future trend etc. which will assist to provide useful information to the organizations and individuals working in the water sector.

This annual report includes overall account of the institute, activities performed by its different directorates and monetary management in the last (2021-2022) fiscal year. It also highlights the background, objectives and outcomes of different physical as well as mathematical model studies and the testing conducted for various properties of soil, concrete, water and sediment as well. Furthermore, this report encompasses the human resource development, research and development activities, development and future prospects etc. which will assist in rendering useful information to the organizations as well as individuals employing in the water sector.

The Editorial Committee likes to express its sincere thanks and gratitude to Chief Advisor Mr. S M Abu Horayra, Director General of RRI for his invaluable suggestions, necessary guidelines and assistance in publishing this report. The committee sincerely recognizes the guidance provided by the advisors for making this report informative and comprehensive. The committee is also indebted to the relevant person who extended their efforts and co-operation in preparing and publishing this report in time.

A. K. M. Ashrafuzzaman
Principal Scientific Officer
and
Convener
Editorial Committee

MESSAGE

From State Minister

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

I would like to spread my congratulation to River Research Institute (RRI) authority for publishing its annual report for the fiscal year 2021-2022.

From its very inception, River Research Institute is serving the nation in the field of Water Resources Engineering. Using the tools of physical modelling and computer-aided modelling and technical know-how RRI has effectuated many studies efficiently for the development project of different ministries including the Ministry of Water Resources of GoB. They do researches in the context of the hydraulic, geotechnical, and environmental arena to support different government agencies and ministries for `getting their job done properly and accurately. River Research Institute conducts tests on soil samples, water samples and construction materials received from government and non-government agencies for their development works. In the last few years RRI has conducted several Environmental Social Impact Assessment (ESIA) Studies in connection with road construction in the Haor region.

Riverbank erosion is one of the serious public apprehensions in our country. Every year, riverbank erosion endangers thousands of riparian people as it gives rise to damage roads, infrastructures, crops, croplands, cattle, homesteads, and farmland. The volatile shifting nature of the rivers not only affects the rural floodplain population but also the population of big cities and towns around the country. Also, the river ecosystem is affected by the changed flow of rivers. Salinity Intrusion in the coastal belt of Bangladesh is aggravating day by day affecting the socio-economic status of the people of this region. Damage to infrastructures in the coastal districts causes by cyclones and storms is very high. Surface and Groundwater contamination is another matter of big concern all over the country.

A better understanding of the hydrologic cycle, the natural process of Ground Water–Surface Water Interaction and Dynamic equilibrium of River System is very crucial for river erosion control. The Development of mid-channel bars and their longitudinal migration is one of the many causes of river erosion. An In-depth research study is needed for the management of mid-channel bars and their longitudinal migration. Accurate and precise assessment of surface and groundwater contamination is urgent for formulating effective mitigation methods to reduce the environmental footprint.

I am sanguine RRI scientist community is capable of taking challenges to solve contemporary issues and problems in the field of Water Resources Engineering as they have done in previous. To shape our water future RRI scientists and engineers will take a coherent approach involving science and technology with their cutting-edge idea and policy.

I applaud the editorial committee for their mammoth painstaking on generating this annual report for the fiscal year 2021-2022.

Zaheed Farooque, MP
State Minister, Ministry of Water Resources
Government of the People's Republic of Bangladesh

MESSAGE

From Deputy Minister

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

I am delighted to express my enthusiastic greetings for the Annual Report 2021-2022 activities of the River Research Institute (RRI). The RRI is acting as a research organization under the Ministry of Water Resources, Government of the People's Republic of Bangladesh. The research organization is reputed, and unique with an updated experimental set-up for conducting Physical and Mathematical modeling across the country.

Being the land of mighty, and transboundary rivers, riverbank erosion and sedimentation are the common phenomena in Bangladesh. As we know, Bangladesh is one of the big Deltas in the world, which experiences floods, drought, storm-surge, cyclones and different types of natural disasters every year. The consequences of these disasters are affecting the livelihood of people, which hinders the economic development of Bangladesh. With a view to the dynamic economic activity, the initiative of the Bangladesh Government is praiseworthy activity. It requires both short-term and long-term changes and interventions in the dynamic system. Regarding this system, the Bangladesh Delta Plan (BDP) 2100 is one of the mega projects of Bangladesh. It is mentioned that the research boundaries of the RRI are contributing to the dynamic system intensively.

The hydraulic research of the RRI conducts Physical and Mathematical modelling, considering the design parameters, and reliable river training measures that boost the economic growth in the country. The RRI emphasizes not only riverbank retreat, navigation but also river pollution, river ecology. Thus, the research organization, RRI focuses on the integrated management around the river in terms of the current demand of the era. Furthermore, the environmental impact assessment study along with river bank failure, soil quality, sediment quality, and structural failure study has magnified the geotechnical research further economic contribution. The RRI is capable of assuring qualified services through development projects, research projects, and management. The multidisciplinary activities of the RRI intensify the research activities sustainably, cross the national boundary, and amplify international knowledge.

Hon'ble Prime Minister Sheikh Hasina announced Vision 2021 with the aim of building an IT-rich Bangladesh in the modern form of Sonar Bangla, the dream of Father of the Nation Bangabandhu Sheikh Mujibur Rahman. The speed at which technology has developed in the world is truly incredible. Digital Bangladesh is no longer a dream but a reality. In continuation of this, Hon'ble Prime Minister Sheikh Hasina has started to transform the country from Digital Bangladesh to 'Smart Bangladesh' by 2041. 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 **SMART Bangladesh** through safe, sustainable, efficient and cost-effective solutions for engineering problems.

I would like to convey my honest appreciation to the Annual Report 2021-2022committee for their outstanding endeavour in preparing the report.

AKM Enamul Hoque Shameem, MP
Deputy Minister, Ministry of Water Resources
Government of the People's Republic of Bangladesh

River Research Institute

MESSAGE

From Secretary

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

I would like to expose my immense pleasure to River Research Institute as the annual report 2021-22 fiscal years is being published. This annual report focuses on overall activities and ascertains the commitment to create value by providing its support service.

The major part of Bangladesh is on the delta formed by three major rivers Brahmaputra, Ganges and Meghna. These rivers and many of the country's other minor rivers originate outside the national boundary of the country and make up the Ganges-Brahmaputra-Meghna River system which is a more complex river system in the world. Riverbank erosion is a common scenario at monsoon in Bangladesh. Almost every year river banks challenge various problems like erosion, bank degradation, bank failure etc. Devastating floods and excessive rainfall accelerate the failure process which results in immense damage to riverbank, agriculture and infrastructures every year. Riverbank erosion occurs both for hydraulic and geotechnical instability.

River Research Institute (RRI) has the mandate for conducting a 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 in the field of hydraulics. On the other hand, it conducts tests and analyses design parameters in the field of geotechnical engineering. Specifically, RRI is such an institute that conducts relevant studies in the field of hydraulic and geotechnical engineering under the Ministry of Water Resources (MoWR), Government of the People's Republic of Bangladesh.

As a research organization and works on important fields, RRI may play an important role to prevent and recommend remedial measures in the field of hydraulic and geotechnical instability on any river protection works in Bangladesh. In addition, RRI is now fully equipped with laboratories with sound know-how through which it may govern the research works at a higher level. In light of these works, the Government may achieve the Sustainable Development Goal (SDG)-6 and Bangladesh Delta Plan (BDP)-2100.

Lastly, I would like to sincerely thank RRI officials and Staff to take vast initiatives and providing persistence for being able to put the institute dynamic, competent and concerned in exclusion.

Nazmul Ahsan
Secretary, Ministry of Water Resources
Government of the People's Republic of Bangladesh

From The Director General's Desk....

River Research Institute (RRI), a statutory public organization, under the Ministry of Water Resources, Government of the People's Republic of Bangladesh, has been established in 1948 with the then name Hydraulic Research Laboratory (HRL) to provide technical support to different development initiatives regarding water resources development undertaken by various ministries of Bangladesh as well as to conduct fundamental research and share knowledge on rivers and allied problems and merged with a wing of Bangladesh Water Development Board and renamed as RRI in 1978.

RRI is operating with three wings namely, Hydraulic Research Directorate (HRD), Geotechnical Research Directorate (GRD) and Administration and Finance Directorate (A&FD). HRD deals with model tests, studies and researches in the field of Flood Control and Drainage, Bank Protection and Stabilization, Coastal Engineering, Hydraulic Structure and Irrigation etc. by means of physical and mathematical modelling. GRD deals with tests and research for the determination of different physical and chemical parameters of soils, construction materials, sediments, bed materials and water along with Environmental and Social Impact Assessment (ESIA) study of various development projects and fundamental investigation on the river and its environment. On the other hand, A&FD provides administrative support to the technical directorates, facilitates overall administration of RRI, accounts and audit, estate, library, public relation and photography and establishment along with operation and maintenance of physical facilities of RRI.

RRI has conducted a significant number of tests on physical and engineering properties of soil, quality of construction materials, sediment characteristics and water quality of the rivers etc. Some fundamental researches have been conducted as well as going on within this time frame in accordance with the Sustainable Development Goal (SDG)-6 and Bangladesh Delta Plan (BDP)-2100.

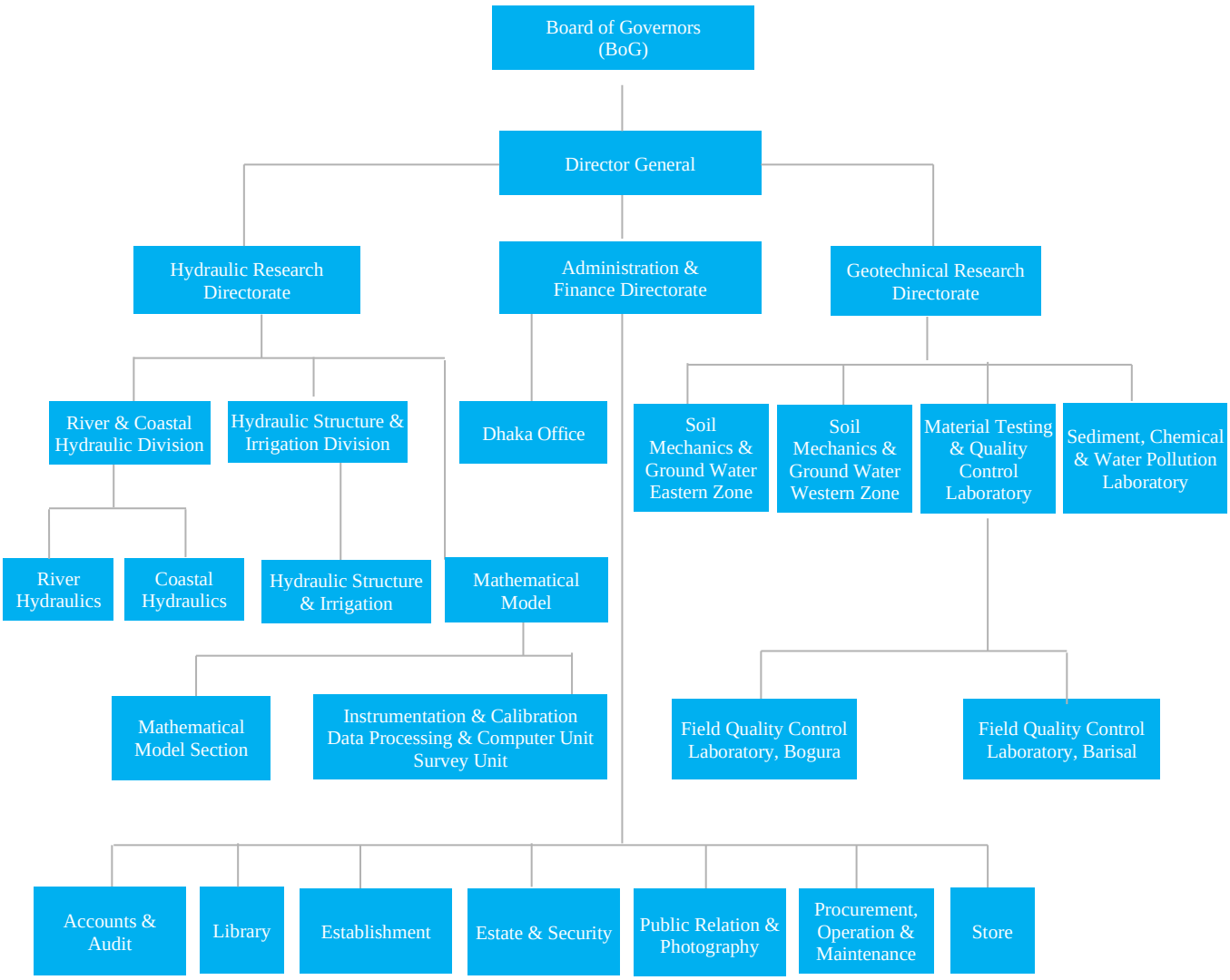
Alongside, RRI is also conducting a multiyear implementation and research on the bamboo pilot project aiming to achieve low-cost bank protection, increase navigation and land reclamation through bamboo bandaling structures in various parts of the country. A multiyear development project, titled "Institutional Development and Capacity Building (Phase-II)" is already completed through which very sophisticated world-class scientific equipment has procured to fulfill the demand of international standard research activities to face the upcoming challenges of physical and environmental activities and disasters. RRI is going to setup an ISO standard laboratory soon in Green Road, Dhaka and serve the nation in the most possible positive way.

Last of all, sincere and cordial thanks are extended to all relevant personnel, especially to the editorial committee who has an important contribution to the publication of the annual report 2021-2022.

S M Abu Horayra
Director General
River Research Institute

River Research Institute

ORGANIZATIONAL STRUCTURE



WHAT RRI DO

The activities of RRI as per the River Research Institute Act, 1990 (Act 53 of 1990) are directed towards the achievements of the following objectives:

- To carry out studies for design supports in river training, riverbank protection, flood control, irrigation and 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 and regional flow network, hydrology, surface and ground water utilization and environmental issues with special attention to salinity intrusion and water quality with a view to develop the water resources.

- To perform tests on construction materials required for river training, riverbank protection, flood control, irrigation and drainage structures and to inspect and evaluate the quality of the construction works thereof.

- To conduct training program on the above-mentioned subjects and to publish reports and 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 and conduct joint ventured research work with other similar local or foreign organizations.

- To take any necessary steps for performing the above-mentioned works

WHAT KIND OF SERVICE CITIZENS CAN EXPECT FROM RRI

- Providing consultancy services for viable technical solutions to the problems related to riverbank erosion, flooding, drainage and irrigation.
- 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.
- 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.
- Conducting applied research on river management, sediment control of river, coast and estuary management etc. using physical and mathematical modelling technology and publishing the research results in report form as well as in periodicals and journals.
- Field level implementation of research outcomes in limited form to assess its effectiveness.
- Conducting basic research to develop understanding of river and coastal processes for the sake of applied research works.
- 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.
- Taking up projects for capacity building of the institute as well as human resource development and conducting joint venture multi-disciplinary studies.
- 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.

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 Directorate, Geotechnical Research Directorate, and Administration and Finance Directorate. The first two directorates operate the research activities while the last is responsible for the overall administration and financial activities of RRI and works for its development.

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. RRI has also been involved in Mathematical modelling since 2009. Physical and mathematical modelling tools are complementary to each other. Both physical and Mathematical model have been proved 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.

RRI has conducted in-house training and seminars in 2021-2022 fiscal year for skill development of its scientists as well as other staffs and officials. During fiscal year 2021-22, two research seminars held at RRI on 30 June 2022 titled "Characterization of soils around the Arial Khan River of Bangladesh" and Eco-hydrological status and impact assessment of Someshwari River in Netrokona and Shitalakhya River in Dhaka, Bangladesh". There is also a seminar named, "Development of Suitable Technologies for Removal of Manganese from Ground Water in Household, Community and Municipal Levels" held at RRI on 28.06.2022 implemented under e-Governance and Innovative Action Plan. In addition to these, there is a training course titled "Activities to be performed to face the challenges of 4th Industrial Revolution"under e-Governance and Innovative Action Plan held at RRI on 25.05.2022 for RRI staffs. There is also a training course all day long related to Secretariat instructions- 2014 on "Service simplification and service digitization" held at RRI on 16.05.2022 and 28.05.2022. A short description of the on-going research works and innovation project are furnished under the section "Research and Development". A list of in-house trainings and seminars appears in this section. Moreover, a number of officials and staffs are trained out-side training. Details description of in-house training, out-side training and seminar are also summarised under the section "Human Resource 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 good 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. Recently, many pieces of equipment have been procured under IDCB project (Phase-II) for Geo-technical Research Directorate as well as Hydraulic Research Directorate. 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 as presented under the section Administration and Finance Directorate (AFD).

Qualified and trained personnel are very much essential to meet the objectives of RRI and 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 scientists, supporting and managerial staffs is shown in Annexures. List of abbreviations is shown in the Annexures. 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 Unnayanmela), Information Fair (Totthomela) etc. Celebrated of national days and memorable moments for RRI officials appeared in Annexures.

HYDRAULIC RESEARCH

The Hydraulic Research Directorate (HRD) 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 and 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

Physical modelling is an authentic tool, which can be used confidently to verify the effectiveness of any structural intervention in the river and coastline protection works by reproducing the natural phenomena of river and coastal hydro-morphology at a reduced scale. The causes of any river and coastal 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. RRI has sufficient physical modeling facilities including indoor and outdoor model areas. Other available facilities include various measuring instruments, tide generator, wave generator, sediment feeder, power generator, workshop etc. 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 given below.

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

Name of the project	Year of completion	Objectives of the Physical modelling
Sustainability of the Buriganga River Restoration Project (Revised)	2021	To augment 141 cumec dry season flow in the Buriganga river by diverting 245 cumec water from the Jamuna river through the New Dhaleswari-Pungli-Bangshi-Turag-Buriganga river system.
Padma River Dredging Management Project	2019	To investigate the efficacy of dredging options, strategies and spoil disposal plan
Sustainability of the Buriganga River Restoration Project	2019	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.
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.
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.
3rdKarnaphully 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.

Physical model study is being conducted at RRI

Physical Modeling Study for Dredging and Bank Protection Works along Tetulia River at Bakerganj and Bauphal Upazillas under Barishal and Patuakhali Districts

Tetulia river originates from the Lower Meghna river at north of Bhola district. The river flows through Tetulia, Nimdi, Kalaiya and Purbamunia and ends up to the Bay of Bengal as the Buragouranga channel at Rangopaldi of Galachipa upazilla under Patuakhali district. It used to flow with a strong or rapid current. However, hydrodynamics of flow has been changed in recent years due to formation of many sand bars. The river separates Bhola island from the main land. The Ramnabad Island is located at the west bank of the river. An offshoot of the Meghna river from Shahbajpur meets the Tetulia river. The total length of the river is about 84 km and the average width is 6 km.

Dhulia Bazar, Gangapur Bazar, Manipur Bazar, Kalaiya port, Dasmuni Bazar are some of the important places nearby the Tetulia river. Tendency of severe erosion is visualized at different parts on both banks. A number of places under Bauphal and Galachipa upazillas are facing severe bank-erosion. On the other hand, the chars and islands that have been formed at various locations on the Tetulia, are now becoming the sites for settlements and crop cultivation.

At present the vast area from Dhulia Launch ghat area in Bauphal upazilla of Patuakhali district to Durgapasha area in Bakerganj upazilla of Barisal district are facing severe bank erosion. In fact, unabated right bank erosion at this river stretch has been taking place over the last four decades as can be seen from the available historical satellite images. In the seventies of the 20th century, the river at the erosion prone area used to be a single-channel river with a few small sized chars in the middle of the channel. However, with the passage of time these small sized chars grew in size causing changes in flow pattern and consequent braid-dominance with anabranches. A number of consequences have been visible including reduced flow depths, over-flow of banks and bank erosion. Such issues are constituted by sediment transport and deposition characteristics along the river bed. BWDB has taken up a project for protection of area about 7.5 km from Dhulia Launch ghat area under Bauphal upazilla of Patuakhali district to Durgapasha area under Bakerganj upazilla of Barishal district from the erosion of Tetulia river with provision of dredging of Tetulia river with a length of around 2835 m. It aims to divert the flow from the eroding bank to the center of the channel thus reducing bank erosion. It is very important to select a suitable dredging alignment that would be sustainable and would bring benefit in terms of reduction of near bank flow velocity.

Strong currents, wave action, tidal influences and upstream torrents are the governing factors for flow. Sediment load influences formation and migration of shallow-depth channels and sand bars. Uneven deposition and distribution of sediment cause river bed variation and corresponding channel changes along the river reach. Banks constituted of fine materials increase fragility leading to lateral shifting of banks. As a consequence, important installations like roads, educational institutes, market areas, farmlands and many other public and private establishments are gobbled up. The outer (concave) bank is gradually advancing towards the countryside. Along with bank protection work, dredging activity would be taken up for safety of the bank from severe erosion. So, fixation of dredging alignment using physical modeling technique is the main purpose of the present approach. The location map of the study area is shown below.

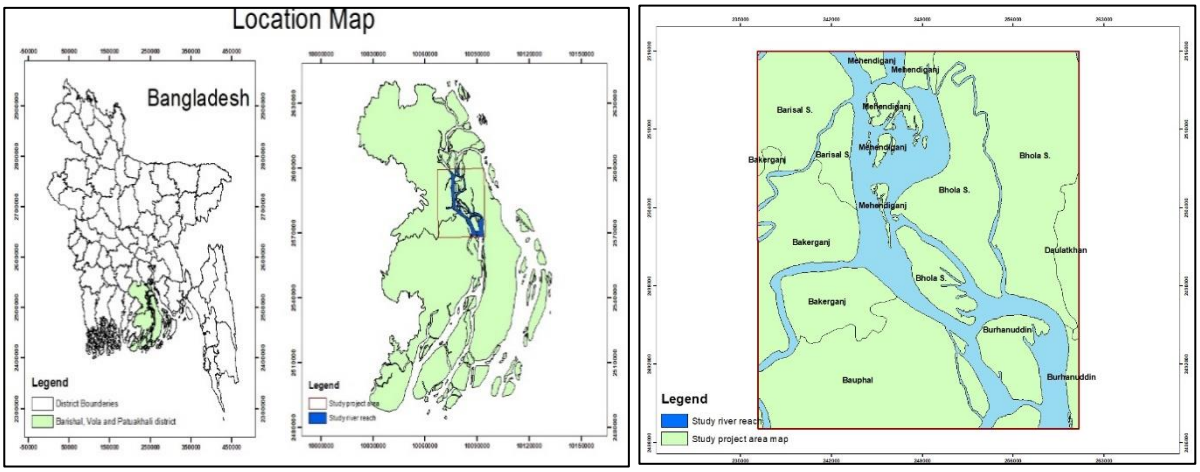
Physical model may be employed to investigate the performance of different options and strategies of dredging and dredged material disposal, sustainability of dredged channel and hydraulic and morphological impacts of dredging. As such, present initiative is taken in order to obtain necessary physical modeling support for effective and sustainable dredging of the Tetulia river at the project site where the river has been experiencing large right bank erosion.
The model can be used as a decision support tool for fixation of dredging alignment and design of bank protection work. The detailed design of the proposed dredging will be performed based on the

hydraulic and morphological design parameters to intended to optimization of dredging alignment and design, study the effectiveness and sustainability of dredging and river training works. The physical model study is conducted with one overall distorted morphological model capable of replicating physical processes of the Tetulia river within the project area. The proposed study is based on existing relevant data and field information involving recent bathymetric and bank line data.
The overall model covers a 40km stretch of the Tetulia river (around 21 km upstream and 19 km downstream from the off-take of the Karkhana river). The model also includes about 10 km stretch of the Karkhana river starting from its off-take from the Tetulia river at Durgapasha union. Since the upstream and downstream boundaries of the model are sufficiently away from the intervention location it is anticipated that the behavior of the physical phenomenon of the river at the area of interest could be predicted with a high precision.

The sustainability and effectiveness of any river dredging depends on how intelligently it is planned and designed. Of course, there would be back-filling tendency of the dredged channel. However, it is important to quantify best suited alignment for maximizing the benefit and lengthening the sustainability of the initiative. Therefore, morphological physical modeling is useful to carry out the dredging activities and thus, overall morphological developments in response to dredging could be observed. The effect of dredging on river morphology could be predicted by this model and effective dredging strategies might be devised.

The preliminary geometric scale of the model would be selected in order to fulfill both theoretical be obtained from the physical model study. It is scale conditions as well as practical requirements. An open-air model bed of adequate dimensions would be used for construction of the model. The initial bathymetry of the model would be reproduced based on the field survey data collected under the framework of this study. The model would be calibrated on the basis of prototype water levels, flow velocities and sediment transport data. Manual sediment feeding would be done with a view to assessing the required rate of sediment feeding during the model run. Continuous monitoring of the model bed would be conducted. A test program showing the test conditions and test objectives would be formulated in consultation with the BWDB officials concerned. The outcomes of the model investigation would assist in devising suitable alignment of dredging together with its appropriate design in order to reduce flow concentration along the erosion affected right bank of the Tetulia river at Dhulia-Durgapasha area. The model would also assist in investigating the efficacy of the proposed bank protection work and its hydro-morphological impacts in the upstream and downstream of the same.

River Research Institute (RRI) is the sole institute in Bangladesh that has vast experience in conducting physical model studies of different river engineering projects. It is, therefore, awarded with Physical Model Study for Dredging and Bank Protection Work along Tetulia River at Bakerganj and Bauphal Upazillas under Barishal and Patuakhali Districts and a contract agreement was signed between BWDB and RRI at Barishal on 20th September 2021 to this end.



The location map of the study area

Study outcomes in brief

Conclusions

From Dhulia to Durgapasha, the near right bank velocity is high enough (1.0m/s to 1.8m/s) to cause bank erosion when tested with flood discharge condition. Bank erosion will continue at this area if appropriate bank protection measures are not taken immediately.

From the float tracks that there is a tendency of attacking the left bank of the Karkhana river and right bank of the Tetulia river in the immediate downstream of the Karkhana river off-take.

Maximum velocity in the left side channel of Char Durgapasha remains below 1.5m/s and the same in the left bank channel is found to be below 1.0m/s under flood discharge.

The average cross-sectional velocity in the Tetulia channel as a whole varies along the erosion prone area and is found to be more than 1.0m/s in different cross-sections.

In the Karkhana river high velocity flow occurs along the left bank up to 3km d/s from the off-take mouth. From there, flow approaches towards the right bank (outer bank) of river bend.

Sustainability of the dredged channel in the right bank channel is less due to relatively quick filling up of the upstream part of the dredged channel. Complex flow pattern in the immediate upstream of the off-take is responsible for such quick filling up of the dredged channel. Such complex flow pattern is caused by occurrence of flow separation near the off-take.

Dredging in the left side channel of Char Durgapasha could be a relatively better solution although it may also involve huge maintenance dredging. As a result of dredging in the left side channel the overall average bed level of this channel may decrease to some extent although a large percentage of the dredged channel may get filled up within a year;

Velocity as well as discharge is increased along the dredged channel in the beginning but with the passage of time the dredged channel is found to have gradually silted up. The upstream portion of dredged channel is silted up earlier than the downstream portion.

It is to be noted here that minimum initial bed level (-29.16mPWD) along the erosion prone right bank of the Tetulia river is recorded at CS72. An examination of the field condition there shows that the reason for occurrence of such deep minimum bed level is local scour near the existing hard material protection works (CC block revetment). There are piecemeal CC block protection works at Dighirpar Launch Terminal. The river bank is protected there from erosion due to presence of such protection measure. However, erosion has taken place in the upstream and downstream of it forming embayment. Therefore, geo-bag protection measure have to be taken to prevent further retreat of the bank line at embayment location.

The proposed bank protection works by BWDB introduced at the right bank is found to work well as found from the model study. Special care should be taken at CS72 where bed level is -29.16mPWD, 138m away from right bank.

In this case, geo-bags/CC blocks should be kept ready for emergency dumping.

The protective structures (combination of CC blocks over geo-bags) proposed by BWDB is effective to protect the erosion prone area from Dhulia to Durgapasha.

In the present physical model, a 40km stretch of the Tetulia river and 10km stretch of the Karkhana river have been included. Therefore, morphological developments beyond the study reach under different discharge conditions remain unknown. Also, the rate of bank erosion varies spatially and temporarily and depends on several factors. The model is able to reproduce bank and char erosion qualitatively. Therefore, it is not possible to predict the rate of bank or char erosion quantitatively.

Test T9 is the recommended test for dredging alignment where length of the dredged channel is 2534 m. If the proposed dredging along the left side channel is intended it will ensure the stability of the bank protection work by reducing the flow through the right bank channel and thereby, reducing the near bank flow velocity. But the dredged channel is mostly found to be silted up. At the end of the test, the average percentage of filling up of the dredged channel is about 45%. However, the cross-sectional area of the left side channel where dredging will be carried out is likely to be increased as a whole due to dredging.

Total volume of material to be dredged for recommended dredging alignment and dredged channel section is 10,20,190 m^3. The volume of filling up of the dredged channel is found about 4,58,081 m^3.

Maximum velocity measured through the dredged channel in test T7 is about 1.91 m/s (Q=19200 cumec) and 1.96 m/s (Q=25513 cumec) at the beginning of test run.

Maximum velocity around the end of launching apron in test T9 is about 1.38 m/s (Q=19200 cumec) and 1.59 m/s (Q=25513cumec).

The maximum scour around the end of launching apron in test T9 (Q=25513cumec) is about 5.92 m at the end of test.

Average thickness of deposition for the entire dredged channel in test T9 (Q=25513cumec) is about 1.70 m after one year.

The suitable locations for dumping the dredged material are Char Hossainpur and Char Jafra situated on the left side of the dredged channel.

Recommendations

The bank protection work (7.0 km is for the protection of right bank of Tetulia river and 0.5 km is for the protection of left bank of Karkhana river from its offtake) proposed by BWDB tested in different tests work well and it is recommended to implement in the field. There should be provision for keeping adequate geo-bags/CC blocks ready for emergency dumping.

Bank protection work and dredging considered under test T9 are the recommended interventions to achieve the project objectives in terms of erosion protection as it provides better results from technical and economical point of view.

The recommended length of dredged channel is 2.534 km in the left side channel having bottom width 120m, bottom level -9.0 mPWD, longitudinal bottom slope 4cm/km and side slope 1:3.

The implementation of the recommended bank protection works and dredging in the field may be carried out immediately for the protection of the erosion prone Dhulia-Durgapasha area and to prevent further bank erosion in the coming year.

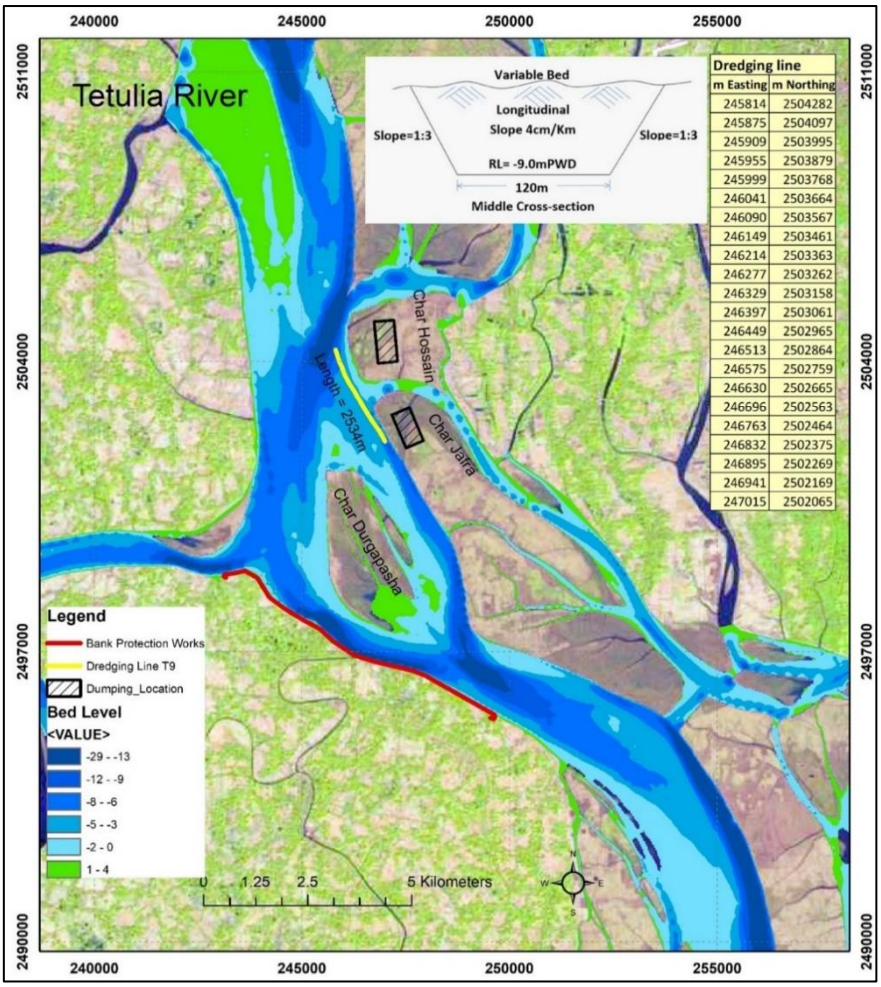
Substantial left bank erosion in the Karkhana river beyond the termination of the proposed bank protection work has been observed during model tests. Based on the model results it is suggested to provide bank protection work on the left bank of the Karkhana river for a length of about 1.5km from its offtake.

Some right bank erosion in the Tetulia river beyond the termination of the proposed bank protection work has also been observed during model tests. Based on the model results it is suggested to provide bank protection work on the right bank of the Tetulia river for a length of about 1.0 km from its termination.

The depth of suggested dredged channel may get reduced considerably after one year despite the fact that overall cross-sectional area of the left side channel where the dredging is suggested will be increased. In order to keep the dredged channel active maintenance dredging is suggested for two years with frequency of once in a year.

Monitoring of the developments in the dredged channel is suggested for taking decision as to maintenance dredging. Cross-section survey along the dredged channel at some preselected locations before dredging, after dredging and during post monsoon period is needed for this purpose.

Bank protection work alignment, dredging alignment, dredged channel section and dredged material dumping locations as shown below may be considered.



Detailed layout of the recommended dredged channel section and bank protection work and potential suitable locations for dumping the dredged material

Mathematical Modelling

At 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 modelling is complementary to physical modelling 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 modelling 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. Some of the Mathematical model studies conducted by RRI are mentioned hereafter.

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 under Rangpur Road Division of RHD.
- Road Bridge over the Banar River on Mymensingh-Goffargaon-Toke Road in Mymensingh District under Mymensingh Road Division of RHD.
- Road Bridge over the river Lohalia at Boga in Patuakhali District under Patuakhali Road Division of RHD.
- Hydro-morphological Study for Pagla-Jagannathpur-Raniganj-Aushkandi Road Project in Sunamganj District under Sunanganj Road Division of RHD.
- Road Bridge over the Kalni River in Habiganj District under Habiganj Road Division of RHD.
- Road Bridge at Nalua-Baherchar over the river Pandab-Paira in Patuakhali District under Patuakhali Road Division of RHD.
- Road Bridge over the Monu River in Moulvibazar District under Moulvibazar Road Division of RHD.

Recently Mathematical model studies conducted at RRI

- Hydro-morphological Study using Mathematical Model for New Sachna-Golakpur Road Project under Sunamganj Road Division of RHD.
- Proposed Sonahat Bridge over the river Dudhkumar under Kurigram Road Division of RHD.
- Proposed Kaharol Bridge over the river Punarbhaba River under Dinajpur Road Division of RHD.
- Improvement of Nikli – Soharmul - Karimganj Road &Gunnodhor GC - Mojlishpure GC Road under Rural Infrastructures Development Project of Kishorgonj District of LGED.
- Hydro-morphological Study using Mathematical Model for Madanpur-Dirai-Sullah (Dirai-Sullah Portion) Road under Sunamganj Road Division of RHD.

Mathematical model studies are being conducted at RRI

During the 2021-22 financial year, the following mathematical models are on-going at RRI.

- Hydro-Morphological Study of the Atul Nagar Ghat Bridge at 28th km of Pirojpur-Nazirpur-Matibhanga-Patgati-Gonapara Highway (Z-7704) on the Kaliganga River under Roads and Highways Department.

Objectives of the Study

- To determine the actual width of opening of the bridges;
- To determine the discharge of water flow of the catchment area near the bridge site, passing under this bridge before, during and after the rainy season so that the bridge approach is permanently stable from erosion caused by heavy wave action;
- To design slope protection work, if required of the approach road and river bank within the vicinity of the bridge.
- To conduct Environmental Impact Assessment (EIA) of the bridges.

- Hydro-Morphological Study of the Bishkhali bridge at 6th km of Binapani-Kachua-Betagi-Mirjaganj Patuakhali Highway (Z-8052) on the Bishkhali river under Roads and Highways Department.

Objectives of the Study

Hydro-morphological study of a river is an essential part of the feasibility study and detailed design. Flood discharge highest flood level, velocity, depth, flow area, flood frequency, historic flow route of river, sediment load and characteristics, bank and bed erosion characteristics are the important parameters obtained from hydro-morphological study. The study should be based on detailed hydrological,

morphological and hydraulic analysis of the river system, using mathematical modelling to determine the width of the opening of this bridge, required slope protection work of the approach road and river bank protection and computation of design flood discharge, design flood level, etc. The Hydro-morphological study with the following Service:

- To determine the actual width of opening of the bridges;
- To determine the discharge of water flow of the catchment area near the bridge site, passing under this bridge before, during and after the rainy season so that the bridge approach is permanently stable from erosion caused by heavy wave action;
- To design slope protection work, if required of the approach road and river bank within the vicinity of the bridge.
- To conduct Environmental Impact Assessment (EIA) of the bridges.
- To determine the actual width of opening of the bridges;
- To determine the discharge of water flow of the catchment area near the bridge site, passing under this bridge before, during and after the rainy season so that the bridge approach is permanently stable from erosion caused by heavy wave action;
- To design slope protection work, if required of the approach road and river bank within the vicinity of the bridge.
- To conduct Environmental Impact Assessment (EIA) of the bridges.

- Hydrological and Morphological study for the Proposed Laxmipasha Bridge at 23rd km of Barisal (Dinarer Pul)- Laxmipasha-Dumki highway (Z-8044) on the Porar Dhon River under Roads and Highways Department.

Objectives of the Study

- To determine the actual width of opening of the bridges;
- To determine the discharge of water flow of the catchment area near the bridge site, passing under this bridge before, during and after the rainy season so that the bridge approach is permanently stable from erosion caused by heavy wave action;
- To design slope protection work, if required of the approach road and river bank within the vicinity of the bridge.
-

- Hydrological and Morphological Study for the Proposed Banaripara bridge at 2nd km of Banaripara (Danduat)- Nazirpur Highway (Z-7710) on the Sandhya River under Roads and Highways Department.

Objectives of the Study

- To determine the actual width of opening of the bridges;
- To determine the discharge of water flow of the catchment area near the bridge site, passing under this bridge before, during and after the rainy season so that the bridge approach is permanently stable from erosion caused by heavy wave action;
- To design slope protection work, if required of the approach road and river bank within the vicinity of the bridge.

Proposals for physical model study

During the 2021-22 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 is mentioned hereafter.

- Physical Modeling Study for Feasibility Study for Augmentation, Conservation and Wise Use of Surface Water Resources through Dredging of the Upstream of Teesta Barrage and Bank Protection Work of the Teesta River.
- Physical Model Study for the “Feasibility Study for the Management of Karatoa River System and Rehabilitation of FCD Projects on Both Bank of Nagar River in Bogura District”.
- Physical Modeling Study for feasibility Study for the Management of the Bhahmaputra and Jinjiram River Basin through Flood Control, Drainage Facility and Bank Protection in Kurigram District.
- Physical Modeling for an offtake structure at GhiorKhal at the left bank of Brahmaputra-Jamuna.

GEO-TECHNICAL RESEARCH

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 narrated in the following sections.

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, Sluices, 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 2021-2022 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 896 nos. of samples from GWC of BWDB and other organizations in fiscal year 2021-22 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.

Visual inspection and scrutinization of disturbed soil samples for simultaneous testing (left) Consolidation triaxial testing using Electro Mechanical Triaxial Testing machine (right)

List of samples received (project-wise in chart), billed amount and volume of work executed during 2021-22 in Soil Mechanics & Ground Water Division

Sl No.	Report No.	Name of Division / Client	Name of Project/Work	No. of Sample Received & Tested	Billed amount (Taka)
01	01 (2021-2022)	Sub-Divisional Engineer Kushtia O&M Sub-Division.	Protective Work along the Right Bank of Gorai river from km. 25.000 to 26.000 (length = 1.000 km) at ChapraUpazila-KumarkhaliDistrict –Kushtiain c/w Gorai River Dredging & Bank Protection under Kushtia O&M Division BWDB Kushtia during the year 2019-2021(pakage no. GRDP-W29, Tender ID: 362279).	06	67500.00
02	02 (2021-2022)	Sub-Divisional Engineer Kushtia O&M Sub-Division.	Protective Work along the Right Bank of Gorai river from km. 26.000 to 27.000 (length = 1.000 km) at ChapraUpazila-Kumarkhali District –Kushtia in c/w Gorai River Dredging & Bank Protection under Kushtia O&M Division BWDB Kushtia during the year 2019-2021(pakage no. GRDP-W29, Tender ID: 362280).	06	67500.00

Sl No.	Report No.	Name of Division / Client	Name of Project/Work	No. of Sample Received & Tested	Billed amount (Taka)
03	03 (2021-2022)	Executive Engineer Sunamganj O&M Division-2 BWDB, Sunamganj.	Construction of 04 vent Sluice gate at Petfula of Alipur-Nurpur area of Yield protection Embankment(Submerged) of Kalaner Haor (Polder-2) of Dowarabazar Upazila under Sunamganj O&M Division-2 BWDB, Sunamganj.	01	51200.00
04	04 (2021-2022)	Sub-Divisional Engineer Kushtia O&M Sub-Division.	Protective Work along the Right Bank of Gorai river from km. 15.500 to 16.250 (length = 0.750 km) at ChapraUpazila-KumarkhaliDistrict –Kushtiain c/w Gorai River Dredging & Bank Protection under Kushtia O&M Division BWDB Kushtia during the year 2019-2021(pakage no. GRDP-W27, Tender ID: 362279).	11	88350.00
05	05 (2021-2022)	Sub-Divisional Engineer Kushtia O&M Sub-Division.	Protective Work along the Right Bank of Gorai river from km. 16.250 to 17.000 (length = 0.750 km) at ChapraUpazila-Kumarkhali District –Kushtia in c/w Gorai River Dredging & Bank Protection under Kushtia O&M Division BWDB Kushtia during the year 2019-2021(pakage no. GRDP-W28, Tender ID: 362280).	11	88350.00
	Total			35	362900.00

Field services of Soil Mechanics and Ground Water Eastern & Western Zone (Soil Mechanics Division)

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 on-going projects. During the fiscal year 2021-2022, three trained soil technicians were posted in the different working sites. 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.

Recently procured equipment (supported by IDCB Project, Phase-II) for Soil Testing Laboratory: Menard Pressure Meter with GeoBox (Apageo, France) (left) and Hydraulic Rotary Drilling Rig (Massenza, Italy) (Right)

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.

Laboratory activities in 2021-22 fiscal year

During the fiscal year 2021-22, a total of 359 number samples/specimens of cement, sand, shingles/stone chips, bricks, concrete cylinders 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.

Category-wise list of samples received from different BWDB Divisions and other organizations during the fiscal year 2021-22

Sl. No.	Name of division/ Other organization/ Field laboratory	Cement	Sand	Stone/ Khoa	Concrete cylinder	MS Rod	Concrete Core Block	Brick/ Hollow Brick	Total sample
1	Faridpur O&M Division, BWDB, Faridpur.	41	72	39	21	21	0	0	194
2	Shariatpur O&M Division, BWDB, Shariatpur.	20	20	13	0	0	0	0	53
3	Magura O&M Division, BWDB, Magura.	2	2	2	30	0	3	3	42
4	Gopalgonj O&M Division, BWDB, Gopalgonj.	4	8	4	6	0	0	0	22
5	Specialized Division, BWDB, Faridpur.	6	5	2	6	0	0	0	19
6	CEO/Project Director, JV of Shanghai Electric and Reverie, Evergreen Plaza (5th Floor), 260/B, Tejgaon I/A, Dhaka-1208.	0	0	0	6	0	0	0	6
7	Jhenadah O&M Division, BWDB, Jhenadah.	1	2	3	0	0	0	0	6
8	Madaripur O&M Division, BWDB, Madaripur.	1	2	1	0	0	0	0	4
9	Engineer Zubair Ahmed, Manager Planning Department, National Tech Communications Ltd.	0	0	0	0	0	4	0	4
10	Director, Hydraulic Research, River Research Institute, Faridpur.	0	4	0	0	0	0	0	4
11	Kushtia O&M Division, BWDB, Kushtia.	1	1	0	0	0	0	0	2
12	XEN, West Zone Power Distribution Company, Faridpur.	0	0	0	0	0	0	2	2
	Total	76	116	64	69	21	7	5	358

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 2020-21.

Sl. No.	Name of division/Other organization/ Field laboratory	Total nos. of sample tested	Billed amount (in Taka)	Recovery (in Taka)
1	Faridpur O&M Division, BWDB, Faridpur.	194	739950.00	739950.00
2	Shariatpur O&M Division, BWDB, Shariatpur.	53	303525.00	303525.00
3	Magura O&M Division, BWDB, Magura.	42	76350.00	76350.00
4	Gopalgonj O&M Division, BWDB, Gopalgonj.	22	76650.00	76650.00
5	Specialized Division, BWDB, Faridpur.	19	89100.00	89100.00
6	CEO/Project Director, JV of Shanghai Electric and Reverie, Evergreen Plaza (5th Floor), 260/B, Tejgaon I/A, Dhaka-1208.	6	5250.00	5250.00
7	Jhenadah O&M Division, BWDB, Jhenadah.	6	23700.00	23700.00
8	Madaripur O&M Division, BWDB, Madaripur.	4	17850.00	17850.00
9	Engineer Zubair Ahmed, Manager Planning Department, National Tech Communications Ltd.	4	19200.00	19200.00
10	Director, Hydraulic Research, River Research Institute, Faridpur.	4	0	0
11	Kushtia O&M Division, BWDB, Kushtia.	2	13275.00	13275.00
12	XEN, West Zone Power Distribution Company, Faridpur.	2	3300.00	3300.00
Total		358	1368150.00	1302675.00

Recently purchased equipment (supported by IDCB Project, Phase-II) for Concrete and Material Testing Laboratory: Concrete crushing machine (Controls, Italy) (left) and Core cutter machine (Hilti, Switzerland) (right) used for cutting concrete block and extract core.

Field services (Deputation of Technicians)

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 2021-22, three number of technicians were deputed in the different work sites of BWDB.

Sediment, Chemical and Water Pollution division

Sediment, Chemical and Water Pollution division is one of the important 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 analysed for using water in different purposes.

Test activities during 2021-2022 fiscal year

A total number of 496 samples including general suspended sediment, bulk suspended sediment, river bed and bank soil samples and water samples were received and tested in the sediment technology laboratory as well as chemical laboratory during the fiscal year 2021-2022. The general suspended sediment and bulk suspended sediment samples were collected by the field personnel of 4 (four) measurement divisions under the Surface Water Hydrology Circle-I of BWDB. The samples were collectedas a routine work by the Surface Water Hydrology Circle-I of BWDB. A total of 41 reports were published from this division during 2021-2022 fiscal year.

Category-wise list of samples with the clients

Sl. No.	Name of client	Category of samples	Nos. of samples received and tested
1	Surface Water Hydrology Circle-I of BWDB	General suspended sediment samples	153
2	Surface Water Hydrology Circle-I of BWDB	Bulk suspended sediment samples	246
3	Surface Water Hydrology Circle-I & II of BWDB	Silt samples	20
4	Institute of Water Modelling (IWM), Dhaka	River bed and bank material samples	18
5	Others	Water samples and silt samples	59
	Total samples		496

Testing Facilities in Chemical and Water Pollution Laboratory

Chemical and Water Pollution laboratory is well equipped laboratory with modern instruments including Atomic Absorption Spectrometer, Spectrophotometer, Gas Chromatography-Mass Spectroscopy,portable Spectrophotometer, portable multi-parameter meter, Aquaculture testing kit, etc. Recently RRI has procured Particle size analyzer,Total Organic Carbon (TOC) analyzer, Carbon-Hydrogen-Nitrogen-Sulphur (CHNS) analyzer, Computerized Microscope Stemi 305andPortable Air Monitoring Systemwith rain gauge for Chemical Laboratory under Institutional Development and Capacity Building (IDCB) Project (Phase-II).These equipment 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.

Portable Air Monitoring System with rain gauge (HAZ SCANNER, Model: HIM-600) is mainly used for EIA purpose. It is noticed that it is used specifically to determine Air particulate matters, humidity, temperature, wind speed with direction etc. Computerized Microscope Stemi 305 is used to determine shape & particle size of soil, bio-physical organism of water samples such as phytoplankton, Zoo plankton etc. 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 colorimeter is used to detect substances in the field as Hach spectrometer does in the laboratory. Portable Multiparameter meter is used to determine pH, DO, EC, TDS, Salinity, etc. from the river. Aqua-culture kit is used to measure Ammonia, Cl^-, CO_2, Hardness, etc. Digital Turbidity meter can be used in this Laboratory to detect turbidity of water samples. TOC analyzer is used to determine the organic and inorganic carbon for water and wastewater samples in mg/l. Particle Size Analyzer is used to determine the particle size soil and sediment samples from 10 nm to 3500 mm. CHNS Analyzer is used to determine the percentage of soil, sediment and water samples.

Besides these, the following facilities also exist in the Chemical and Water Pollution laboratory:

- Determination of p^H, arsenic, Salinity 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.

Recently procured equipment (supported by IDCB Project, Phase-II) for Chemical Laboratory: (a) TOC Analyzer, (Shimadzu, Japan) (b) CHNS Analyzer with air purifier, (Perkin Elmer, UK)

Revenue earned from Sediment, Chemical and Water pollution division

A total of Tk. 630375.00 has been billed during the fiscal year 2021-2022for testing of sediment samples. In total Tk. 599713.00 has been received in this fiscal year 2021-2022and a total of Tk. 516274.00 is remaining unpaid up to June 2022 in which Tk. 412000 is in 2020-2021 fiscal year and remaining Tk. 381338.00 from previous fiscal years from different clients of BWDB and other organisation

Scientists observed test activities with Particle Size Analyzer (MalyernPanalytical,UK) (left) Mr. Md. Moniruzzaman, SO, briefing about function & operating system of Portable Air Monitoring System

Dhaka Laboratory

Dhaka laboratory has been established on October 2021 in 72, Green Road, Dhaka-1205. The laboratory is well equipped and has the facilities to test soil, sand, sediment, water, and cement samples. The Specific Gravity, Natural Moisture Content, Sieve & Hydrometer Analysis, Unit Weight, Organic Content, Liquid Limit & Plastic Limit, etc. parameters of soil samples; Fineness Modulus (F.M.), Unit Weight, Specific Gravity, Organic Impurities of sand samples; Normal Consistency and Setting Time of cement samples; Sediment Concentration, Specific Gravity; Sieve & Hydrometer analysis of sediment samples; pH, Electrical Conductivity, Color (True or Apparent), Carbon-di-Oxide/Acidity, Carbonate/Bi-Carbonate, Alkalinity, Sulfate, Orthophosphate, Chloride, Fluoride, Chlorine Content Total/Free, Iodine Content, Bromine Content, Ammonia-Nitrogen, Nitrate-Nitrogen, Nitrite-Nitrogen, Salinity, Hardness, Ca-Hardness, Mg-Hardness, Turbidity, Total dissolved solid, Total solid content, Total Suspended/Insoluble Solids, Total Iron: UV-VIS, Ferrous Iron/Ferric Iron, Silica Content, Manganese: UV-VIS, Dissolved Oxygen, Chemical Oxygen Demand, Arsenic (Kit Method), etc. parameters of water samples can be determined in Dhaka Laboratory.

The important equipment of Dhaka Laboratory are HACH DR1900 Spectrophotometer, HACH DRB 200 Reactor, HACH HQ30D Multi-parameter, Duran Vacuum Filtration Device, Constance Force Convection Laboratory Oven 200°C and 300°C, Constance Muffle Furnace 1200°C, Controls Limit Device, Controls Sample Mixture, Controls Sieve Shaker and Set, Controls Compaction Device, Shimadzu Precision Balance, Kyowa Optical Microscope, Humboldt Setting Time Device, Cole-Parmer Micropipette, Soil Hydrometer, Magnetic Stirrer, Autoclave, Reagents, etc.

Since its establishment Dhaka Laboratory has tested 220 samples and published 8 reports. The total billed amount of those reports are 188,850.00 BDT, of which 38,700.00 BDT has been received from the client and 150,150.00 BDT are due. Moreover, 560 water samples have been tested in the laboratory and 320 samples have been tested in-situ in Someshwari River, Netrokona and Shitalakshya River, Narayanganj by Dhaka Laboratory for RRI's research purpose during 2021-2022.

Equipment of Dhaka Laboratory

ADMINISTRATION AND FINANCE

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.

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 employing in this institute is 257 and 161 respectively. The details of manpower are given in the following table as shown below:

Class-wise approved and existing manpower in RRI

Sl. No.	Class	Approved manpower	Existing manpower
1	1st Class	68	42
2	2nd Class	03	02
3	3rd Class	119	72
4	4th Class	64	45
	Total	257	161

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 16139 nos. and the total expenditure under this directorate during the fiscal year 2021-22 is 1831.76 lakh.

Total collection of items in the Library

Sl. No.	Description	Collection in 2021-2022	Total
1	Books	88	2549
2	Journal	2	2668
3	Reports	48	5688
4	Other publications	2	5234
	Total	140	16139

Total expenditure in establishment

Sl. No.	Description	Amount (Tk. In lakh)
1	Officers' salary	236.25
2	Staff salary	364.83
3	Allowances	554.16
4	Supply and services	210.99
5	Capital expenditure	101.13
	Total	1467.36

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 2021-22 is outlined below.

Works executed by Operation and Maintenance (Civil Engineering)

- Repair and maintenance of different office buildings such as administration, medical centre, mosque, ansar camp 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, woodwork 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, 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

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

Newly constructed Generator house (left) for 350 KVA Diesel Engine Generator and Garage (right) for Truck-mounted Geotechnical Drilling Rig

RESEARCH AND DEVELOPMENT

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.

Two research works have been conducted in 2021-2022 fiscal year, of which one is completed and other three are carried out at present fiscal year. Completed research work entitled "Development of Suitable Technologies for Removal of Manganese from Ground Water in Household, Community and Municipal Levels" and on-going research work entitled "Characterization of soils around the Arial Khan River of Bangladesh" is under Geo-technical Research Directorate. On the other hand, Hydraulic Research Directorate undertook a research project entitled "A study on coastal processes in Bangladesh and its socio-economic & environmental implications which is continuing at present. The undertaken two research projects, institutional development and capacity building (IDCB) project and four Bamboo bandaling pilot projects have been briefly described hereafter.

Research projects

(a) CHARACTERIZATION OF SOILS AROUND THE ARIAL KHAN RIVER OF BANGLADESH

The major part of Bangladesh is on the delta formed by three major rivers Brahmaputra, Ganges and Meghna. These rivers and many of the country's other minor rivers originate outside the national boundary of the country and make up the Ganges-Brahmaputra-Meghna river system (River, Banglapedia). 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 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%).

In many areas, the soil surveys recognized active, young, and old floodplain landscapes. Active floodplains occupy land within and adjacent to the main rivers where shifting channels deposit and erode new sediments during the annual floods.

There is active bank erosion almost in all major rivers in the country causing damage to valuable land, settlements and infrastructures from year to year. Because of high density of population along the river banks a great numbers of people are also displaced due to this continuous bank erosion process. These poor displaced people migrate to nearby towns and cities and live sub-human life in the slump areas. This has created a great natural and social problem in the country. Bank protection is therefore, one of the prime necessities for poverty alleviation and national growth.

Arial Khan River is one of the main south-eastward outlets of the river Padma. Bifurcating from the Padma at 51.5-km southeast of Goalanda in Rajbari district, the river flows through Faridpur and Madaripur districts. On its way, the Arial Khan maintains its link with the Padma through a number of streams and canals or khals. The river maintains a meander channel through its course and is erosion in nature. A number of settlements have already been destroyed due to severe riverbank erosion and the process is running.

The study area of the Arial Khan river situated in between Padma bridge and southern entrance of the highway. So, many numbers of structures will be constructed on the river bank of Arial Khan and its periphery as per development goal. The main constraint is failure of riverbank. Riverbank failure occurs both for hydraulic and geotechnical instability. Stability analysis is an utmost important work for any of the bank protection. The undertaken study seems to meet up the prediction of the stability of riverbank of Arial Khan river as geotechnical characterization is an utmost important engineering aspect for stability and settlement analysis. As a result of implementing study output in the building structure, it may be the safety of lives, land & sustainability of the infrastructures against the forces acting in the rivers. In light of that major point of view, this research study has been undertaken and desiring that expected outcome will assist the implementing authority for protection of works as well as people.

Figure-1: Bank of Arial Khan River, Faridpur
(Source: Image photo, Arial Khan River, Banglapedia)

OBJECTIVES

The main objective of the research is to find out geotechnical characteristics of soils and why bank failure occurs to relevant soils. The specific objectives of the study are as follows:

- To determine the geotechnical properties with hydrology
- Characterize the soils according to its properties
- Slope stability analysis
- Settlement analysis
- Social Impact Assessment
- Recommendations for remedial measure of bank failure

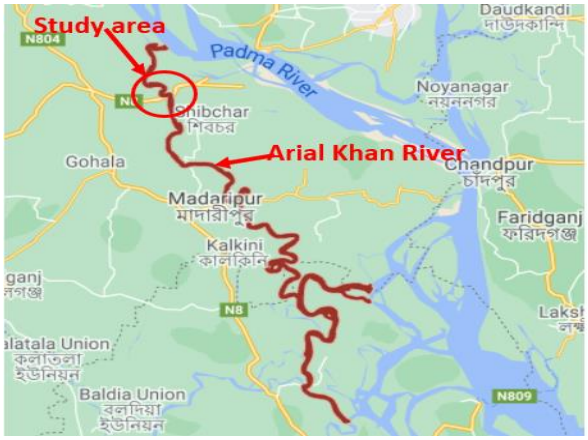


Figure-2:Study Area

KEY INFORMATION

- Duration: Two years and four months (March/2020 to June/2022)
- Total Cost: 24,08,161.00
- Funding: RESEARCH FUND of RRI (GoB)

PRESENT STATUS

The research has been approved in 23rd March'2020 and completed June'2022. Report compilation works are running. Final report will be published very soon.

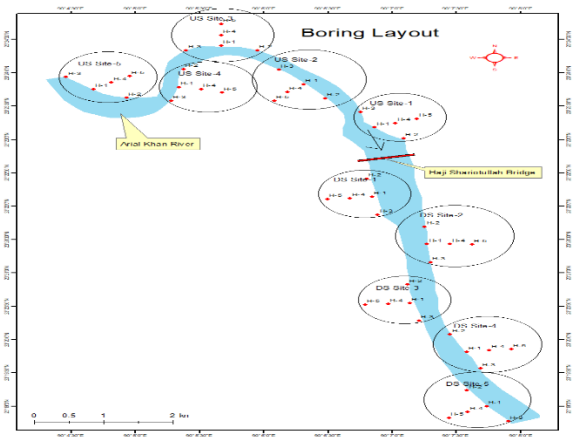


Figure-3: Boring Layout

Figure-4: Showing the Soil Boring Works

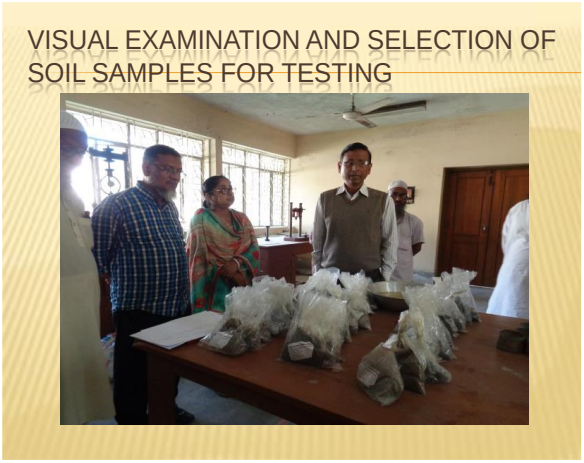


Figure-5: Visual examination and selection of soil samples for testing

Figure-6: Particle size analysis by Malvern particle size analyzer

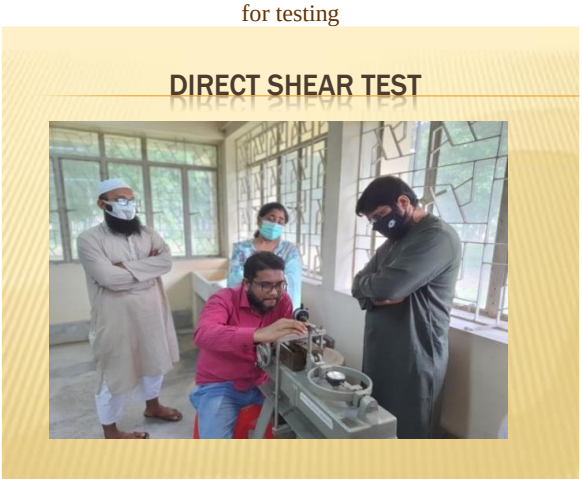


Figure-7: Running Direct Shear Test in the Laboratory

Sample ID	Depth (m)		SPT (N-values)	Grain Size Analysis			GWL in m
				Clay (%)	Silt (%)	Sand (%)	
D-1	1.5	SILT, some fine sand	9	3.00	65.00	30.00	3.76
U-1		Faty CLAY		4.00	85.00	11	
D-2	3.0		1	16.00	82.00	2.00	
D-3	4.5		1	4.00	87.00	9.00	
U-2				5.00	86.00	9.00	
D-4	6.0		1	4.00	84.00	12.00	
D-5	7.5		1	4.00	85.00	11.00	
D-6	9.0		2	12.00	83.00	5.00	
D-7	10.5	SILT, trace fine sand	3	3.00	88.00	9.00	
D-8	12.0	Silt little fine sand	6	0.00	80.00	20.00	
D-9	13.5	SILT, some fine sand	7	3.00	75.00	22.00	
D-10	15.0	FINE SAND, some silt, trace mica	15	1.00	27.00	72.00	
D-11	16.5	FINE SAND, some silt, trace mica	14	0.00	25.00	75.00	
D-12	18.0	FINE SAND, some silt	12	0.00	26.00	74.00	
D-13	19.5	FINE SAND, little silt	15	0.00	13.00	87.00	
D-14	21.0	FINE SAND ,some silt	14	0.00	25.00	75.00	
D-17	25.5		50	0.00	25.00	75.00	
D-18	27.0	FINE SAND, some silt	40	0.00	27.00	73.00	
D-19	28.5	FINE SAND, some silt	35	1.00	27.00	72.00	
D-20	30.0	FINE SAND,trace silt	36	0.00	9.00	91.00	

Figure-8: Soil character of left bank of Arial Khan river

Sample ID	Depth (m)	values)	SPT (N-	Grain Size Analysis			GWL
				Clay (%)	Silt (%)	Sand (%)	
D-1	1.5	FINE SAND, little silt, trace mica	10	0	11.00	89.00	3.35 28m
D-2	3.0	SILT, some fine sand	5	1.00	70.00	29.00	
U-1	3.55	Faty CLAY		4.00	68.00	28.00	
D-3	4.5	FINE SAND, some silt, trace mica	5	0.00	39.00	61.00	
D-4	6.0	FINE SAND AND silt, trace mica	8	0.00	46.00	54.00	
D-5	7.5	FINE SAND, some silt, trace mica	17	0.00	30.00	70.00	
D-6	9.0	FINE SAND, some silt, trace mica	11	0.00	24.00	76.00	
D-7	10.5	FINE SAND, some silt, trace mica	26	0.00	30.00	70.00	
D-8	12.0	FINE SAND, some silt, trace mica	14	0.00	35.00	65.00	
D-9	13.5	FINE SAND, some silt, trace mica	14	0.00	24.00	76.00	
D-10	15.0	FINE SAND, some silt, trace mica	14	0.00	27.00	73.00	
D-11	16.5	FINE SAND, some silt, trace mica	15	0.00	25.00	75.00	
D-12	18.0	FINE SAND, some silt, trace mica	13	0.00	24.00	76.00	
D-13	19.5	FINE SAND, some silt, trace mica	42	0.00	27.00	73.00	
D-14	21.0	FINE SAND, some silt, trace mica	24	0.00	29.00	71.00	
D-15	22.5	FINE SAND, some silt, trace mica	77	0.00	31.00	69.00	
D-16	24.0	FINE SAND, some silt, trace mica	32	0.00	23.00	77.00	
D-17	25.5	FINE SAND, some silt, trace mica	58	0.00	31.00	69.00	
D-18	27.0	FINE SAND, some silt, trace mica	28	0.00	26.00	74.00	
D-19	28.5	FINE SAND, some silt, trace mica	28	0.00	29.00	71.00	
D-20	30.0	FINE SAND, some silt, trace mica	25	1.00	32.00	67.00	

Figure-9: Soil character of right bank of Arial Khan river

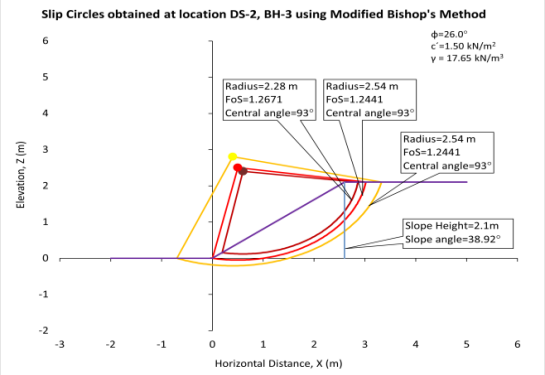


Figure-10: Slope stability analysis by Slip circle of left bank Arial Khan River using Bishop Simplified Method

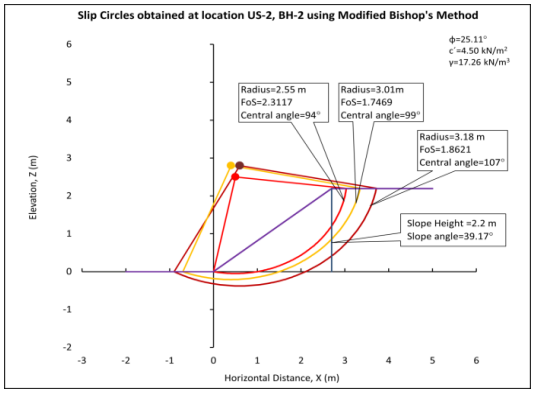


Figure-11: Slope stability analysis by Slip circle of right bank Arial Khan River using Bishop Simplified Method

Result & Discussion

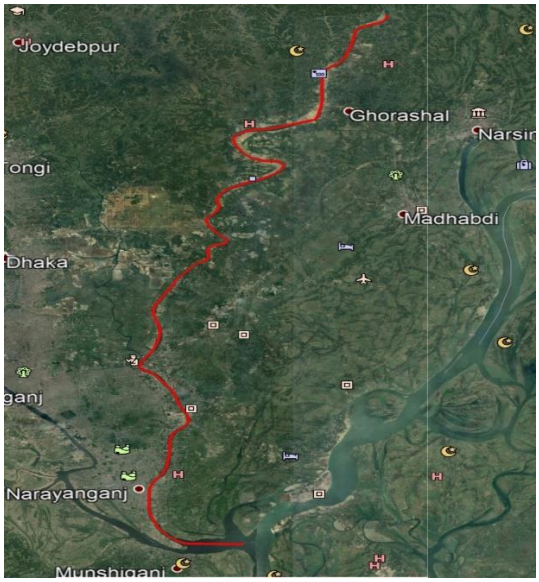
- Soil character reveals that soil layers have been changed from silty sands to well graded sands with very low plasticity to no plasticity
- Density of soil layers have been changed from very loose to medium dense and then dense in order of increasing of depth with a few exceptions and such occasional layers contain very loose to medium dense soils.
- The safe and unsafe safety factors are found from slope stability analysis.
- The safety factors reveal that slopes are somewhere stable and somewhere unstable.
- Soil character express that there are no extended loads on the study area so, in that case immediate settlement may occur however, serious settlement may occurs where the slopes are unstable.

Conclusion and Recommendation

- There are several methods to improve the slopes usable and safe which are susceptible to failure by sliding.
- Grouting and injection of cement into specific zones help in increasing the stability of slopes.
- Consolidation by surcharging helps in increasing the stability of slopes
- Slope flattening reduces the weight of the mass tending to slide
- Densification by increasing the shear strength of non-cohesive soils

(b) Eco-hydrological status and impact assessment of Someshwari River in Netrokona and Shitalakhya River in Dhaka, Bangladesh

Someshwari River



Shitalakshya River

Someshwari, a transboundary river of Bangladesh originates from hilly area of Meghaloya,India. The river flows through different parts of Netrakona District and finally ends with the Kangsha River. A tributary of the river meets the Balia River and another tributary flows into the haor areas of Sunamganj District. The total length and altitude of the river estimates about 25 km and 11m, respectively. On the other hand Shitalakshya River is a distributary of the Brahmaputra. In its initial stages it flows in a southwest direction and then east of the city of Narayanganj in central Bangladesh until it merges with the Dhaleswari near Kalagachhiya. The Shitalakshya River was once an important center for the muslin industry. Even today, there are centres of artistic weaving on its banks. There also are a number of industrial units on its banks, including the Adamjee Jute Mills. Thermal power houses are located along the river. Shitalakshya River is one of the most polluted river around Dhaka city where as Someshwari river in Netrokona is quite different.

The river ecosystem is the complex interactions between physicochemical parameters and biological life forms including Phytoplankton in a natural environment. Phytoplankton is the first link in the food chain. They are known as primary producers, since they produce the first forms of food. The aquatic environmental quality is dependent on river hydrodynamics and physicochemical parameters of the flowing water. Therefore, it is also very important to assess the several physicochemical parameters: pH, Dissolved Oxygen, Biochemical Oxygen Demand, Air Temperature, Water Temperature, Transparency, Total Dissolved Solid, Electrical Conductivity, Nitrate, Phosphate, Silicate, Salinity, Alkalinity, Heavy metals, Mineralogy of bank and bed materials, etc. for assessing the seasonal variation of ecological environment of these rivers for maintaining alive and proper river ecology for survival of lives around the rivers. So present study is to compare the river eco-system of two rivers where one has little pollution sources and other has enormous pollution sources so that we can understand how pollution is threatening lives and river ecology and deficiency in our measure to protect our environment and lives.

The specific objectives of this research work are:

- Exert the influence of the hydrological variables to the river ecosystems.
- Biomass, abundance and distribution of available phytoplankton and benthic diatoms of the study area.
- Seasonal variation of physicochemical parameters.
- Seasonal variation of heavy metals and minerals on water, sediment and bank soils.
- Seasonal variation of biological parameters including Phytoplankton.
- Try to detail study about diatom function and ecology of river continuum.
- Determination of ecological quality of the study area.
- Determination of new type of phytoplankton for Bangladesh.
- Determination of causes and origin of pollution.
- Way of mitigation against pollution.


Sample Collection from Shitalakhya River

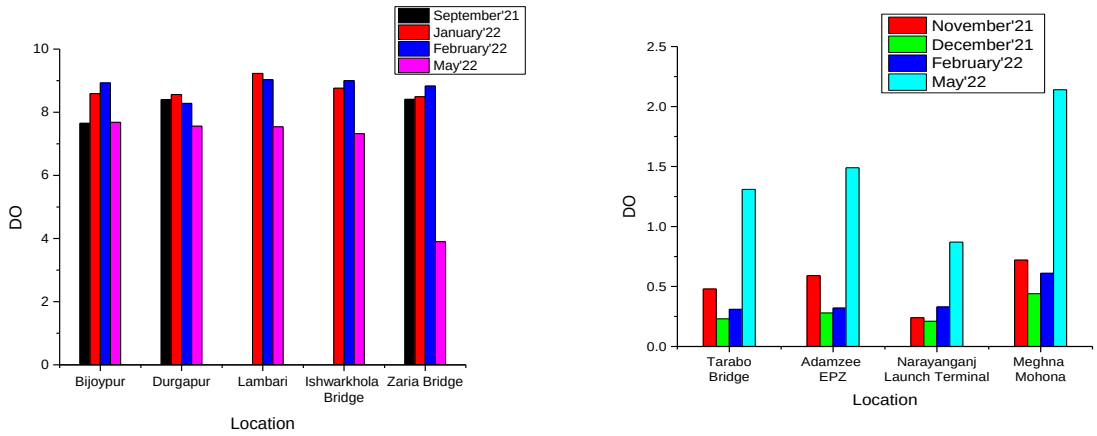
Sample Collection from Someshwari River

Duration: From April 2020 to June 2022)
Funding: GoB

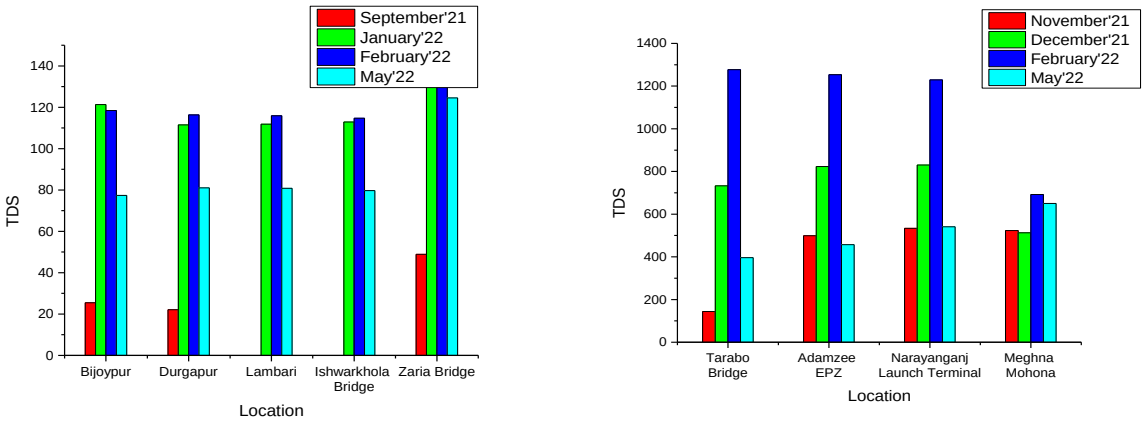
The research approved in April'2020 by Director General of River Research Institute. Four different periods for four seasons were selected for sample collection; five locations for Someshwari River, from BGB camp to kongsho- Someshwari confluence and five locations for Shitalakhya from Kanchan Bridge to Shitalakhya- Dholeswari confluence were selected. Some in-situ tests for PH, temperature, DO, TDS etc. were done during sample collection time. Water sample to test for heavy metal (Ni, Cr, As, Cd, Pb and Hg), SRP, SRS Chlorophyll a, Phytoplankton, macrophytes, BOD, COD, Chlorine, Bromine, SO4, PO4, etc were collected. Soil sample to test for heavy metal for Anions and Cations (K, Ca, Mg, Mn, Fe, So4, Cl, Po4, No3), Benthic Macro invertebrate, Benthic Diatom were collected.

So the phytoplankton, benthic macroinvertebrate, benthic diatoms and water quality parameters including nitrate, phosphate, silicate, dissolved oxygen and other physicochemical parameters were monitored during the study period. The variation in water quality parameters along the rivers were also surveyed over the study period to help to investigate the effects of cyanobacterial blooms on the water quality of the rivers.

Water Quality Parameters



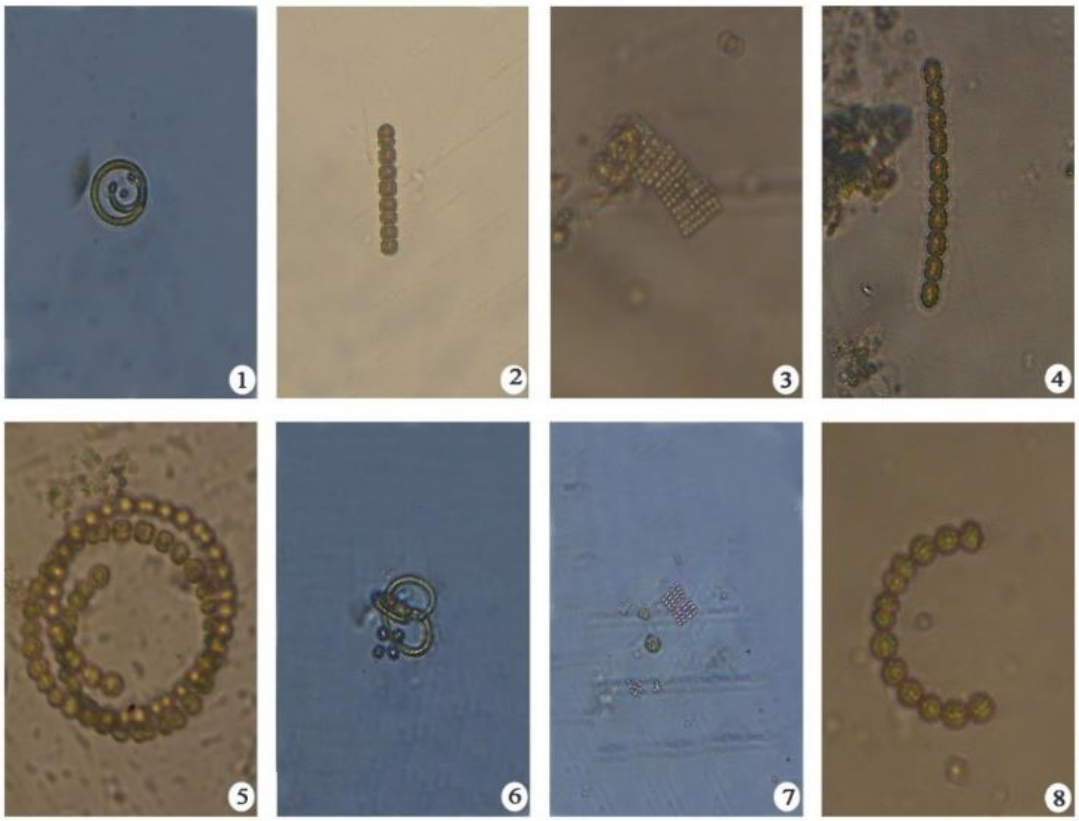
DO level of Someshwari River (left) and Shitolakhya River (Right)



TDS level of Someshwari River (Left) and Shitolakhya River (Right)

The results also showed that the following Cyanobacterial blooms were observed:

Shitalakkhya River	Someshwari River
1. Anabaena affinis Lemm.	1. Anabaena ballyganglii J. C. Banerji
2. A. ballyganglii J. C. Banerji	2. Cylindrospermopsisraciborskii (Wolosz.) Seenayya & SubbaRaju
3. A. california O. Borge	3. Merismopediaelegans A. Br. ex Kütz.
4. A. orientalis Dixit	4. OscillatoriageitlerianaElenkin
5. A. utermöhliiGeitler	5. PelonemaaphaneSkuja
6. A. variabilisKuetz ex Born	6. SpirulinagiganteaSchmidle
7. AnabaenopsisarnoldiiAptkerj	7. Sp. laxa G. M. Smith
8. An. elenkinii Miller	
9. An. raciborskiiWolosz.	
10. An. tanganikae (West) Wol.	
11. Cylindrospermopsisraciborskii (Wolosz.) Seenayya & SubbaRaju	
12. CylindrospermumdoryphorumBrühl	
13. GomphosphaerialacustrisChodat	
14. Merismopediaelegans A. Br. ex Kütz.	
15. Me. minima Beck	
16. Me. punctataMeyen	
17. MicrocystisaeruginosaKütz.	
18. Mic. flos-aquae (Wittr.) Kirch.	
19. OscillatoriageitlerianaElenkin	
20. O. geminate Menegh.	
21. O. irrigua (Kütz.) Gomont	
22. O. limosa Ag. ex Gomont	
23. O. pseudogeminata G. Schmid.	
24. PelonemaaphaneSkuja	
25. SpirulinagiganteaSchmidle	
26. Sp. laxa G. M. Smith	



Phytoplankton species found in Someshwari River 1) Raphidiopsis sp. 2) Anabaena sp. 3) Merismopedia sp. 4) Anabaena sp. 5) Anabaenopsis sp. 6) Spirulina sp. 7) Merismopedia sp. 8) Anabaena sp.

Cyanobacterial blooms

In this investigation different cyanobacterial blooms (Microcystis, Anabana, Nostoc, Oscillatoria, Anabaenopsisetc) were found which are toxic to the river water of Shitalakkhya. These bacteria can severely damage water ecosystems, causing fish and plants to suffocate and die.

Cyanobacterial blooms also create problem to the water quality and unsafe for animals and people by releasing cyanotoxins into the water. Massive growth of cyanobacteria (blue–green algae), leading to the production of blooms, scums, and mats can also occur in nutrient-enriched water bodies throughout the world.

Cyanobacterial mass accumulations attract the attention of water authorities and utilities, environmental and health agencies, and water-user groups, since they present water-treatment, supply, conservation, and health problems. The position of cyanobacteria in the priorities for the management and protection of water quality in countries where health problems associated with the toxins have been perceived. Health hazards presented by cyanobacterial toxins and derived risk assessments are likely to increasingly influence the ranking of eutrophication problems among water quality issues in drinking and recreational waters.

Spirulina

The river water of Shitalakhya contains Spirulina. Spirulina is rich in a range of vitamins and minerals essential for maintaining a healthy immune system, like vitamins E, C, and B6. Research finds that Spirulina also boosts the production of white blood cells and antibodies that fight viruses and bacteria in your body. But, this Spirulina is not hygienic because of pollution in the river. At first, This Spirulina should be collected from river water then it should be purified through pure ex-situ culture.

The research also showed that, with the increasing rate of the concentration of nutrients accelerate the growth of cyanobacteria. When cyanobacterial particles were largely decomposed, and chlorophyll a content from the phytoplankton collected from the river decreased. The results indicated that cyanobacterial blooms have a great impact on the water quality of surrounding rivers.

HUMAN RESOURCE 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.

RRI scientists and officers participated in different trainings and workshops during the 2021-2022 fiscal year at RRI and outside of RRI. The title and duration of these training programs and seminars were as the following:

Sl No	Title of the training / Seminar	Duration
1.	Training on Concept and Practices of Integrated Water Resources Management	25/10/2021-31/10/2021
2.	Training on Grievance Redress System and GRS Software	10/12/2021
3.	Training on Service Delivery in accordance with serial no. 1.3.1 of Citizen's Charter Implementation Action Plan 2021-2022	10/12/2021
4.	Training on Learning Session on Contemporary Issues	26/12/2021
5.	Training on National Integrity Strategy	27/12/2021
6.	Training on Progress Observation and Monitoring of Service Process Simplification (SPS)	06/01/2022
7.	Workshop on Delta Plan 2100	30/01/2022
8.	Training on Oceanography: Principles and Applications	26/02/2022 to 12 Weeks
9.	Training on Development Project Processing and Management	14/02/2022-17/02/2022
10.	Training on Modern office Management	13/03/2022-24/03/2022
11.	Training on Audit Issues	28/03/2022
12.	Training on Anti Corruption Act and Rules	29/03/2022
13.	Training on Information and Communication Technology	17/04/2022-28/04/2022
14.	Training on Secretariat Instruction-2014	16/05/2022
15.	Training on e-Filling and Unicode Font	27/05/2022
16.	Training on Service Simplification and Service Digitization	24/05/2022
17.	Training on What to do to meet the Challenges of 4IR	25/05/2022
18.	Training on Learning Session on Contemporary Issues (Water Resources: Past, Present and Future)	31/05/2022
19.	Training on the Application of Drones for Environmental Monitoring, Flight, Navigation, and Safety Knowledge	18/05/2022-09/06/2022

A view of participants in the in-house training

MONETARY 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 2019-2020 and 2020-2021 are given hereafter:

Earnings and Expenses for the fiscal year 2021-2022

Earnings		Expenses	
Items	**Taka (Lakh)**	**Items**	**Taka (Lakh)**
Govt. grant	1695.90	Establishment: • Officers salary 282.93 • Staff salary 402.52 • Allowances 439.85 • Supply and services 329.91 • Retirement benefit assistance 150.06 • Research Grant 34.57 • Capital expenditure 20.74 • Refund of non-expended money 35.32	1695.90
Model study	59.74	Model study	57.09
Geotechnical testing fee	23.41	Geotechnical testing	14.08
Others	52.71	Surplus (+)	64.69
Total	**1831.76**	**Total**	**1831.76**

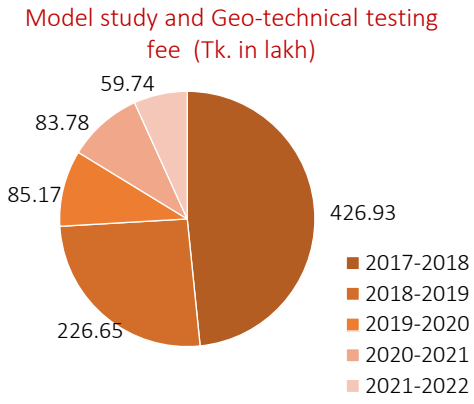
Earnings and Expenses for the fiscal year 2020-2021

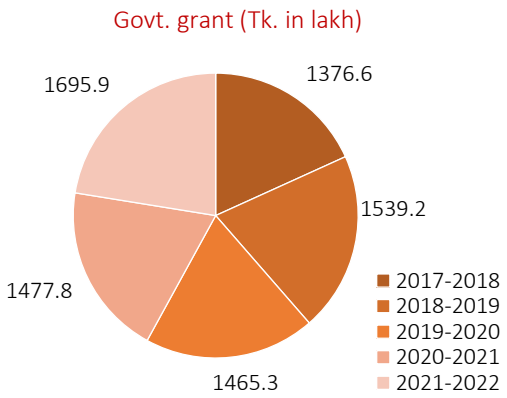
Earnings		Expenses	
Items	**Taka (Lakh)**	**Items**	**Taka (Lakh)**
Govt. grant	1477.80	Establishment: • Officers salary 236.25 • Staff salary 364.83 • Allowances 554.16 • Supply and services 210.99 • Capital expenditure 101.13 • Refund of non-expended money 10.44	1477.80
Model study	45.07	Model study	18.15
Geotechnical testing fee	38.71	Geotechnical testing	15.99
Others	43.47	Surplus (+)	93.11
Total	**1605.05**	**Total**	**1605.05**

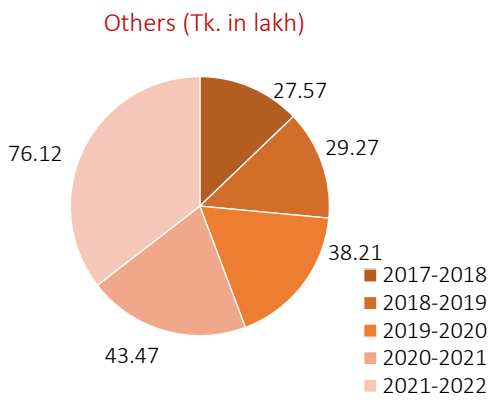
Significant features of RRI's earnings, expenses and closing balance in recent years (last 5 years) are given here.

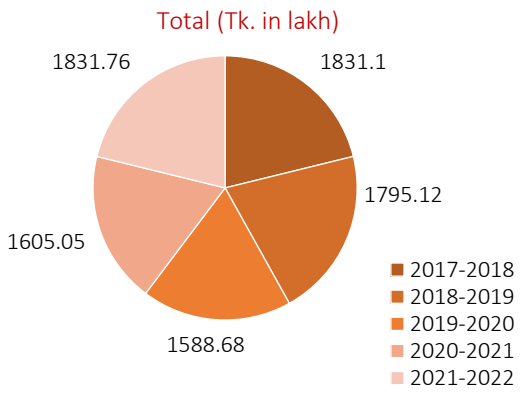
Earnings

Sl. No.	Sources of income	Total (Tk. in lakh)				
		2017-2018	2018-2019	2019-2020	2020-2021	2021-2022
1	Model study & geo-technical testing fee	426.93	226.65	85.17	83.78	59.74
2	Govt. grant	1376.60	1539.20	1465.3	1477.80	1695.90
3	Others	27.57	29.27	38.21	43.47	76.12
	Total	**1831.10**	**1795.12**	**1588.68**	**1605.05**	**1831.76**





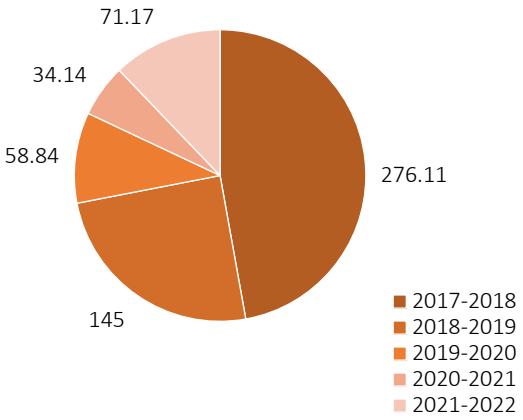




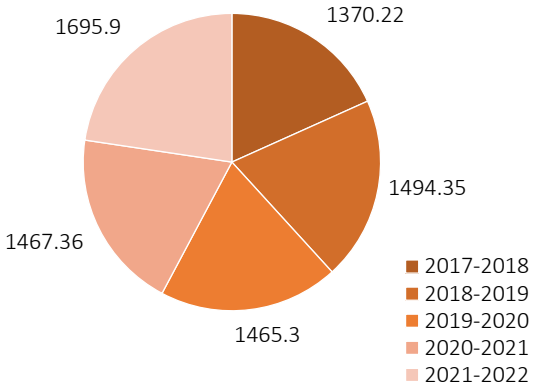
Expenses

Sl. No.	Description	Total (Tk. in lakh)				
		2017-2018	2018-2019	2019-2020	2020-2021	2021-22
1	Model study and Geo-technical testing.	276.11	145.00	58.84	34.14	71.17
2	Establishment	1370.22	1494.35	1465.3	1467.36	1695.90
3	Refund of non-expended money	6.38	44.85	36.65	10.44	64.69
	Total	**1477.06**	**1652.71**	**1560.79**	**1511.94**	**1831.76**

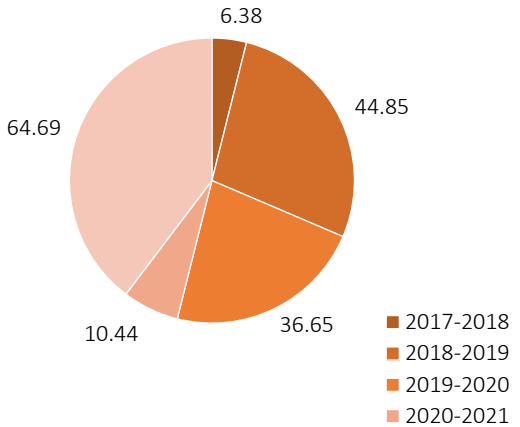
Model study and Geo-technical testing fee (Tk. in lakh)



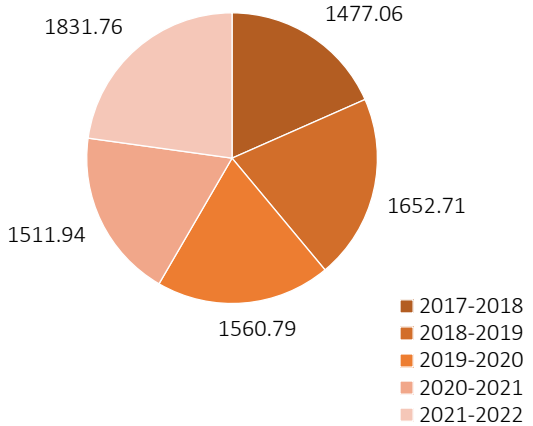
Establishment (Tk. in lakh)



Refund of non-expended money (Tk. in lakh)



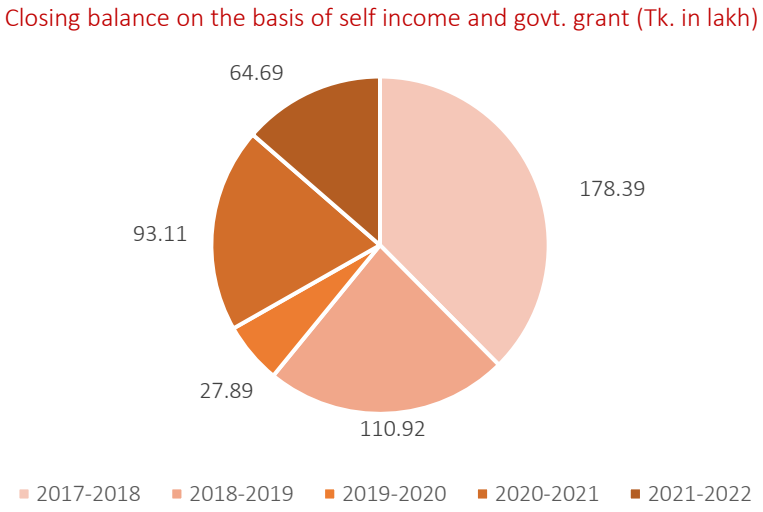
Total (Tk. in lakh)



Closing balance

Sl. No.	Description	Total (Tk. in lakh)				
		2016-2017	2017-2018	2018-2019	2019-2020	2020-2021
1	Closing balance on the basis of self-earnings and govt. grant	(+) 104.92	(+) 178.39	(+) 110.92	(+) 27.89	(+)93.11

NB: (+) indicates surplus.



INVENTORY OF PROJECTS WITH REVENUE RECEIVED

The revenue earned in the last fiscal year (2021-22) from the model studies conducted by Hydraulic Research Directorate (HRD) and from the sample test accomplished by Geotechnical Research Directorate (GRD) are given here.

Name of the models in HRD with estimated cost and money received during the fiscal year 2021-22

Sl. No.	Name of the model	Total estimated cost (Tk in lakh)	Money received during 2020-21 (Tk in lakh)	Remarks
1	Physical Modeling Studyfor Dredging and Bank Protection Works along Tetulia River at Bakergani and Bauphol Upazillas under Barishal and Patuakhali Districts	1.90	59.74	Shall be Completed in the fiscal year 2022-23
	Total	1.90	59.74	

Volume of works done by GRD and revenue earned during the fiscal year 2021-22

Sl. No.	Name of the discipline	Total no. of samples tested	Total billed (Tk. in lakh)	Money received (Tk. in lakh)
1	Soil Mechanics & Ground Water Division	Disturbed-380 Undisturbed-00	3.63	3.63
2	Material Testing and Quality Control.	366	13.03	13.03
3	Sediment, Chemical and Water Pollution.	1222	6.30	6.00
	Total	1968	22.96	22.66

DEVELOPMENT AND FUTURE 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 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 Bogura 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 on-going 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, 3rdKarnafullyRoadway 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.

ANNEXURES

Padma Multipurpose Bridge

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Note: Sequence of the officials in the list has been maintained in accordance with the official gazette of the Government of the People's Republic of Bangladesh published on February 9, 2020.

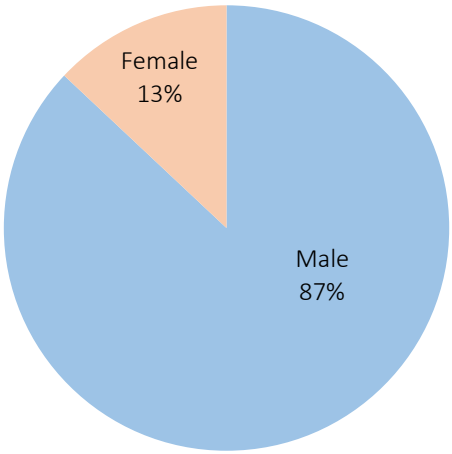
ABBREVIATIONS

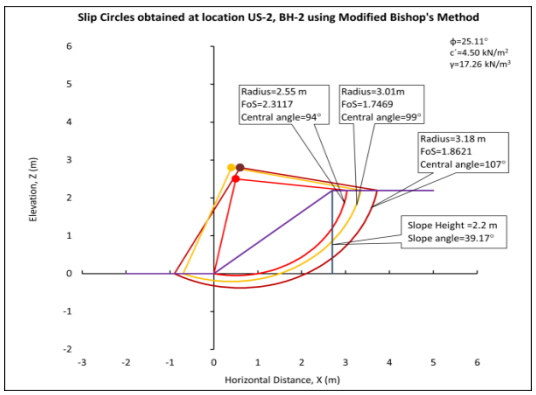
A	AD	Assistant Director
	ADB	Asian Development Bank
	AFPM	Active Flood Plan Management
	A & F	Administration and Finance
	A & FD	Administration and Finance Directorate
	AIT	Asian Institute of Technology
	ASTM	American Society for Testing Materials
	ASO	Assistant Scientific Officer
B	B.A	Bachelor of Arts
	BAU	Bangladesh Agricultural University
	BARD	Bangladesh Academy for Rural Development
	BCA	Bangladesh Crystallographic Association
	BCL	Bangladesh Consultant Limited
	BCSIR	Bangladesh Council of Scientific and Industrial Research
	BIAM	Bangladesh Institute for Administrative Management
	BIM	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
C	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
D	DDC	Design Development Consultants Limited
	DC	Deputy Commissioner
	DD	Deputy Director
	DG	Director General
	DHI	Danish Hydraulic Institute
	DIFPP	Dhaka Integrated Flood Protection Project
	Dip.	Diploma
	DPP	Development Project Proforma
	D/S	Downstream
	DU	Dhaka University
E	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

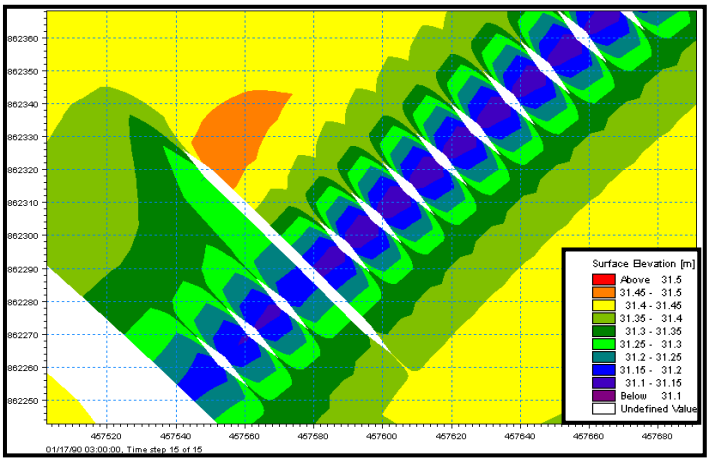
E	ESIA	Environmental impact statement
	ENGG.	Engineering
F	FAP	Flood Action Plan
	FCDI	Flood Control, Drainage & Irrigation
	F-IEB	Fellow of the Institution of Engineers, Bangladesh
	FM	Fineness Modulus
	FPM	Farm Power and Machinery
G	GBSP	Ganges Barrage Study Project
	GDP	Gross Development Profit
	GHH	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
H	Hons	Honours
	HP	Horse Power
	HR	Hydraulic Research
	HRD	Hydraulic Research Directorate
	HRL	Hydraulic Research Laboratory
I	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
J	JOCL	Japan Overseas Consultants Limited.
	JU	Jahangirnagar University
	JnU	Jagannath University
K	KUET	Khulna University of Engineering & Technology
	KUL	Katholic University of Leuven
	KVA	Kilo Volt Ampere
L	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	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
M	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
N	NHC	North Hydraulic Consultants Limited
	NMC	Natural Moisture Content
	NU	National University
	NAHRIM	National Hydraulic Research Institute Malaysia
	NHC	North Hydraulic Consultants Limited
	NOAMI	National Oceanographic and Maritime Institute
O	O & M	Operation & Maintenance
	OTM	Open Tendering Method
P	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
R	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
S	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
T	TDS	Total Dissolved Solids
	ToR	Terms of Reference
	TU	Technical University
U	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
W	WR	Water Resources
	WRDP	Water Resources Development Project
	WRE	Water Resources Engineering
	WRM	Water Resources Management
	WRS	Water Resources Survey







Professional staff in 2022

Directorate	DIR	CSO	PSO	SSO	SO	TOTAL
Hydraulic Research	-	1	2	6	2	11
Geotechnical Research	-	1	3	4	1	9
Administration and Finance	1	-	-	-	1	2
Total	2	3	7	4	15	30

DIR: Director, CSO: Chief Scientific Officer, PSO: Principal Scientific Officer, SSO: Senior Scientific Officer, SO: Scientific Officer

Directorate-wise total employee in 2022

Directorates	1st Class	2nd Class	3rd Class	4th Class	TOTAL
Hydraulic Research	15	-	13	12	40
Geotechnical Research	12	-	33	14	59
Administration and Finance	10	01	33	31	75
Total	37	01	79	57	174

ANNUAL REPORT

2021-22

River Research Institute

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