BANGLADESH WATER DEVELOPMENT BOARD

PROJECT COMPLETION REPORT: IMED-04/2024

Name of the Project: **Detailed Study for Riverbank Erosion Prediction and Sustainable Mitigation Strategies for the Medium Rivers in Bangladesh**

PROJECT PERIOD: May 2022 to June 2024

Directorate of Planning-1

Bangladesh Water Development Board

Government of the People's Republic of Bangladesh
Ministry of planning
Implementation Monitoring and Evaluation Division

PROJECT COMPLETION REPORT (PCR): IMED 04/2024 (Revised)

A. PROJECT DESCRIPTION

01.	Name of the Project	:	**Detailed Study for Riverbank Erosion Prediction and Sustainable Mitigation Strategies for the Medium Rivers in Bangladesh (Project code- 224357700)**
02.	Administrative Ministry/Division	:	Ministry of Water Resources (MoWR)
03.	Executing Agency	:	Bangladesh Water Development Board (BWDB)
04.	Planning Commission Sector/Division	:	Environment, Climate change and Water Resources
05.	Type of Project (Investment/Technical/Feasibility Study): Feasibility Study		
06.	Location of the Project (As per Project Document): **Bangladesh**		

Sl. No	Division	District	City Corporation/ Municipality/Upazila
Entire Bangladesh			

07. Estimated Cost, Implementation Period and Approval: (In Lakh Taka)

Subject	Approved Estimated Cost				Implementation Period	Date of Approval	Approved by
	Total	GOB (Foreign Exchange)	PA (RPA)	Self-finance			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Original	388.00	388.00			May 2022- July 2023 (15 months)	01.06.2022	MOWR
1st No Cost Extension (If Applicable)					May 2022- June 2024 (26 months)	11.07.2023	MOWR

08. Objective of the Project

Overall objective: The main objective of the study is to predict riverbank erosion, vulnerability assessment and recommend appropriate solutions for protective measures for the medium rivers of Bangladesh.

Specific Objectives (in bullets):

- Identification of causes that trigger erosion vulnerability;
- Development of Erosion Prediction tool through planform analysis using satellite images and mathematical modelling;
- Development of the automation tool for riverbank erosion prediction;

- Development of strategies for sustainable erosion mitigation measures;
- Prediction and prioritization of probable erosion vulnerable locations with different probability lines;
- Assess disaster impact and prepare mitigation plan;
- Design of the proposed protective structures;

09.Background of the Project (In brief):

Bangladesh lies in the deltaic deposits of the Ganges-Brahmaputra-Meghna River system, more commonly known as the Bengal Delta that forms the second largest delta in the world. About 400 rivers including their tributaries and distributaries have crisscrossed this low-lying delta plain before ultimately emptying into the Bay of Bengal in the south. Every year these rivers carry about one trillion cubic meters of water and one billion tons of sediments. The huge amount of sediment is the main driver behind the dynamic morphological nature of our rivers. Bankline shifting and avulsion are some of the frequent phenomena that the rivers go through as they are still adjusting with the delta formation process. The alluvial floodplains of the rivers are prone to erosion as they are composed of highly unconsolidated and erodible sediments. Monsoon floods associated with severe riverbank erosion hit the country every year grasping thousands of hectares of floodplains. Ever since the industrial revolution, a large number of modern factories, industries, infrastructures are built near the riverbanks due to smooth transportation and communication developments. Agricultural lands thrive on the ease of availability of water from river flow, the livelihood of people living along the banks and in the char areas revolve around the rivers. Riverbank erosion, one of the most unpredictable natural hazards, poses a substantial threat to the existence of all such things. However, with the advancement of the latest technology, it is now possible to predict the potential location and spatial extent of bank erosion to a certain degree of accuracy.

Thus, it has been now sixteen years that the predictions for the mentioned major rivers are made accessible to numerous national organizations. These organizations are responsible for proper river management such as planning and designing the bank protection works as well as for implementing any emergency interventions.

However, erosion prediction for the medium rivers (e.g. the tributaries and distributaries of the major rivers) holds crucial importance as much as the major ones do. Most of the rivers in our country are either distributary or tributary or internal branches of the major rivers and a large number of people make their livelihoods living under the risky condition of frequent flooding and erosion from those rivers. As a result, lately, there has been an emerging need to predict the morphological behavior of those rivers in addition to the major rivers.

This concept note attempts to make predictions for the morphological changes and assess the erosion vulnerability of different attributes in some of the medium rivers of Bangladesh. Initially, erosion-prone medium rivers will be selected from different hydrological regions of Bangladesh. The river selection criteria will be based on literature reviews and analysis of time-series satellite images as well as available secondary data sources. Then, it attempts to identify the main drivers/causes that outline the prevailing hydro-morphological behavior of the medium rivers. In addition, it proposes a variety of mitigation measures required to minimize the socio-economic loss caused by riverbank erosion.

Finally, the study intends to go for a pilot experiment i.e. initial small-scale implementation of the overall process- from making predictions to planning and design of the erosion preventive measures- in the selected medium rivers. The purpose of piloting this study is to establish and improve the holistic framework developed for reducing riverbank erosion in the medium rivers, so that it can be eventually applied to the major/big rivers of Bangladesh in full-scale, where the erosion rates are significantly much higher.

10.Major Activities:

The major activities of the work will include, but will not be limited within the followings:

- Reviewing past reports and scientific research papers to study the morphological state of the medium rivers;
- Analyzing the hydrology and geo-morphology of the rivers;
- Collection, Processing and analysis of satellite images;
- The hydrological data collected in Flood Forecasting and BWCSRP projects will be considered in this project;
- Providing a comprehensive understanding of the overall base morphology of the rivers with significant parameters like planform, historical development, changes in width, sinuosity by analyzing old maps and time-series satellite images;
- Studying the development processes of meandering bends, assess the life span of the eroding bends including the rate and direction of the migration of the meandering bends;
- Identification of the parameters of the meandering bends that trigger riverbank erosion of the rivers;
- Identifying the trend of erosion-accretion along the banks of the rivers and assess the spatial and temporal variation of the erosion-accretion rate;
- Identifying the interconnectivity of the rivers in the upstream area;
- Setting, calibration and validation of the mathematical modelling;
- Velocity pattern and scour depth assessment through mathematical modeling;
- Developing a set of erosion prediction tool for the selected medium rivers based on their unique hydro-morphological characteristics and updating the prediction tool every year;
- Development of the automated tool for riverbank erosion prediction one-year ahead;
- Development of Risk Map;
- Outlining the existing erosion mitigation measures for bank protection that are widely used in the country;
- Identifying suitable bank protection measures and evaluating the stability of the protective structures and prioritizing Erosion Vulnerable Locations;
- Recommending the best option from the available mitigation measures that will be appropriate for a particular eroding bend of a river based on the evaluation;
- Designing the suitable bank protection structure along the erosion vulnerable reaches;
- Assessing socio-economic characteristics;
- Cost-benefit analysis of all components;

- Conduct KII, FGD, workshop and other types of mass discussion session for communicating with local beneficiaries and disseminating the study outputs;
- Disseminating the knowledge established on morphological development of the medium rivers and engineering design of protective works through interactive training and workshop.

11. Reasons for Revision (if applicable):

11.1 Reasons for No-Cost Time Extension (if applicable):

- 1st time No-Cost Time Extension
  Additional time required to collect river erosion data from different areas at the field level to determine and validate sustainable erosion mitigation strategies.

12. Financing Arrangement (Source-wise):

12.1 Status of Loan/Grant

a) Foreign Financing:

Source (s)	Currency as per Agreement	Amount in US$ (million)	Nature (Loan/Grant/supplier's credit)	Date of Agreement	Date of Effectiveness	Date of Closing	
						Original	Revised
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)

b) GOB:

Total amount	Loan	Grant	Cash Foreign Exchange
(1)	(2)	(3)	(4)
388.00	-	388.00	-
388.00	-	388.00	-

c) Self-finance/Equity:

Total amount	Self-finance	Equity	Cash Foreign Exchange
(1)	(2)	(3)	(4)

12.2 Utilization of Project Aid (Source wise):

Source (s)	Total Amount		Actual Expenditure		Unutilized Amount	
	In Us$	In Local Currency	In Us$	In Local Currency	In Us$	In Local Currency
(1)	(2)	(3)	(4)	(5)	(6)	(7)

12.3 Reimbursable project Aid (RPA):

Source (s)	RPA Amount		Amount	Amount	Amount	Remarks
	As per Project Document	As per Agreement	Spent	Claimed	Re-imbrued	
(1)	(2)	(3)	(4)	(5)	(6)	(7)

B. IMPLEMENTATION POSITION

13. Implementation Period:

Implementation Period as per Project Document		Actual implementation	Time Over-run (% of original implementation period	Remarks
Original	Latest Revised			
(1)	(2)	(3)	(4)	(5)
June 2022-July 2023 (14 months)	June 2022-June 2024 (25 months)	June 2022- June 2024 (25 months)	78.57 %	Additional time required to collect river erosion data from different areas at the field level to determine and validate sustainable erosion mitigation strategies

14. Cost of the Project:

Description	Estimated Cost		Actual expenditure	Cost over-run (% of original cost)	Remarks
	Original	Latest revised			
(1)	(2)	(3)	(4)	(5)	(6)
TOTAL	388.00		327.87	-15.50%	
TAKA	388.00		327.87		

15. Information regarding Project Director (s):

Name, Main Designation & Grade. Mobile Number (From Beginning)	Full time (Yes/No)	Part time (Yes/No)	Responsible for more than one project	Period		Remarks
				Joining	Transfer	
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dr. Robin Kumar Biswas Superintending Engineer (Civil) Directorate of Planning-1 BWDB, Dhaka Grade-4 (50,000 to 71,200) Mobile:01884415967	Yes	No	Yes	21.06.2022	Till date	

16. Personnel:

16.1 Personnel of Project implementation Unit (PIU):

Sl. No.	Name of Post (Grade)	Approved Strength	Employed during Implementation
(1)	(2)	(3)	(4)
1	Executive Engineer(Grade-5)	3	
2	Sub-divisional Engineer(Grade-6)	2	
3	Research Officer(Grade-9)	1	
Total=		6	

16.2 Personnel Required after the Project Completion: N/A

Sl. No.	As Preposed in Project Document (PD)		Recruited (Yes/No)	If not recruited explain reason and latest status
	Name of Post	Number		
(1)	(2)	(3)	(4)	(5)
Total=				

17. Training (Foreign/Local): N/A

Category	Sl. No.	No. of Days/Weeks/Months (D/W/M), Batch & Participants					
		As in Project Document			Achievement		
		D/W/M	Batch (s)	Participants(s)	D/W/M	Batch (s)	Participants(s)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Local Training							
Sub Total=							
Foreign Training							
Sub Total=							
Total=							

(PD= Project Document)

18. Component-wise Progress (As per latest approved Project Document):

Name of Component	Unit	Quantity	Estimated Cost (Taka in Lac)					Actual Progress (Taka in Lac)				
			Total	GOB	PA	Self-finance	Others	Total	GOB	PA	Self-finance	Others
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
(a) Revenue:												
1. Feasibility Study (Local Professionals 56.00 Man-month)	MM	56.00	371.68	371.68				323.37	323.37			

Name of Component	Unit	Quantity	Estimated Cost (Taka in Lac)					Actual Progress (Taka in Lac)				
			Total	GOB	PA	Self-finance	Others	Total	GOB	PA	Self-finance	Others
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
2. Computer Consumables	LS		1.07	1.07				1.05	1.05			
3. Printing & Binding	LS		0.50	0.50				0.48	0.48			
4. Map	LS		1.00	1.00				0.96	0.96			
5. Honorarium	LS		7.50	7.50				0.11	0.11			
6. Domestic travel expenses	LS		2.00	2.00				0.76	0.76			
7. Fuel and Gas	LS		1.00	1.00				0.00	0.00			
8. Petrol,Oil and Lubricants	LS		1.00	1.00				0.17	0.17			
9. Entertainment Expenses	LS		1.00	1.00				0.00	0.00			
Sub-total (Revenue)			**386.75**	**386.75**				**326.90**	**326.90**			
(b) Capital												
10. Supply of 1 Laptop			1.25	1.25				0.98	0.98			
Sub-total (Capital)			1.25	1.25				0.98	0.98			
Total a+b (Revenue+ Capital)			**388.00**	**388.00**				**327.88**	**327.88**			

19. Procurement of Transport (in Nos.) :

Type of transport	Number as per Project Document	Number Procured with date	Transferred to Transport Pool with date	Transferred to O & M with date	Condemned/ damaged with date	Returned or transferred to following project	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Car							
Jeep							
Microbus							
Minibus							
Bus							
Pick-up							
Truck							
Motor - Cycle							
By-cycle							

Type of transport	Number as per Project Document	Number Procured with date	Transferred to Transport Pool with date	Transferred to O & M with date	Condemned/ damaged with date	Returned or transferred to following project	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Speed Boat							
Launch							
Others with name							

20. Project Consultant (s) (Local/Foreign):

Name of the Field	Approved man month		Actual man month utilized	Number of Deliverables		Remarks
	As per Project Document	As per contract		As per Project Document	Actual	
(1)	(2)	(3)	(4)	(5)	(6)	(7)
a) Local:						
CEGIS	56	56	56	5	5	
b) Foreign:						

21. Infrastructure/Erection/Installation Tools & Equipment:

Description	Quantity (as per project document)	Quantity Procured with date	Transferred to O & M with date	Disposed-off as per rule with date	Balance	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)

22. Procurement of Goods, Works and Services:

22.1 Information on packages:

a) Total number of packages as per Project Document: (Goods- 2, Works-N/A, Services- 1)

b) Total number of packages procured:(Goods- 2, Works- N/A, Services-1)

c) Reason for not procuring (if any): N/A

d) Number of packages for which the estimated cost is more than 1% of the estimated cost of the project: N/A

22.2 Detailed Package-wise information of Goods, Works and Services (For each case the highest 50 (fifty) packages) (Please use the format as in Annexure-I (a), I(b) and I(c))

C. FINANCIAL AND PHYSICAL TARGET AND PROGRESS

23. Original and Revised Financial Provision and physical Target (as per Project Document):

Financial Year	Financial provision & physical target as per Original Project Document						Financial provision & physical target as per latest revised Project Document					
	Total	GOB	P.A.	Self-finance	Others	Physical %	Total	GOB	P.A.	Self-finance	Others	Physical %
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
2022-23	165.00	165.00	-	-	-	42.49%	-	-	-	-	-	-
2023-24	211.00	211.00	-	-	-	55.94%	-	-	-	-	-	-
Total=	376.00	376.00	-	-	-	98.43%	-	-	-	-	-	-

24. Revised ADP allocation and progress:

Financial Year	Revised Allocation & target						GOB Release	Expenditure & physical progress						Unspent* GoB Released
	Total	GOB	P.A.	Self-Finance	Others.	Physical %		Total	GOB	P.A.	Self-Finance	Others.	Physical %	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)= 8-10
2022-23	165.00	165.00	-	-	-	42.49%	163.21	158.18	158.18	-	-	-	44.06%	5.03
2023-24	211.00	211.00	-	-	-	55.94%	188.65	169.70	169.70	-	-	-	53.25%	18.95
Total=	376.00	376.00	-	-	-	98.43%	351.86	327.88	327.88	-	-	-	97.31%	23.98

*Attach the Proof for Reconciliation of Unspent GOB Released

**To determine the physical quantity, use the formula as in the circular of Planning Division

D. ACHIEVEMENT OF OBJECTIVES OF THE PROJECT

25. Project objective, Actual achievement and Reason for shortfall (if any):

Objectives as per Project Document	Actual achievement	Reasons for shortfall (if any)
a) Identification of causes that trigger erosion vulnerability	Based on an extensive literature review and prevailing hydro-morphological processes, important key parameters contributing to riverbank erosion have been identified, encompassing both hydraulic and geotechnical parameters. These include width, radius of curvature, flow velocity, sediment size, channel bed slope, channel cross-section depth, and Manning's n, among others. These factors are essential for predicting areas at risk and developing targeted interventions. These parameters have been used to develop the erosion prediction tools. The final report of the study has been attached in Annexure 2. Please see Chapters 03, 04 and 05 for details.	
b) Development of Erosion Prediction tool through planform analysis using satellite images and mathematical modelling;	It is the first initiative to develop erosion prediction tools both using satellite images and mathematical modelling and machine learning as well. A comprehensive set of erosion-prediction tools has been developed, integrating planform analysis using satellite images with mathematical modelling techniques. Three methods were employed in the prediction tasks: probabilistic methods, deterministic approaches, and various machine learning models due to their effectiveness and popularity in erosion-prediction tasks. Erosion prediction tools using the above methods can identify the vulnerable locations not only in the meandering bends but also in the reach of a river. Developed tools also take into consideration the presence of bank protection works along banks where there will be no erosion. The final report of the study has been attached in Annexure 2. Please see Chapters 06 and 07 for details.	
c) Development of the automation tool for riverbank erosion prediction	This part is the biggest achievement of this study. No such tools were automated before. As a result, tools can predict the extent and magnitude of the lateral erosion automatically with accuracy. Tools have been automated in such a flexible way that any data can be incorporated in the future and it will automatically count the new values and their importance to improve the accuracy of the tools. Bankline delineation was an integral part of the development of prediction tools and the main input features for the development of the tools. As such, this process was automated under this project.	
	Google Earth Engine (GEE), a cloud platform for processing satellite imagery, was utilized for this task due to its extensive remote sensing data and flexibility in creating custom algorithms. Landsat images, with a spatial resolution of 30 meters, were selected due to their extensive historical availability, making them ideal for analyzing channel activity and changes over time. There is flexibility in the prediction tools to improve detection accuracy by incorporating Sentinel images, which offer a higher resolution of 10 meters or more higher resolution in future. The final report of the study has been attached in Annexure 2. Please see Chapter 5 (Section 5.3 and Section 5.4), Chapters 06 and 07 for details.	

Objectives as per Project Document	Actual achievement	Reasons for shortfall (if any)
d) Development of strategies for sustainable erosion mitigation measures;	Effective management of riverbank erosion requires a proactive approach. Sustainable mitigation measures have been developed and Policy implications for riverbank erosion have also been addressed. The final report of the study has been attached in Annexure 2. Please see Chapters 08 (Sections 8.1 and 8.3) for details.	
e) Prediction and prioritisation of probable erosion vulnerable locations with different probability lines	In this study, prediction tools have been developed to identify the erosion-vulnerable locations along both banks of the rivers. These prediction tools require more refinement before field-level application. Nevertheless, prioritization criteria have been included in the report. The final report of the study has been attached in Annexure 2. Please see Chapters 08 (Section 8.2) for details.	
f) Assess disaster impact and prepare mitigation plan;	Although, prediction tools are in the refinement phase disaster impact and mitigation plans are provided in the report. The final report of the study has been attached in Annexure 2. Please see Chapters 08 (Sections 8.1 and 8.2) for details.	
g) Design of the proposed protective structures	As the prediction tool is in the development phase, therefore no design has been made.	

E.BENEFIT ANALYSIS

26. Annual Out-put: Not applicable for study project

Items of out-put	Unit	Estimated quantity expected at full capacity	Actual quantity of out-put during the 1st year of operation at full capacity (or during, real production for newly completed project)

27. Cost/Benefit: Not applicable for study project

Item	Estimated	Actual

28. Please give reasons for shortfall, if any, between the estimated and actual benefit: Not applicable for study project.

E. MONITORING AND AUDITING

29. Monitoring: Not applicable for study project

Name & Designation of the inspecting official	Date	Identified Problems	Recommendations
1	2	3	4
a) IMED:			
b) Ministry/Agency:			
c) Others: (Please specify)			

30. Auditing during and after Implementation:

30.1 Internal Audit:

Period of Audit	Date of submission of Audit Report	Sl. No.	Major findings/objections and Money involved	Whether objections resolved or not (if not, mention status)
1	2	3	4	5
Total findings/objections and Money involved=				

30.2 External Audit:

Period of Audit	Date of submission of Audit Report	Sl. No.	Major findings/objections and Money involved	Whether objections resolved or not (if not, mention status)
1	2	3	4	5
Total findings/objections and Money involved=				

F. POST-PROJECT REMARKS

31. General Observations/Remarks on the Project

31.1 Background

Bangladesh lies in the deltaic deposits of the Ganges-Brahmaputra-Meghna River system, more commonly known as the Bengal Delta that forms the second largest delta in the world. About 400 rivers including their tributaries and distributaries have crisscrossed this low-lying delta plain before ultimately emptying into the Bay of Bengal in the south. Every year these rivers carry about one trillion cubic meters of water and one billion tons of sediments. The huge amount of sediment is the main driver behind the dynamic morphological nature of our rivers. Bankline shifting and avulsion are some of the frequent phenomena that the rivers go through as they are still adjusting with the delta formation process. The alluvial floodplains of the rivers are prone to erosion as they are composed of highly unconsolidated and erodible sediments. Monsoon floods associated with severe riverbank erosion hit the country every year grasping thousands of hectares of floodplains. Ever since the industrial revolution, a large number of modern factories, industries, infrastructures are built near the riverbanks due to smooth transportation and communication developments. Agricultural lands thrive on the ease of availability of water from river flow, the livelihood of people living along the banks and in the char areas revolve around the rivers. Riverbank erosion, one of the most unpredictable natural hazards, poses a substantial threat to the existence of all such things. However, with the advancement of the latest technology, it is now possible to predict the potential location and spatial extent of bank erosion to a certain degree of accuracy.

Thus, it has been now sixteen years that the predictions for the mentioned major rivers are made accessible to numerous national organizations. These organizations are responsible for proper river management such as planning and designing the bank protection works as well as for implementing any emergency interventions.

However, erosion prediction for the medium rivers (e.g. the tributaries and distributaries of the major rivers) holds crucial importance as much as the major ones do. Most of the rivers in our country are either distributary or tributary or internal branches of the major rivers and a large number of people make their livelihoods living under the risky condition of frequent flooding and erosion from those rivers. As a result, lately, there has been an emerging need to predict the morphological behavior of those rivers in addition to the major rivers.

This concept note attempts to make predictions for the morphological changes and assess the erosion vulnerability of different attributes in some of the medium rivers of Bangladesh. Initially, erosion-prone medium rivers will be selected from different hydrological regions of Bangladesh. The river selection criteria will be based on literature reviews and analysis of time-series satellite images as well as available secondary data sources. Then, it attempts to identify the main drivers/causes that outline the prevailing hydro-morphological behavior of the medium rivers. In addition, it proposes a variety of mitigation measures required to minimize the socio-economic loss caused by riverbank erosion.

Finally, the study intends to go for a pilot experiment i.e. initial small-scale implementation of the overall process- from making predictions to planning and design of the erosion preventive measures- in the selected medium rivers. The purpose of piloting this study is to establish and improve the holistic framework developed for reducing riverbank erosion in the medium rivers, so that it can be eventually applied to the major/big rivers of Bangladesh in full-scale, where the erosion rates are significantly much higher.

31.2 Justification/Adequacy

The extensive river system of Bangladesh play a vital role in the nation's socio-economic development sector and are a potential natural resource. Unfortunately, due to the dynamic nature of the rivers, millions of people are suffering every year. The conditions of the rivers are also deteriorating owing to a number of reasons- heavy sedimentation, poor off-take connection, unplanned human interventions etc. Moreover, most of the rivers in our country do not have any bank protective structures. In order to bring about economic growth and environment sustainability under various changing conditions, proper understanding of the river systems is required, especially in the area of water resources management.

The lack of balance between the available natural resources and a plan for the sustainable management of the resources against rising uncertainties has initiated the need to formulate strategic plans. Accordingly, the Government of Bangladesh has adopted two long-term strategic plans: Vision 2041 and Bangladesh Delta Plan 2100 (BDP 2100). The goal of Vision 2041 is the ultimate eradication of poverty and elevate the country status as High Income Country (HIC) by 2041. This vision is a continuation of Vision 2021. In addition, one of the aspects of Vision 2041 is to address the global commitment of achieving the Sustainable Development Goals (SDGs). On the other hand, Delta Plan 2100 is envisioned as a comprehensive plan with a holistic water resources management approach. Protecting the riverbanks and coastal lands from erosion is one of the proposed measures as part of the sediment management strategy to ensure sustainable and integrated river systems and estuaries management.

The country needs to maintain its current pace of development as well as implement effective tools that will eventually lead to achieving the long-term goals. Given the adopted long-term plans, the erosion prediction tool can be immensely beneficial to forecast erosion and will help in taking early actions to protect the riverbanks from erosion. Every year educational and religious institutes, health centers, disaster shelters, government and non-government organizations, agricultural lands, households, growth centers, roads, and embankments are being swallowed by bank erosion. According to a BWDB estimate in 2007, the economic damage caused by bank erosion was more than 75 million USD1. The financial loss was extreme at that time but the estimated value has reduced to some extent in the coming years. In 2019, riverbank erosion displaced at least three lakh people across the country and demolished the home of at least 8000 people in northern districts of the country during intense July floods2. The displaced people

fight with unemployment after losing their homes and agricultural lands. Early access to the erosion forecasting information can make the community living under the risk of bank erosion more conscious. If they knew that their land is going to be washed away in a few months, they would not plant the seeds or construct any new structure on it. In this way, necessary arrangements can be made beforehand that will save the country from a colossal amount of monetary loss as well as reduce the distress of the people. Therefore, they are the rightful people to get hold of the prediction data.

The prediction data can benefit its potential users in various ways. National organizations like Bangladesh Water Development Board (BWDB), Water Resources Planning Organization (WARPO), Department of Disaster Management (DDM), Local Government Engineering Department (LGED), Roads and Highways Department (RHD), Bangladesh Inland Water Transport Authority (BIWTA), and NGOs can use the erosion prediction and vulnerability results. For example, BWDB can use the prediction data for planning and maintaining their flood embankment, irrigation and bank protection structures or RHD for rehabilitation and planning of their infrastructure.

Predictions for the three major rivers- the Jamuna, the Ganges, and the Padma has been done successfully for the past sixteen years. There are many important medium rivers connected to the major rivers that experience severe erosion every year. It is, indeed, high time to gradually include the medium rivers under the erosion prediction tool. This will play a significant role in saving the natural and human resources, which will eventually bring the country a step closer to achieve its long-term goals.

31.3 Objectives

The main objective of the study is to predict riverbank erosion and vulnerability assessment and recommend appropriate solutions for protective measures for the medium rivers of Bangladesh. The specific objectives are as follows:

- Identification of causes that trigger erosion vulnerability;
- Development of Erosion Prediction tool through planform analysis using satellite images and mathematical modelling;
- Development of the automation tool for riverbank erosion prediction;
- Development of strategies for sustainable erosion mitigation measures;
- Prediction and prioritization of probable Erosion Vulnerable Locations with different probability lines;
- Assess disaster impact and prepare mitigation plan;
- Design of the proposed protection structures.

31.4 Project revision with reasons: Not applicable

32. Rationale of the project with respect to Concept, Design, Location and Timing (Consider the following issues):

The country needs to maintain its current pace of development as well as implement effective tools that will eventually lead to achieving the long-term goals. Given the adopted long-term plans, the erosion prediction tool can be immensely beneficial to forecast erosion and will help in taking early actions to protect the riverbanks from erosion. Every year educational and religious institutes, health centers, disaster shelters, government and non-government organizations, agricultural lands, households, growth centers, roads, and embankments are being swallowed by bank erosion. According to a BWDB estimate in 2007, the economic damage caused by bank erosion was more than 75 million USD1. The financial loss was extreme at that time but the estimated value has reduced to some extent in the coming years. In 2019, riverbank erosion displaced at least three lakh people across the country and demolished the home of at least 8000 people in northern districts of the country during intense July floods2. The displaced people

fight with unemployment after losing their homes and agricultural lands. Early access to the erosion forecasting information can make the community living under the risk of bank erosion more conscious. If they knew that their land is going to be washed away in a few months, they would not plant the seeds or construct any new structure on it. In this way, necessary arrangements can be made beforehand that will save the country from a colossal amount of monetary loss as well as reduce the distress of the people. Therefore, they are the rightful people to get hold of the prediction data.

The prediction data can benefit its potential users in various ways. National organizations like Bangladesh Water Development Board (BWDB), Water Resources Planning Organization (WARPO), Department of Disaster Management (DDM), Local Government Engineering Department (LGED), Roads and Highways Department (RHD), Bangladesh Inland Water Transport Authority (BIWTA), and NGOs can use the erosion prediction and vulnerability results. For example, BWDB can use the prediction data for planning and maintaining their flood embankment, irrigation and bank protection structures or RHD for rehabilitation and planning of their infrastructure.

Predictions for the three major rivers- the Jamuna, the Ganges, and the Padma has been done successfully for the past sixteen years. There are many important medium rivers connected to the major rivers that experience severe erosion every year. It is, indeed, high time to gradually include the medium rivers under the erosion prediction tool. This will play a significant role in saving the natural and human resources, which will eventually bring the country a step closer to achieve its long-term goals.

33. Brief description on planning and financing of the project and its applicability (Consider the following issues):

33.1 Project Identification

The project is being taken since erosion prediction for the medium rivers (e.g. the tributaries and distributaries of the major rivers) holds crucial importance as much as the major ones do. Most of the rivers in our country are either distributary or tributary or internal branches of the major rivers and a large number of people make their livelihoods living under the risky condition of frequent flooding and erosion from those rivers. As a result, lately, there has been an emerging need to predict the morphological behavior of those rivers in addition to the major rivers. Under this circumstance, the project is identified for implementation.

33.2 Project Preparation

This project is prepared with a view to making predictions for the morphological changes and assess the erosion vulnerability of different attributes in some of the medium rivers of Bangladesh. Initially, erosion-prone medium rivers will be selected from different hydrological regions of Bangladesh. The river selection criteria will be based on literature reviews and analysis of time-series satellite images as well as available secondary data sources. Then, it attempts to identify the main drivers/causes that outline the prevailing hydro-morphological behavior of the medium rivers. In addition, it proposes a variety of mitigation measures required to minimize the socio-economic loss caused by riverbank erosion.

Finally, the study intends to go for a pilot experiment i.e. initial small-scale implementation of the overall process- from making predictions to planning and design of the erosion preventive measures- in the selected medium rivers. The purpose of piloting this study is to establish and improve the holistic framework developed for reducing riverbank erosion in the medium rivers, so that it can be eventually applied to the major/big rivers of Bangladesh in full-scale, where the erosion rates are significantly much higher.

33.3 Appraisal

There has always been an emerging need to predict the morphological behavior of medium rivers in addition to the major rivers. To overcome this problem, a PFS is formulated by addressing the issues regarding the medium rivers in Bangladesh. A review meeting was held regarding the PFS of this. Decisions were taken and the PFS was corrected based on the decisions taken in that meeting. Finally the DPEC meeting held on 24/03/2022 and the project was approved on 01/06/2022.

33.4 Credit Negotiation: N/A
33.5 Credit Agreement: N/A
33.6 Credit Effectiveness: N/A
33.7 Loan Disbursement: N/A
33.8 Loan Conditions: N/A
33.9 Project Approval: N/A
33.10 Others(specify) : N/A

34. Analysis of the post- implementation situation and result of the project (Consider following issues):

34.1 Whether the beneficiaries of the project have clear knowledge about the Target/Objectives of the project.
34.2 Programme for use of created-facilities of the project
34.3 O & M Program of the project.
34.4 Impact of the project (Direct & Indirect)
34.5 Transfer of Technology and Institutional Building through the project.
34.6 Employment generation through the project.
34.7 Possibility of Self employment.
34.8 Possibility of Women-employment opportunity.
34.9 Women's participation in development.
34.10 Probable Impact on Socio-Economic activity.
34.11 Impact on environment.
34.12 Sustainability of the project.
34.13 Contribution to poverty alleviation/reduction.
34.14 Opinion of the public representatives, local elite, local administration, teachers, religious leaders, women's representatives etc.
34.15 Contribution of Micro-credit programs and Comments on overlapping with any NGO activities.

35. Problems encountered during Implementation (with duration & steps taken to resolve those) (Consider following issues):

35.1 Project management:
35.2 Project Director:
35.3 Land Acquisition:
35.4 Procurement:
35.5 Consultancy:
35.6 Contractor:
35.7 Manpower:
35.8 Law & Order:
35.9 Natural calamity:
35.10 Project financing:
35.11 Allocation and release:
35.12 Design formulation/approval:
35.13 Project aid disbursement and re-imbursement:
35.14 Mission of the development partners:
35.15 Time & Cost Over-run:

35.16 Project Monitoring:
35.17 Delay in Decision:
35.18 Transport, Training:
35.19 Approval and Others:

36. Remarks & Recommendations of the Project Director:

This study focuses on making predictions for the morphological changes and assess the erosion vulnerability of different attributes in some of the medium rivers of Bangladesh. Initially, erosion-prone medium rivers was selected from different hydrological regions of Bangladesh.

Erosion Prediction tool was developed through planform analysis using satellite images and mathematical modelling and three prediction methods were developed e.g. probabilistic method, deterministic method and machine learning approaches.

The biggest achievement of this study is the development of the automation tool for riverbank erosion prediction.

Strategies for sustainable erosion mitigation are formulated based on the identified vulnerable areas using the developed predictive tools. Moreover, Erosion-vulnerable locations were predicted and prioritized by drawing probability lines for various river bends using probabilistic methods.

It was found that prediction results provide the lateral extent of erosion of vulnerable locations. This will help to assess the extent of erosion in the predicted vulnerable locations through impact analysis.

Finally, in future, this study will assist to take pragmatic measures to reduce the risks involving erosion and flood inundation in medium rivers.

22.12.24

Date.....

Signature and seal of the Project Director

(Dr. Robin Kumar Biswas)
Superintending Engineer (Civil)
Directorate of Planning-1
BWDB, Dhaka.

37. Remarks/Comments of Agency Head:

The study successfully identifies the main drivers/causes that outline the prevailing hydro-morphological behavior of medium rivers. Then, it proposes a variety of mitigation measures required to minimize the riverbank erosions that are prevalent in medium rivers.

BWDB accurately forecasts flood and informs people by warning them about flood risks. Similarly, the organization is optimistic about implementing the findings in this study to accurately predict erosions and other challenges associated with medium rivers and take emergency and pragmatic measures to minimize them and reducing/eliminating the socio-economic losses incurred by them.

Date.....

Signature and seal of Agency Head

(Muhammad Amirul Haq Bhuiya)
ID No. 660118001
Director General
BWDB, Dhaka.

38. Remarks/Comments of the Secretary/Senior Secretary of the Ministry/Division:

The findings of the study can be utilized to accurately forecast erosions and other problems specific to medium rivers and carry out necessary steps needed to reduce/eliminate them.

Date.....

Signature and seal of Secretary

Annexure-1(a)

Information Related to Procurement of Goods:

Package No.	Description of Procurement Package GOODS	Unit	Quantity	Procurement Method & Type	Contract Approving Authority	Source of Fund	Estimated cost in Lakh BDT	Time code for process	Not used in GOODS	Invite/ Advertise Tender	Tender opening	Tender Evaluation	Approval to Award	Notification of Award	Signing of Contract	Total time to Contract Signature	Time for completion of Contract (Days)
1	2	3	4	5	6	7	8	9	10	11	12	13	14				18
GD/01	Computer Consumables	Lot	1	RFQ	PD	GoB	1.07	Planned Dates	N/A	24-07-2022	07-08-2022	07-08-2022	08-08-2022	08-08-2022	09-08-2022	16	30 Days
								Actual Date	Do not purchase								
GD/02	Supply of 01 Laptop	Lot	1	RFQ	PD	GoB	1.25	Planned Dates	N/A	24-07-2022	07-08-2022	07-08-2022	08-08-2022	08-08-2022	09-08-2022	16	30 Days
								Actual Dates		05-06-2024	09-06-2024	09-06-2024	09-06-2024	10-06-2024	10-06-2024	06	10 Days
								Deviation		683	673	673	672	673	672	10	20 Days
Total (Goods)							**2.32**										

* Please mention Dates for plan and actual
* Deviation in days (difference between plan and actual)
*Plan as per procurement plan described in project document

Annexure-1(c)

Information Related to Procurement of Services:

Pack-age No.	Description of Procurement Package SERVICES	Unit	Quantity	Procurement Method & Type	Contract Approving Authority	Source of Fund	Estimated cost in Lac BDT	Time code for process	Advertise EOI	Issue of RFP	Technical Proposal opening	Technical Proposal Evaluation	Financial Proposal Opening & Evaluation	Negotiation	Approval	Signing of Contract	Total time to Contract Signature	Time for completion of Contract (Days)
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*	*19*
SR/01	Detailed Study for Riverbank Erosion Prediction and Sustainable Mitigation Strategies for the Medium Rivers in Bangladesh	MM	56	SSS	As per DoFP	GoB	371.68	Planned Dates	-	24-05-2022	21-06-2022	21-06-2022	21-06-2022	22-06-2022	23-06-2022	26-06-2022	34	365 Days
								Actual Dates	-	07-07-2022	11-08-2022	11-08-2022	11-08-2022	11-08-2022	4-9-22	19-9-22	75	304 Days
								Deviation	-	45	52	52	52	51	74	86	41	61 Days
Total(Services)							**371.68**											

* Please mention Dates for plan and actual
* Deviation in days (difference between plan and actual)
*Plan as per procurement plan described in project document