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ASSESSING THE SOCIO-ECONOMIC IMPACTS OF RUBBER DAM CONSTRUCTION ON BAKKHALI RIVER

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ABSTRACT

The Bakkhali River is one of the most important tidal rivers in Southern Bangladesh. In 1995, a rubber dam was constructed across the river to conserve perennial water for irrigation that changed the geo-morphological pattern of Bakkhali River. Different methods including Focused Group Discussion (FGD) and structured questionnaire were used to know the environmental as well as the socio-economic impacts of construction a rubber dam. Analysis of the data from the Bakkhali River of the year 1996 (pre-dam situation), 2003 (post-dam situation) and 2008 (post-dam situation) reported major changes in north-west part of the river, adjacent to the rubber dam where as less changes occurred in the upstream, far from the rubber dam. However, the river course-changing pattern due to sedimentation is measured 83.62 ha (upstream) and 75 ha (downstream) by using planimeter. It can be stated that the downstream of the river is in danger according to the morphological viewpoint but in terms of socio-economic perspective the upstream zone of the Bakkhali River is more vulnerable.

Keywords: Rubber Dam Construction; GIS; Socio-economic impacts

INTRODUCTION

Structures of river are important elements for most of the river system in which rapid changes in flow, sediment discharge and hydraulic geometry must be accommodated. Construction of several structures like bridge piers, abutments, river training and habitat improvement (spurs, vanes, bend-ways, fish-way etc) is of common practice in river engineering. On the other hand, their impact on hydraulic and geo-morphologic condition of rivers may give rise to river instability as well as negative environmental consequences. The complex hydraulic and morphological aspects at these points have an important bearing on problems, however remain poorly understood. Consequently, quantitative assessment of flow properties, turbulent characteristics and river bed evolution (local and general) induced by river structures still remains one of the challenging issues in river engineering practice.

Numerous studies have been performed on floodplains as well as tidal plains but the effect of dams on river banks has not been adequately investigated. Jongman Rob, (1992) studied land use and floodplain management of the Rein River in the Netherlands using data collected from the river bed and its floodplains and found that floodplain land use were highly effective in river erosion and sedimentation patterns (Jongman Rob, H.G., 1992). Liu and Yu (1992) investigated the effects of Danjingko hydroelectric dam built in 1973 across the Hanjiang River. They showed that dam construction considerably reduced water level and increased flood inundation area and riverbed scouring due to reduced sediment load and

increased erosion power of water. Ripendra, (2002) carried out floodplain analysis and flood risk assessment simultaneously with a study of river hydraulics, topography and floodplain land use along the Rakhandal River in Nepal. Hydrologic data, digital landscape modeling and satellite images are mainly used to identify the pattern and morphological changes of hydraulic regime (Kolejka, J., 2006; I-Sloff, C.J., 1991; Alam and Hossain, 2006; Kolejka J., 2006). For sustainable development, identification of morphological changes is essential.

Channel morphology is the result of mutual interactions of four broad categories of variables such as fluid dynamics (which include velocity, discharge, roughness and shear stress), channel character or channel configuration (e.g. channel width, channel depth, channel slope, channel shape, channel pattern etc.), sediment load and Bed and bank materials (composition and character i.e. coarse, fine, medium etc.). Fig. 1 shows its different variables of channel morphology [Hossain, M. M. (1998) and I-Sloff, C.J., (1991)] and [Environmental Systems Research Institute (ESRI), (1994), Understanding GIS ARC/INFO Method. Redlands, California, U.S.A] and Institute of Water Modeling (IWM) Concept Proposal on Command Area development of Monu River FCDI Project, March, 2002. Fig. 2 shows the different types channel pattern. The rivers studied are meandering rivers in pattern.

Many researchers use remote sensing technology in studying channel pattern study which is a part of morphological change study [Kolejka, J., (2006), and I-Sloff, C.J., (1991)]. Alam and Hossain [Kolejka, J., (2006),] studied identifying the morphological changes of a distributary of the ganges in response to the declining flow using remote sensing.

Bakkhali is the most important tidal river in Southern Bangladesh from both economic and geographical viewpoint. In 1995, a rubber dam was constructed at the brackish zone of the river to conserve perennial water for irrigation over a command area of 6000 hectares. However, a few inherent problems exist with the construction of the rubber dam. Key among them are: (1) gradual disappearance of brackish ecology (2) water logging at the upstream and substantial reduction of environmental flow (e-flow) at the downstream the river, (3) alteration of the geo-morphological scenario of lower Bakkhali. So, in this study, an attempt has been taken to present the environmental impacts induced by the rubber dam on the Bakkhali River to protect the whole aquatic environment.

STUDY AREA

Bangladesh suffers various climate disasters like droughts (the northern part), floods (mainly the central part) and salinity intrusion (the southern part). The coastal part of Bangladesh is extremely affected by fresh water crisis due to increased salinity (Mahtab, S.B., 2012).From the economic and geographical viewpoint, Bakkhali is the main tidal river of Cox's Bazar in southern Bangladesh.It is located at latitude $20^0 85.40^/$ to $21^0 46.92^/$ north and longitude $91^0 96.60^/$ to $92^0 34.37^/$ east (Fig 4).

Cox's Bazar town is situated at the downstream of the river. It originates in the Arakan Mountains and flows north then turns to the west to pass through Ramu and Cox's Bazar cities, finally falling into the Bay of Bengal after meeting with several tributaries. According to physiographic divisions of Bangladesh the project area lies within the tertiary hills of eastern folded belt. The location of the study area is shown in Figure 1 below.

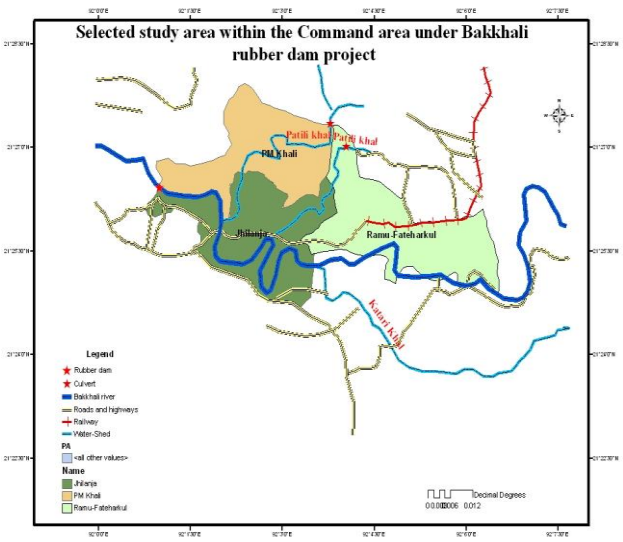

Fig 1: Location of study sites under the command area of Bakkhali rubber dam

Input Data

A questionnaire survey was conducted to assess the socio-economic impact of the morphological changes among the local representatives, 234 households and experts (200 persons) through Focus Group Discussion (FGD). Proportionate representation of social class was maintained in selection of the households. However, in order to present the actual picture of the affected area, samples were distributed as follows: poor 147, middle 75 and rich 12. Number of poor and middle class respondents was kept much higher to assume that the sample represents the population exactly. For upstream and downstream, the sample size was same to compare the vulnerability extent between these two selected areas.

Using a face-to-face technique, empirical data were collected for the study by sample survey method where the universe contains whole area. Based on the information and the data, collected from the first visit, several meetings with the team members were done and an interim test information-checklist was prepared. The information-checklist was pretested in the non-sampled area through a pilot survey before finalization. The final information-checklist contained both pre-coded and open-ended questions.

Results and Discussions

Table 1, Table 2 and Table 3, shows the socio-economic parameters affected due to erosion and siltation in Bakkhali River area. Major causes of erosion are currents, strong river discharge, high waves, and increases of population. Settlement along the flood plain of the river decreases flood passages of the river. As mentioned in Mahtab, 20People live in proximity to the active river channels and are exposed to high risks from erosion and channel changes. Land use practices depend mainly on the depth of flooding and population pressure that increase crop variety and production in the flood plain area. On other hand, in a tidal plain like Bakkhali River, the land use practices especially agricultural activities depend mainly on the availability of fresh water from the upstream. As the study period was dry season, siltation rather than erosion was the main driving force for the morphological changes of Bakkhali River.From the study, agricultural land, associated people, irrigation, fisheries, hydraulic structures are identified as most affected parameters due to the morphological changes of the Bakkhali River. Among these affected parameters, agricultural land and irrigation are the most vulnerable factor. Previous studies report that significant volume of water can be conserved in the Bakkhali project by reducing the depth of standing water used in the Boro fields. There is a scope for saving water by improving existing irrigation and

channelization systems. The surplus volume and additional volume can be conserved by improving management practices can meet the overall environmental flow requirement without

Table 1: Environmental Impact Evaluation for Erosion and Siltation in Bakkhali river (For Upstream)

time		Probability (P)	Severity (S)	Impact value (IV=P*S)	No impact	Positive Impact	Insignificant	Low	Medium	High
1	Physical Environment									
	Topography									
	Plain land	1	6	6				H		
	Soil			0	H					
	Erosion	3	3	9					H	
	Siltation	6	6	36						H
	Environmental flow	6	6	36						H
	Pollution	2	1	2			H			
2	Ecological environment			0						
	Terrestrial flora	5	4	20						H
	Aquatic flora	5	5	25						H
	Terrestrial Fauna	5	6	30						H
	Aquatic fauna	6	6	36						H
	Destruction of plantation	3	3	9					H	
	Disturbance to wildlife	2	2	4				H		
3	Socio-economic environment			0						
	Loss of land	2	3	6				H		
	Agriculture	6	6	36						H
	Residential/Community	4	3	12					H	
	Industrial/Commercial	2	3	6				H		
	Impact on			0						
	Crops/Plantation	6	6	36						H

Table 2: Environmental Impact Evaluation for Erosion and Siltation in Bakkhali river (For Downstream)

		Probability (P)	Severity (S)	Impact value (IV=P*S)	No impact	Positive Impact	Insignificant	Low	Medium	High
1	Physical Environment									
	Topography									
	Plain land	1	4	4			H			
	Soil									
	Erosion	3	3	9					H	
	Siltation	6	6	36						H
	Environmental flow	6	6	36						H
	Pollution	5	4	20					H	
2	Ecological environment									
	Terrestrial flora	4	3	12					H	
	Aquatic flora	4	5	20						H
	Terrestrial Fauna	4	4	16					H	
	Aquatic fauna	5	6	30						H
	Destruction of plantation	5	5	25						H
	Disturbance to wildlife	3	2	6				H		
3	Socio-economic environment									
	Loss of land	2	2	4			H			
	Agriculture	4	5	20						H
	Residential/Community	3	4	12					H	
	Industrial/Commercial	5	6	30						H
	Impact on									
	Crops/Plantation	4	5	20						H

Table 3 The socio-economic parameters affected by erosion and siltation

Negative Impact Severity (S)		Probability (P)	
1	No damage	1	Negligible
2	Minor damage (Hazard to single receptor)	2	Slide
3	Minor damage (Hazard to multiple receptor)	3	Possible
4	Significant damage (Hazard to single receptor)	4	Likely
5	Significant damage (Hazard to Multiplereceptor)	5	Very likely
6	Destruction of single/multiple receptor	6	Inevitable

CONCLUSIONS

This type of study is helpful for planning and management in an effective manner as it could be incorporated into the historical changes of the river morphology. The study area is already affected by the adverse effects of climate change as mentioned by (Mahtab and Khan 2018). By analyzing the images of Bakkhali River, significant morphological changes have been occurred in both upstream and downstream. Siltation occurs along a 33 km long of the river over time of 12 years period. As the study period was winter, the morphological changes of the river due to erosion are noticed very negligible. But the river course-changing pattern due to sedimentation is measured 83.62 ha (upstream) and 75 ha (downstream) by using planimeter. From the study, agricultural land, associated people, irrigation, fisheries, hydraulic structures were identified as most affected sectors due to the morphological changes of the Bakkhali River. In a conclusion, it can be stated that according to the morphological point of view downstream part of the river is in danger but in terms of socio-economic perspective the upstream zone of the Bakkhali River is vulnerable. The environmental restoration of the river's upstream will ensure sustainable agriculture and fisheries along with industrial advancement and socio-economic development. Moreover, there is a scope for saving water by improving existing irrigation management as well as to improve the morphological structure of the river. The surplus volume and additional volume conserved by improving management practices can meet the environmental flow requirement followed by morphological structure of the river without compromising the irrigation water requirement.

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