INTANGIBLE BANK EROSION: A THREAT TO THE LIFE OF MATLA-BIDYADHARI INTERFLUVE IN SUNDARBANS

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Abstract:

In recent days, frequent bank erosion in the inhabited parts of Sundarban delta has become a burning issue as no such previous attempts were successful to tame the tidal circuit of the Sundarban delta. Man, since his initial inhabitance in this part of West Bengal, has always overexploited these blessed tidal rivers who have all-time gifted hectares and hectares of fertile floodplains and jungles for easy and smooth livelihood. But side by side, man misunderstood their natural gift and tried to capture their natural activities to gain more and more. Ultimately these natural agents like tidal channels khals, creeks have either decayed due to the inhuman activities with them or changed their hydrological character to cope up with the present awkward fluvio-geomorphological conditions.

This article mainly focused on the changing courses of those major tidal channels like-Matla River, Bidyadhari River, some major interlinking tidal channels like Hogol Nadi-Karatal Gang, tidal khals like Pathankhali Khal and creeks through bank erosion and alarming bank conditions in the inhabited parts of the world's largest delta, Sundarbans. The author also has narrated how the bank erosions became an annual routine and also became intangible in nature due to unscientific land use and land reclamation programmes in the juvenile deltaic parts of Sundarban delta. The Matla-Bidyadhari interfluve has been taken as a model unit one in Sundarbans to discuss the topic because it represents similar hydro-morphological characteristics and land use pattern found in the other inhabited interfluves of Sundarbans.

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Introduction:

The Matla-Bidyadhari interfluve is located in the district of South 24 Parganas in West Bengal, India and is situated in the central part of the Indian Sundarbans having an average altitude of 2 to 4 meters from the mean sea level. It stretches from the 22˚24'38.98"N to 21˚54'22.84"N latitudes and from 88˚37'30.56"E to 88˚52'57.38"E longitudes. From hydro-morphological point of view this interfluve is lying in both active and mature delta of Sundarbans. The length of this region from north to south is 51.94 km or 33.52 miles and is of 26.40 km or 16.40 miles from east to west covering an area of about 728.578 km². The southern tip of this interfluve (Herobhanga Is.) where the wide confluence of Matla and Bidyadhari rivers can be noticed is just roughly 45 km. away from the mouth of Bay of Bengal. This interfluvial part of the Sundarban delta consists four Blocks such as-Canning- I & II, Basanti and Gosaba in the South 24 Parganas of West Bengal. Tides occur twice a day and uninterrupted modification of the islands can be observed in relation to the shape and size of the islands and interfluves since its very origin. Bank erosion is the major tool to the tidal channels, khals and creeks to adjust their discharge and decaying and origin of new and new channels and creeks is a common natural phenomenon here.

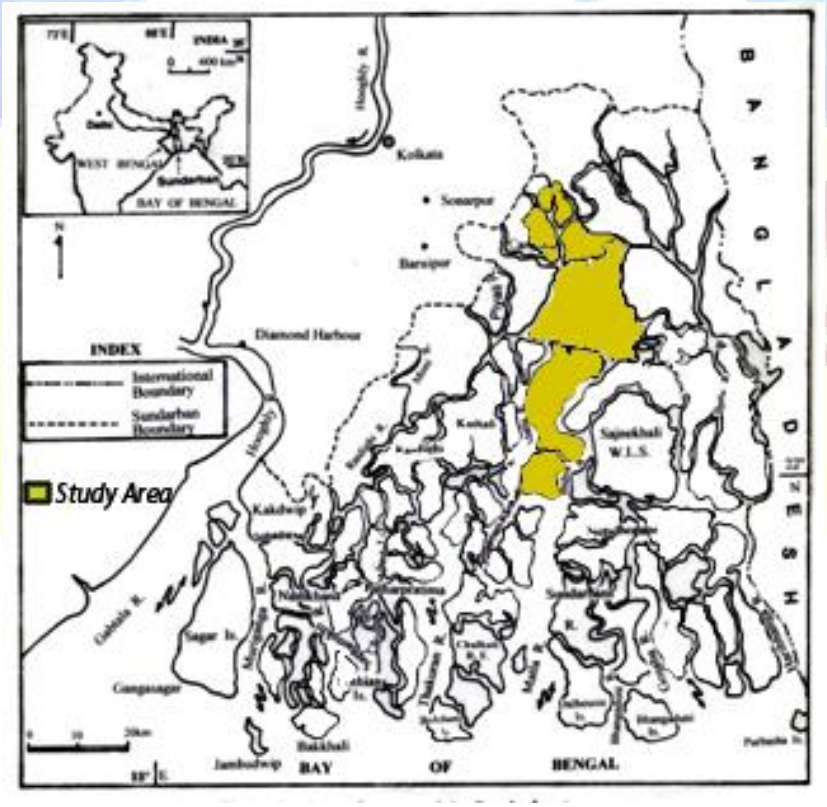


Fig. 1: Location of Matla-Bidyadhari Interfluve in Indian Sundarbans

Causes of bank erosion due to the tidal dynamics in the Sundarbans:

The tidal water coming from the Bay of Bengal is directly heating the south-easternmost corner of the Ajmalmari island or Reserved Forest and a small branch of the major tidal waterline amidst R. Matla escapes through the Suia Gang which move further northward through the Ajmalmari River. The major portion of the tidal water coming from the Bay of Bengal is thus moves further towards north heating the south-easternmost part of the Herobhanga Reserved Forest at the confluence of R. Bidyadhari and R. Matla and bifurcates into two. One branch flows towards north-west through the R. Matla and another through towards northeast direction through the R. Bidyadhari. Due the presence of lots of meanders in both the R. Matla and R. Bidyadhari, the incoming tidal current does not response as earlier. Now the tidal current coming directly from the Bay of Bengal which got almost an easy linear movement faces difficulties to get passage to further northward movement. During this journey the tidal current loses its velocity and splashes haphazardly wherever it gets a minute chance to move forward. As the tidal water from the Bay of Bengal moves northward i.e. just opposite to the direction of the river water which is moving almost southward direction, so there are so many spots along both the banks of R. Matla, R. Bidyadhari, Hogol Nadi, and R. Bara Herobhanga Khal etc. where turbulent water is formed and whirling of water accelerates the erosional works of the tidal mechanism at those very spots. The places along the riverbanks, which experience frequent bank, collapse, particularly during the full moon and new moon as well as during the spring and neap tide, caused only due to the tidal actions round the year.

The bank erosion mainly takes place due to combined activities of man and nature - discharge, flow diversion, formation of shoals, migration of ephemeral bars near the bank, channel scouring, cohesiveness of the texture of the banks, soil humidity of that area, bank configuration, bank failure, anthropogenic activities, the making of the embankments and excavation of the bank side areas for different purposes, the difference in sediment load in different seasons etc. (Das, 2005).[i]

Processes of erosion in Sundarbans: The erosional and depositional works go hand in hand done by both of the sea and the rivers in Sundarbans. So the processes of erosion of the rivers and the sea are quite similar in the active zones of Sundarbans. Here, the erosional processes are done in four ways, such as- 1) Hydraulic action 2) Abrasion or Corrasion 3) Corrosion or Solution. Besides these four erosional processes of the bank erosion in Sundarbans, the author has also

rectified another most important process i.e. 5) Eddies originated due the mixing of the River water and the Tidal water at the basement of Banks.

1. Bank erosion due to the hydraulic action: Hydraulic action is mostly responsible in the bank erosion of Sundarbans. It refers to the impact of the moving water on the components of the banks**.** Repeated flows of striking tidal waves enlarge the incipient joints, fracture patterns and thus help in breaking the bank materials into smaller pieces. Thus striking breaking waves during the high tides, particularly during the spring tides, also exert enormous pressure on the air trapped hollows and crevices within the banks. The hollows which are created due the continuous walking by the banks also accelerate this process in Sundarbans.

2. Bank erosion due to the Abrasion or Corrasion: In Sundarbans, particularly in the active zones where the sea water has more accessibility, Corrasion is an effective process at the mouth of the rivers like Matla. It is mainly done with the help of the natural tools of the tidal wave like- coarse sand, pebbles etc.

3. Attrition: It involves mechanical wear and tearing as well as consequential breakdown of fragments due to mutual collision affected by the backwash which remove the fragments from the base of the banks which are transported back to the Bay of Bengal during the ebb periods.

4. Bank erosion due to the Corrosion or Solution: Corrosion refers to the chemical process by which different soluble rock materials are dissolved due to the contact with the sea water. In Sundarban this process of corrosion is quite common. Due the inflow of tidal water f from the Bay of Bengal and the downward outflow of river water different types of soluble material affect the chemical composition of the bank materials which ultimately modifies the nature of the banks in future.

5. Bank erosion due to the works of Undercurrents: It is the most wide spread phenomena taking place almost all over the active zones of the Sundarbans in South twenty four Parganas in West Bengal. As the rivers of Sundarbans are under process of rapid decaying, the inflow are under process of rapid decaying, the inflow of the tidal water which follow the route, the

returning outflow of tidal water associated with sweet water of the rivers do not follow the same route. Thus small eddies are originated daily around the areas of the base of the banks wherever they get an ideal place. In the First stage (Fig. 2), we see the banks with the high tide water line hitting the base of the banks. In the Second stage, erosional works of the tides weakens the basement of the banks and continuous wetting and drying twice a day make the banks deficient to bear the hydraulic pressure of the larger waves. The broken brown lines are indicating the previous positions of the banks. In the Third stage, an eddy is originated enlarging the hollows and the air trapped joints or crevices. Thus the hollow slowly enlarges due to the undercurrent at the basement. From the third stage, the erosional processes actually starts by the low tide water level at the basement of the banks and undercutting process continues even after the withdrawal of the tidal water i.e. during the ebb periods. Scouring and enlarging of the hollows at the toe of the banks goes on by the erosional action done by the low tide water at the hollows or bores. Ultimately, in the Fourth stage, the upper portion of the bank collapses on the river and forms semi-point bar at the side of the bank with the deposited material accumulated during the breakage of the banks. It is a continuous and most common process of bank failure in the Sundarbans.

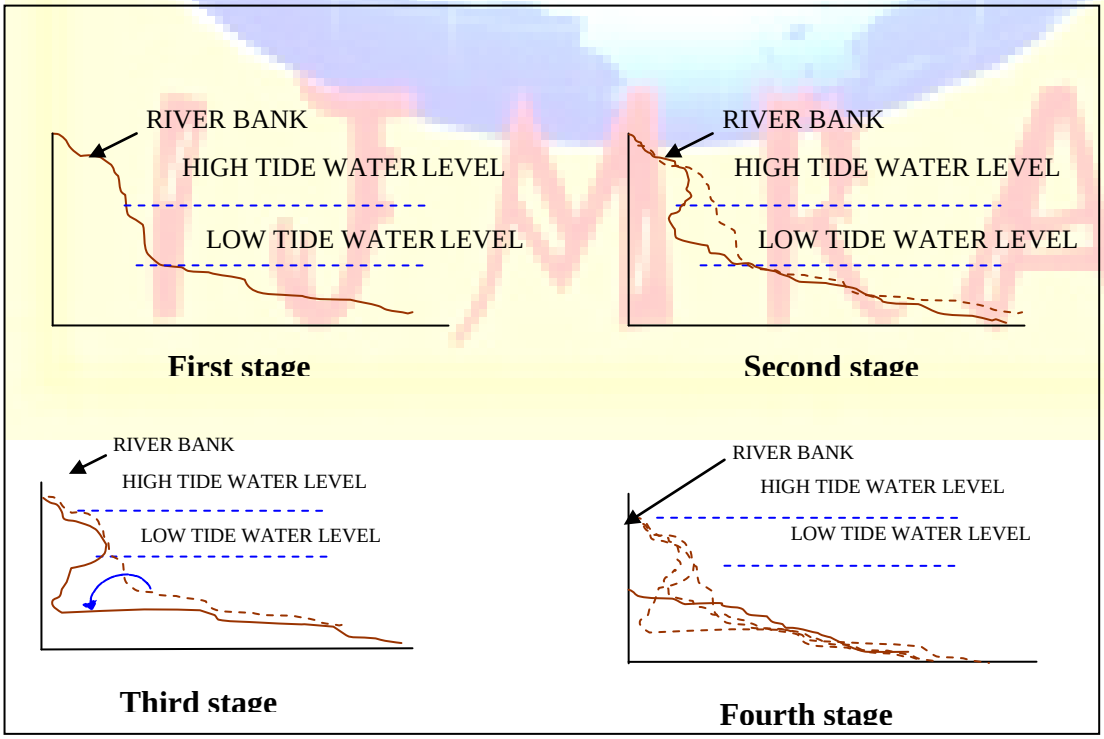


Fig. 2: Diagrammatic representation of the bank erosion by undercurrent in the tidal channels of Sundarbans

According to Petts (1984) the types of bank failure can be categorized into two, such as – (A) general forms (based upon Thorne, 1982) with features of high latitude river bank failure (based on Church and Miles, 1982) ; and, (B) undercutting and cantilever failure of a river bank on the R. Severn, U.K.(after Thorne and Lewin,1979).[ii] The bank failure is quite related with the undercutting and cantilever failure of a river bank. In Sundarbans, weathering and weakening act on intact bank material to reduce its strength and decrease bank stability. The process of undercutting is mostly associated with the most effective processes are directly related with soil moisture conditions which operate to reduce bank strength, and to loosen and detach particles or aggregates.

The structure and texture of the bedrock of the river side areas particularly along the banks of the tidal rivers and channels or creeks in the Sundarbans are very much correlated with the tidal mechanism in bank erosion. In general, the places where bank erosion is common in the Matla-Bidyadhari interfluve due to tidal actions are made up of fine clay and silt. Besides this the soil is also very much alkaline as the salinity of the river water is raised due to the mixing of the tidal water coming from the Bay of Bengal. Salinity level remains lowest during the incoming Monsoon period i.e. from June to September due to the inflow of huge amount of fresh water. But the concentration of the salinity in the interfluve is maximum (0.4 to 15 ppt) during the dry seasons i.e. during the winter season from December to February (Hoque et. al., 2006). The average salinity of the Bay of Bengal at the mouth remains 30%◦.[iii]

The above multi-functioning factors are working day and night, here and there in Sundarbans without any rest. Nevertheless, the bank erosion during the tidal bore on 14.09.2008 the tidal currents in R. Matla and R. Bidyadhari was very much turbulent which caused a bank collapse of at least 2.5 km area at Masjidbari near Gadkhali. The most striking feature, which was noticed that is the bank failure is quiet common and regular along the Hogol Nadi, the interlinking tidal river between the R. Matla to the west and R. Bidyadhari to the east. The places which experienced bank collapse during the ‘Bhara katal’ or ‘Shanrashanri Ban’ (Bengali term of tidal bores) i.e. the full moon tide

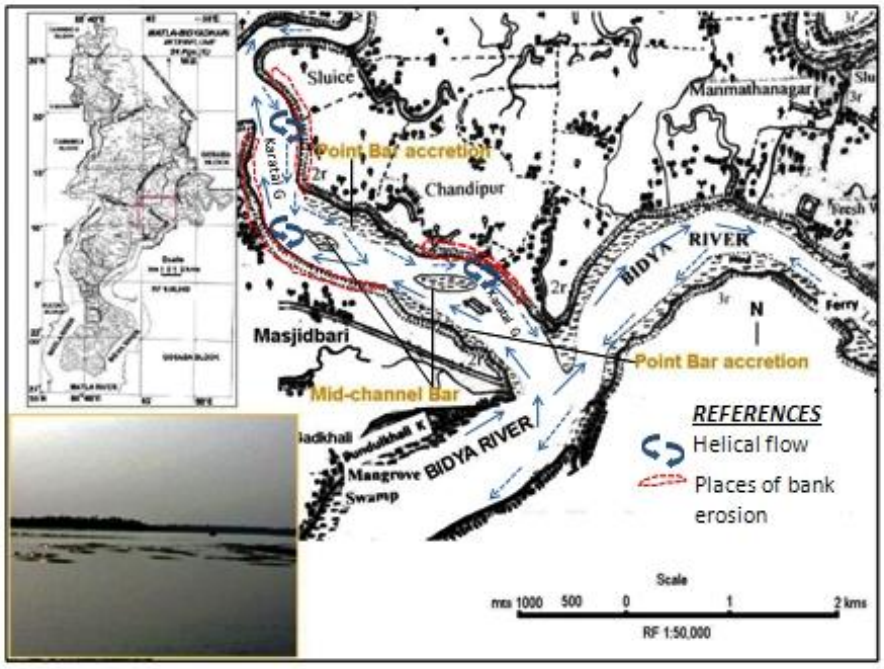


Fig. 3: Fluvio-geomorphological status in Karatal Gang along village Masjidbari, 2010

which occurs at the end of the monsoon in the month of October, 2008 are Harbhangi, Sonakhali No.6, Sajinatala, Masjidbari and Chandipur (red dotted lines in Fig. 3) near Gadkhali along the Hogol Nadi. The most devastating bank failure was from Masjidbari bazaar to Kamardanga Kalimandir in Masjidbari GP (Gram Panchayat, lowest administrative unit in India) where at least 2.5 km long embankment was eroded by the tidal action on 14.09.2008. It seems that this bank failure was not a sudden one; rather it was an obvious phenomenon. The condition for the bank failure was quiet sure and ideal at Masjidbari because it falls in the zone of vortex undercurrent caused due to the mixing of the havoc influx of incoming tidal current from the R. Bidyadhari and weaker tidal undercurrent of the Hogol Nadi (Fig. 3).

According to the local residents of Masjidbari like Deepak Mazumdar and Rana Mondal the problem of bank erosion has been experiencing by them since 1964 and this erosion has been devastating in last two decades. Every time 'Ring Bund' has been made on behalf of the State Government to protect the embankments but it was in vein. Now they think that 'Sausage process' or repairing the breached embankment by 'bats' or 'Block pitching' or 'Porcupine' can reduce the rate of vulnerability of the breaching of the embankment in this area. It has seen that a

large sand deposit or 'Chara' has been emerged in the middle of the R. Bidyadhari and due to this during the high tides; the tidal water hits the chara and turns straight to the Masjidbari area. The only reason behind the undercutting mechanism of tidal water is the rapid siltation of the R. Bidyadhari in the middle portion.

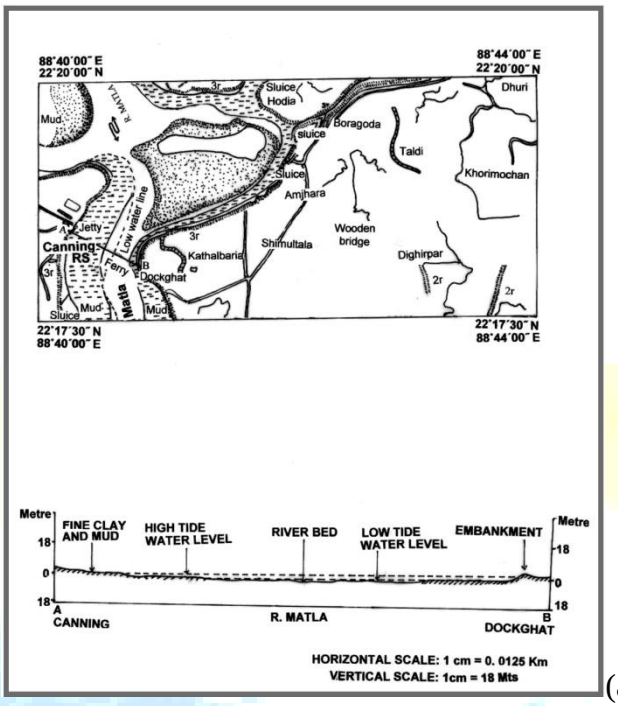
The sediment load is higher in the rivers of Sundarbans rather than the marine tidal water. Two prominent eddies or vortexes are created due to the mixing of sluggish undercurrent with higher sediment load coming from north-west to southeast through the Hogol Nadi from beneath and the strong and high volume of tidal water with lower sediment load moving above it from the

Plate 1**:** Erosion due to undercurrents at the ferry ghat near Basanti Bazaar, 2008

southeast to north-west through the R. Bidyadhari. The high tides occurring during the Bhadra (Bengali month) i.e. during August and September are usually higher than the rest of the year which is also known as the 'Sanrasanri ban' locally. During the year 2008, some portion of the bank of R. Bidyadhari at Sonagan village near Gosaba, has been eroded by the tidal action. On the other hand, according to the local people of Basanti, Mr. Siman Sahu, they used to play football on the chara (shoal deposits) on the Hogol Nadi near Sajinatala just 15 to 20 years before. But now days, it is totally under the Hogol Nadi. It is thus indicating that the depth of the Hogol Nadi has increasing. This is caused due to the continuous siltation of the R. Matla which resulted continuous decrease in the depth in the upper reaches near Canning also having 2 to 3 prominent shoal deposits. During the journey of approximately 17.69 km of Matla River from the confluence

of Matla and Bidyadhari River and Hogol Nadi, we can notice at least 5 to 8 small to large shoal deposits and some shoal are of 0.25 to 2.5 km of length. The shoals are the barriers to the incoming tidal water of R. Matla which are coming by passing the acute meander west of Sonakhali. So, maximum portion of the water instead of moving further northward turns right and flows in opposite direction bending towards the Hogol. So the tide is sudden and very fast at Port Canning whereas it's rhythmic in case of Hogol Nadi. The huge volume of tidal mass forcefully enters during the high tide as well as during the ebbs. The Hogol Nadi experiences both the burdens ebb and tide. Thus the undercutting process is accelerated and side by side the banks which are hit by the undercurrent are eroded from beneath. This causes the weakening of the basement of the embankments and results in the form of bank failure.

The depth of the lower reaches is relatively higher than the upper reaches of R. Matla near Jharkhali of Basanti (Fig. 4). It does not allow the incoming tidal water to move further north. But during the ebb period, the stored water is added with the seaward regression of water and gets opportunity to enter the Hogol Nadi with greater volume and discharge. This leads the scouring of the river bed wherever it returns to its own destiny i.e. the Bay of Bengal. This path of undercutting is can be noticed during the ebb period clearly when we find the bed of the rivers are exposed but the water remains flowing southward rapidly either through the middle or through one side of the banks. In both the beds of R. Matla and R. Bidyadhari, shoal deposits can be noticed but the major difference between them is the absence of any such prominent deposits on the bed of R. Matla in the lower reaches from Garanbos to the mouth. Two large and prominent depositional features can be noticed along R. Bidyadhari.


88°40'00" E
22°20'00" N
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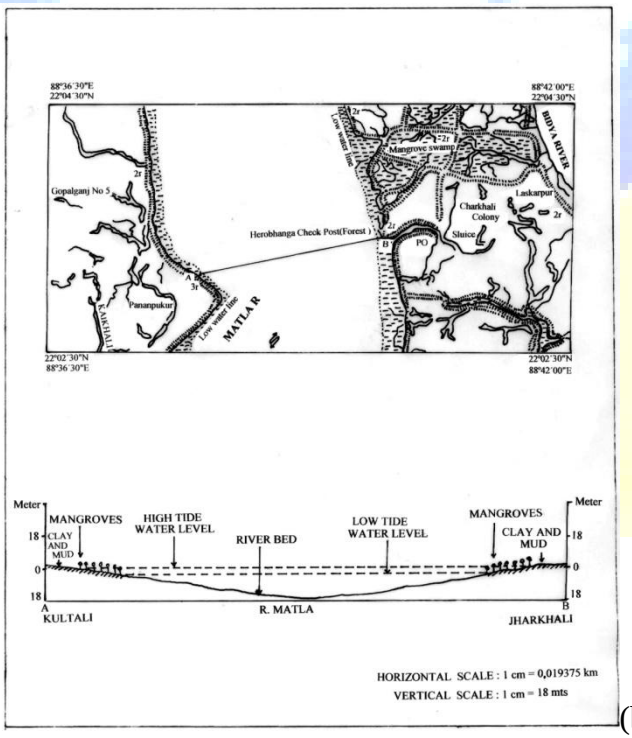
Sluice
Hodia
Dhuri
Mud
Boragoda
sluice
Taldi
Khorimochan
Sluice
Amjhara
Jetty
Canning
RS
Ferry
Low water line
Kathalbaria
Shimultala
Wooden bridge
Dighirpar
Dockghat
Matla
Mud
Sluice
22°17'30" N
88°40'00" E
22°17'30" N
88°44'00" E
Metre
FINE CLAY AND MUD
HIGH TIDE WATER LEVEL
RIVER BED
LOW TIDE WATER LEVEL
EMBANKMENT
Metre
A
CANNING
R. MATLA
B
DOCKGHAT
HORIZONTAL SCALE: 1 cm = 0. 0125 Km
VERTICAL SCALE: 1cm = 18 Mts

(a)


88°36'30"E
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22°04'30"N
Mangrove swamp
BIDYA RIVER
Gopalganj No 5
Laskarpur
Charkhali Colony
Herobhanga Check Post(Forest)
Sluice
PO
Panampukur
MATLA R
Low water line
22°02'30"N
88°36'30"E
22°02'30"N
88°42'00"E
Meter
MANGROVES
CLAY AND MUD
HIGH TIDE WATER LEVEL
RIVER BED
LOW TIDE WATER LEVEL
MANGROVES
CLAY AND MUD
Meter
A
KULTALI
R. MATLA
B
JHARKHALI
HORIZONTAL SCALE : 1 cm = 0,019375 km
VERTICAL SCALE : 1 cm = 18 mts

(b)

Fig. 4: (a) Cross section along R. Matla (Canning ferry ghat-Dock ghat) and (b) along R. Matla (Kultali ferry ghat-Herobhanga Forest Check Post) in Indian Sundarbans, 2008

Several efforts have been made by the Forest department of Sundarban Development Authority to protect the bank erosion and to maintain the environment of the area by afforesting lots of native pneumatophores like Kankra (Bruguiera gymnorhiza), Garan (Ceriops decandra), Gol Gokul (Nipa fruticans), Sundari (Heritiera minor) etc on the shoal deposits or on the charas in R. Bidyadhari and on the charas of R. Matla but the trees were too weak to prevent the bank erosion caused by the tidal actions. According to Forest Department's version of S.D.B (Sundarban Development Board), the mangrove trees have been afforested from Gadkhali to Chandipur to reduce the magnitude of bank erosion. But unfortunately during the rainy season, the undercurrent loosens the base of the banks and the roots of the trees are ultimately uprooted. In Sundarbans, lots of areas along the banks of the tidal inlets can be noticed with the mangroves leaning towards the rivers and creeks or tidal channels.

Besides this another though minor anthropogenic factor accelerates the undercutting process of the river banks of Sundarbans is, the continuous walking along the banks by the local 'Dhibars' or 'Jeles' (nomadic fishermen or fisherwomen in Bengal) and making of 'choukos'(Plate 2) which led the basement of the bank along the tidal channels very rough and

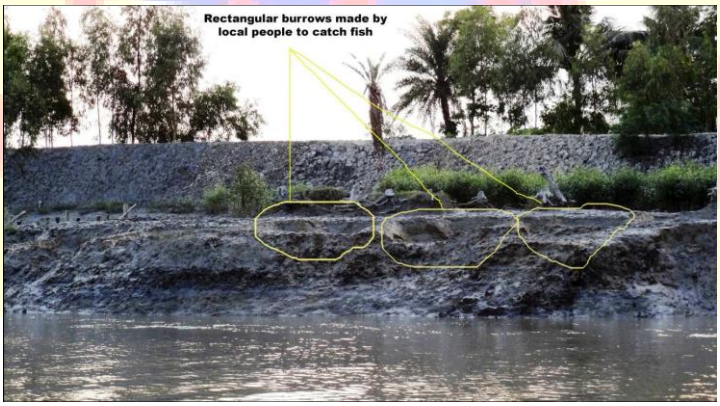

Plate 2: 'Choukos' (Rectangular burrows made temporarily to catch shrimps or prawns during high tides along the river banks), 2011

full of holes. The very newly deposited silt and clay by the tidal channels along the toe of the immature banks are when are undisturbed remains smooth and tidal water use to flow up and down without scouring the surface of the toe of the banks. But it is noticed that whenever lots of holes are created by the 'Mindharas' (local term used for fisherman) who mainly comes down the bank at the river to catch the 'Bagda' (Prawn) their walking on the bed of the river just adjacent to the banks toe creates lots of holes or bores on the juvenile silt. Thus the pressure of their feet creates the holes which are enlarged and slowly increase in depth and area by the small whirling of water or eddies created during the high tides. Though it seems a very negligible cause behind the weakening of the structure of the basement of the tidal banks, but continuous accumulation and merging of the holes created by the walking over the mud allows the undercutting process of the undercurrent during the high tides in the rivers, channels and creeks of the Sundarbans. Tidal bores accelerate the creation of smaller to later larger eddies which ultimately results mass breaking down of the banks.

The slope ratios as well as the soil conditions of the Matla-Bidyadhari interfluve play a major role and obviously they are one of the key controlling factors in the process of the bank erosion caused by the tidal mechanism in the Sundarbans. Particularly in the most parts of Sundarbans rivers are having a long run for a unit fall of 1 meter in the channel base altitude, as the terrain of the delta is very gentle. The average high tide data for the vernal and autumnal periods in meters from Gosaba (V/3.5, A/5.25) indicate that maximum part of the prematurely reclaimed sections is lower than the average high tide level (Mukherjee, 1976).[iv] Therefore, if the areas along the banks are not protected by embankments they will be drowned obviously.

Common remedial measures taken against the river bank erosion in Sundarbans:

Several measures have been taken by the State Government and the local people to protect the banks by making the embankments from time to time. The Sundarban Development Board (S.D.B.) has tried their level best to satisfy the local people every time by taking several measures at the places of frequent bank erosion.

On behalf of the Irrigation Department of Canning, South 24 Parganas, the major measures which are taken during the breaching of the embankments or banks are – a) Block Pitching at 4:1 slope taking the top level of tidal crest at 6.40 meters and average high tide level

of 4.50 meters (1976) ; b) Making of Porcupine Cage to increase the deposition of silt along the banks to change the tract of the inflow of tidal water and to divert it from the havoc bank failure zones ; c) Felling the cubes made up of bamboos or dip trees along the toe of the banks; d) Dumping of nylon crate at the base of the banks ; e) Dumping of Polly packs on the bank walls where wave dash is relatively less stronger etc. which increases the water pollution.

Even after taking so many measures by the Government of West Bengal, every year the bank collapse is a common phenomenon to the people living with the tidal rivers of Sundarbans. It seems that this region can't get rid of this chronic disease of breaching forever.

Author's emerging perceptions from the field and Proposals to reduce the magnitude of the bank erosion in Matla-Bidyadhari Interfluve:

1. Accept the dynamism of the flow of the rivers particularly in case of the rivers and channels of Sundarbans.
2. Intensive hydro-morphological studies should be done with giving more emphasis on the recent trend of the temporal variation of tidal discharge along with changing courses of the major tidal channels of this endangered delta from hydro-ecological point of view.
3. Intangible bank erosion emerges from human interferences and results of unscientific land reclamation since the British projects in Sundarbans.

Propositions:

a. A separate official sectors should be made on behalf of the Block or Panchayat level to forecast the noticeable micro-level changes in the nature of the direction of the tidal inflow

b. Any structural foundation is not desirable in and around the premises of the river banks of Sundarbans and settlements areas yet to be constructed in future, should be restricted to the matured parts of the interfluves.

c. Old and unusable sluices should be replaced or and decayed khals or canals should be dredged so that they can distribute the tidal water naturally and according to nature's demand.

d. Prediction for the areas to be prone to bank erosion in future should be done to reduce the loss of life with the application of latest mapping with GIS technologies.

e. River Geographers should carry more and more research work or surveys to unfold the hidden dynamics working behind the uncertain bank erosions.

f. Each and every small to large, narrow to wide, shallow or deeper tidal channels, khals and creeks in Sundarbans influence the entire hydro-morphological environment either directly or indirectly. So, the dynamic tidal circuit of Sundarbans should be understood first before any operation on the riverbanks here. Nature should be given the first priority as no such delta is will be artificially made by man in a year.

Conclusion:

Each part of the world is characterized by particular set of ecological as well as economic potentialities. At the same time some deterministic rules also concerned with it as imposed by nature. Human being should not only think about the possible prospects of economic potentialities but attraction be extended towards its limitations imposed by nature that should be obeyed strictly. It is true that when population has rapidly been increasing it is difficult to human being to keep the nature like drainage network in its own form. But on the other hand it is equally true that any kind of economic activities without obeying the Principles of nature will ultimately bring economical and ecological failure, as Neodeterminism Concept says. So, this is to time to stop a while and think over the effects of past human activities on nature and to make plan for the establishment of an ecologically balanced nature. Should this dream be realized, the study would surely earn its most desired value, and that would be tribute to the villagers of Matla-Bidyadhari interfluve- a model unit in Indian Sundarbans.

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