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ANALYSIS OF THE FACTORS RESPONSIBLE FOR RIVER BANK EROSION : A STUDYIN BERHAMPORE BLOCK, MURSHIDABAD DISTRICT, WEST BENGAL.

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Short Profile

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ABSTRACT:
River Bank erosion has emerged to be one of the most annoying environmental hazards these days. It is a complex process which incorporates actions of several complex processes and cannot be attributed to any single process. At present, the average quantum of land engulfed by the rivers is about 800 hectares in West Bengal. River Bhagirathi –Hooghly, the most prominent river of the state has resorted to large scale bank slumping and flood in western part of Berhampore block, Murshidabad. Though there has been immense study on the erosional activity of this river in the state. Eminent national and international scholars have detected the causes of such erosional activities to be the typical flow properties of the river, the structural and compositional properties of the bank and climatic characteristics of the concerned area. This paper tries to throw some light upon the factors which have probably acted jointly to produce such large scale wearing way of land in this part of the planet.

KEYWORDS: Water Discharge, River Bank Erosion, Bank Slumping, River Oscillation.

INTRODUCTION

The word erosion has been derived from a Latin word “erodere” which means to gnaw. In fact erosion is the process in which various erosive agents, obtain and remove rock debris from the earth's crust and transport them for long distance (Savindra Singh, 1973). River Bank erosion is a hazard. Almost all Indian rivers are prone to bank erosion making half of the country's land affected and the plight of millions deplorable. In West Bengal, the river Bhagirathi- Hooghly makes large scale devastations in the Districts of Malda, Murshidabad, Nadia and Hooghly. Though there have been a lot of studies on different aspects of bank erosion and works of eminent scholars highlight the problem of Malda and Murshidabad. BerhamporeBlock of Murshidabadis a typical prey to such large devastating attitude of the river. Here, massive rate of corrosion and disintegration of the right bank of the river Bhagirathi has left thousands homeless with all their properties lost. There has been a trial on our part to develop into the problems and to find out the causes behind such activity of the river.

OBJECTIVES:

The major objectives of this paper are to detect the problem of bank erosion in Berhampore Block, and to find out reasons behind such erosion.

METHODS:

Analysis of river bank erosion has been primarily carried out by Google Earth and SRTM images using Map Info, and Arc GIS software. Distance between the river bank and a placemark taken at a definite coordinate was calculated for six years from 2009 to 2014 .Soil samples were collected and duly tested in the Laboratory of the Central Water Commission, Berhampore Unit. Daily water discharge and Mean Water Level were collected from CWC, Berhampore Unit.Climatic data were collected from the Meteorological Department. These all secondary data are calculated from different Govt. offices and suitable cartographic techniques are used to predict for the study area.

STUDY AREA:

Berhampore Community Development Block is an administrative division in Berhampore Subdivision of Murshidabad district in the Indian states of West Bengal. Berhampore town and Daulatabad police stations serve this block. The headquater of this block is at Berhampore, Kasimbazar, Goaljan and Gorabazar are census town of this block. Total area of this block is 194.67sq.km[2]. Gram Panchayet of Berhampore Block are Bhakuri-1, Bhakuri-2, Chhaighari, Daulatabad, Gurudaspur, Haridasmati, Hatinagar, Madanpur, Manindra Nagar, Neallispara, Goaljan, Noada, Nowdapanur, Radharghat,-1, Radharghat-2, Rajdharpara, Rangamati, Chandpara, Sahajadpur and SatuiChowrigachha[3].The study area is characterized by an average elevation of 18 meters (59 ft) above the mean sea level. It possesses an average slope of nearly 7 degrees. The river Hooghly (also known as the river Bhagirathi) flows in a south eastern direction along the middle part of Berhampore block. The river in Berhampore has registered numerous riverine features, the ox bows, the cut offs, a number of paleo channels, and an extensive flood plain. Here the river is at its late maturity and lateral erosion of the river is continuously widening the valley sides.

Figure No- 01

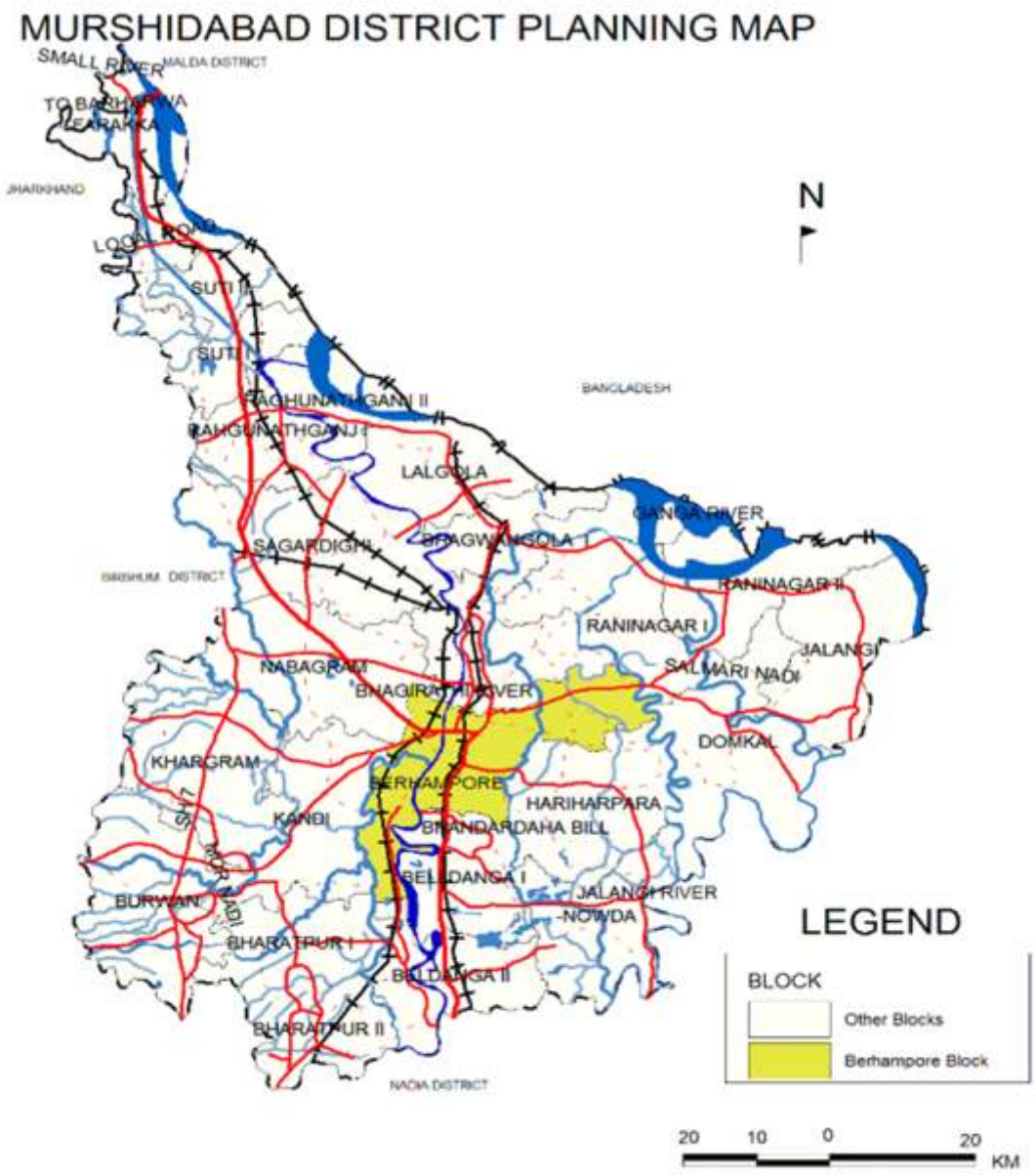

Fig: Location & Planning Map of Murshidabad District.
Source: Lay out by Author in MapInfo Software.

FACTORS INFLUENCING BANK EROSION:

Hydraulic action- this is the ability of moving water to dislodge and transport rock particles. It occurs when the motion of water against a rock (or earth) surface produces mechanical weathering. This process is the result of friction between the moving water and the static stream bed and banks. This friction increases with the speed of the water and the roughness ofthe bed. Once loosened the smaller particles are actually held in suspension by the force of the flowing water, these suspended particles can scour the sides and bottom of the stream (Wikipedia).The flow forces were 6 times

more effective than any other process (Knighton 1973; Hook 1979; Simons 1979). Slumping-Slumping or collapse of large blocks is more closely related to soil moisture than flow conditions although stages of river oscillation can control the rate of slumping. Wet bank slumping mainly takes place when the main flow has receded and the bank is thoroughly wet. And can be a major contribution to bank retreat. The process is influenced by bank stratigraphy for example where cohesive materials overlie non cohesive ones, a relatively common condition in rivers flowing thorough alluvial deposits.

Table No- 01: Factors Influencing Bank Erosion. Source: Fluvial Forms and Processes: David Knighton 1984.

Flow Properties	Magnitude, Frequency and variability of streams Discharge magnitude and Distribution Velocity Degree of turbulence	
Bank Material Composition	Size, Gradation, Cohesivity, Stratification of bank sediments	
Climate	Amount, Intensity and duration of rain	
Subsurface Conditions	Seepage Force, Piping, Soil Moisture Level.	
Channel Geometry	Width and Depth of channel, Height of bank.	
Biology	Type of Vegetation, Root Density	
Anthropogenic	Urbanization, Land Drainage reservoir, Development, Boating	

ANALYSIS OF THE FACTORS OF BANK EROSION IN BERHAMPORE:

The most important flow propertyis discharge. Discharge is the volume ofwater passing through a given crosssection in a unit time. The catchment of ariver above a certain location isdetermined by the surface area of all landwhich drains towards the river fromabove that point.Below, are the diagrams whichshow the discharge of the river Bhagirathi river in Berhampore CWC unit.

Table No- 02 Daily Water Discharge Report of Bhagirathi River in Berhampore CWC Unit.

Date	Maximum Temp (^{0}C)	Minimum Temp (^{0}C)	Depth from MWL	Total Discharge (m^3/sec)	Mean Velocity (m/sec)
01.08.2014	35	27	14.605	1185.62	0.835
02.08.2014	36	29	14.620	1219.60	0.843
04.08.2014	36	28	14.640	1195.95	0.839
05.08.2014	35	27	14.640	1190.59	0.839
06.08.2014	35	27	14.660	1201.66	0.843
07.08.2014	35	27	14.640	1188.16	0.839
08.08.2014	37	29	14.660	1200.92	0.841
09.08.2014	34	27	14.675	1215.06	0.844
11.08.2014	33	27	14.800	1252.45	0.852
12.08.2014	33	27	14.900	1291.71	0.862
13.08.2014	35	28	14.930	1300.77	0.865
14.08.2014	33	27	14.990	1326.73	0.866
16.08.2014	33	27	15.090	1360.11	0.871
18.08.2014	33	26	15.340	1427.29	0.883
19.08.2014	34	27	15.420	1450.89	0.882
20.08.2014	33	27	15.495	1492.61	0.891
21.08.2014	33	27	15.530	1505.15	0.893
22.08.2014	34	28	15.560	1506.54	0.891
23.08.2014	34	28	15.560	1511.28	0.894
25.08.2014	34	29	15.435	1458.10	0.879
26.08.2014	34	26	15.365	1430.65	0.873
27.08.2014	34	27	15.265	1469.72	0.867
28.08.2014	34	28	15.185	1457.28	0.862
29.08.2014	34	26	15.060	1344.80	0.847

Source: Central Water Commission, Berhampore Unit.

Table No-2 represents the maximum and minimum temperature, mean water level, total discharge and mean velocity of river Bhagirathi in a point of CWC, Berhampore unit (near K.N.College). In August, 2014 the total average Mean Water Level was 15.05 m. and total water discharge was 33479 m 3 /sec. and average was 1339 m 3 /sec. and 8.6 m/sec was the mean velocity of Bhagirathi river. It is calculated as----

$$\text{Velocity (V)} = \frac{\text{Total Water Discharge (Q)}}{\text{Area (A)}}$$

Average temperature is measured by thermometer and Mean depth is calculated by Echo sounder and thr section line marked by Tangent Sextant. About 30 points are observed to collect the data. Here average temperature is genetally stagnant but it differs from summer to autumn. In summer month average water level is high due to pressure of south-west monsoon rain and huge load of Farakka Barrage. As well as the depth of river is also high than other month. The sediment movement in tidal estuary of the Hugli is the function of a complex fluvial system that can hardly be governed by inducing 40000cusec (1132 cumec) of water. The south flowing peak discharge in the Hugli even during monsoon hardly exceeds 4246 cumec only. This has also important role in

degeneration of deltaic rivers. One major reason of increasing sediment load in the river is the depletion of forest cover, expansion of agriculture in the catchment areas and increasing bank failure in Murshidabad and Nadia districts. Since the construction of a series of dams across the western tributaries, the peak discharge in the Bhagirathi has been reduced and thereby the ability to flush the sediment towards the deeper sea has declined.

The diminishing headwater supply and increasing sediment load posed serious challenge for navigation also. The catchment areas of the western tributaries to the Bhagirathi have been drastically modified during last two centuries. The hydraulic regime of this area was largely modified due to expansion of agriculture, indiscriminate exploitation of ground water, depletion of forest cover, expansion of road and railways and building of dams and barrages across the rivers. All these events were combined to contribute increasing sediment load and diminishing water in the Bhagirathi-Hugli River. Since the dams had been built across some of the western tributaries, the peak discharge of the Bhagirathi has been reduced. This in turn affected the ability to flush the sediment load into the sea. Most of the off takes of these spill channels have been closed either by man or by nature itself. As a result there is no headwater supply to these spill channels to maintain their original flow and they virtually become dead. On the other hand a little more discharge causes flood in the upstream areas. The off-take of Sialmari has also been closed by construction of a sluice to prevent the flood spill of river Padma. Outfall point of river Bhairab with Jalangi has changed appreciably. The off-take of river Jalangi from Padma has been closed by the Krishnagar- Jalangibazar road embankment resulting in stoppage of entering the flood spill of river Padma into river Jalangi. So the Jalangi-Bhairab-Sealmari area becomes problematic even during normal rainfall

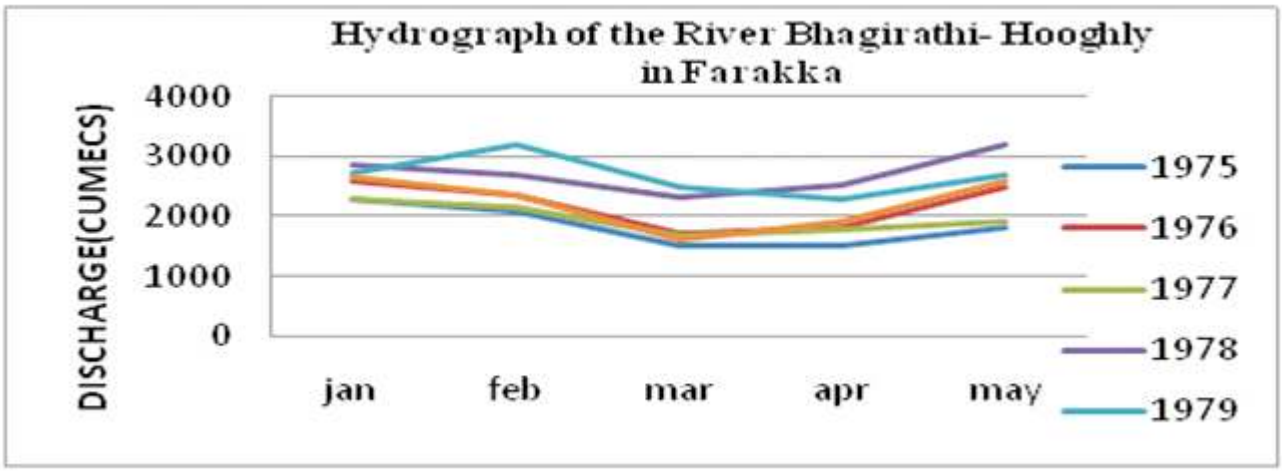

Figure 2: Source Erosion inBhagirathi.2000, A case Study in Farakka.

This diagram (figure-1) is the hydrograph ofthe river in Farakka in from 1975-1979.From this diagram it is clearthat the construction of the barrage hasregulated the discharge of water of theriver. In 197, when the minimumdischarge of the river was 1999cumecs, itturned to below 1000 cumecs in2000.The most notable change isobserved from July. In 1970, the Julydischarge was 22358, cumecs whereas in2000, July, the maximum discharge was1500cumecs and the average dischargewas, between 1000 and 1500 cumecs.The September discharge was thehighest. In 1970 the September dischargewas, 38992 cumecs and the regulateddischarge in 2000 was only nearly 3000cumecs. Therefore the control of water inthe Farakka is notably important in theprocess of river shifting. A continuousdischarge is not that effective in bankerosion as compared to a sudden highdischarge. The problem of river shifting inNadia lies here. It happens that Farakkabarrage at

times emits very large volumesof water mainly during and after rainyseason. This sudden emission of a large volume of water, causes slumping of the river bank. According to people of theaffected areasof Berhampore. It is after theconstruction of the Farakka barrage,that, large scale bank failures have takenplace. Again they say that bank failuresare most in the months of SeptemberOctober and November. Firstly after theheavy monsoonal rainfall in Berhamporeand the emission of large volume of waterfrom the Farakka reservoir, hugeamounts of land get inundated. That isflood condition occurs after the heavyrain of July to September. This floodcondition weakens the subsurface soillayer which predominantly consists ofsand. Sand is a soil particle which has theleast Cohesivity and has the highesterosibility. The weakening of the sandylower layer, causes bank slumping andtherefore the river bank is graduallywashed down into the river bed.

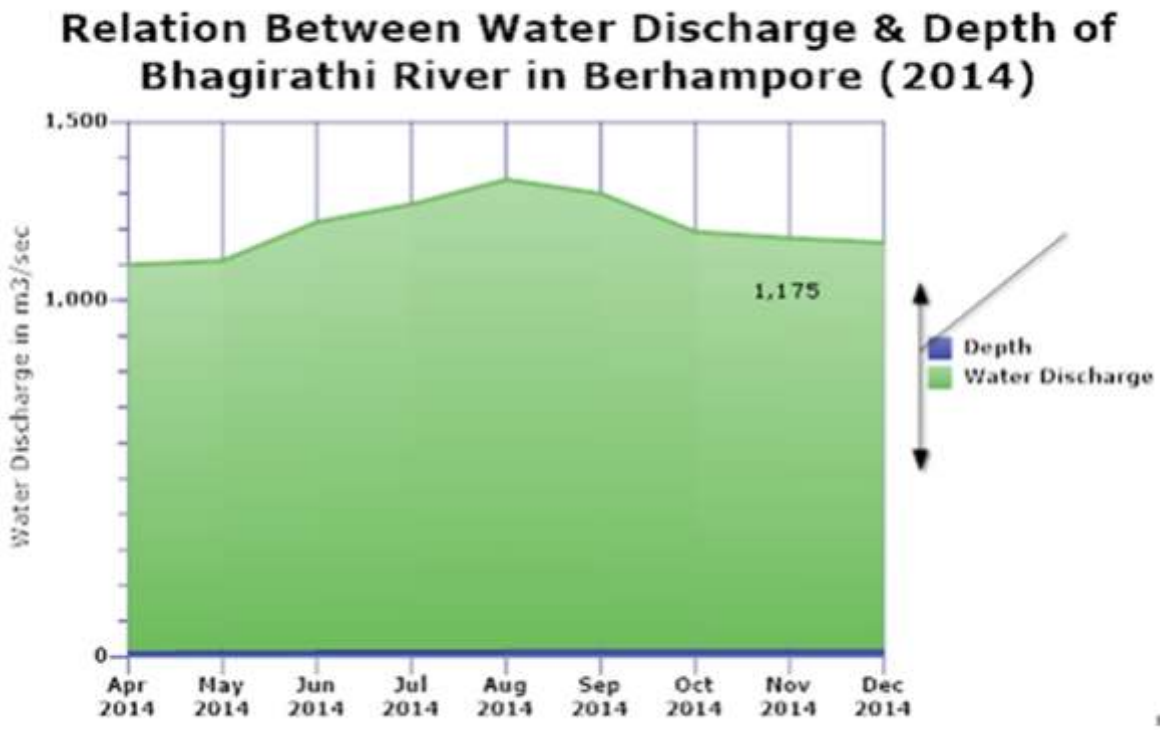

Figure 3:Water Discharge & Depth of Bhagirathi at Berhampore Unit
Source: Data collect from Central Water Commission, Berhampore

Therefore from the above findings it is clear that the bank is composed of mainly sand and loam or a composition of both. This is the reason that the bank is so fragile and erosion is so prominent here.

CLIMATE:

The March 19 issue of Science reports that climate has a previously unappreciated influence on river meandering, researchers have found. Colin Stark and colleagues correlated a 20 to 30 year-old record of typhoon rainfall in Japan with digital elevationmodels and found that climate directlyinfluenced river meandering, presumably by weakening the bedrock channel walls.Expanding their analysis to a larger region of the western North Pacific, the researchers found that rivers'

sinuosity was greatest in the subtropics, where extreme rainfall and flood events are common, and decreased both toward the equatorial tropics and mid-latitude Japan, where such extremes are rare. The results also indicate that underlying bedrock strength, as opposed to tectonic uplift as some have proposed, acts as a secondary control. (Chinese eurekalert) The study area has a hot, wet and dry tropical climate. Rainfall occurs in the months of May to September from the south –west monsoonal wind. Summer months start from the middle of March. The temperature remains nearby 35 degrees or more in these months with an average of 27 degrees.

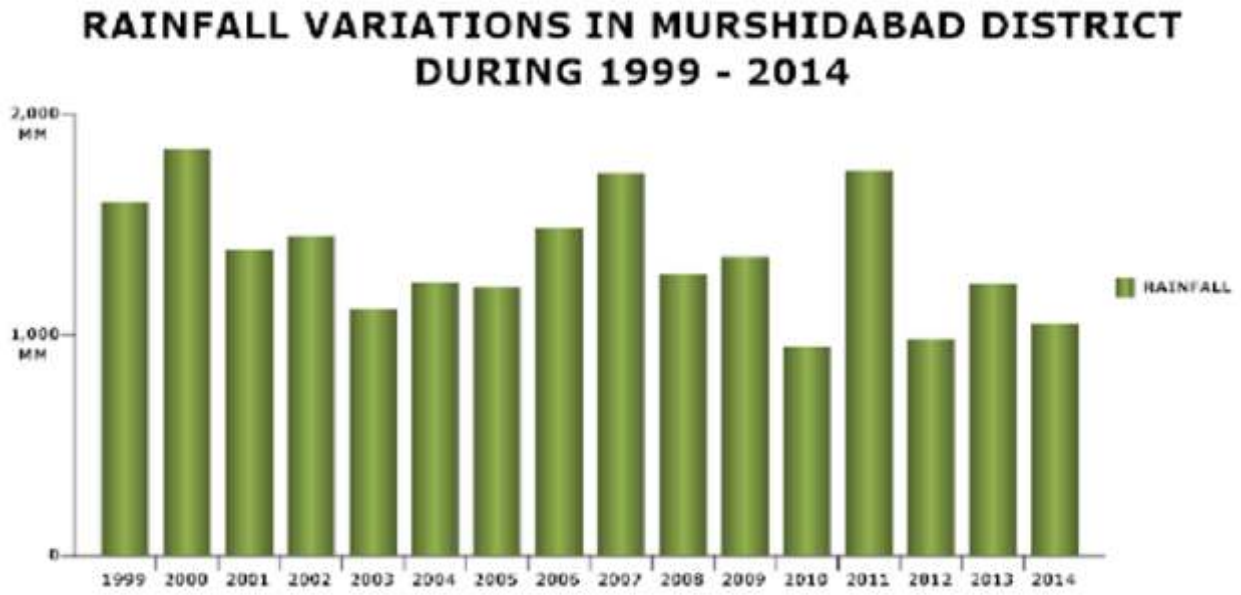

Figure 4: Average Rainfall from 1999-2014 in Murshidabad
Source: Data from Meteorological Department, India

From the fifteen years average rainfall diagram of Murshidabad district, we find that rainfall in the District varies from about 200 to 300 mm. The rainfall is obtained mainly by the south west monsoonal winds and therefore the maximum rainfall occurs in the summer months. 92% of the rainfall is obtained in the period between April and November. According to the villagers surveyed, maximum rainfall occurs in the period between July and September and this is the most vulnerable time of the year whenboth acute flooding and river bank failureoccurs.

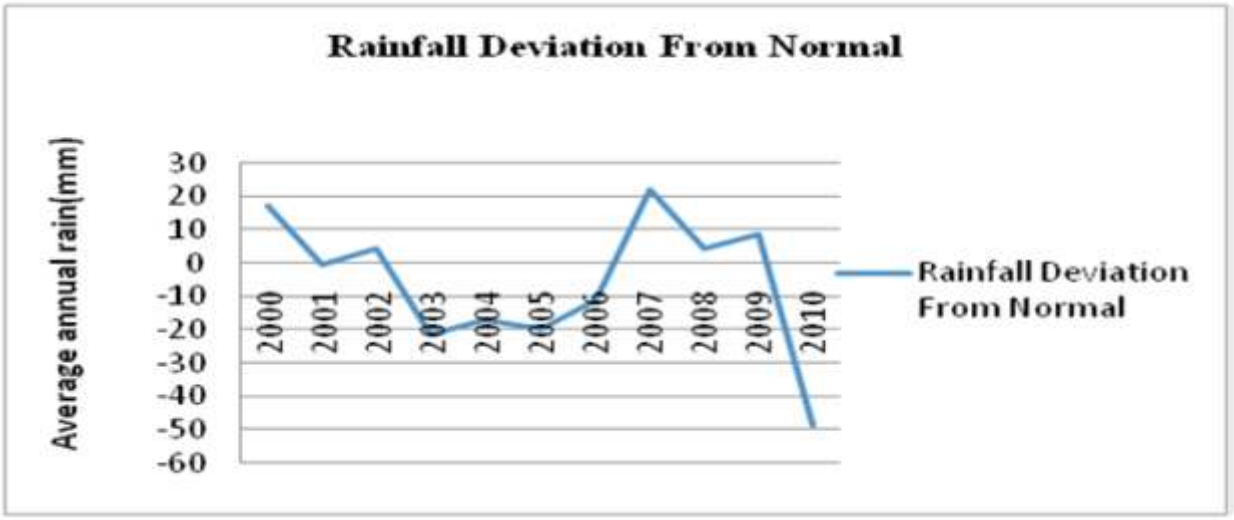

Figure 5: Rainfall Deviation from Normal in Murshidabad District.
Source: District Statistical handbook 2010, Murshidabad.

Here it is found that, only in2001, rainfall was near normal. Otherwise, rainfall is very high or very low and fluctuation has become more or less a normal phenomenon here. Both rainfall and runoff factors must be considered in assessing a water erosion problem. The impact of raindrops on the soil surface can break down of soil aggregates disperse the aggregate material. Lighter aggregate materials such as very fine sand, silt, clay and organic matter can be easily removed by the raindrop splash and runoff water; greater raindrop energy or runoff amounts might be required to move the larger sand and gravel particles. Soil movement by rainfall (raindrop splash) is usually greatest and most noticeable during short-duration, highintensity thunderstorms. Although the erosion caused by long-lasting and lessintense storms is not as spectacular or noticeable as that produced during thunderstorms, the amount of soil loss can be significant, especially when compounded over time. Runoff can occur whenever there is excess water on a slope that cannot be absorbed into the soil or trapped on the surface. The amount of runoff can be increased if infiltration is reduced due to soil compaction, crusting or freezing. Runoff from the agricultural land may be greatest during spring months when the soils are usually saturated.

CHANNEL GEOMETRY

Channel geometry representingthe size and shape of cross sectional andlongitudinal channel form, includeswidth, channel depth, wetted perimeter,channel slope, channel bends, shape of channel thalwegs , and their interrelationships . (S . Singh Geomorphology, edit. 2007). Channel width, is the mean of measurements taken at crossovers wherein crossover means straight line joining two points across a channel. The reach under study, has the average width of 295 meter. Thisproves that despite the fact that rapid erosion is taking place in Berhampore area. The width of the river channel is a factor of the volume of water in the stream, and the slope of the river channel. The overall depths at the upper part of the reach have shoaled considerably. The deepest water in the deep waterpocket has a maximum depth of 14.6meters. Bank erosion was observed on the right bank. The. The crossing between the two sand patches showed a least depth of 0.4 mtrs. The maximum depth obtained at the lower part of the channel is 16.0 mtrs. The overall depths at the

Upper Part of the reach showed further improvement of 8.2 mtrs. In eastern bank the depth is high than western bank. As a area of Municipality eastern bank is made of boulder but the western bank is generally damaged by this river per year drastically.

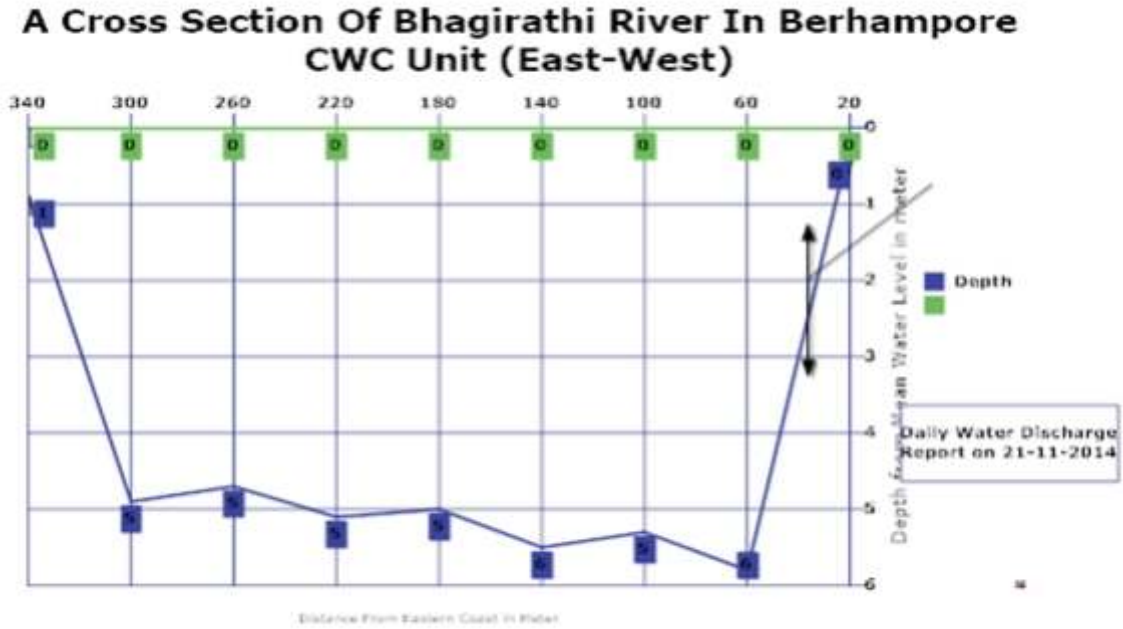

Figure 6: East-West cross section of Bhagirathi River in Berhampore
Source : Data collected from Central Water Department.

SLOPE FACTOR:

Slope of the area ranges between, 0 degree and 3.5 degrees. It was observed from SRTM data processed by Global Mapper. So that in south –western monsoonal period the river bears large amount of water which causes flood particularly in western bank. Which are depicted in following photos -----

Figure: River Bank Erosion and its Effect as Flood

VEGETATION OF THE REGION-

Soil erosion potential is increased if the soil has no or very little vegetative cover of plants and/or crop residues. Plant and residue cover protects the soil from raindrop impact and splash, tendsto slow down the movement of surface runoff and allows excess surface water toinfiltrate. The erosion- reducingeffectiveness of plant and/or residuecovers depends on the type, extent andquantity of cover. Vegetation and residue combinations that completely cover the soil, and which intercept all falling raindrops at and close to the surface andthe most efficient in controlling soil (e.g. forests, permanent grass. Partially incorporated residues and residual roots are also important as these providechannels that allow surface water to move into the soil. As we travelled by the side of the Ganges, we could see a number of deciduous trees. These trees shed their leaves in winter. Plants of low height also dominate the area. Shrubs and grasses with hard knify leaves are found scattered. Though the soil is sandy, it has a good percentage of silt and loam in it. The ground has grass but is not covered by it. The height of the shrub layer is seen to increase towards the river but as erosion proceeds, it engulfs the land areas. We heard a date palm tree falling in the river just the day before our 4th day of survey. Al these processes have a joint action on the bank materials and thus cause a substantial part of land to get detached and flow away with the running water.

CONCLUSION:

Erosion is a complex process brought about by the compound actions of several processes. In order to check erosion in Berhampore block particularly western bank of Bhagirathi river , though many schemes have been adopted by the government, only sand bags along the bank are in vogue. To fight erosion, a number of measures can be effectively followed.
i)Concretization of river banks, ii) Plantation of erosion resistant crops, iii) Regular desilting of the river bed, iv) Use of nut fibers as well as synthetic erosion control options have been proved useful by the erosion control team of the Granite Environmental, v) Use of erosion control mats of coir straw, wood fibers and coconut fibers and synthetic erosion resistant mats.

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