RESEARCH PAPER | Geography | Volume : 3 | Issue : 6 | June 2013 | ISSN - 2249-555X

Qualitative Assessment of River Bank Erosion Risk in Jirania Rural Development Block, Tripura

KEYWORDS: River Haora, Bank material, Bank Erosion Hazard Index (BEHI), Root density.

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ABSTRACT *In Jirania R.D. Block, a large number of people are threatened by erosion hazard of both the banks of the River Haora. Here two villages namely, Rabicharan Thakur Para and Golak Thakur Para, with two sites each have been identified as most vulnerable places. Main objective of this study is to carry out the qualitative assessment of bank erosion through Bank Erosion Hazard Index (BEHI). Bank erosion variables considered for BEHI ranking include bank height ratio, root depth ratio, weighted root density, bank angle, surface protection and bank material. About 14.09 acre area has already been lost. Here the rate of bank erosion is 2.82 m/year. People have lost their houses, agricultural lands and had to build their houses elsewhere. But these newly built houses are again under threat of such hazard. Therefore, bank erosion hazard at these sites need proper attention for protection measures.*

Introduction:
Stream bank erosion is a dynamic and natural process as stream meanders across the landscape, however, in many places the rate of stream bank erosion has increased markedly because of hydraulic and geotechnical processes (Rosgen, 2001). Riverbank Erosion is an endemic and recurrent natural hazard. When rivers enter the mature stage, they become sluggish and meander. These oscillations cause massive riverbank erosion. Bank erosion may affect one or both banks of a channel reach, causing the channel to widen. Alternatively it may simply contribute to the migration process of meanders, without necessarily changing the size of the channel. This happens if sediment deposition on one bank offsets erosion on the opposite bank to maintain a stable channel width.

Severe bank erosion is going on in several sections of the River Haora, West Tripura District. The total length of the Haora River is 53 km out of which 8 Km has been considered for the present study where Jirania is situated. Rabicharan Thakur Para and Golak Thakur Para areas are vulnerable places affected by this erosion in Jirania.

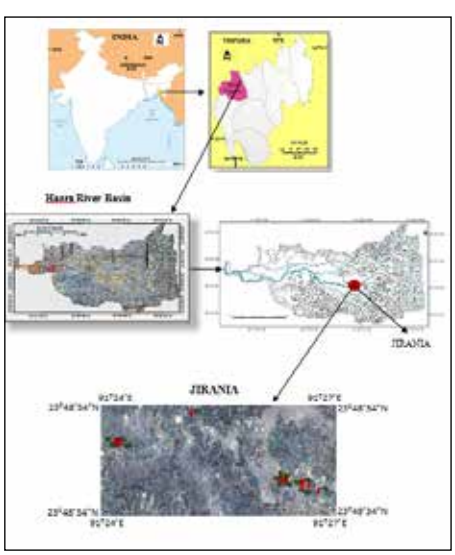

Fig. 1: Location map of the study area
Study Area: Jirania extends from 23° 48′ 34″ N to 23° 48′ 54″ N latitude and 91° 24′ E to 91° 27′ E longitude (Fig.1). Geologically the study area falls under Tipam group of rocks which is characterized by sand rocks with shale and fossil woods. The area experiences tropical monsoon climate. Temperature ranges between 9° C to 35° C and average annual rainfall is 200mm. Pedologically, the area is characterized by flood plain soils and soils of low lying residual hills with valley. Texturally these are sandy. Geomorphologically the area is characterized by plateau top, denudational hills and pedeplain.

Aims and Objectives :
Aim of this research work is to carry out qualitative assessment of bank erosion hazard of the Haora River at two selected sites of Jirania R. D. Block. To fulfill this aim, the main objectives are:
1) To identify the causes of bank erosion of the Haora River in Jirania.
2) To calculate Bank Erosion Hazard Index (BEHI).

Materials and Methods:
Software:
1. GEOMATICA V 10.1(for GIS mapping).
2. MS Excel (for statistical analysis).
3. Adobe Photoshop CS.
4. Map Source.

Data used:
1. Survey of India topographical maps (1:63360), Ref No. 79M/1, 5 and 9.
2. Land use data of Jirania mouza.
3. andsat imagery (ETM PAN and MSS).
4. Google Earth imagery (2005).

Discussion and Results:
River bank erosion or lateral movement of river bank is proportional to erodibility of the bank and erosivity of the flow velocity. Jirania is situated along the bank of the Haora River. Two villages namely, Rabicharan Thakur Para (RTP) and Golak Thakur Para (GTP) are suffering from severe bank erosion. The main causes of bank erosion in these areas are as follows:

1. Nature of bank material: All sites of both RTP and GTP experience non-cohesive bank material i.e., sand dominates the bank with maximum percentage, 95.5% and 93% respectively which lead to maximum erosion and ultimately widening of the channel. But at GTP the amount of erosion is comparatively less due to high root depth

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and density. Fig.2 shows the detail result of hygrometer test.

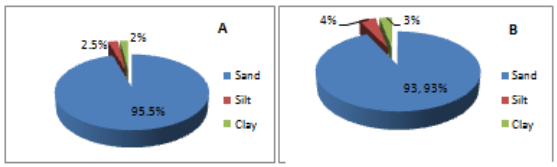

Fig. 2: Analytical results of soil test at (A) Rabicharan Thakur Para and (B) Golak Thakur Para.

2. Low shear strength: As the concentration of sand is high along the banks of the Haora River at Jirania, shearing strength of the bank material is low at all the sites which leads to high bank erosion. Because sand can't resist stress produced by the force of water and this low shearing strength of the material causes high bank erosion.
3. Short meander wave length: Site 1 and 2 of GTP and site 4 and 5 of RTP are characterized by high bank erosion though at different rate due to difference in the meander wave length at these sites (Fig.3). In RTP the meander wave length at two sites are 230m and

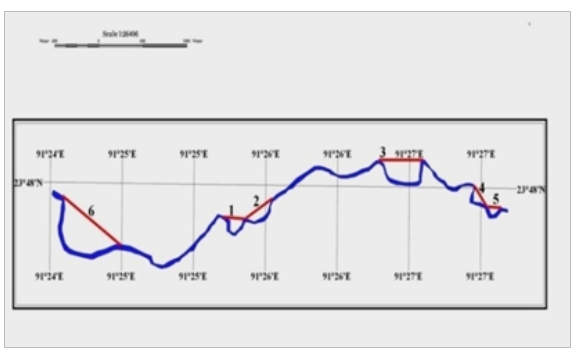

Fig.3: Meander wave length of all sites within the study area.

[Fig.3 about here]160m but at GTP these are 240m and 360m. More is the meander wave length less is the flow velocity attack. Here, among the four sites, second site of RTP is characterized by lowest meander wave length (160m) i.e. meander curvature is narrower, which indicates that at this site the attack of flow velocity is more (0.49m/s). Again, in case of GTP at the second site the River Haora is flowing through a wider meander curvature with 360m wave length and the flow velocity is less (0.36m/s). Due to this process the Hora River bank migrates from north to southward direction within the Jirania Block (Fig. 4).

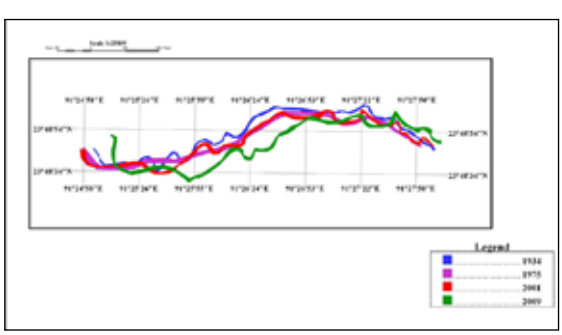

Fig. 4: Temporal Changes of the course of the Haora River in Jirania from the year 1934 to 2009.

[Fig.4 about here]4. Root Density: Root protects the bank material from erosion. If the roots of the trees enter very deeply and spread widely, it keeps the soil very tight which resist the attack of flow velocity but where root depth and density is low or absent, as in case of RTP, then high erosion occurs [Plate 1 (a) and (b)]. In GTP root density is 8.63 m/m^2 due to which less erosion occurs (Table 1).

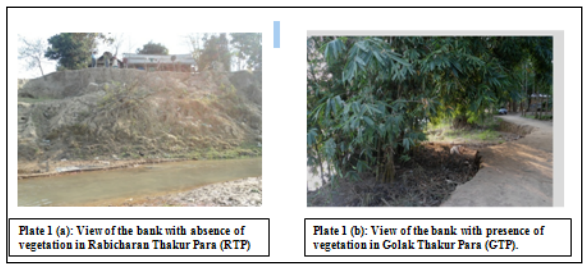

Plate 1 (a): View of the bank with absence of vegetation in Rabicharan Thakur Para (RTP)

Plate 1 (b): View of the bank with presence of vegetation in Golak Thakur Para (GTP).

5. Bank angle: Gentle bank angle is less susceptible to bank failure in comparison to the steep slopes. The River Haora has a steep bank (81°) at RTP [Plate 2 (a)] whereas in GTP the bank angle is moderate (45°) [Plate 2 (b)]. Steep banks with non cohesive materials favour the process of liquefaction which leads to the collapse of the overhanging portion of the bank after high water level drops.

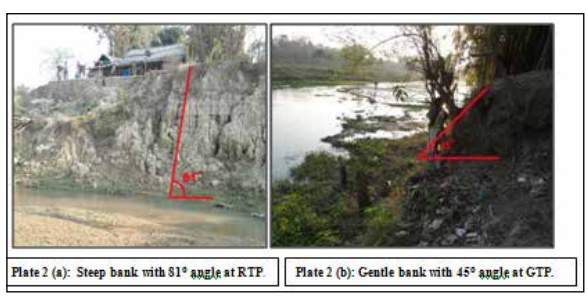

Plate 2 (a): Steep bank with 81° angle at RTP

Plate 2 (b): Gentle bank with 45° angle at GTP.

6. Extraction of sand: This anthropogenic activity most adversely affects the Haora River banks in Jirania Block. Here the people are indiscriminately collecting sand from the river bed, both manually and mechanically. Extraction of huge volume of sand from the bed leads to deepening of the channel which is again supplemented by materials from the bank toe. This activity is also responsible for the weakening of the non-cohesive soil at the bottom of the bank and ultimate failure of the upper portion during rainy season. Local people are of the opinion that bank failure has increased in recent years due to such activity.

Bank Erosion Hazard Index (BEHI): For this study key stream bank characteristics have been identified that are sensitive to various erosional processes in order to develop BEHI rating. These stream bank variables include bank height ratio, root depth ratio, weighted root density, bank angle, surface protection and bank meterial composition. Field observations of potential erodibility were transferred to relative ratings (

Bank Height Ratio(C) = Study bank height (A) / Bank full height (B)

Volume : 3 | Issue : 6 | June 2013 | ISSN - 2249-555X

Fig. 5(a): Bank Height Ratio of the banks at Golak Thakur Para (1) and Rabicharan Thakur Para (2).

Site	A / B	BEHI Rating
Golak Thakur Para (1)	1.0	Very Low (1.0)
Rabicharan Thakur Para (2)	1.67	High (6.4)

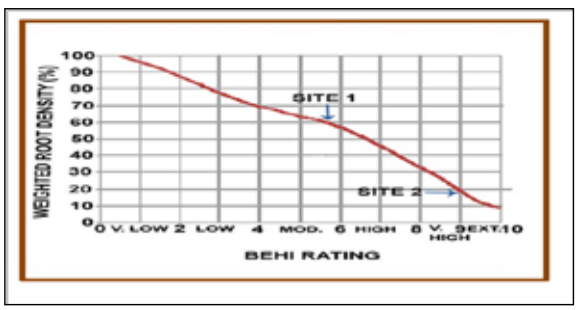

Fig. 5(b): Weighted Root Density of the banks of Rabicharan Thakur Para and Golak Thakur Para

Site	F * E	BEHI Rating
Golak Thakur Para (1)	60%	Low (5.7)
Rabicharan Thakur Para (2)	17 %	Very High (9)

Bank Angle (H)

Fig. 5(c): Angle of the banks of the River Haora at Rabicharan Thakur Para and Golak Thakur Para

Site	(H)	BEHI Rating
Golak Thakur Para (1)	45°	Mod (5.6)
Rabicharan Thakur Para (2)	81°	High (8.3)

Above graphs (Fig. 5 a, b and c and tables show the stream bank erodibility variables in relation to the Bank Erosion Hazard Index (BEHI).

The field measured variables assesmbled as predictors of erodibility (BEHI) were converted to a risk rating of 1-10 (10 being the highest level of risk). The risk ratings from 1 to 10 indicate corresponding adjective values of risk of very low, low, moderate, high, very high and extreme potential erodibility (Table 2).

These relationships were established based on a catalog of field observations as opposed to a factor of safety analysis as described by Thorne (1999) and Simon,et.al. (1999).

Table 2: Bank Erosion Hazard Index Ranking

BEHI Variables	Golak Thakur Para (Site 1)	Rabicharan Thakur Para (2)
Bank Height Ratio (C)	1.0 (Very Low)	6.4 (High)
Root Depth Ratio (E)	3.2 (Low)	8 (Very High)
Weighted Root Density (G)	5.7 (Mod)	9 (Ext.)
Bank Angle (H)	5.6 (Mod)	8.3 (Very High)
Surface Protection (I)	5.5 (Mod.)	8.3 (Very High)
Bank Material	10 (Extreme)	10 (Extreme)
ADJECTIVE RATING	MODERATELY HIGH	EXTREME
TOTAL SCORE	31	50

Conclusion:

From the above discussion it is clear that within 8 km stretch of the Haora River two villages namely Rabicharan Thakur Para and Golak Thakur Para are under extreme and moderately high risk zone of bank erosion. The study shows that Golak Thakur Para is under moderately high risk zone because here root depth, root density is high and bank angle is less steep. But nature of bank material is responsible to convert this site as moderately high risk zone. Again, at Rabicharan Thakur Para there is no root to protect the soil from erosion and bank is very steep (81°) and sandy. Steeper slope contributes to sediment transport and to bank erosion. Non-cohesive bank material i.e., sand leads to maximum erosion which ultimately leads to widening of the channel. From BEHI (Table 2) it is clear that Rabicharan Thakur Para is under extreme erosion zone (total score 50). On the other hand, though all the variables at Golak Thakur Para show low to moderate rank but the presence of sandy soil (93%) in the bank makes it moderately high erosion prone area (total score 31).

Due to this hazard many families have lost their houses, livestock, standing crops, significant amount of agricultural lands twice or thrice and had to rebuild their houses which are again under extreme and moderately high risk zones. Therefore, proper protection measures are necessary to save these erosion risk prone areas through revetments, plantation of trees etc. thereby increasing the stability of the banks.

Acknowledgement:

Authors are thankful to the Department of Science and Technology, Govt. of India for providing financial help to carry out this project work.

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