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Research Article

PISCICULTURE- A CHANGING TREND IN MATLA-BIDYADHARI INTERFLUVE IN INDIAN SUNDARBANS

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ABSTRACT
Sustenance of the growth of this delta according to the law of nature has always been neglected in case of Sundarbans. Land reclamation programmes initiated by the British in Sundarbans not only let them get new and new agricultural lands but new and new economic sources also were being introduced from time to time over this incomplete deltaic region of Sundarbans. Time is the major factor which controls the development of active delta to be a mature one and a mature delta to be a moribund one. For this reason only, the local people of this delta couldn't find to maintain their simple livelihood as impact of embankments on changing fluvio-geomorphological environment is still absent in their mind, that mind which made the idea of making of embankments to secure their life from floods as well as to develop pisciculture. There are yet many researches to come in front to overcome the crude problem of this delta. This article has mainly highlighted the changing fluvio-geomorphological environment and increasing practice of pisciculture instead of age old agricultural practices in Matla-Bidyadhari interfluve- a model unit in the Sundarban delta having both the hydro-morphological characteristics of the mature and active deltaic environment.

INTRODUCTION
The study area stretches from 21º57'N to 22º45'N latitudes and 88º35'E to 88º53'E longitudes covering an area of 728.578 km² within the Dampier-Hodges Line in the South 24 Parganas District of West Bengal, India. The study area is interfluves of River Matla (eastern bank) and River Bidyadhari (western bank) located in the centre of Indian Sundarbans and is 45kms (approx.) away from the Bay of Bengal. Administratively the study area is situated in the middle part of the South 24 Parganas District of West Bengal, India envisaging the parts of Canning-II and Gosaba Block and entire Basanti Block.
In general, the temperature ranges between 28˚C-36˚C in Pre-Monsoon (March- May) and it ranges between 10˚C-24˚C during the Post Monsoon (October- February). The annual rainfall during this year was also very high i.e. 26.55 cm. (second highest in amount in last decade after the year 1995). The annual rainfall averages 1800 mm. more than 80.0% of which comes during the monsoon. In an average, the Relative Humidity (%) remains from 71%-74% during November- March. Dense ground moist occurs in early morning during January-February. The average relative humidity is nearly 80%-84%. Skies are moderately clouded in May, heavily clouded in monsoon season, and clear or lightly clouded during rest of the year.

Relief
The Matla-Bidyadhari in the Sundarban Delta is gently sloping floodplain having an average height of 2-3mts above mean sea level near the Bay of Bengal. Unfortunately, the SOI Toposheets of this region have contour intervals of only 20mts above mean sea level in this regard. Hence, Mukherjee (1976) prepared a relief map of the entire Rarh Bengal having a contour interval of 3mts. The researcher having consulting both the maps with field investigations has prepared the relief map (Figure 2) of the study area. From the relief map of the study area it has been observed that about 70% of the interfluve, particularly the entire northern half and some patches to the south of this region is flatland with an average height of 2mts above M.S.L. About 12.41% of the region particularly to the middle and eastern parts of this interfluve is a lowland area with an average height of about 3-6mts above M.S.L. About 5.82% area, particularly to the south-west of this interfluve is little bit elevated and not a monotonous floodplain with an average height ranging 6-8mts above M.S.L.

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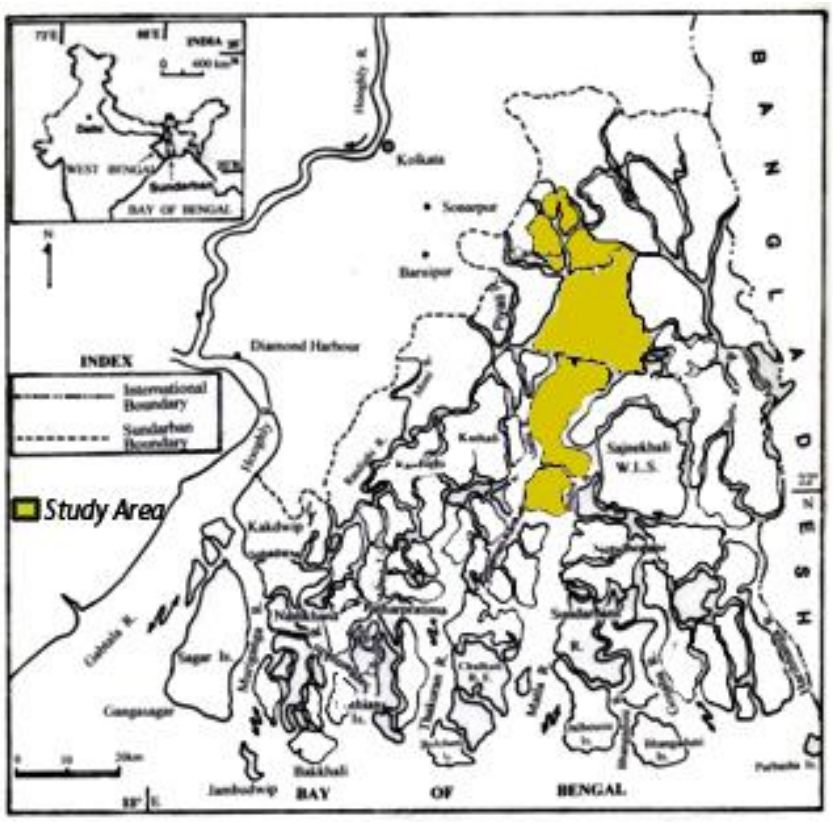

Figure 1: Location of Matla-Bidyadhari interfluve in Indian Sundarbans

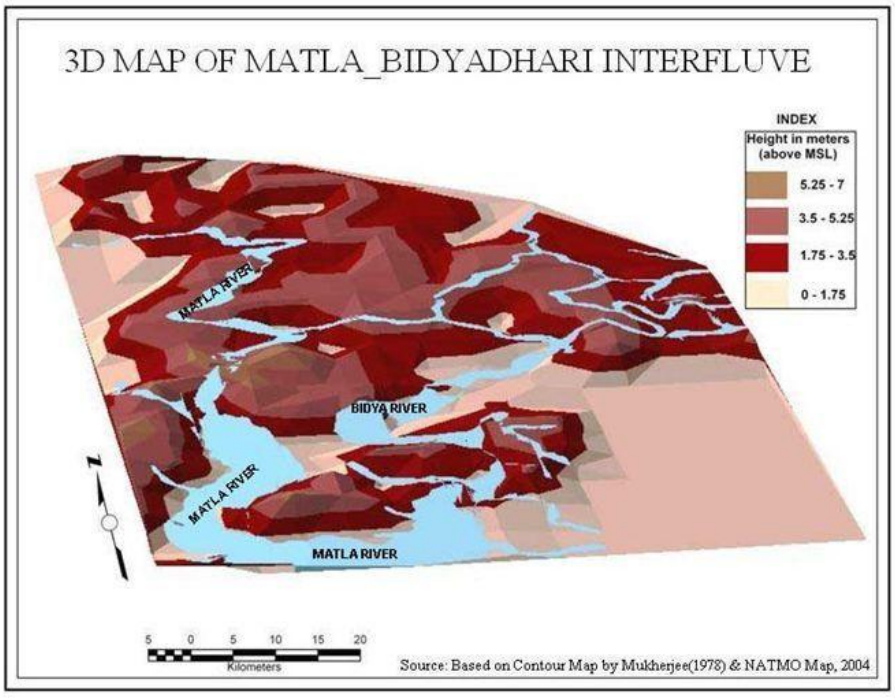

Figure 2: Three-Dimensional presentation of the relief of Matla-Bidyadhari interfluve in Indian Sundarbans, 2010

About 12.41% this interfluve to the north-east and southern island part (Herobhanga Reserved Forest) is an active elevated estuarine area with an average height of more than 9mts above the M.S.L. Hence, the Matla-Bidyadhari interfluve is not at all a monotonous floodplain.

The Matla–Bidyadhari interfluve can be categorized into the following meso-geomorphic units based on the altitude, morphological characteristics, drainage pattern and characteristics or in other word on the basis of its hydro-morphological characteristics. They are- (a) Mature Flatland (b) Active lowland with acute meanders, (c) Flatland with intertidal channels, (d) Active delta with numerous creeks and (e) Active elevated estuary.

Drainage

The major two rivers Matla and Bidyadhari flow along the western and eastern margins of the interfluve area respectively. R. Matla, after joining with Karati or Kuriabhanga Nadi in Canning-II Block

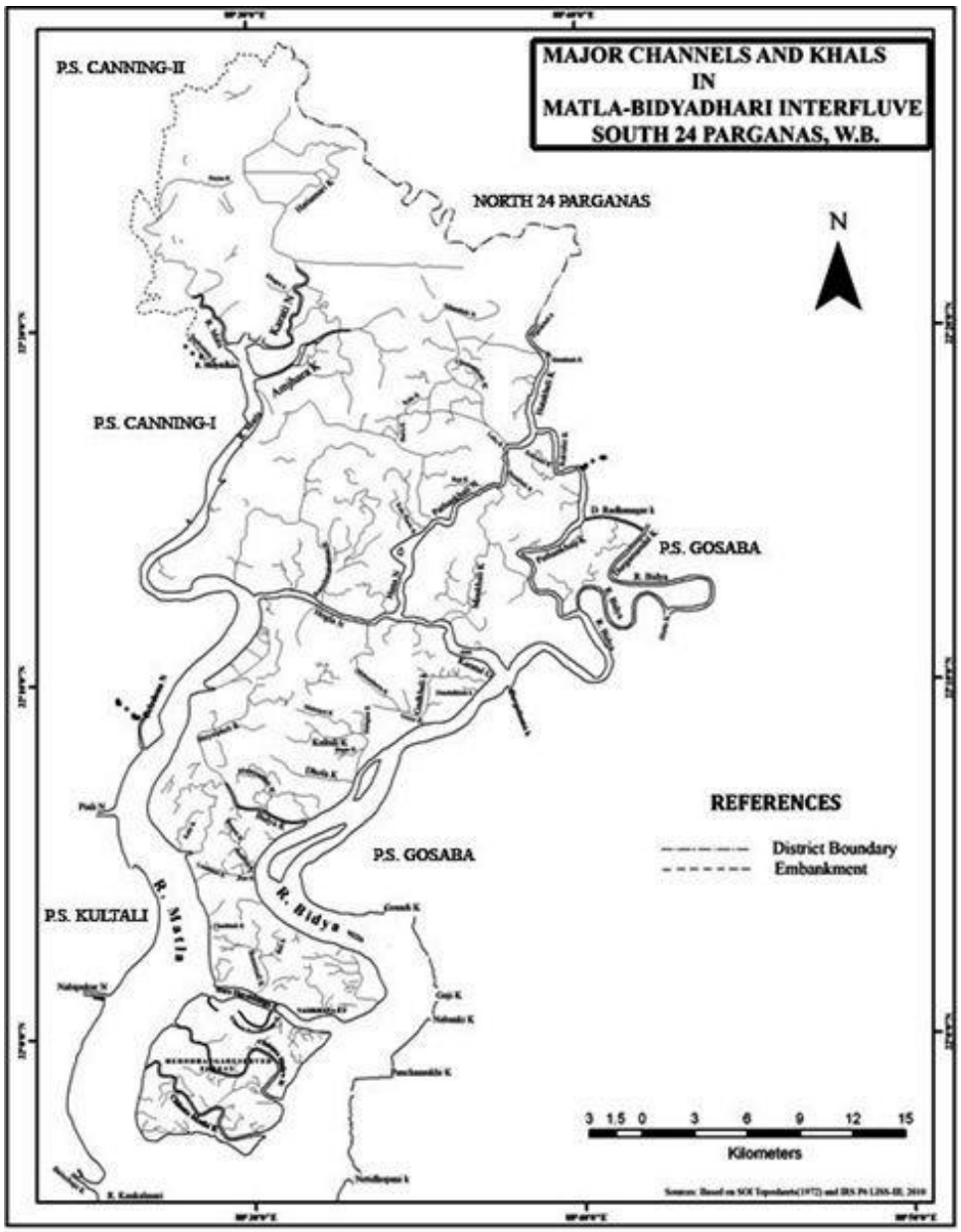

Figure 3: Drainage status of Matla-Bidyadhari interfluve in the active and mature Sundarbans, India

of 24 Pgs. (S), flows almost in north-south direction (except between village Amratala and Ananda Abad in Basanti Block) with major left hand tidal channels like- Athara Beki Khal (joining near village Kathalberia), Hogol Nadi (joining near village Purandar) and Bara Herobhanga Khal (near Lot no. 126 of Basanti Block). The right hand tidal channels are- Belladonna Nadi (joining in Canning-I Block), Piyali Nadi, Nabipukur Nadi and Bainchapi Khal (joining in Kultali Block). The R. Bidya joins the R. Matla (near the Lot. 124 of Basanti Block) and their combined flow (at 21º 56'N latitude and 88º 40'E longitude) in the name of R. Matla ultimately joins the Bay of Bengal between Bulcheri and Dalhousie islands in 24Pgs. (S). R. Bidyadhari on the other hand, has a complex flow and is known by different names all along its stretch in Sundarbans. It starts its journey from Salt Lake to Canning where its slope run ratio is 52,500 in the mature deltaic part of Sundarbans (Mukherjee, 1976). Thereafter, it flows from Dhania to Canning having a ratio of 14,166 and 16,875 in mature and active deltaic parts respectively. Another course flows from Kajla to R. Raimangal having a slope run ratio of 9,167 in the mature deltaic part and 19,678 in the active deltaic part of Sundarban delta (Mukherjee, 2002). Ultimately it joins the R. Matla near Herobhanga R.F. and their combined course meet the Bay of Bengal to the south. It has an acute meandering course with lots of ox-bow lakes in the area within the Pathankhali Nadi to the west, Hatakhali-Durgamandal Khal and Karatal Gang-R. Bidyadhari interlinked network. Whereas, only 22.1kms of the course of R. Matla falls under the mature delta (3-6mts above M.S.L.) and 37.3kms of its course falls under active deltaic parts (<3mts) of the Sundarban Delta. The recent study (2010) has found that the R. Matla has slope-run ratio of 22,100 in the mature deltaic parts between Canning to village Charanikhali in Basanti Block of South 24 Parganas. It has a slope run ratio of 37,300 between village Charanikhali and Herobhanga R.F. and 49,240 from Herobhanga R.F. to the mouth at Bay of Bengal in the active deltaic parts of the Bengal Delta. From hydro- morphological point of view the R. Matla has already attained the mature deltaic conditions in the area with an average height between 3-6mts between Canning to Charanikhali in the Basanti Block. Lots of tributary, sub-tributary, distributaries and sub-distributing tidal channels, locally called khals (Figure 3).

Table 1: Block-wise name of the rivers and khals in the Matla-Bidyadhari interfluve of 24 Pgs. (S)

NAME OF BLOCKS	NAME OF THE KHAL(K)	NAME OF THE RIVER (R) OR NADI (N) OR GANG (G)
CANNING-II	TAMBULDAHA K, KHAGRA K, PAYNA K, HATIAMARI KATHARABEKI K, BHUBAN K, ATHARA BEKI K	R. MATLA, KARATI OR KURIA- BHANGA N
BASANTI	AMJAHARA K, ATHARA BEKI K, KALU K, BARIA K, CHUNAKHALI K, LEBU K, PIPRAKHALI K, KALA HAZRA K, RAMCHANDRAKHALI K, ROA K, HATAKHALI K, MOKAMBERIA K, GADKHALI K, DUNDULKHALI K, GOYER K, SHIBGANI K, MALSOYET K, KULTALI K, BAGAR K, SHIYALPHELI K, NARAYANTALI K, DHOLA K, BIDYA K, BASANTI K, KALIR K, LOTAMANI K, JORA K, HALDHOA K, CHARKHALI K, BALI K, BENAMALL K, BARA HEROBHANGA K, CHHOTA HEROBHANGA K, CHHOTA MATLA K, CHHOTA BIDYA K	R. MATLA, HUGLI OR HOGOL OR HOGLA N, KARATAL G, PATHANKHALI N, HANA N, R. BIDYADHARI OR BIDYA
GOSABA	RAKTABIR K, KATYAANI K, MOUKHALI K, JHAUKHALI K, PATHANKHALI K, DAKSHIN RADHANAGAR K, DURGAMANDAL K	PATHANKHALI N, R. BIDYA OR Bidyadhari

Some of the khals are manmade also. These khals, channels and creeks play a vital role in the distributing network of the high tide water and ebb tide water twice a day here. These khals (Figure 2) also help in natural land building processes of the Sundarban Delta. The Matla-Bidyadhari interfluve has an average drainage frequency of 4 streams/ km². Due to rapid decaying and abandoning of the channels, khals and creeks in the upper reaches, particularly in the mature Sundarbans, the drainage frequency is very low that is less than 2streams/km². On the other side, drainage frequency increases as we move towards the estuarine parts of the Matla-Bidyadhari interfluve where it is above 9 streams/ km². Shiyalpheli-Bidya is the longest khal in Matla-Bidyadhari interfluve. Two most important interlinking channels between R. Matla and R. Bidyadhari are – (a) Hogol Nadi-Karatal Gang and (b) Bara Herobhanga Khal.

Hence, the higher range of tidal bores during the monsoon periods and sometimes during the pre-monsoon and post-monsoon accompanied by the cyclonic storm originated by the intense low-pressure over nearby Bay of Bengal accelerates the damages caused either by storms or by bank tidal floods. The combined activities of the cyclones and tidal bores are important hydro-climatic phenomenon in this interfluve of Sundarbans.

Pedological Character of the Interfluves

Soil is the basis of any land use and the source of livelihood to the cultivators and fisherman in the Sundarban delta which share more than 80% of the population of Matla-Bidyadhari interfluve. The study area is generally covered by two major types of soil – (a) Non-saline soils and (b) Saline soil of tidal origin. The major components of these soils are the Gangetic alluvium and the salinized Gangetic alluvium. In case of the Gangetic alluvium the soil is rich in calcium and magnetite which are salt free and rich in nutrients. The soil of this deltaic region undergoes partial transformation in their exchange complex due to the exchange reaction with sodium chloride of the tides of Bay of Bengal. During the inflow of the tidal water from the Bay, the suspended materials rush back through the numerous tidal rivers and creeks like the Hogol Nadi, Karatal Gang, Bara and Chhota Herobhanga Khal, Shiyalpheli Khal, Bidya Khal, Dhola Khal, Jora Khal, Pathankhali Khal, Maukhali Khal, Hatakhali Khal, Durgamandal Khal etc. and get partially deposited due to the gravitational force becoming greater than the force of suction exerted by ebb water or outflow of the outgoing tidal Bay water in the flood plains situated inland. Particularly the soil with high pH value (above pH 7.9) can be noticed along the lower course of the R. Bidyadhari at Birinchibari, Laskarpur and Jyotishpur, Nafarganj mouza of Basanti Block to the South eastern section of the interfluve. Soils have been collected from 10 stations of the interfluve region and the maps have been prepared on the basis of the laboratory analysis report. All these maps show the spatial distribution pattern of the soil character.

A report on average NPK condition of the Deltaic West Bengal was prepared by Bagchi and Mukherjee (1976), so, a comparative study has been done between the report of 1976 and the present (2010) analyzed report of the researcher. It is noticed that the average pH value and the average conductivity have been increased and percentage of organic carbon has decreased. The pH value has increased in the eastern and southern parts of this interfluve than that of the pH value during 1976. Besides, the Phosphate content has decreased than that of the 1976. Rather, the average Potassium content has increased now days. From the field observation, the probable reasons for remarkable increasing rate of salinity may be pointed out like- (i) direct heating of the land due to continuous removal of canopy of the mangroves caused by the rapid deforestation in this interfluve. This leads to direct heating of the bare land increasing the rate of evaporation during the dry summer and dry winter seasons. (ii) The low-lying areas flooded with saline tidal water during the monsoons or tidal bores or during heavy cyclonic weather cannot return to the tidal channels and act as back swamp due the reverse slope of the embankments. Water percolates through the sub-soils and spread around the adjacent fields and creases the residue as salt layer over the top soil during the dry seasons. (iii)The salt layer just after the rain caused by temporary low pressure formed over Bay of Bengal just 45kms (approx.) away to the south, use to spread the patches of isolated salt layers to the surrounding areas. Thus, frequent drizzling or shower caused by the frequent cyclonic disturbances creates water logging conditions in the shallow areas inside. (iv) The sodium chloride and

other soluble minerals coming with the marine water settles over the top soil along the tidal channels due to poor drainage conditions in the Matla-Bidyadhari interfluve of South 24 Parganas, West Bengal.
The amount of Organic Carbon depends on soil texture, climate, vegetation and historical and current land use/management. Soil texture affects it because of the stabilizing properties that clay has on organic matter. As the interfluve is located both in the mature and active deltaic parts of Gangetic Delta the organic matter can be trapped in the very small spaces between clay particles making them inaccessible to micro-organisms and therefore slowing decomposition. In addition, clay offers chemical protection to organic matter through adsorption onto clay surfaces,

Table 2: Comparison of Average Soil Conditions during 1976 and 2010

Soil parameters	Years		Remarks
	1976	2010	
pH Value	7.0	7.94	Increased
Avg. Conductivity (T.S.S. in m. mhos/cm)	1.0	2.17	Increased
Avg. Organic Carbon (%)	0.51%	0.32%	Decreased
Avg. Nitrate content (N) / Lbs. per Acre Or kg. / ha	NA	48 Lbs./ Acre Or 21.77 kg./ha	-
Avg. Phosphate (P) / Lbs. per Acre Or kg. / ha	14 to 32kg/ha.	41 Lbs./ Acre Or 18.60 kg./ha	Decreased
Avg. Potassium (K) / Lbs. per Acre Or kg. / ha	39 to 271 kg/ha	245.81 Lbs./ Acre Or 111.50 kg./ha	Increased

Sources: Soil Map prepared by Bagchi & Mukherjee (1976) and Laboratory analysis by the research scholar (2007)

which again prevents organic matter from being decomposed by bacteria. Soils with high clay content therefore tend to have higher Organic Carbon than soils with low clay content under similar land use and climate conditions. The eastern and western marginal areas of this interfluve have clayey soil along the R. Matla and R. Bidya respectively. The soil in the eastern part of this interfluve within the Pathankhali Nadi, Hatakhali Khal-Durgamandal Khal-R. Bidyadhari- Karatal Gang has more clay content with higher percentage of organic carbon. The southern part criss- crossed by lots of tidal channels, khals and creeks have also abundance of clayey soil. Hence, climate also affects organic carbon amount as it is a major determinant of the rate of decomposition and therefore the turnover time of carbon in soils (Milne, 2009).

Plate 1: Salt layer over the top soil in Jyotishpur (L) and Pathankhali (R), March 2008

From the above it is very much clear that the increasing trend of pH value since last few decades in the soil of the Matla-Bidyadhari interfluve indicates that this part of Sundarbans is going through substantial increase in salinity in floodplain which is ultimately discouraging extensive agricultural practice here. It has also been observed that the increasing salinity and tidal water intrusion are the major reasons behind the annual crop failure in this region. So, people are opting other economic activities among which the pisciculture seems to be the most attractive one as the increasing natural swamps and saline tidal water are the best habitat for the shrimps and prawns, which has a great market demand in nearby markets centered at Canning.

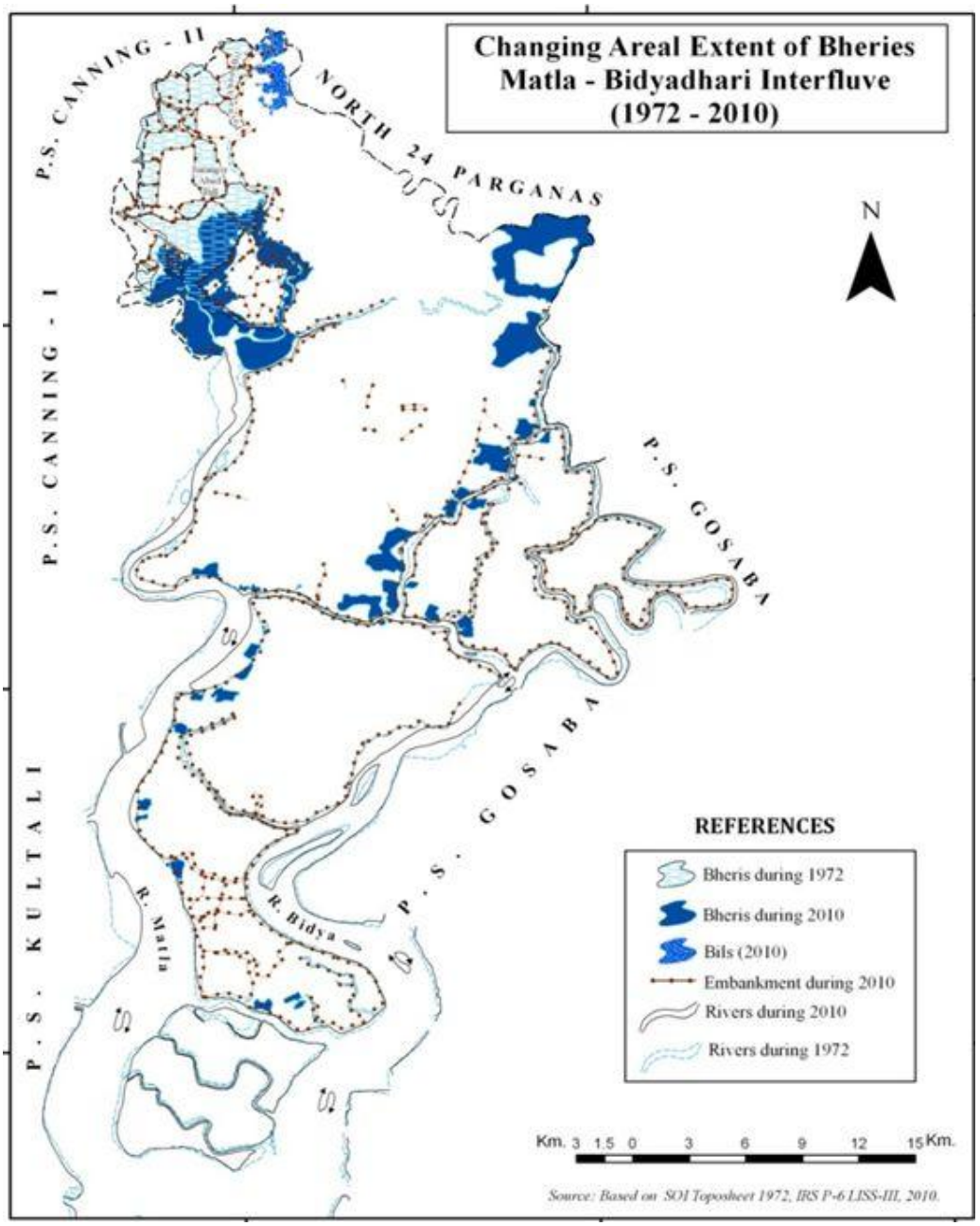

Figure 4.17: Spatio-temporal changes in the fisheries in Matla-Bidyadhari interfluve of South 24 Parganas, West Bengal since last 3 decades (1972-2010)

Pisciculture – A Changing Trend of Land Use

Hectares after hectares of agricultural land have been turned into bheris for developing the crustacean to the commercially viable extent thereby making these lands unfit for agriculture anymore owing to salinity. Taking full advantage of the agriculturally upset and helpless poor people, different companies engage them in collecting young of the Prawn and other fishes.

Poor people, simply for the sake of a tempting payment, engage in this difficult task. Age no bar, from seven to seventy, all will be seen collecting the young of the Prawn all day long (Gour, 2011). Besides, From the household reports of 1951 and 2001 census years in this interfluve of South 24 Parganas, it has been noticed that the number of riverside or major khals adjacent villages in the Matla-Bidyadhari interfluve of South 24 Parganas having more than the average households has been increasing rapidly during the last 5 census decades whose main economy is the pisciculture. The ideal fluvio-geomorphological environment for the cultivation fish like the- Tiger Prawns, Shrimps, Pompret, Bhetki, Parsey which has an age-old huge market demand in the states of India and foreign countries, have mainly invited the people particularly towards the geomorphologically vulnerable active zones in this interfluves. This quick profit and substitute of the annual crop failure in the geomorphologically active or highly erodible juvenile floodplains and higher salinity with low NPK value in the zones of active lowland with acute meanders, active delta with numerous creeks and active elevated estuarine zones have also accelerated the growth of fisheries in the entire interfluve (Figure 4). The net area available for and net area under effective pisciculture in the Canning-II, Basanti and Gosaba Blocks also changed from time. During the 2003-04, the Canning-II Block had net area of 114.00 hectares available for pisciculture. But during the 2006-07 this area reduced to 108.00 hectares in 2006-07. Whereas, the net area available for pisciculture and net area under pisciculture in the Basanti and Gosaba Blocks in the Matla-Bidyadhari interfluve show a continuous increasing tendency in 2006-07. In 2010, the area under fisheries in the Mature Flatland of the Matla-Bidyadhari interfluve had the maximum (37.47 km²) area under fisheries in the Matla-Bidyadhari interfluve which shared almost 14.44% of this geomorphic unit. The zone of Active lowland with acute pisciculture meanders have 1.64 km² areas under fisheries i.e. 2.09% of this geomorphic unit. 25.16 km² (9.96%) of area is under fisheries in the zone of Flatland with intertidal channels.

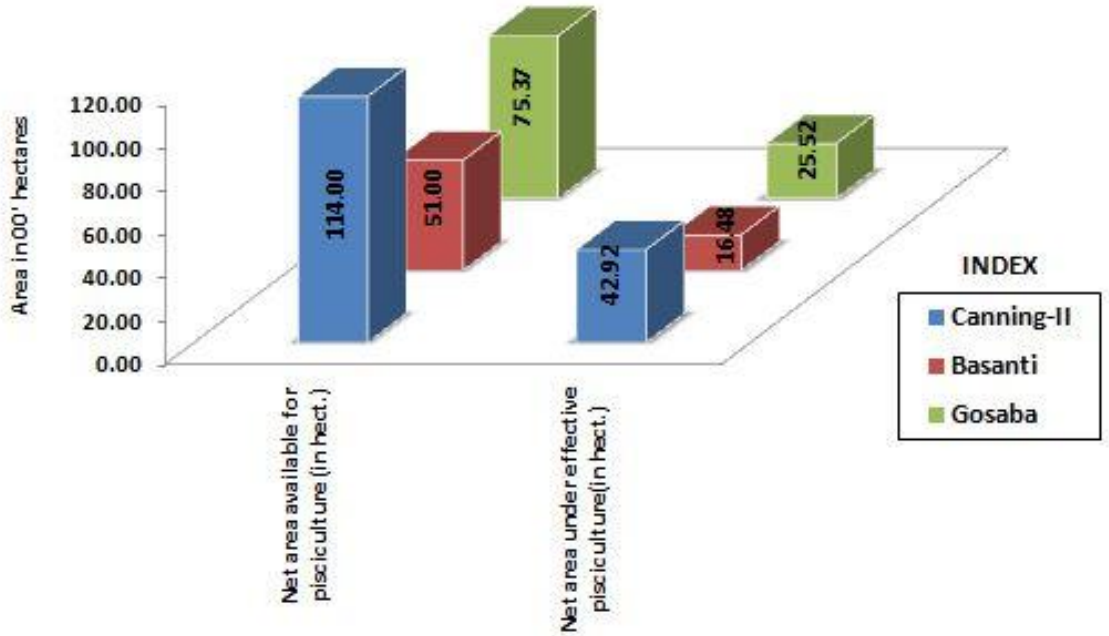

Figure 4.18: Net Area available for and Net Area under pisciculture in Canning-II, Basanti and Gosaba Blocks in South 24 Parganas, 2003-04

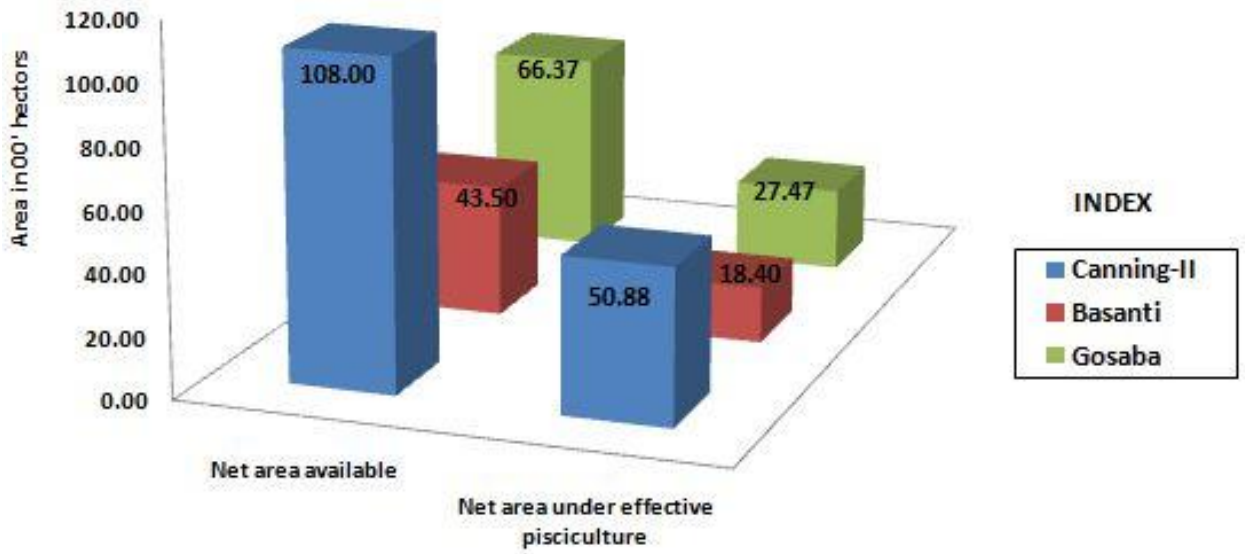

Figure 4: Net Area available for and Net Area under pisciculture in Canning-II, Basanti and Gosaba Blocks in South 24 Parganas, 2006-07

Plate 2: (a) - (d) Showing different methods of practising

Bulk of fish is collected from different parts of the Sundarbans, including Basanti, Gosaba and Sandeshkhali and part of Kultali. Basanti Block in Matla-Bidyadhari Interfluve alone has 26,612 persons engaged in fishery in 9 Government aided fisheries in 2006-07 having 4350.00 hectares of net area available for pisciculture. But there are lots of unofficial or unauthorized bheris along the R. Matla and R.

Plate 3: (a) Cutting the embankment to bring saline tidal water to the agricultural field to make it fishery, Laskarpur (Basanti P.S.) and (b) Converting the agricultural fields into fishery, Parbatipur (Basanti P.S. in South 24 Parganas, W.B.)

Bidyadhari in the Active lowland region (Plates 3) and in the villages in the active elevated estuary also where it is found that the cutting of the embankments and malpractices of intentional inviting of the saline water intrusion also increase the salinity in the nearby agricultural plots which in future become infertile and again changes the land use here.

CONCLUSION

In response to the land reclamation programmes and the steady growth of population the main land use characteristics of the inhabited interfluves like- Matla-Bidyadhari, a slow but steady conversion of agricultural land to fisheries can be noticed in recent days. The early use of the incomplete juvenile floodplains of the Sundarban delta and the age old unplanned reclamation programs which were initiated by British for collecting revenue only are highly responsible for the changing hydro-morphological behaviour of this part of the entire Sundarban delta. The age old agricultural problems in this deltaic part of India have somehow forced the poor villagers to convert the agricultural lands to fisheries. The temporary profit from fisheries may lead to mass devastation in future because of rapid spread of the pisciculture which inversely will affect the adjacent agricultural field which are not expected to be highly saline from natural hydro-morphological conditions. The unending greed of the human being is the main enemy for present day environmental degradation of these interfluves and inviting the rapid salinization of the newly forming floodplains. So planning should be installed cautiously for the optimum utilization of land and the fluvio-geomorphological environment of each inhabited interfluves in the Sundarban delta should be understood from the grass root level.

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