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POST-EVALUATION OF THE GANGES LEFT BANK EROSION PROTECTION PROJECTS FROM PANKA NARAYANPUR TO INDO-BANGLADESH BORDER

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Abstract

River training and bank protection is an important responsibility of Bangladesh Water Development Board (BWDB) as the damage caused by bank erosion disaster every year is colossal. So far BWDB has taken up a number of such projects some of which are a great success while some others have failed to serve the intended purposes. Post project evaluation allows recognizing project achievements and identifying techniques and methods that worked or not worked. A lack of post evaluation may inhibit appropriate project and policy adjustments. This paper describes post evaluation of two important BWDB bank erosion mitigation projects which were implemented at Panka Narayanpur to Indo-Bangladesh border along the left bank of the Ganges during 2002-2005. The aim of the evaluation is primarily to compare the actual outcomes of the project with the projections made at the appraisal stage. The investigation of different aspects of the project can provide important lessons derived from field experience which would be beneficial for the successful implementation of new projects. The overall impact of the completed project will result in a number of effects, which can be classified in the form of costs and benefits, direct and indirect or tangible and intangible. It is identified from the post evaluation that the negative results of the first project have been successfully nullified by implementing the second project through close monitoring of the developments after implementation of the first project. The post evaluation also indicates that site specific solutions have to be devised for successful project implementation together with proper planning and ensuring of construction as per design and within the stipulated time frame.

Introduction

Water resources planning and evaluation activities have usually emphasized future cost and benefits of potential projects. Detailed planning documents, the principles and guidelines are available to Bangladesh Water Development Board (BWDB). However, no comparable document exists to guide retrospective, post reviews of river bank protection projects and progress. Preferences may change considerably after execution of such type of project. Broadening BWDB water resources management to integrate a greater degree of post evaluation may help resolving some of the nation's water resources controversies. Post evaluation takes place after the completion of the project and often more in-depth since it focuses analysis of impacts. Besides, it is time-consuming, costly and calls for persons with special skills. So far systematic post evaluation of implemented projects and use of the lessons learned in formulation of future projects is limited. However, the need for

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such post evaluation of projects is gaining more and more importance for sustainable water resources development. A post project evaluation is a very useful and powerful way of adding a continuous improvement mechanism. This continuous improvement mechanism helps make each succeeding project more successful. Post project evaluation typically involve the project team and major stakeholders meeting together and reviewing what went well and what went badly during the project. This input can help participants make the right decisions and plans so that the next project runs better. It can also help clear up misunderstandings and other issues.

BWDB, whose one of the important responsibility is to arrest bank erosion throughout the country. The organization has implemented a number of river training and bank protection projects on the Ganges which is a trans-boundary river. After traveling about 2240 km through India, it enters Bangladesh at Panka Narayanpur, near Shibgonj Upazilla under Chapai Nawabganj district and18 km downstream of Farakka Barrage and runs for about 100 km as a boundary between India and Bangladesh. The travelling length through Bangladesh is about 230 km. It is wide wandering river with a bank full width of about 5 km.

The hydrology of the Ganges river is very intricate especially in the Ganges Delta region. The hydrologic cycle in the Ganges basin is governed by the Southwest monsoon. About 84% of the total rainfall occurs in the monsoon from June to September. Consequently, stream flow in the Ganges is highly seasonal. The average dry season to monsoon discharge ratio is about 1:6, as measured at Hardinge Bridge, an important monitoring point where India and Bangladesh jointly monitor water level and discharge under water sharing treaty, 1996. The maximum peak discharge of the Ganges as recorded at Hardinge Bridge point in Bangladesh, recorded 70,000 m^3/s. The minimum-recorded discharge at the same was about180 m^3/s in 1997. Prior to constructing Farakka Barrage (1975), minimum recorded discharge was about 1297 m^3/s in April 1966. The water surface slope of the river is about 5 cm per km (FAP 24 1996a).

The bank material of the Ganges within Bangladesh territory consists of loosely packed sand and silt. These materials are highly susceptible to erosion. The bank erosion process along the Ganges is controlled by its wandering plan form characteristics. Maximum bank erosion, however occurs in the meandering reaches, near the outer bend can still migrate laterally within the corridor. In the period 1984-1993, the maximum observed rate was 665 m/year. Along the right and left bank of the Ganges, erosion rate are 56 m and 20 m per year respectively. About 45 km^2 area of valuable land has been eroded by the Ganges for the period of 1990-2000 (BWDB 2010). The width of the river varied from 1.7 to 10 km in 1984 and 1.9 to 11.7 km in 1993. The average width of the river

in 1984 was 4.37 km, which increased to 4.69 km in 1993. The widening rate of the river is 36 m/year. Some rivers cause erosion in large scale and high frequency due to their unstable character. Ganges river assumed a braided pattern consisting of several channels separated by small islands in their courses.

The study area (Panka Narayanpur to Indo-Bangladesh Border) is located on the left bank of the Ganges river immediately downstream of the Indo-Bangladesh border that falls under Shibganj and Nawabganj Sadar Upazila under Chapai Nawabganj district. The Latitude and Longitude of the project area are $24^0 30'$ to $24^0 38'$ and $88^0 24'$ to $80^0 28'$ respectively shown in Figure 1.

Huge amount of agricultural land engulfed by the progressive bank erosion in the study area led BWDB executing two projects in the study area namely Panka Narayanpur Project and Babupura to Indo-Bangladesh border Project. The length of the study area along the left bank is 14 km at Panka Narayanpur and 9 km from Babupura to Indo-Bangladesh border. The river is very dynamic and erosion prone within the reach between Panka Narayanpur and Indo-Bangladesh border.

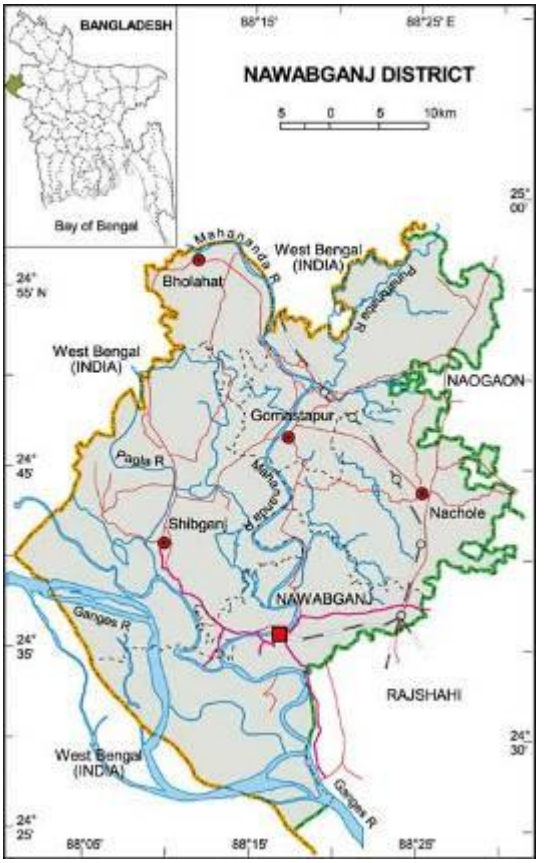

Figure 1. Location of the study area

Methodology

The following steps have mainly been followed to extract data and information for the purpose of this study:

- Collection and review of relevant study reports, documents, publication books, scientific journals etc.;
- Collection and analysis of time-series satellite images of the study area;
- Stakeholder consultations that include BWDB officials and local people on whom there is direct impacts of the project.

In the course of evaluation, standard evaluation criteria have been used under the same matrix where two sets of responses have been explored. First set characterizes BWDB's endeavors and consequences while other reveals people's voices.

Findings from the study

The major findings from the study based on literature review, image analysis and data analysis have been presented hereafter.

Historical trend of morphological changes

In 1990s, the Ganges river increased its width by causing serious erosion along the left bank in the reaches upstream of Chapai Nawabganj district. A study (IWM 2006) showed that the bank line moved up in the north direction up to 6 km at the rate of 600 m per year. This movement had been continued and the bank line was shifted up to 7 km within the period 1990-1999. This continued bank erosion posed the threat of causing merger of the Pagla river with the Ganges in the near future. It is predicted that the merger of the Pagla with the Ganges may cause merger with the Mohananda river in the long run.

These critical morphological situations of the river systems may put the Rajshahi-Chapai Nawabganj region at risk. Lateral bank shifting (of about 7 km) due to progressive erosion is shown in Figure 2.

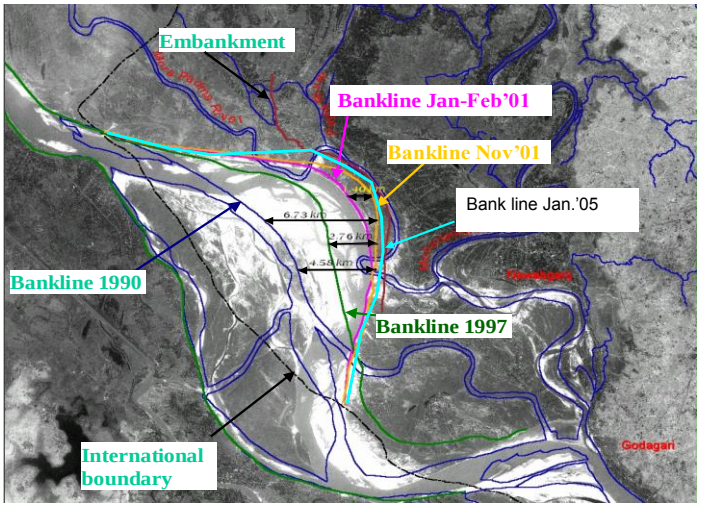

Figure 2. Bank line shifting of the Ganges River at Panka Narayanpur to Indo-Bangladesh border (Source: IWM 2006)

Model studies and implemented measures

The threat arisen out of such unabated bank erosion in the studied area led BWDB to take up a project during the year of 1996 aiming at combating the bank erosion problem. Due to complexity in dealing with erosion problem, BWDB commissioned River Research Institute (RRI) to carry out a physical

model study for the erosion prone area under this project. RRI recommended some structural measures for the protection of vulnerable area after accomplishing physical model study. In the following monsoon, the bank line for the modeled area shifted towards north and the erosion rate per year was more than 500 m. Under such conditions, it was not possible for BWDB to take structural measures recommended by RRI. The severity of bank erosion was continued and the BWDB formed a technical committee in 1999 in order to protect the most vulnerable Panka Narayanpur area. The committee recommended construction of 8 (eight) nos. of spurs and the length, location and orientation of 8 spurs were finalized by Institute of Water Modeling (IWM) and also verified by RRI. As per recommendation of the technical committee, IWM carried out 2D mathematical model study to meet up the objectives set forth by BWDB. RRI conducted physical model study accordingly with a view to observe bank retreat between the spurs finalized by IWM.

Seven spurs (except spur #1) out of eight, constructed fully in 2002 working season under the project taken by BWDB in the study area. After 2003 flood, about 66 m RCC (Reinforced Cement Concrete) portion out of 150 m was completed but during flood season (July) earthen shank of the spur 1 failed and detached from the concrete tail. At that time about 4 km of bank line, both at upstream and downstream of spur #1 was severely eroded. About 100 m of the RCC head of completed spur #8 was uprooted in late September of the same year. During the following flood, about 3km bank at upstream of spur #2 was under severe erosion attack due to concentration of main flow along the left bank. The lateral shifting of bank line towards countryside by this erosion was 500 m to 1500 m. Due to this embayment, 100 m concrete head of spur #2 and spur #7 including some portion of shanks was damaged in August-September 2004. Shanks and concrete heads of spur #2, #7 and #8 were partially damaged in 2003-2004 floods and were destroyed by 2005 flood. Required amount of hard material and sand filled geo-bags were dumped in the affected areas aiming to protect the spur field and their anticipated effectiveness. Prior to flood in 2005, 900 m bank revetment between spur #3 and #4 along with 1080 m bank revetment works at both upstream and downstream of damaged spur #2 was constructed as an emergency basis in order to arrest further embayment of the river.

During monsoon in 2004, the erosion continued along the left bank of the Ganges consequent with about 1500 m bank line shifted locally near the failed spur. Thus created a renewed threat of merger of the Ganges with the Pagla river near the bank of the damaged spur #2. In December 2004, the most vulnerable location was the point where the minimum set back distance between the Pagla and the Ganges was only 150 m. The bank erosion within this reach still showed increasing trend and propagated towards upstream direction i.e. Babupura to Indo-Bangladesh border. Addition to this, the area between spur #6

and spur #8 (cross dam, embankment, and link channel) became vulnerable due to the damage of spur #7 and spur #8.

In 2005, BWDB planned to implement adaptive mitigation measures on the Ganges left bank erosion in order to arrest this continued erosion and to prevent further damage of existing spurs. In this context, it became obvious that the Ganges left bank from Babupura to Indo-Bangladesh border, upstream of spur #3 and the area between spur #6 and #8 should be protected by adopting appropriate protective measures. Before implementing such type of adaptive mitigation measures, it was necessary to carry out both feasibility and detail study to decide about the optimum solution of the erosion problem. Accordingly, IWM carried out feasibility and detail study in which numerical modeling was a component to find out the probable solutions mitigating existing bank erosion problem and strengthening previous protective measures. IWM recommended bank revetment (more detailed descriptions in IWM 2006) at different locations within the project area. Concurrently, RRI suggested bank revetment (detailed in RRI 2006) to protect the vulnerable area. Both the model results were quite similar to each other excepting only 1000 m increasing length of revetment for proposed revetment 1 towards upstream direction.

Post-project conditions

Field visit revealed that spur #3, #4, #5 and #6 are still existing in the field and functioning well some of which (spur #5, #6) can be evident from Figure 5 and Figure 6. Emergency basis constructed revetment between the damaged spur #1 and #2 and another revetment between existing spur #3 and #4 are in good shape and functioning well. The revetments constructed at the downstream of existing spur #6 are also in good condition. Different types of bank protective structures such as spur and revetment constructed under two projects have positive bearing to arrest bank erosion for a 23 km long stretch of left bank of the Ganges river.

Figure 3. The pictorial view of head of Spur #5

Figure 4. Photographic view of head of Spur #6

BWDB's monitoring program

Monitoring is an essential task principally for riverbank protection project. It means to observe a situation for any change, which may occur over time. Close monitoring of the evolution of bank line is, therefore, necessary to have forewarning of impending danger. It will help taking appropriate measures on time.

Damage and failure of bank protective works are very common phenomena particularly in large rivers. Governing factors of such impairment are improper design and construction method, lack of regular monitoring and unavailability

of funds in time (BWDB 2010). Therefore, routine monitoring is an imperative tool for any successful water resources project especially during and after implementation. Since, the project was completed successfully and the constructed spurs and revetment are functioning well at present field condition, it would be an imperative task for BWDB to take necessary steps regarding close monitoring of the structures so that the project objectives would be achieved profitably without any major damage and failure in future.

Having considered this situation, BWDB has undertaken close monitoring program for the studied project through monthly and weekly field visit during dry and flood season. The concerned BWDB's official informed that frequent field visits were made when they have got message regarding bank erosion of the project area. However, proper repair and maintenance works have not been made due to lack of funds.

Post-evaluation of the implemented projects

An evaluation is a rational and objective assessment regarding the relevance, effectiveness, efficiency, sustainability and impact of activities in the light of specified objective. An important goal of evaluation is to provide recommendations and lessons to the project managers and implementation components that have worked on the projects and for the ones that will implement and work on similar projects. Evaluation can also be used to promote new projects get support from governments, raise funds from public or private institutions and inform the general public on the different activities. According to the United Nations Development Programme (UNDP), an outcome indication has two components: the baseline, which is the situation before the project begins and the target, which is expected situation at the end of the project. Through the evaluation process, using same matrix, two sets of answers were searched out. One set represents BWDB's attempts & consequences and other set represents people's views. Major comparative Matrix between two sets of views is shown in Table 1. It can be fairly said that, some specific differences are found between them.

Table 1. Major comparative matrix for the evaluation of implemented projects

Evaluation criteria	Project name: River bank protection of Panka Narayanpur area		Project name: River bank protection of Babupura to Indo- Bangladesh border	
	BWDB's Attempts and consequences	**People's voice**	**BWDB's Attempts and consequences**	**People's voice**
Relevance	As per people's demand and restoring the environmental degradation of the vulnerable area, BWDB had undertaken a project.	Experiencing serious bank erosion of the Panka-Narayanpur area and comprehending possible merger of the Ganges river with the Pagla river people raised their voice to take necessary action.	Owing to the failure of 4 nos. of constructed spurs under the previous project and progressive erosion at upstream and downstream of the existing spurs, BWDB had undertaken another project in 2005 at Babupura to Indo-Bangladesh border which encompassed the previous project area.	People's perception became optimistic since their demands had not been reflected fully in the previous project.
	In 2002, BWDB erected 8 nos. of spurs under the project.	People's tones were, bank protective structures like spurs were not adequate to combat the erosion. Their demands were to construct embankment with revetment.	About 4.05 km and 8.00 km revetment at upstream and downstream of the existing Spurs were constructed under this project. Also repair works were done to strengthening the existing Spurs.	

Evaluation criteria	Project name: River bank protection of Panka Narayanpur area		Project name: River bank protection of Babupura to Indo- Bangladesh border	
	BWDB's Attempts and consequences	**People's voice**	**BWDB's Attempts and consequences**	**People's voice**
Effectiveness	In one year later (In 2003) 2 nos. of spurs at upstream and 2 nos. of spurs at downstream were fully or partially damaged and were not working effectively. Constraining factors • Improper design and construction of these spurs • Quick morphological changes at upstream • Inflexibility of budget allocation and lengthy approval process • Unavailability of fund in time	Populace felt unsecured. They demanded pragmatic solution to arrest bank erosion since their demand were not fulfilled.	Newly constructed revetment works along with existing spurs were sufficient to arrest the bank erosion. In addition to that, restoring environmental degradation was also achieved.	Public felt protected and satisfied as their demand were fulfilled.
Efficiency	All the constructed spurs were not functioning properly due to changes of flow field at the head of individual spur.	People shouted repeatedly to take necessary measures to protect bank erosion.	The combined effect of revetment and spurs were positive to produce smooth flow field without endangering the bank.	People were convinced . They felt more confident and their attitudes were positive.

Evaluation criteria	Project name: River bank protection of Panka Narayanpur area		Project name: River bank protection of Babupura to Indo- Bangladesh border	
	BWDB's Attempts and consequences	**People's voice**	**BWDB's Attempts and consequences**	**People's voice**
Sustainability	Project's objectives were not achieved completely considering environmental aspects since the constructed spurs failed to protect the homestead aside the bank along with mango garden.	Numbers of distressed people were increased alarmingly and they moved to another places for their settlement and livelihood as benefits were unlikely to be maintained for an extended period.	The project's objectives were fulfilled considering all aspects including environment.	Inhabitants aside the bank had stayed in their parental homestead and were satisfied for maintaining their livelihood smoothly.
Impact	After implementing the project, employment opportunity, income, social wellbeing of the affected people had been increased to some extent.	There was adverse environmental impact around the project area. General people of that area were not benefitted.	After executing the project, employment opportunity, income, social wellbeing of the affected people had been augmented notably.	People hadn't seen any adverse impact of the implemented project and felt benefitted.

It is depicted from Figure 5 (Satellite image 2015) that, sedimentation occurred among the spurs. Main channel has been shifted from left bank to the right bank due to the combined effect of revetment and spurs erected in the exposed area. Other area remains with the left bank. At the downstream of spur #6, the bank line has been shifted to the left in comparison with bank line 2006. The bank line at upstream of spur #6 is found to be almost same for 2006 and 2015.

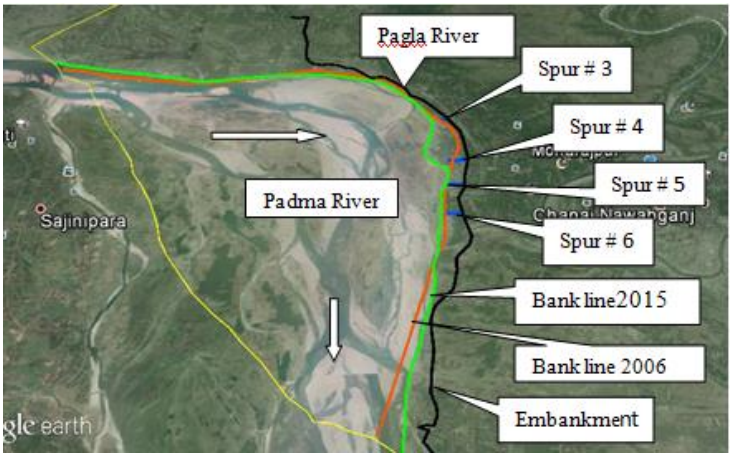

Figure 5. Bank line of the Ganges River at Panka Narayanpur to Indo-Bangladesh border (Source: Satellite image 2015)

Concluding remarks

Two projects were commissioned by BWDB in 2002 and 2005 asynchronously to arrest the bank erosion at Panka Narayanpur area and from Babupura to Indo-Bangladesh border under Chapai Nawabgonj district. The second project aims to strengthen the constructed structures under the first project and to mitigate exposed bank erosion in the upstream of the first project location. Investigation of the present status of the projects in terms of structural integrity and efficacy for preventing bank erosion and also the results of the public consultation and beneficiary investigation have shown local people's contentment with the benefits of the latter project. The project has also contributed to the upgrading and enrichment of the people's living environment as well as the economic and social advancement. In light of this, the latter project is considered to have reverted positive efficacy and impacts in many ways whereas preceding project was unavailing at some points with the outcome made at the appraisal stage.

Bank protection works should be planned and designed based on thorough understanding of geo-morphological and ecological processes of the exposed area, rather than merely imitation of form, as in blind application of a classification scheme. In addition to that, employment of physical as well as numerical model studies needs to be considered prior to implementing bank protection project since they are complementary to each other and have been proved to be very essential tools for finding safe and less expensive solutions of different water related problems. Most of the river bank protection projects in Bangladesh implemented by BWDB have not been subjected to objective post-project evaluation due to lack of evaluation program and unavailability of necessary fund and manpower. As a consequence, opportunities to learn from

past experience to improve future project planning and design have been lost.

Summarizing the overall evaluation of projects, subsequent definite recommendations can be made:

- In a mighty river like the Ganges, construction of a series of spurs may be considered to facilitate formation of a stable river course safely away from the bank without endangering the structures. The appropriate placement, dimension and orientation of the structures should be finalized by employing physical and numerical studies;

- Preferably all spurs of the series should be constructed in the same hydrological year or a sequence of construction should be devised through hydraulic modeling studies;

- There should be a mechanism for third party inspection and monitoring of the construction works thoroughly by forming a team and effectiveness should be checked by both field inspection and discussion with the local people;

- The existing practice of design for revetments, groynes and spurs has to be reviewed for each specific project and design should be modified according to the site condition, if necessary; and

- Provision of necessary funds for operation and maintenance and also for monitoring and evaluation of the implemented project should be included in the project proposal.

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