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RIVER COURSE SHIFTING AND SEDIMENTATION OF THE MATLA RIVER OF SUNDARBAN REGION, INDIA

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ABSTRACT

The Matla river is a importance part of sundarban region. To yet, our understanding of the Matla's fluvial dynamics, particularly in its lower reach, is limited. Questions such as why the river's course changes so regularly and the accumulated sediments in the surrounding area. The government's policy of withholding water-related data impedes open scientific study. The current research examines the shifting channels and deposited sediments of West Bengal's Matla of Sundarban river system since the turn of the century. The Matla River's main stem is split into two arms near Purandar. One travels through Kultali-Garanbose and then the Sundarbans. The other flows through Basanti, Pathankhali, Surjyaberia, Masjidbati, and finally meets the Bidyadhari river. The most notable geomorphic condition of the Sunderbans' Matla basin are fluvial, estuarine, and tidal river systems, tidal creek systems, and sandy delta beaches. These dynamic agencies' responsibilities have resulted in a variety of erosional and accretional structures throughout the drainage basin. Some of the notable geomorphic features in the area include a natural levee, a point bar, a mid channel bar, a swash platform, a wash over flat, and an ebb-tidal delta.

Keywords: Matla River, Region, River Course, Sedimentation, Shifting, Sundarban

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INTRODUCTION

The Matla-Bidyadhari interfluves are located in the central Sundarbans of India and are characterised by both a continental and a marine environment. Furthermore, this interfluve is distinguished by a mature and active deltaic ecosystem, with the largest mouth river Matla in the Bay of Bengal and the longest and widest linear course in the entire Sundarban Delta. The meandering or sinuous channel flow, seasonally varying discharge, the intricate tidal network, and frequent shifting of the tidal channels are the special and unique hydrological characteristics of this mature and active deltaic part of the study area. The research region is a dynamic erosional and depositional topographic unit dominated by the intertidal, subtidal, and estuarine environments. Because of the various tidal behaviours, the entire interfluve had to be disassembled. Even during the Monsoons, the severed streams do not provide enough water, relying heavily on the Bay of Bengal. Anatomizing channel patterns, meandering creeks, wider tidal mouths of the ancient distributaries of the R. Matla and R. Bidyadhari, channel bifurcations, interconnected tidal channels such as the Hogol Nadi Karatal Ganga channel, and so on are significant drainage features that play an important role in the land development process in the studied area. The vegetation cover on the depositional surface achieves sediment stability in a tidal environment. During tidal inundation, the mangroves' continued natural growth and development operate as a cohesive force for sediment deposit. In the Bay of Bengal, between 21 and 21 22'N latitude, there is a large natural depression known as "Swatch of No Ground" where the depth of water changes abruptly from 20mts to 500mts (Fergusson, 1963; Ghosh & Mandal, 1989). This strange depression drives the silts to the south and/or east, forming new islands (Bose, 2006). Britishers began land reclamation in the Sundarbans' premature flatlands or juvenile lowlands along major tidal rivers such as the River Matla, River Bidyadhari, and others in 1770 A.D. and later carried out by the non-resident zamindars (landlords) and by the landless farmers. The continuous erosional and depositional activities of the tidal channels, khals, and creeks in this greatest estuarine delta have always resulted in frequent changing of river courses. As a result, it is regarded as the most serious issue here. Rapid population growth, rapid encroachment of human settlements on erodible tidal channel banks, removal of forest cover, and rising magnitude of regular cyclones generated over the neighbouring Bay of Bengal.

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OBJECTIVES

The main objectives are follows-

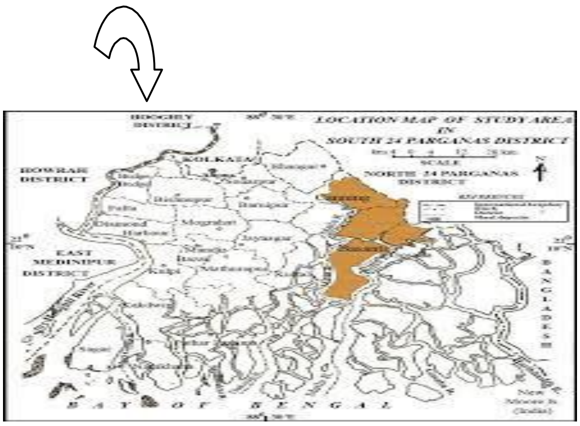
- The entire piece includes two unique visions, one of which features Delta and the fluvio-environmental changes.
- To make an appraisal of Matla's fluvio environment.
- To highlight the current issues concerning the hydrological characteristics of the Matla River.
- To examine the causes of this region's shifting fluvio-morphological character.
- To analysis the Matla River's sedimentation problem.

METHODOLOGY

The proposed work follows the easiest way to examine the Matla's shifting course and deposited sedimentation is to compare successive maps made and published over the centuries with modern satellite pictures available from India's National Remote Sensing Agency. Prior to Rennell's maps, however, maps were neither cartographically exact nor geographically reliable. Those maps, including Rennell's, are not able to be registered or layered on a GIS platform.

Location Map

The Matla River forms a large estuary in and around the Sundarbans in the Indian state of West Bengal's South 24 Parganas district. Field measurements were taken in the Matla River near Kaikhali (latitude: 22° 02′ 42.60″ N; longitude: 88° 38′ 27.57″ E) at a water depth of 10 m.



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OCT 2023 | Vol. 4 Issue 5
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Fig: Location map of the study area

River course shifting and Sedimentation

Matla River System

The Matla River is the most important and active river in the Indian Sundarban in terms of damage. For its violent or destructive tendency in the past, it was known locally as 'Matla' (meaning intoxication). It is one of the Sundarbans' major rivers. The sources of two branches of the head streams are located in Canning and Barasat, respectively. It flows south for roughly 120 km, combining with rivers such as the Karati or Kuriabhanga Nadi, the Atharabanki Khal, and the River Bidyadhari. During high tide and flood periods, the confluence of these three rivers becomes much more dangerous and violent. Unfortunately, it is also decomposing at a faster rate. In this river arena, embankment breaches and flooding of nearby settlements are common occurrences. Previously, this river served as Kolkata's sewage system. During the rainy season, excess water from Kolkata was discharged through the rivers Matla, Piyali, and Bidyadhari. This was the only means of transit between the Sundarbans' eastern reaches and Kolkata. Nonetheless, due to its violent nature, the British invaders did not entice Matla for their shipping line. Rapid siltation in its riverbed has caused alarm among locals on both sides of the river, particularly from Canning to Basanti.

Factor of The Matla River Shifting:

The nature of shifting tidal rivers in Matla-Bidyadhari is primarily determined by two key factors: erosional and depositional activity. These are morpho-hydrological factors (a) and anthropogenic influences (b). Both are to blame for the narrowing and quick degradation of the river beds of the tidal channels here.

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- **Morpho-hydrological factors**

Since the Sundarban Delta's inception, morpho-hydrological forces have included erosional and depositional activity working day and night in these tidal drainage basins. However, we must distinguish between the factors that cause erosion and deposition in non-tidal channels and those that cause erosion and deposition in the tidal fluvio-geomorphological environment, as these differ significantly from a hydro-morphological standpoint. Field observation, data analysis of the erosional and depositional activities and features and shifting courses of the major tidal rivers of this interfluves. I have found the cyclic tidal-character of this interfluves.

It has been observed that the upper reaches of tidal rivers such as R. Matla and R. Bidyadhari face a sufficient shortage of downstream water due to various factors such as delinking with major feeding drainage such as khals and other non-tidal rivers, jacketing of the upper reaches by embankments since the British colonial periods, geological disturbances such as upliftment or subsidence of the Bengal basin due to tectonic activities, etc. Incoming high tide water cannot move adequately through the restricted upper reaches and is diverted in various directions to handle the influx of tidal water. It may be referred as the first stage of the tidal cycle when a tidal river like Matla deviates from its main course either by overtopping the banks or by eroding the astride banks.

The changing of tidal river channels occurs as a result of bank erosion. However, the sediment load conveyed by these tidal channels used to settle in shallower areas of the riverbeds because the slope was too mild to take the sediment burden farther upstream. The creation of shoal deposits or point bar accretion occurs. As the channel gradient is smooth, the upper portions of the tidal channels encounter more depositional activities than erosional activities. However, because of the construction of those point bars, mid-channel bars, or shoal deposits upstream, the entering high tide water encounters impediments again in the next tide. Furthermore, resistance from the river's recent ebb flow causes the top of the advancing front to topple forward, giving the bore the appearance of a moving waterfall. It creates an abrupt change in hydraulic pressure along the western and eastern banks of this interfluve, causing bank failure, especially when a certain vortex of tidal dynamics occurs. For example, in 2007, a bank failed in Mazidbari hamlet in Basanti Block. The undercutting process becomes more active following the abrupt fall of tide water following tidal bore. The cyclic tidal bore loosens the compactness of the bank-wall of tidal channels like Matla and

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Bidyadhari throughout the year, and during dry seasons, the banks are cracked, causing them to collapse along those fractures when a spring or neap tide occurs.

Anthropogenic factors

The British Government in India has long undervalued the Sundarbans' tidal rivers. It is well known that from time to time, some British officials attempted to locate a navigation path across the intricate network of tidal creeks and channels in order to utilise the natural resources of the greatest delta. Some of them conducted surveys to better understand the intricate drainage system in the dense natural mangrove forest. Lord Canning (Governor General of India from 1856 to 1858, and Governor General and Viceroy from 1858 to 1862) was the first to express an interest in creating Kolkata a rival to Singapore. In 1864, he gave it his all to make this endeavour a success. However, he was unlucky in that the concept of creating a big port at Canning disappeared with the choking of the Matla River due to insufficient headwater supplies. Rather, the Matla River raged down on the new port town in 1867, reducing it to a "bleached skeleton" (Bhimani, 2004).

The illegal filling of the decaying channel for new and new land area for settlements and for acquiring new and new non-saline agricultural lands eventually disrupted the natural outlet system of the high tide water and increased the chances of water-logging during low tides, which converted to marshes for prawn cultivation. This purposeful increase in marshy area eventually leads to devastation during monsoon tidal bores, as shown in the Bidyadhari-Matla-Karati Nadi area near Port Canning.

The rapid decaying of the upper reaches of R. Matla near Canning caused poor and sluggish drainage condition of the earlier active khals and ox-bow lakes and ransacks the immature floodplain.

The Sundarban Delta is continually being modified, moulded, and shaped by the impact of the tides, with erosion processes more evident near estuaries and deposition processes along the banks of inner estuarine rivers influenced by the faster discharge of sediment from seawater. Sundarbans rivers today transport little freshwater because they are generally cut off from the Ganges, whose outflow has migrated eastward from the Hooghly-Bhagirathi systems since the 17th century. The extent of interfluves such as Matla in the Sundarbans has altered over time in response to changes in the length, width, and depth of the tidal channels. Geo-Analyst,These channels are actually the distributing channels of the Ganga

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and Padma Rivers, and two major factors are responsible for such intangible shifting of the Sundarbans tidal channels, namely the continuous but slow subsidence of the Bengal basin towards the east and the differential rate of erosional and depositional processes.

Dam construction

The problem of dam contraction is caused by river course movement.There are numerous unscientific dams in the Malta River. The river flow changed direction in order to build the dam. And the river geomorphology was altered as a result of the dam.

Fig: Dam contraction

- **Practice of fisheries:**

Fisheries are one of the area's main sources of income. There were numerous fisheries along the Matla River. The fisheries provide 40% of the funding. One of the causes of river course is the unscientific design of fisheries.

Fig: Fisheries

- **Making for Matla setu**

Matla Setu is a bridge that spans the Matla River in West Bengal. In January 2011, former West Bengal Chief Minister Buddhadeb Bhattacharjee inaugurated the 644-metre (2,113-

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foot) long Matla river bridge at Canning town in Caning subdivision. It is known as the Matla Bridge. It connects Canning and Basanti.The bridge can be found at 22°18′20″N 88°40′46″E. The bridge connects Canning to the direct tourism centre of Jharkhali and the Sundarbans' entrance. With the completion of this bridge, residents of the Sundarbans will be able to travel by road to Kolkata and the surrounding areas. The Sundarbans are easily accessible to tourists. As a result, the area has experienced economic development. However, as a result of this building, the river is facing numerous environmental issues. The river alters the river's natural flow.

Fig: Matla Setu

Spatio-temporal changes of River course

River has changing nature since time-immoral but on the basis of the availability of proper map, 1924 has been taken as the base year. The mass embanking of lots of tidal rivers and khals in Sundarbans for arresting their course to reduce the saline water intrusion and prevent bank- erosion was initiated by Claude Russell in 1770. That unplanned implementation and malpractices of bunding the tidal channels and khals here and there in the entire Sundarbans led to rapid change in hydrological behavior of the major tidal rivers like Matla and Bidyadhari etc. as their natural drainage systems were severely hampered. Slowly they started delinked from their sources and their faded upper courses receded seaward and channels migration was started. Side by side, rapid decaying also raised their riverbeds leading outward horizontal pressure as their depth decreased too much. This leads to the erosion and deposition also along the immature bank areas. It has been found from the hydrological analysis that due to chronic shortage of the discharge in their upper reaches, some major tidal rivers or khals have been shortened too many waterways and khals were also abandoned between 1932 and 2010. It was also noticed during the research work by the

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researcher that rapid silt deposition has narrowed down some channels in an alarming rate and side by their riverbed is sometimes risen over the nearby communities.

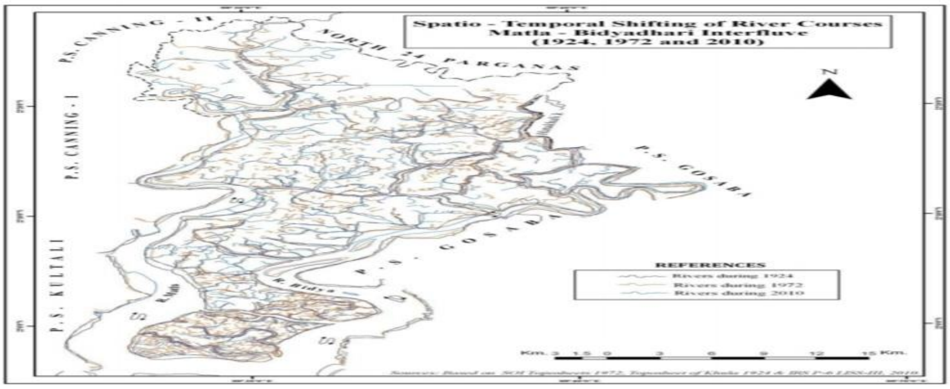

Fig: Spatio-temporal shifting of river courses in Matla-Bidyadhari interfluve (1924-1972-2010)

Channel Shifting

Channel shifting is inherent in alluvial rivers, and the problem, which involves oscillation, avulsion, and abandonment of streams or segments of streams, occurs in all physiographic zones of the state save the Himalaya, the Barind tract, and the western plateau. Every year, the Stats River erodes around 8 square kilometres of land beyond the Sundarban zone (Doi w-go wb,2011). Apart from property delineation in freshly emerging sandbanks, this huge loss of land and asset poses major challenges for the impacted individuals.

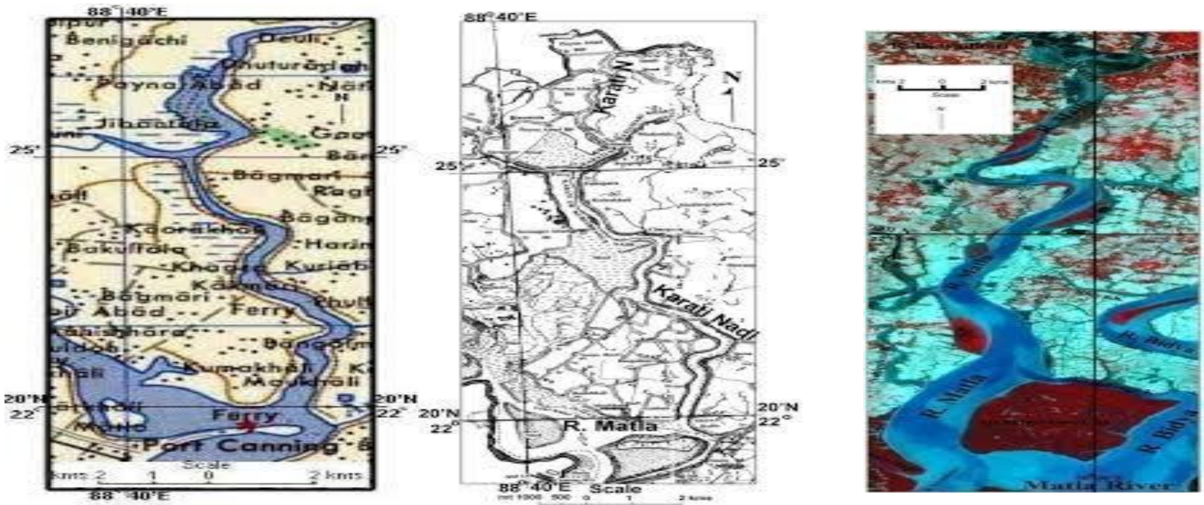

Fig .Matla during(a)1924 (Toposheet of Khulna),(b)1972 (SOI TOPOSHEET,1972) and during(c)2014 (IRS P6 LISS-III,2014).

However, over the twentieth century, the length of these tidal rivers or khals decreased to 59.40kms, 9.81kms, and 6kms, respectively. The Amjhara Khal, one of the key irrigation

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sources and a vital interlinking route between the R. Matla to the west and the R. Raimangal to the east via Rampur Khal, was the most disappointing. The length of this khal is constantly shrinking; it is now about 6.00 kilometres long, down from 25.97 km in the early 1930s. Previously, it was a key mode of water transit for people living in the Bengal Delta's east and west. This river's water was used for Aman cultivation in villages such as Hediar Abad, Daharani, Athara Beki, and Gabbuni in the present Canning-II Block, and Kumarkhali, Chara Bidyarabad, Titkumar, Khari Machan, Dhuri, and Amjhara in the Basanti Block. However, field investigation suggests that it currently flows as a narrow tidal stream only during high tides, and it supplies only 5 towns along the western part of this khal. Similarly, it happened in the case of Karati or Kuriabhanga Nadi, which was previously an active agent of the Sundarbans' tidal network. The Karati Nadi had a relationship with R. Raimangal via R. Bidyadhari in its upper stages during the 1920s, and the Payna Bil used to collect enough water from this river. However, due to the indiscriminate harnessing and mis-use of this tidal channel's river water and river-bed for fisheries, as well as the rapid formation of large marshes near Canning where it meets the Matla river, the upper reach has almost been captured by cultivators or fishermen over the last 9 decades. Previously, up until the mid-twenties, this Kuriabhanga river aided in both agricultural activities in its eastern drainage basin and fishery in its western drainage basin. However, both agriculture and fisheries are currently seeing lower yields.

Effect of River Course Change

When a river channel changes course, local industries, communities, and agriculture along the former channel course suffer greatly. The former waterway's economic activity is frequently curtailed, and in some cases, seaports must be relocated. The change in the flow of the Matla River has caused numerous problems in the surrounding area. The issue of river course modification is discussed more below-

- **Problem of communication:**

The Matla River is a vital part of the town's communication infrastructure. Canning to the basanti, gosaba, chunakhali, sonakhali, bhangankhali, and atharobaki rivers. However, as the river's channel changes, communication suffers.

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- **Sedimentation on old riverbed:**

The river changes course and finds a new path, but the old river bed becomes sedimented. Because there is no water flow. The river bank erupted, and sand, cobbles, and clay soil accumulated in the river bed. When the river has a soft path, it changes its course and sediments in the former river bed.

- **Loss of availability of fishes:**

In the region sundarban the most of the people are engaged with fishing. But the change of river effect the availability of fishes . The fish get new path so he avoid the old path.

- **Problem of agriculture:**

Agriculture is the most important economic sector in the region. They rely on river water, but changes in river course have an impact on agriculture.The agricultural situation is hampered by the economic growth rate.

- **Problem of water availability:**

The river course changes the availability of water.Some areas along the Matla River's bank have been reduced. The population experienced numerous challenges, and agriculture, which is dependent on Matla River water, has been impeded.

Sedimentation on Malta River:

River course alteration causes sedimentation. When the river enters the lower part of the river, the flow of the river decreases dramatically. The river bed rises day by day due to sedimentation. Because of this, the river Distribution pattern of benthic foraminifera in surficial sediments in the 2135 sq km region of the Bay of Bengal's continental shelf zone demonstrates the presence of three foraminiferal biofacies between 5m and 112m water depth. The first and second biofacies are primarily limited to sand and silty sand deposits, whereas the third biofacies are mostly limited to clayey silt deposits. 46 benthic foraminifera taxes were found in the study area. The presence of sand shoals, sand ridges, and a plentiful supply of sandy materials provided by the Hoogly and Muriganga rivers leads to the widespread distribution of Astrorotalia trispinosa and Astrorotalia -Ammonia biofacies. The

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abundance of euryhaline species with thick tests, well preserved and broken shells implies that the rounded/symmetrical morpho-group is thriving in the western and northern edges of the area. The Gosaba and Matla rivers, on the other hand, supply less sand and more clayey silt in the southern half of the area, favouring the formation of Nonion biofacies and the abundance of angular/asymmetrical morpho-groups. The benthic assemblage of this biofacies is primarily composed of stenohaline taxa that thrive in the subtle distinction between the aforementioned categories. Biogenic (B) diversity index of benthic foraminifera: The territorial (T) ratio of sediments and foraminiferal density are lower in the western and northern sections of the region than in the southeastern section, indicating that the former domain has a higher rate of sedimentation than the latter. The distribution of benthic foraminiferal assemblages in three major subgroups (Rotalina Miliolina Textularina) in triangular diagrams implies a shifting environmental set-up in the prodeltaic region, from near-shelf to outer-shelf environment, from north to south of the survey area. The inferred foraminifera biofacies contact is fairly conformable to the bathymetries contour, with the exception of two tidal ridges on the western edge of the area.

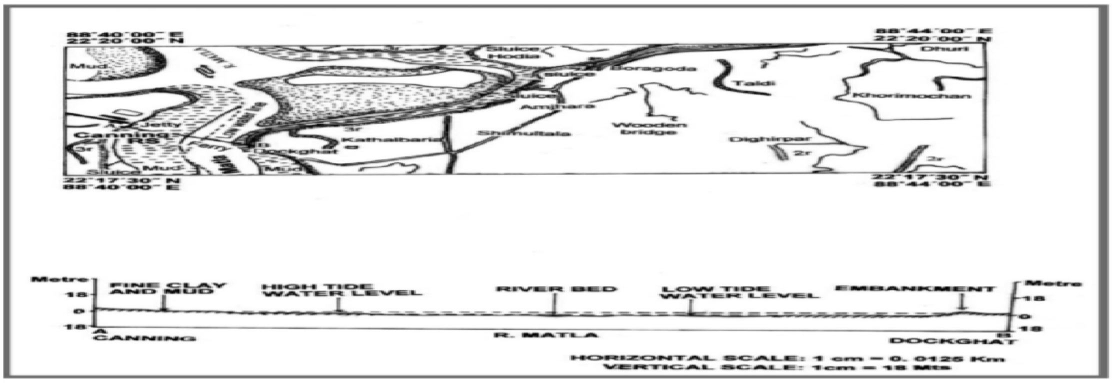

Fig: cross section profile Of Matla river between Canning ferry ghat and Dockghat

We can tell from the above cross section profile that the river bed is not the same.There are numerous river beds. Crossing between the canning ferry ghat and Dockhhat. Fine clay and mud were deposited at the beginning of the river, followed by high and low tides. There are numerous river embankments. According to the Toposheet research of this area, both banks of this river in the lower reaches. Observation has indicated that the upper reaches of the R. Matla are deteriorating at a rapid rate, with channel scouring and bank erosion occurring due to river shifting over the last eight decades. Because of the creation of huge shoal deposits in the upper reaches, the maximum bank erosion, channel bed scouring, and river course shifting occur on a regular basis. Furthermore, helical flow is originating as a result of intricate channel flow in

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and around the shoal deposits that have been accumulating at the higher reaches since 1924.

Erosional and Depositional Processes of the river systems

This interfluves has been subjected to continuous erosional and depositional activity for the last 86 years (1924-2010). It has been found that the river Matla and river Bidyadhari have shifted a lot particularly in their lower reaches in the active deltaic parts Whereas, maximum depositional cases are concentrated in and around the upper reaches Table: Varying width of R. Matla and R. Bidyadhari during last 86 years (1924-2010)

Years	R. Matla	Width in km
1924	Between Dalhousie Is. and Bulchery Is.	10
	At the Confluence with R. Bidyadhari	3.5
2010	Between Dalhousie Is. and Bulchery Is. 10	12.09
	At the Confluence with R. Bidyadhari	4.5

Sources: Toposheets of Khula and Putney Is. (1924), SOI Toposheets (1972) and IRS P6 LISS- III (2010)

of these two major tidal channels and erosional activities in their lower reaches. It has been discovered that the R. Matla and R. Bidyadhari's mouths are identical widened for about 3kms and 1 km respectively since last 86 years due to erosion. The higher portions of the interfluve are dominated by abandoned channels, which are utilised as agricultural plots or residential orchards. For these economic purposes or unscientific ways of land reclamation or flood protection programmes by erecting embankments, a massive behavioral change in hydrological character of the major tidal channels, creeks and khals are being noticed by the scholar. It has been found that R. Matla received somewhat larger deposits than R.

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Bidyadhari since it obtained roughly 16.75 km2, whilst R. Bidyadhari gained 15 km2. The major rivers or khals that have only deposited in this interfluve over the last 86 years are the Karati Nadi or Kuriabhanga Nadi, Payna, Amjhara, and Rampur Khals in the mature parts to the north of this interfluve; Bidya Khal, Shiyalpheli Khal in the active lowlands of this interfluve to the south; and Hatakhali, Durgamandal Khals in both the mature. The estuarine component of this interfluve near the Herobhanga R.F. was eroded more than it was deposited. During this time, the majority of yearly bank erosion episodes have been concentrated in this interfluve along the Hogol Nadi-Karatal Gang interlinking channel between R. Bidyadhari and R. Matla. This could be owing to the constant catering of the R. Matla and R. Bidyadhari's high tide water.

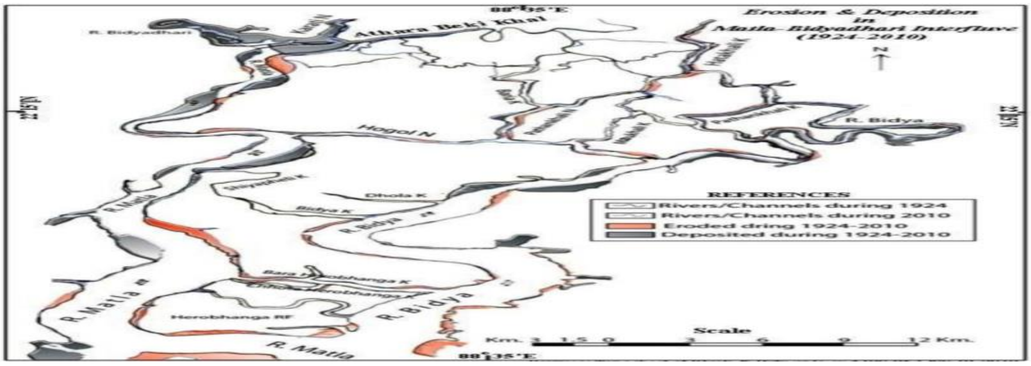

Fig: Erosion and deposition in Matla-Bidyadhari interfluve of South 24 Parganas, West Bengal during the last 86 years (1924-2010)

Depositional features in Matla:

i) Levees and shifting embankme

The natural embankments flanking a river flowing at a higher level than the adjacent terrain are referred to as a 'Levee' (Bagchi, 1944). Desiccation cracks are visible on both sides of tidal rivers, streams, and channels, and salt deposits are visible on the surface of natural banks or levees. The typical height of the banks of main rivers and interfluves, such as the R. Matla, R. Bidyadhari, Hogol Nadi, and Karatal Gang, etc., ranges from 1 metre to 6 metre from the M.S.L. From the point of view of the vertical section of the levees, the upper portion (1-2mts from the low tide water level) of the levees contains high amount of salt which is very much cracked and fragile during the dry seasons. The bottom level of the levees from the river or the creek water is at all time contact with the tidal inflow or outflow. The tide and ebb water in the dry seasons particularly during the December-May do not

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interfere in the modification of the upper portion of the levees. From the point of view of the texture of the soil of the tidal levees, the average granular size of the bottom level up to 1-2mts height varies from 0.0312mm to 0.125mm. This indicates that the lower portion of the tidal levees is made up of very fine laminae of silt, clay and sand. As the lower section of the levees is always spelled by the low and high tide twice a day and roots of the mangroves are of substantial component of bank deposits, the color of the lower section is dark grayish due to high rate of oxidation and as we move towards the upper section, the grayish color fades up and turns into very light brown or whitish brown at the topmost level. Bio-turbational disturbances have less of an impact on the lowermost area of the levees. The typical grain size of soli of the levee ranges between 0.125mm and 0.5mmnts above 1mt height from the water level of the tidal rivers or channels and creeks.

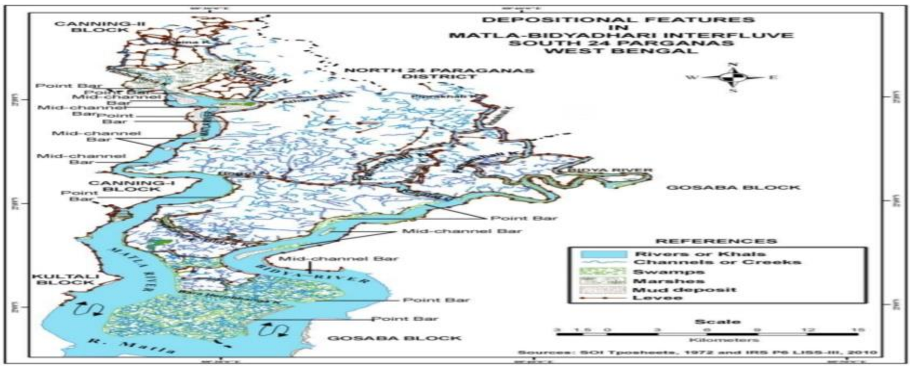

Fig. Depositional features in Matla River

ii) Shoal deposits or Chara

Shoal deposits can be found in both the R. Matla and R. Bidyadhari beds, although the fundamental distinction is the absence of any such significant deposits on the R. Matla bed in the lower reaches from Garanbos to the mouth. In recent years, two huge and one tiny and conspicuous charas have been observed along R. Bidyadhari. The Hogol Nadi has 2 to 3 prominent shoal deposits. In the course of R. Matla from the confluence of Matla-Bidyadhari Rivers and Hogol Nadi and Karatal Gang, 5 to 8 small to large shoal deposits can be noticed. Some of them are of 0.25 to 2.5kms in length. These shoals are the barriers to the incoming high tide water coming to the upper reaches of the R. Matla near Canning. As the upper reaches of the R. Matla has almost decayed so, maximum portion of the incoming tidal water instead of moving further northward turns towards eastern direction mainly through the Hogol Nadi. So the tide is sudden and very fast at Port Canning whereas it's rhythmic in case of Hogol Nadi. During both high and low tides, a massive amount of tidal mass enters

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violently. Because of the abrupt rise and fall of the maximum range in tidal bore, the flow of the Matla and Bidyadhari, as well as the related channels and creeks, is the most dynamic in nature. Furthermore, there are more than 5-6 small to large scale shoal deposits along R. Matla and R. Bidyadhari, and the acute meanders of R. Matla and R. Bidyadhari do not allow the incoming spring tide to spread uniformly over the vast shallow interior area quickly enough to match the rapid rise at the entrance.

CONCLUSION

The above micro level overview clearly shows that the fluvio-geomorphological environment in the Matla river has been changing over the previous 8-9 decades, and each geomorphic division of this has its own locational and hydro-morphological significance. This study can help us understand the secret tidal mechanisms that drive every moment land development and land loss processes in the world's largest delta. The mature and active deltaic locational significance, the erosion and deposition done by the largest and most destructive river, R. Matla, and an ageold meandering R. Bidyadhari with many footprints of earlier tidal activities in this part of Sundarban delta, is obviously a model area in Sundarbans to explain the changing nature of the tidal rivers, tidal creeks, and the reasons behind the current hydrological problems like increasing salinity. According to the above discussions, not only are tidal channels, khals, and tidal creeks changing their courses naturally, but human interferences such as early reclamation, indiscriminate clearance of mangroves, and jacketing the natural dynamic courses by unplanned and unscientific embankments are also responsible for changing the nature of the tidal resources in this part of the Sundarbans. Finally, the changing character of the fluvio geomorphological environment in Matla, South 24 Parganas, West Bengal, has had and continues to have a significant impact on land usage in Matla.

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