

River Erosion and the Financial Losses of the Rural Households: Survey Results of Three Areas in Bangladesh

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I. Introduction

Erosion of rivers is a common feature in our riverine country. Every year a huge amount of land is eroded along the banks of the rivers, more predominantly along the mighty rivers of Brahmaputra, the Jamuna, the Padma and the Meghna. Information available in this regard shows that during 1984-93 annual erosion amounted to 100 metres in length by the Jamuna on its left bank and 84 metres on right bank, while the Padma eroded 38 metres on the left and 120 metres on the right (Table I). Total amount of land eroded annually by the Jamuna was estimated to be 5020 hectares and that by the Padma was 1800 hectares. As a consequence the width of the rivers is increasing and at present the average width of the Jamuna stands at 11.22 kilometres.

Another small-scale study by Elahi, 1987 carried out in three Upazillas namely Chilmari, Kurigram and Bhola, the country's worst possible eroded localities, recorded the erosions rate of 13.0, 22.75 and 10.83 percent of their land coverage, respectively, in the 1980s. According to his study, displaced population in those areas number 20.0, 15.8 and 18.6 percent, respectively, and total annual financial loss was estimated to be Tk. 200 million. It may also be noted that erosion washes away the roads, markets and different institutional buildings which cannot be replaced quickly because such re-constructions are costly and require millions of Taka besides difficulties in the availability of suitable land.

In addition to loss of land, people lose their valuable houses and trees and thus, become homeless. They are to shift and resettle elsewhere, which is costly and becomes almost impossible owing to scarcity of suitable housing plots. Many of them sometimes migrate to nearby towns for possible job opportunities leading to the growth of squatters in the country as observed in the towns of Gaibandha,

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Sirajgonj, Tangail, Jamalpur etc. Most of them are at hard-core poverty level having inadequate access to employment and income. As a whole, eroded households are hard hit and very poor and the economic condition of the landless living there is deplorable. The immediate question is can we not control river erosion? The answer is may be, but cost is abnormal and often beyond one's financial capacity. Field experiments in terms of structural measures are, however, continuing at national level and the economic studies are, being carried out.

So far no rehabilitation programme for eroded households has been undertaken in the country. They, thus, are to rehabilitate themselves at their own cost which is too much expensive and often unbearable. Relief services provided by public and private agencies are too scanty and can hardly meet one month's expenses for daily necessities. The present paper does not, however, intend to investigate into all the above questions. It plans simply to study the primary characteristics of the households that already experienced river erosion and to estimate their losses of land and other assets. It also tries to report their existing levels of living. The main objectives in specific are to:

- (i) report the principal characteristics and occupations of eroded households vis-a-vis the non-eroded ones;
- (ii) estimate annual household income and determine the poverty status,
- (iii) explain the reasons for river erosion; and
- (iv) suggest possible measures against the river erosion.

Table 1: Bank Erosion and Accretion and Changes in width of the Major Rivers in Bangladesh during the Period 1984-93

Item	Jamuna	Ganges	Padma	Upper Meghna	Lower Meghna
T. Bank Erosion Rate (metre/year)					
1.1 Left Bank	100	(-) 20	38	7	65
Right Bank	84	56	120	(-) 9	180
2. Maximum Erosion (Metre/year)	780	665	620	Na	825
3. Bank Erosion (Hectare/year)	5020	2240	1800	50	1170
4. Bank Accretion (Hectare/year)	890	1010	230	50	400
5. Average width (metre)					
5.1 1984	9720	4367	5690	3400	6660
5.2 1993	11220	4693	7120	3400	8900
6. Rate of Change in width (metre/year)	184	36	159	_____	249

Source: Quoted from Sarker, and et al, 2003

The paper has been organized as follows. Following the introduction, survey methodology is described in Section II. In the third section survey findings are discussed. Income and poverty situation are examined in Section IV. The possible causes of river erosion and protection measures are briefly reported in Section V and VI, respectively. The paper ends with concluding remarks in Section VII.

II. Survey Methodology

The field survey was carried out in three purposively selected areas where construction of river protection structure was completed three years back. The areas benefited from the protection structures are largely Kamarjani in Gaibandha, Bahadurabad and Ghutail in Jamalpur. In Kamarjani the immediate benefited villages are Dhutichora and Kathihara and those in Bhadaurabad are Kulkandi and Muradabad. Ghutail on the other hand is a market area protected by the revetment. In all these villages and markets a complete census of households and business establishments was done. From the census households of each of the three selected localities, minimum 30% of households were selected at random. Total census households amount to 2790, from whom 904 samples or 32% of census establishments were selected as shown in Table 2.

In the selection of samples, the random sampling technique could not be strictly followed due to inconvenience in administering the survey. The proportional shares of establishments in the contiguous *paras* in the village ranging between 30 and 34 were covered. While selecting the samples particular attention was given to include all available occupational groups and women headed households so that the samples could be made as far as possible representative. To collect data a very short questionnaire was administered. The main questions included there are (i) erosion status of the households (ii) principal occupation of the household heads (iii) amount of losses incurred in the last five years preceding the field survey (iv) annual income etc.

Table 2: Number of Census and Sample Households in the Study Areas

Study Area	Census Households and Establishments (No.)	Sample Households and Establishments	
		No.	Percent
(i) Kamarjani	720	244	34
(ii) Bahadurabad	1315	431	33
(iii) Ghutail	755	229	30
All Areas	2790	904	32

Source: Field Survey, 2004

III. Survey Findings

3.1 Households Eroded

Households living in the surveyed areas report losses of land, houses, trees and other assets due to river erosion. Most of the sample households experienced erosion of land. In the present study families who lost their houses and had to shift elsewhere for residential purpose are considered to be eroded households. The period considered for such erosion is five years preceding the survey of 2004. Losses of assets including houses and land occurred before five years were not taken into account in the current study.

Of the total sample households, 41 percent reported the erosion of houses, the highest being in Kamarjani, followed by Bahadurabad (Table-3). In Ghutail, one-third of them was eroded, although larger number of the samples mentioned of losses of land there.

Table 3: Number of Eroded Households by the Study Areas

Study Area	Sample Households (No.)	Eroded Households	
		No.	Percent
(i) Kamarjani	244	140	57
(ii) Bahadurabad	431	190	44
(iii) Ghutail	229	75	33
All Areas	904	405	41

Source: Field Survey, 2004

3.2 Amount of land Eroded:

It is expected that the eroded households will be losing more land due to erosion than that of the non-eroded ones. The eroded households will also be more losers in terms of other assets including houses. Information collected shows that in the last five years an eroded household on average lost above three acres of land contrary to less than two acres by non-eroded families (Table-4). It is abnormally high in Ghutail. Value of other assets including houses, household articles, trees etc is also substantially high. Such losses by an eroded household was estimated to be Tk 22313 during five years or Tk. 4500 per year other than land. This is definitely unbearable for a poor household of the country.

The figures available with us are difficult to accept. It seems that the Survey Officers did not mention the period of five years as specified in the questionnaire.

Table 4: Amount of Land (decimals) and other Assets ((Tk.) lost by an Eroded and Non-eroded Household (Average per Household)

Study Area	Land lost (decimals)		Other Assests (Taka)	
	Eroded	Non-eroded	Eroded	Non-eroded
(i) Kamarjani	104	65	10396	2897
(ii) Bahadurabad	88	8	12339	394
(iii) Ghutail	1236*	486*	67979	245
All Areas	312	184	22313	791

Source: Field Survey, 2004

3. Socio-economic Characteristics of the Eroded Households

3.1 The land ownership Distribution by Size.

The land ownership distribution of households finds the landless maximum (56% among the eroded and 46% among the non-eroded ones) followed by small land owners (Table-5) in both these types of households. The medium and the large land owners are few (5 and 1 percent, respectively) among the eroded cases while they are more than double among the non-eroded households. The existing pattern of land distribution in the study areas is almost similar to the country's average situation.

The land distribution by ownership size, furthermore, shows that a higher proportion of the landless (51%) lost their land due to erosion and it is 60% in Kamarjani where marginal owners are also severely affected. Significant numbers of both marginal and small land owners are also affected by land loss (Table-6). In Bahadurabad the three small ownership groups (landless, marginal and small) are equally affected. The immediate question is what is the amount of land lost by each category of household.

Table 5: Distribution of Households by Land Ownership Size and by the Erosion Status

Study Area	Landless		Marginal		Small		Medium	
	Eroded	Non-Eroded	Eroded	Non-Eroded	Eroded	Non-Eroded	Eroded	Non-Eroded
Kamarjani	37.1	32.9	27.9	22.4	27.9	28.9	5.7	11.8
Bahadurabad	63.3	55.7	10.6	9.5	19.6	18.4	6.0	12.4
Ghutail	68.8	38.8	11.3	22.4	16.3	25.2	2.5	12.9
All areas	55.6	45.8	16.5	16.3	21.7	22.6	5.2	12.5

Note: Landless (Upto 0.5 acre), marginal (0.51-1.0 acre); Small (1.0 to 2.5 acre), Medium (2.5-5.0 acres) and large (5.01 acres and above)

Source: Field Survey, 2004

Table 6: Proportion of Sample Households affected by Erosion by Land Size in the Study Areas

Study Area	Landless	Marginal	(Percentage of the Group)	
			Small	Medium
Kamarjani	59.8	62.9	56.5	38.1
Bahadurabad	49.4	47.7	50.6	27.3
Ghutail	48.2	21.4	26.0	9.5
All Areas	51.1	46.6	46.4	25.6

Source: Field Survey, 2004

3.2 Land Ownership Size

Regarding the land ownership size, the eroded households have lower size in all the three study areas. The difference in land size between eroded and non-eroded families is abnormal at Bahadurabad where the size of an eroded household is just half of that in non-eroded cases (Table-7). Surprisingly, the household of Ghutail have little cultivable land, reportedly eroded away overtime. The average size of holding of sample households is low (0.79 acre) at Bahadurabad and it is far below one acre (0.69 acre) in case of eroded households, which is too meagre for survival.

Table 7: Land Owned and Cultivated Holding Operated by a Household

Study Area	Land Owned (decimals)	Cultivated Holding (decimals)
1. Kamarjani	<u>120.0</u>	<u>128</u>
1.1 Eroded	110	136
1.2 Non-eroded	140	113
2. Bahadurabad	117	97
2.1 Eroded	78	69
2.2 Non-Eroded	<u>157</u>	<u>126</u>
3. Ghutail	128	*
3.1 Eroded	86	*
3.2 Non-eroded	<u>141</u>	<u>-</u>
4. All areas:	119	79
4.1 Eroded	90	78
4.2 Non-eroded	<u>148</u>	<u>80</u>

Note: * Negligible

Source: Field Survey, 2004

3.3 Age and Education of the Household Heads:

It is surprising to find that socio-economic characteristics of the sample households, whether eroded or not, are almost similar, although minor differences exist of among the study Areas. Average age of the household head is 42 years in the study areas and it is reportedly highest in Kamarjani. Family size is significantly lower in Bahadurabad compared to two other areas. Ghutail is found quite advanced in respect of literacy level where illiterate heads are only 14 percent contrary to 42% in the remaining other areas (Table-8).

Table 8: Age, Education of the Households Head and the Family Size

Study Area	Age (years)	Education (%)		Family Size (No.)
		Illiterate	Secondary and above	
1. Kamarjani	<u>45</u>	<u>42</u>	<u>28</u>	<u>5.4</u>
1.1 Eroded	46	45	25	5.4
1.2 Non-eroded	44	37	34	5.4
2. Bahadurabad	<u>41</u>	<u>42</u>	<u>36</u>	<u>3.7</u>
2.1 Eroded	42	38	40	3.7
2.2 Non-Eroded	41	47	32	3.7
3. Ghutail	<u>42</u>	<u>14</u>	<u>64</u>	<u>5.6</u>
3.1 Eroded	42	22	60	5.5
3.2 Non-eroded	42	10	66	5.7
4. All areas:	<u>42</u>	<u>35</u>	<u>42</u>	<u>4.7</u>
4.1 Eroded	43	38	37	4.6
4.2 Non-eroded	42	32	44	4.7

Source: Field Survey, 2004

3.4 Occupational Distribution:

Occupational distribution of households has been examined on the basis of principal occupation of the household heads. Such distribution finds Kamajani, an agricultural area, while Ghutail as the non-agricultural one where only about 10% are farming households (Table-9). As a whole, 36% of households are farmers. There are of course wide differences among the study areas as well as between the eroded and the non-eroded households. In Bahadurabad, 30% are traders among the eroded households contrary to only 14% among the non-eroded ones, of whom significant numbers are occupied in agriculture (46%). In Kamarjani, traders are fewer among the eroded, perhaps because of serious financial constraint which is evidenced from high figures in wage works (Table 9), almost

three times of that among the non-eroded households there. It may be concluded that there is actually no definite occupational pattern between the eroded and the non-eroded households.

Table 9: Occupational Distribution of Households in the Study Areas

Study Area	(Percent in an area)				
	Farming	Wage Works	Trading	Service	Others
1. Kamarjani	<u>61.1</u>	<u>12.0</u>	<u>19.4</u>	<u>2.8</u>	<u>4.6</u>
1.1 Eroded	61.4	15.7	15.7	2.1	5.0
1.2 Non-eroded	60.5	5.3	26.3	3.9	3.9
2. Bahadurabad	<u>37.0</u>	<u>25.3</u>	<u>21.8</u>	<u>10.5</u>	<u>5.5</u>
2.1 Eroded	28.1	24.6	29.6	11.1	6.5
2.2 Non-Eroded	45.8	25.9	13.9	10.0	4.5
3. Ghutail	<u>9.3</u>	<u>19.3</u>	<u>63.4</u>	<u>7.9</u>	—
3.1 Eroded	10.0	22.5	52.5	15.0	—
3.2 Non-eroded	8.8	17.7	69.4	4.1	—
4. All areas:	<u>35.7</u>	<u>20.3</u>	<u>32.4</u>	<u>7.8</u>	<u>3.8</u>
4.1 Eroded	35.8	21.2	29.4	8.8	4.8
4.2 Non-eroded	35.6	19.3	35.4	6.8	2.8

Source: Field Survey, 2004

4.1 Annual Income

As far as annual income is concerned, it is quite low (Tk. 37808) per household in the study areas and it is the lowest at Kamarjani (Tk. 25808) as shown in Table 10. Income is high in Ghutail having Tk. 63848 for a household as it is a market area and the people there are mostly traders. It is again surprising to note that there are little differences in income between the eroded and non-eroded households. They may be because agriculture there contributes a small amount, to the extent of only 31% of their income. They are largely dependent on non-agricultural income indicating that income distributions of households in the study areas are different from elsewhere in the country. There are however, wide differences among the areas. In Kamarjani agriculture shares 55%, contrary to only 19% in Ghutail. There are also significant level of differences in agricultural income between eroded and non-eroded households at Ghutail and Bahadurabad (Table-10). Overall, the study areas have lower income and agriculture there has a small share in total household income.

Table 10: Households Living Below Poverty Levels by Principal Occupation of the Household Head

Study Area	Annual Income (Taka)	Share from Agriculture (%)
1. Kamarjani	<u>25305</u>	<u>55</u>
1.1 Eroded	25104	54
1.2 Non-eroded	25674	58
2. Bahadurabad	<u>29783</u>	<u>33</u>
2.1 Eroded	29422	24
2.2 Non-Eroded	30140	42
3. Ghutail	<u>63848</u>	<u>19</u>
3.1 Eroded	64100	12
3.2 Non-eroded	63712	24
4. All areas:	<u>37808</u>	<u>31</u>
4.1 Eroded	34600	27
4.2 Non-eroded	40978	34

4.2 Poverty Situation

Erosion prone areas are largely poor because of lack of employment opportunities and poorly developed agriculture. Furthermore, among all households eroded people are apprehended to be poorer and more poverty stricken. Information collected confirmed the hypothesis that about three-fourths of the eroded households live at below poverty level* compared to 64% among the non-eroded ones (Table II). It is also noticeable that in the study areas as a whole over two-thirds (69%) of the households live at below poverty level against the country's average of nearly half. It may also be noted that among these three areas Kamarjani is the poorest with 87% of their people at poverty level. Financial condition is, however, better in Ghutail but there farmers are worst affected.

Poverty does not affect all occupation groups by the same extent. Wage workers are observed to be worst sufferers as their employment opportunities are very limited besides existing poor wage rates. The data in this respect show that almost all wage working households as well as those from miscellaneous occupational groups live at below poverty level. A very high proportion of farmers in both the eroded and the non-eroded areas also suffer from poverty (Table-12). A bit better position is noticed with the service-holders at Bahadurabad and the traders at Ghutail. We may conclude here that the households residing in the erosion prone areas specially along the banks

* The usual poverty and the hard-core poverty lines are estimated to be Tk. 39120 and Tk. 33720 per household after adjustment of the country's inflation rates based on the BBS estimate of the national poverty line for the rural people.

Table 11: Households Living Below Poverty and at Hard-Core levels in the Study Areas

Study Area	Below Poverty Level		At Hard-Core level		All Households	
	Eroded	Non-eroded	Eroded	Non-eroded	Below poverty	At Hard-Core
Kamarjani	87.1	86.8	83.6	84.2	87.0	83.8
Bahadurabad	75.9	72.6	69.3	66.7	74.3	68.0
Ghutail	42.5	41.5	23.8	23.8	41.9	23.8
All areas	73.3	64.4	65.4	55.0	68.8	60.1

Table 12: Households Living Below Poverty Levels by Principal Occupation of the Household Heads

Style Area	Farmers	Wage Labours	Traders	Service	Others	Total
1. Kamarjani						
1.1 Eroded	84.9	100.0	100.0	—	100.0	87.1
1.2 Non-eroded	87.0	100.0	95.0	—	100.0	86.8
2. Bahadurabad						
2.1 Eroded	82.1	100.0	66.1	18.2	100.0	75.8
2.2 Non-Eroded	67.4	98.1	75.0	15.0	100.0	72.6
3. Ghutail						
3.1 Eroded	100.0	33.0	21.4	91.7	—	42.5
3.2 Non-eroded	100.0	65.4	25.5	83.3	—	41.5
4. All areas:						
4.1 Eroded	84.7	97.5	55.3	40.5	100.0	73.3
4.2 Non-eroded	76.1	87.8	44.0	27.6	100.0	64.4

Source: Field Survey, 2004

of the big rivers like the Jamuna and the Padma are miserably poor and there over two-thirds of the people are living at below poverty level.

5. River Erosion

The study has made it clear that the river erosion is destroying the farm economy and making people poorer in the river bank areas of our country. It is usually believed that the erosion cannot be controlled as the big rivers are still active and unstable; and their channels are continuously shifting. It may be of interest to know the exact reasons for river erosion although it is commonly understood to be due to changes in the velocity of water flow which is but effected by many other factors as described below:

5.1 Causes of River Erosion

Modifications of water flow velocity, discharge, sediment load and river morphology in unstable river channels are major factors initiating erosion and deposition of silt. It also depends on the natural stability of the subsoil and its extent of changes. Successive erosion and deposition often leads to rapid changes in the river platform and slope. Changes in river bed elevation can also promote rapid bank erosion.

In general, surface erosion of river banks or along the river bed occurs if the driving erosive forces exceed the resistive forces of the individual grains or of the conglomerates in case of cohesive materials. The main factors responsible for surface erosion of river banks are as follows (Ministry of Water Resources, 2001):

- (i) Current induced shear stress;
- (ii) Wave loads (wind generated, ship and boat generated);
- (iii) Seepage (excessive pore pressure);
- (iv) Surface runoff;
- (v) Mechanical action (desiccation, ship impact, activities of human and animals).

Shear stress induced by current flow is the main hydraulic erosion factor. It is again effected by primary and secondary current, irregularities in the cross sectional shape of the channel, changes in the roughness of the river bed etc. Obstructions to the flow as well as variations in the roughness of the river bank and/or river bed causes changes in the velocity distribution and the secondary flows. As a consequence, the river starts to develop bends and scouring occurs. The influence of wave action is important along the actual bank line, i.e. the transition between water and adjacent flood plain of a river.

5.2 Erosion places and its Timing

River erosion occurs more at the bend of the river and also near the bridge/culvert where the velocity of water flows is constrained, resulting in scouring there. Intensity of erosion is again higher in the bank line having meandering soils which are generally sandy and fragile. Deposits of sediments on the water channels, which restrict water flow causing diversion of the direction of current, also causes erosion of the chars and the banks.

In our country erosion generally occurs in the monsoon season when the speed of the current sharply rises due to excessive flow of water from upper riparians and

erodes away loose soil making holes in the river banks. Sudden receding of flood water level also causes erosion as at that time the degree of compaction of soil declines. Heavy deposition of silts at the late monsoon when elevates the river beds restricting the flow of water also erodes away the fragile river banks. Huge accumulation of sediments followed by development of bars and islands promotes widening and development of braided channels.

VI. Bank Protection Measures

In order to prevent erosion of river banks suitable measures are required. These may be either single or combined, structural and non-structural. In general there are three types of measures for erosion control. They are:

- (i) River training measures which are intended to influence the flow conditions or channel properties downstream of the man made interventions;
- (ii) Structures, which are aimed at reducing the hydraulic effects directly in front of an area to be protected, e.g., groynes, and
- (iii) Structures, to protect the actual bankline without relevant active interference on water i.e., revetments.

Each of them must be designed properly to resist hydraulic loads and to prevent the river channels from uncontrolled changes. River training measures are the mechanisms which are built either on the main land or in the flood plain as attached chars or those built as floating structures.

Structural measures are of course highly expensive depending on the type of structure built against erosion. Cost estimates show that the revetment constructed at Bahadurabad against the Jamuna amounts to US\$ 10,100 per metre and the groyne at Kamarjani costs US\$ 6,900 (BETS, 2002). Protection structures constructed elsewhere in the country (Sirajgonj Town protection – US\$ 29,300) are found more expensive. Of the two recently built structures, Bahadurabad one appears to be more effective. It is 800 metres long constructed at a cost of US\$ 8.1 million which is expected to be immediately benefiting 1.5 sq. Kilometres or only 150 hectares. This sounds abnormal at least for farm land and perhaps not advisable. For town protection such structural measures may be suggested depending on the value of assets to be protected. Besides structural measures, the well-designed river training and continuous dredging may help regular flow of water through the existing streams. Also special plantation by bamboos and grass along the banks may help protect land from erosion, and farmers accordingly may be trained.

VII. Concluding Remarks

River erosion is a common feature along the banks of the rivers specially along the country's mighty rivers. Such erosion destroys fertile cultivable land and make many people homeless and landless. Annual loss of land per household in the study areas is estimated to be 0.62 acre which is too much for a farm household. Besides land, total loss of other assets including houses amounts to over Tk. 22,000.00. The losers of land are again observed to be higher among the marginal land owners. Many of them overtime become wage workers as self employment opportunities are fewer there. Migrant workers are reportedly high from Kamarjani and Bahadurabad. Their living conditions are miserably poor as evidenced from their housing conditions, more prominently at Kamarjani. There about 85% of households are living below poverty level which is extraordinarily high. Economic conditions are more deplorable among the wage workers, all of whom are but poverty stricken. People at Ghutail are a bit better where over 60% are traders and their shares of income are significantly higher from non-agriculture (80%).

River protections, specially structural measures, are quite costly and it amounts to over US\$ 10,000 per metre which is difficult to fund by the Bangladesh Government. Their maintenance operation is also not easy. Under the circumstances, people who are capable are expected to gradually shift to elsewhere in the country and take precautionary measures well ahead of erosion possibility following the erosion forecast, may be made by the Water Development Board or the Local Government. A long-term development plan may also be prepared for the erosion prone areas where creation of employment opportunities should be given top priority. Also well designed dredging may be undertaken in the critical areas of the channels towards regular flow of water through the existing streams. Special plantations by bamboos and grass on the riverbanks by the farm households may also help reduce the intensity of erosion.

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