The Encroaching Ganga and Social Conflicts: The Case of West Bengal, India.

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ABSTRACT

The course of the Ganga upstream and downstream of the Farakka barrage continues to change unabated. This has resulted in many problems like land reallocation causing border dispute between Jharkhand and West Bengal and created a class of neo-refugees. The Government of West Bengal apprehends that the gnawing river may outflank the barrage in near future making project redundant. While millions of rupees are wasted every year in bank protection, the programme of rehabilitating the erosion-victims was not taken into account. The land eroded from left bank of Ganga in Malda is more than 200 sq.km. ; While that from Murshidabad is about 356 sq,km. Since the flow of river intercepted at farakka, the sedimentation on the riverbed has increased. The barrage authority has so far denied the progrmme of silt management. The huge load of boulders utilised in anti-erosion works are dislodged every year and deposited on the riverbed. The basic objective of the Farakka Barrage has been frustrated as the problem of siltation in the Hugli estuary remains unsolved and port of Kolkata is not yet accessible to the large sea-going vessels. Though it is admitted in the official documents that the intensity of erosion in Malda and Murshidabad has increased after the construction of Farakka Barrage, the question of rehabilitation of the erosion-victims has not been given any heed.

Prelude:

The water resource engineering in India during the post-independent era was largely dedicated towards the expansion of irrigation to ensure the food security for the growing population. The irrigation was the prime objective of 96% of 4291 dams built in India (WCD, 2000). The Farakka Barrage does not belong to this category and is unique in status even in the world. It was built with the pious intension of inducing water into the Hugli river with a view to flush the sediment load into the deeper part of estuary and resuscitate the navigational status of the Kolkata port. No other river-valley project of the world is comparable to the Farakka Barrage Project in respect of its objective that was based on arithmetic hydrology without any regard to multi-dimensional fluvial dynamics of the river. 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. Our conservative estimate based on the Tide Tables for 2004 published by Kolkata Port Trust reveals that during the high tide in May total amount of water induced into the estuary varies from 2559-6790×10^6 m^3 with the sediment load ranging from 2.60-6.80×10^6 ton. A similar estimate during August-September shows those to be1857-6813×10^6 m^3 and 1.86-6.81×10^6 ton respectively. The south flowing peak discharge in the Hugli even during monsoon hardly exceeds 4246 cumec only. This poses most serious constraints for silt management in the estuary.

While constructing barrage across Ganga at Farakka and even during the last three decades of its operation, the silt-management in the Farakka pond was given scant or no attention. It was largely the silt that has been trapped upstream of the barrage and that caused the disastrous consequences. The river bed upstream of the barrage is now so clogged with sediment that even a country boat can not negotiate freely during lean months. The river has been gnawing its left bank to open a new outlet outflanking the Farakka Barrage. The Geo-political scenario of the subcontinent has so changed since 1971 that operation of Farakka Barrage does not find a smooth passage. Since the introduction of high yielding technology and expansion of irrigation in the upper and middle Ganga plain, the available water at Farakka during lean months dwindles far below the threshold limit and thereby exerts stress on the Indo-Bangladesh relationship. Nor the recommended discharge of 1132 cumec is induced for the port of Kolkata that continues to face the problem of navigational hazards. The annual discharge hydrograph of Bhagirathi at Jangipur below the outfall of feeder canal for the year 2000 was extremely skewed as tributaries like Bansloi,Pagla, Madhabjani,Kanloi contributed huge discharge because of a cloud burst in late September over uplands of Santal Parganas in Jharkhand. The lean season induced discharge in the river was below the threshold limit fixed for the maintenance of the navigability of the port of Kolkata. The fluvial dynamics in the Hugli river is so complex that the concept of flushing the sediment seems to be a myth. One should also keep in mind that Farakka Barrage Project was designed on the data base of late 1950. But the catchment area of the Ganga has been drastically modified during last five decades and the present situation demands the review of the project afresh.

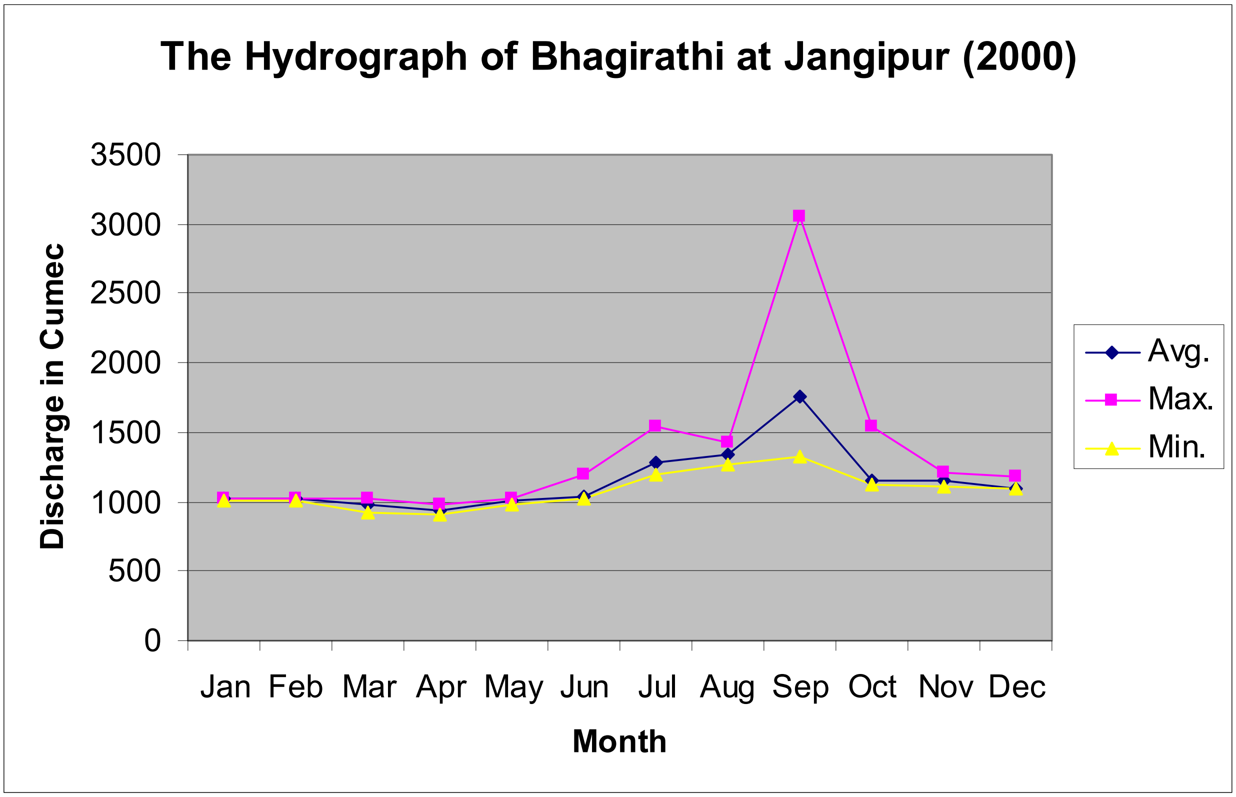


Fig.1: Source: KPT, 2000

Kolkata Port: A colonial legacy:

The European Merchants first visited Bengal during early 16th Century. Satgaon was then the most important trading centre located on the eastern bank of Saraswati, a distributary of the Hugli river. But it was extremely difficult to approach the port from the sea because of the decaying status of Saraswati. The large ships had to anchor at Batore and only *Bazras* could reach Satgaon during high tide (Mukherjee, 1938).

The Port of Kolkata emerged during late 18th.century under colonial rule, though the wooden ships had been plying through this river during preceding centuries (Ghosh, 1972).Earlier in 1651, East India Company selected Hugli as the site for their trading operation (Nair,1995). Hugli maintained its importance till the end of 17th. century. In 1686, English came in a conflict with Mughals and started to look for a better and secured anchorage. In 1690 Job Charnock returned to Kolkata as he was granted permission by Emperor Aurangjeb for trading operation. The British rulers after taking over the total administrative control over this part of the subcontinent, the hinterland of the port of Kolkata extended far from Assam to Uttarpradesh. But the sailing had always been an arduous task in 200km. stretch from Sandhead to Kolkata because of the presence of many under-water shoals and sinuous thalweg of the river (Ray, 1990). The 20th. Century witnessed a revolution in the ship building technology and ships of larger size and greater draught started to dominate the maritime trade. A sea-going ship requiring draft of more than eight metres could hardly approach the an inland riverine port like Kolkata . It is only during high tide a ship ventures to sail up the Hugli estuary and that too is not a smooth ride.

The diminishing headwater supply and increasing sediment load posed serious challenge for navigation. 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. The Port Authority of Kolkata started to dredge the navigation channel since 1820 and continues to do so even today. But such palliative measure does not reverse the decay of river.

A Project to Resuscitate the Dying Bhagirathi Channel and Navigability of the Port:

The difficult and dangerous state of navigation in the Hugli estuary was a matter of deep anxiety of the British, as the navigation was intimately related to colonial exploitation. In fact, decay of the Bhagirathi-Hugli river started long before the establishment of Kolkata port. The earliest description of the decay of Bhagirathi dates back 6, January, 1666. Tavernier, the French traveller wrote- *"Bernier was going over land from Rajmahal to Cossimbazar as the river route was impracticable…when the river is low it is impassable because of large sand bank which lies before the town called Suti"*.(Rudra,1992). About a century after Bernier, Rennell(1788) witnessed -"*Cossimbazar river is almost dry October to May*". The Off-take was so closed with sand deposit that cargoes sailing down Ganga had to anchor at Suti in Murshidabad and goods were carried down to Jangipur on land and thence transported down the Bhagirathi on small boats. Since the closure of the Bhagirathi off-take, Jalangi and Mathabhanga-Churni were used as alternative routes of navigation. Captain Brame noted-" *Jalangi was used for main line of steamers from Calcutta to Goalundo or Assam during rains from 1858 to 1866. But subsequently it* *deteriorated and Mathabhanga was used for navigation in 1882. It was quite good up to 1884 and afterwards gradually deteriorated; while Jalangi improved and by 1890 it became so bad that we abandoned it in favour of Jalangi and it was never used since. We used Jalangi for main line of steamers (towards Goalundo, Assam) upto1896. We continued to use Jalangi for small craft up to 1907 from which date forward we ceased to use the river altogether*"(Rudra,2000a). In 1853, Bengal Chamber of Commerce proposed the establishment of a substitute port on the bank of Matla river, some 40km. to the south of Kolkata. The Port was named after Lord Canning. The newly built port decayed within a decade and was officially closed in 1871 (GoI 1865). It was then obligatory for the British Imperial Power to explore the ways and means to resuscitate the navigational status of Kolkata port. The engineers first tried to cut open the off-take point of the Bhagirathi to induce water from the Ganga. But such attempts were proved futile as the water-level of Ganga fell five metres below the bed-level of Bhagirathi during lean months. The off-take ceaselessly migrated from one point to other between 1781-1925 (Mitra,1953) and the process continued till 1975 when a barrage across the Bhagirathi was constructed and thereby closed its link with the Padma.

The construction of barrage across the Ganga and diversion of water towards the Bhagirathi was first suggested by Sir Arthur Cotton as far back as in 1853. Many other British Engineers supported this view though they were not unanimous about the site of the barrage. The proposal to resuscitate the port of Kolkata was shelved till the independence when the National Government paid heed on the proposal. In 1957, Government of India invited Dr. W. Hensen to explore the causes of decay of the Hugli river and to suggest remedial measures. After careful investigation, he suggested that *"The best and only technical solution of the problem is the construction of a barrage across Ganga at Farakka with which the upland discharge into the Bhagirathi-Hooghly can be regulated as planned, and with which the long term deterioration in the Bhagirthi-Hooghly can be stopped and possibly converted into a gradual improvement. With a controlled upland discharge a prolongation of freshet period will be obtained, and the sudden freshet peaks which will cause heavy sand movement and bank erosion will be flattened"* (GoI,1975). The hypothesis arithmetic hydrology of the Farakka Barrage Project was subsequently proved untenable. In a tidal estuary like Hugli where ratio of volume of water carried by a north flowing tide and that by southward flowing monsoon freshet may be disproportionate to the order of 78:1 and thus the idea of flushing the sediment load down to deeper estuary was too optimistic. In view of massive volume of tidal water, the induced water is too meagre to bring any positive impact.

The construction of Farakka barrage was started in 1962 and was completed in 1971. The excavation of the 38km.long feeder canal took about four years and the project was commissioned on the

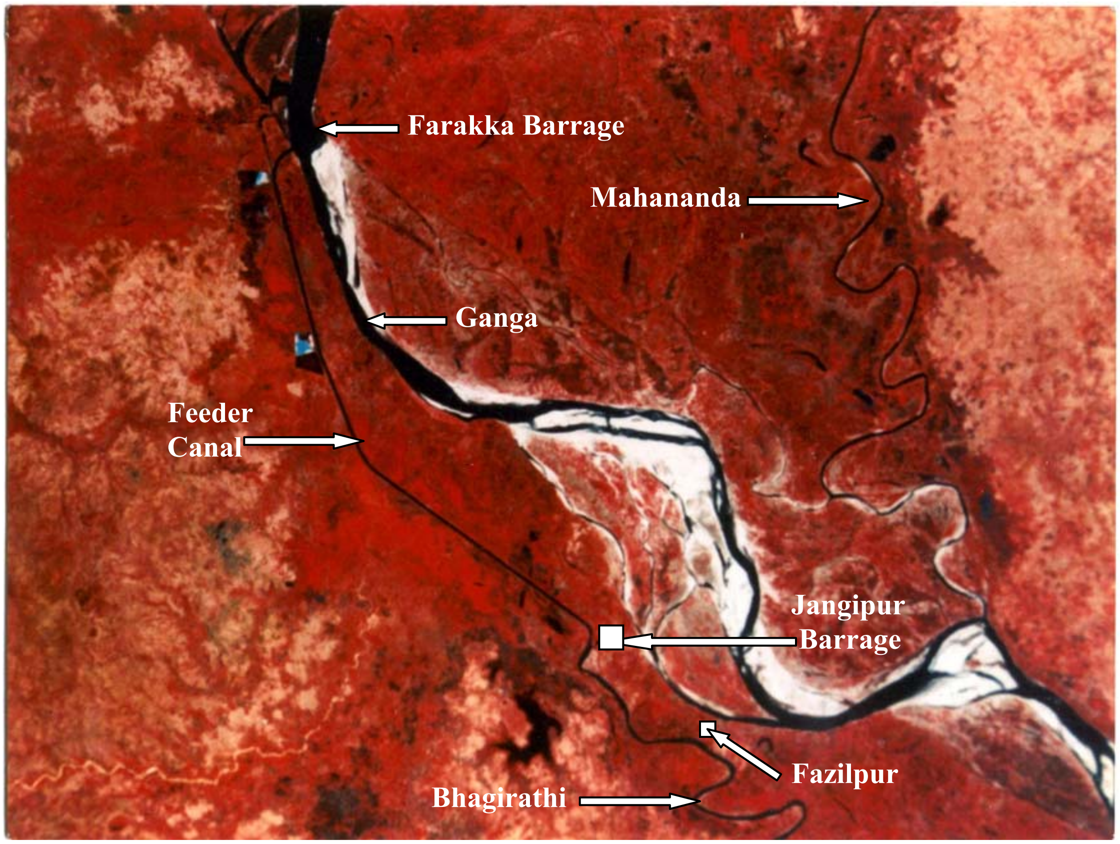


Image-1: Layout of the Farakka Barrage Project.

21st.May, 1975. During the construction of this mighty barrage, there was a transformation in the political scenario of this subcontinent. Bangladesh emerged as a sovereign country from erstwhile East Pakistan and this rendered a new dimension to the dispute over the sharing of Ganga water. There was also large-scale expansion of irrigation in the upper Ganga basin since introduction high yielding techniques in agriculture. In absence of any national policy relating to interstate sharing of water, the upper riparian state started to abstract water from Ganga indiscriminately. This caused diminution of water in the lower reach leading to many social stresses. However, Let us have a glance at the technical detail and layout of the Farakka Barrage Project.

SALIET FEATURES OF THE FARAKKA BARRAGE PROJECT

A. Farakka Barrage:	
Length:	2.62Km.
Number of Bays:	109
Span of Each Bay:	18.30m.
Lowest Bed Level:	10.30 m above m.s.l.
Pond Level:	21.90 m above m.s.l.
Crest Level of Spillway:	15.80 m above m.s.l.
Crest Level of Under Sluices and River Sluices:	14.30 m above m.s.l.
B. Head Regulator	
Pond Level:	21.90 m above m.s.l.
Full Supply Level at Land:	1133 cumec.
Clear Water Way:	11 bays of 12.20m.each.
Crest Level:	18.10 m above m.s.l.
C. Feeder Canal:	
Length:	38.30 km.
Design Discharge:	1133 cumec.
Bed Width:	150.80m.
Full Supply Depth:	6.10m
D. Jangipur Barrage:	
Length:	212.70m.
Number of Bays:	15
Span of Each Bay:	12.2m.
Crest Level:	12.80m. above m.s.l.

Source: Basu(1982)

Myth and Reality:

The fluvial processes operating the in the Hugli estuary is extremely complex. In this funnel shaped and north-south aligned estuary, the tide dominates over the diminishing headwater supply even during the peak of monsoon. The Hugli estuary is unique in nature compared to many other outlets of the Ganga. It is the only river that reaches the sea in a southerly direction while all others flow in a south-easterly direction. The Bhagirathi-Hugli river has a catchment area an covering about 55617 sq.km.and that is drained by seven major tributaries namely, Pagla, Bansloi, Mayurakshi, Ajoy, Damodar, Rupnarayan

,Haldi and the two offshoots of Ganga – Jalangi and Churni. The lower 281 km. of river is tidal while the upper 221 km. remains perennial during lean months mainly by the induced water of the Ganga-Bhagirathi feeder canal.

The induced water through Ganga-Bhagirathi feeder canal was supposed to flush the sediment load from the estuary and keep the navigation channel free from siltation. But the objective was proved a myth as sedimentation in the estuary continues unabated. It is admitted in the published document of the Kolkata Port Trust that induced discharge from Farakka Barrage has had not been able to negate the estuarine sedimentation. The annual quantum of dredging has increased from 6.40m.m^3 during pre-farakka days to 13.24m.m^3 during post-farakka days. (Sanyal and Chakraborty, 1995) This has further been increased to 21.18m.m^3 per annum during 1999-2003.

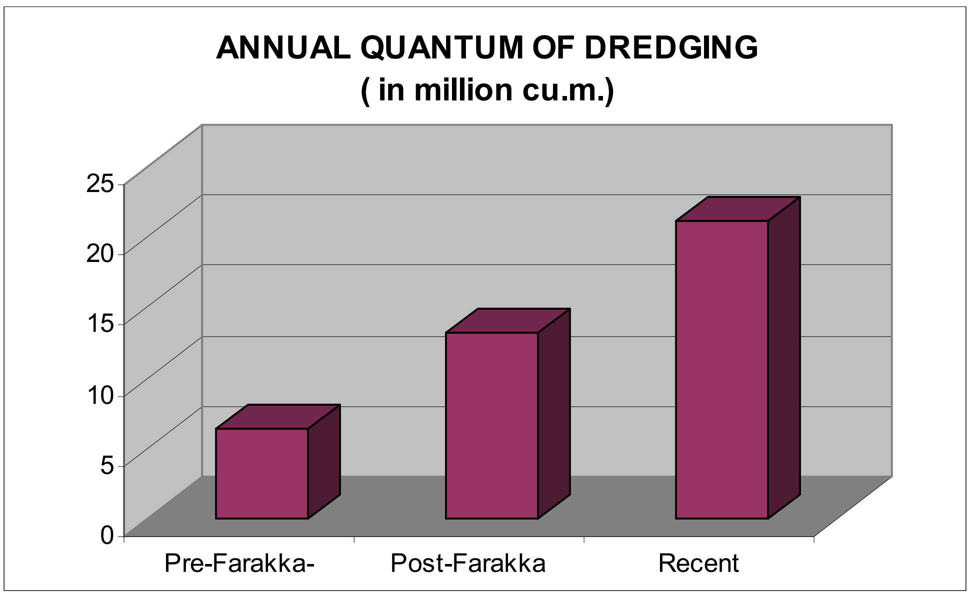


Fig.2**: Pre-Farakka- till 1975; Post-Farakka-1976-1994; Recent-1999-2003.**

There are various sources contributing sediment load into the Bhagirathi-Hugli river. The Feeder Canal was supposed to induce relatively silt-free water from Farakka Pond through its three tier head regulator. The annual sediment loads at Jangipur and Berhampur are estimated to be 7.09 and 15.60 million tons respectively. The Kolkata Port Trust has estimated the sediment load being transported down Nabadwip as 25.66×10^6 t/yr. It is important to note that out of the 10.06×10^6 t/yr being added between Berhampur and Nabadwip, Ajoy and Mayurakshi contribute about 3.91×10^6 t/yr. The Jalangi and Churni pour in 3.71×10^6 t/yr between Mayapur and Kalinarayanpur. Though Damodar, Rupnarayan, Haldi and Rasulpur creek add 11.22×10^6 t/yr between Uluberia and Haldia, the annual sediment load transported below Diamond Harbour is 23.68×10^6 t/yr and that is 1.98×10^6 t. less than the load observed at Nabadwip. This proves beyond doubt that about 13.20×10^6 t/yr. is either being deposited or remains in circulation every year between Nabadwip and Diamond Harbour. The Kolkata Port Trust has estimated that a total load of about 26.93×10^6 t/yr remains in circulation annually between Diamond Harbour and Sagar and that creates impediment to navigation. The sediment movement in the estuary is tide dominated and that can push back 4.90 to 14.67×10^6 tons of sediment each time. It is difficult to estimate how much of this load is left behind by the ebb flow.(see sediment flow model). 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 in 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. No less than fifteen under-water shoals create barriers across the navigation route approaching the port of kolkata.

. The differential velocity of the high and low tide is one of the major causes of decay of the river. In this north-south aligned estuary, on rushing tide flows at a faster velocity (~ 9 km/hour) and deflected towards eastern bank due to coriolis force. The water-level may fluctuate from 0.96 m to 5.71 m during August-September at Sagar and that at Diamond Harbour is observed to be between 0.90 – 6.45 m within around six hours(GoI,2004). The ebb tide flows back along the western bank at a slower velocity (~ 6 km/hour) during next eight hours. This fluvial dynamics leaves behind a substantial part of the sediment that entered into the estuary with high tide. Major Hirst (1915) apprehended that the *"forces controlling it are so powerful that any artificial interference would be futile".* The experience of Kolkata Port Trust corroborates this view and as such the port has tendency to migrate southward from Kolkata-Haldia-Kalpi to Sagar.

The Farakka Barrage: intercepted flow and trapped sediment:

The 2.64 km long Farakka Barrage was designed to divert 40,000 cusecs (1133 cumec) of Ganga water towards Bhagirathi so that the navigational status of the Calcutta Port could be resuscitated. This mighty intervention into the river impaired its dynamic equilibrium in many ways. Mr P.K.Parua (2002), former Superintendent Engineer of the Farakka Barrage Project, has noted that *"the construction of the barrage has disturbed this apparent equilibrium condition and the river started to adjust this huge human interference by aggradation and degradation of its bed and channel pattern by erosion and siltation. The processes will continue for a quite long time in such a mighty river till a new dynamic equilibrium is established. In the post-barrage condition, the normal sediment transport system has been intercepted due* *to controlled operation of the barrage gates and river bed on upstream started aggrading with the change of erosion / deposition pattern of river bed and banks. The new sand islands have come up gradually with general rise in river bed level and formation of deep narrow thalweg on left side. The normal flood level has increased with reduction in channel capacity. This has increased the flood intensity on upstream at lesser discharge in post barrage situation which could be noticed in Malda district in during last two decades".* The Irrigatin and Waterways Directorate, Government of west Bengal, was firm to opine that construction of Farakka Barrage and the menace of erosion in Malda are intimately related (Ray,2000). The 13^{th}. Legislative Aseembly Committee. (2004) in its 7^{th}. Report noted " *It is accepted all levels that the construction of Farakka Barrage is solely responsible behind the erosion of river Ganges in Malda district* ".

Since the pond level at Farakka was elevated from 15.24m to 21.95 m. by impounding $87mm^3$ of water, the hydraulic gradient of the Ganga above the barrage was flattened, leading to increasing tendency of flood and erosion. The one major impact of impounding of water has been sedimentation and resultant reduction of the cross-sectional area of the river. The Ganga-Brahmaputra system contributes largest amount of sediment among all rivers and that was estimated to be 1667×10^6 t/yr(Milliman and Meade,1983). There are differences of opinion among the experts about the annual sediment load carried by Ganga at Farakka. Abbas and Subramanium(1984) measured it as 801×10^6 t/yr. Wasson (2003) has put forward a lesser figure and that is 729×10^6 t/yr The estimation of this author puts the figure to 736×10^6 t/yr. The State Irrigation Department came forward with a surprisingly low estimate of 301×10^6 t/yr (Ray, 1999). Many dams and barrages constructed across the tributaries of Ganga intercept the sediment flow and thereby reduce the available load at Farakka. Wasson wrongly conceived that out of *729×10^6 t/yr that passes Farakka, 328* $\times 10^6$ t/yr *is lost down the Hugli river leaving an estimated 401* $\times 10^6$ t/yr *pass to Bangladesh down the Padma compared with 440* $\times 10^6$ t/yr *measured in Bangladesh.* But the three tier head regulator at the off-take point of the feeder canal hardly allows more than 6.76×10^6 t/yr pass to Jangipur and remaining 328.24×10^6 t/yr is being trapped in the Farakka pond. In addition to this trapped sediment load, tons of boulders which are used for anti-erosion works along the banks, are too often dislodged and deposited into the river. The construction of a 100-m long spur requires 14357 tons of boulders. Out of 27 spurs constructed so far upstream of the Farakka Barrage, 20 spurs have been fully or partially swept away. The Spur Nos. 18, 20 and 24 which were recently re-constructed have also been out-flanked. The river borne sediments, boulders and ruins of the eroded village are combined in the riverbed and create formidable obstruction to the flow of the river. The current is thus deflected towards the causing erosion thereon.

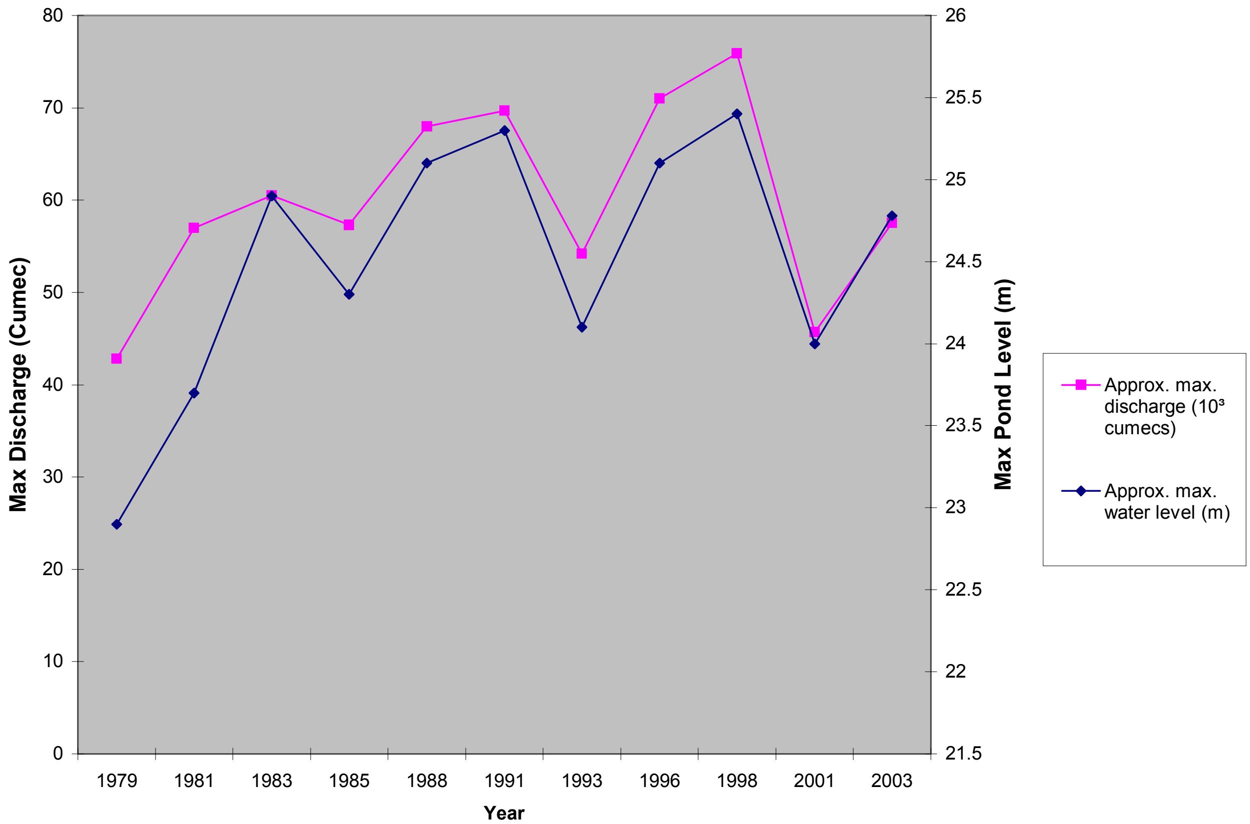
The reduction of the cross-sectional area and gradual meander formation between Rajmahal hills and Farakka has altered the direction of flow which is no longer co-axial to the barrage. The flow has rather become oblique and concentrates more towards the right side of the barrage. This causes swelling of water during the peak of the monsoon. One bay of the barrage cannot discharge more than 30,000 cusecs (840 cumec) of water, but because of the obliquity of the flow, additional 40% water is often concentrated along the right hand side bays. It is striking to note that the peak discharge at Farakka in the year 1981 was57000 cumec and maximum pond level was observed to be 23.70m. But in the year 2003 the peak discharge (57520 cumec) was slightly higher than that of 1981 but the pond-level was elevated to 24.78m. This is a clear indication of the induced sedimentation and reduction of the cross-sectional area of the river.

Table-1: **Peak Discharge and Pond-Level at Farakka**

Year	Approx. max. discharge (10^3 cumec)	Approx. max. water level (m)	Increase in height (m) (Original pond level: 21.95 m)
1979	42.80	22.90	0.95
1981	57.0	23.70	1.75
1983	60.5	24.90	2.95
1985	57.30	24.30	2.35
1988	68.0	25.10	3.15
1991	69.70	25.30	3.35
1993	54.20	24.10	2.15
1996	71.0	25.10	3.15
1998	75.90	25.40	3.45
2001	45.68	24.00	2.05
2003	57.52	24.78	2.83

Source: Compiled from Parua(1999 and 2003); Rudra(2003);Bandyopadhya & Mallik, 2004.

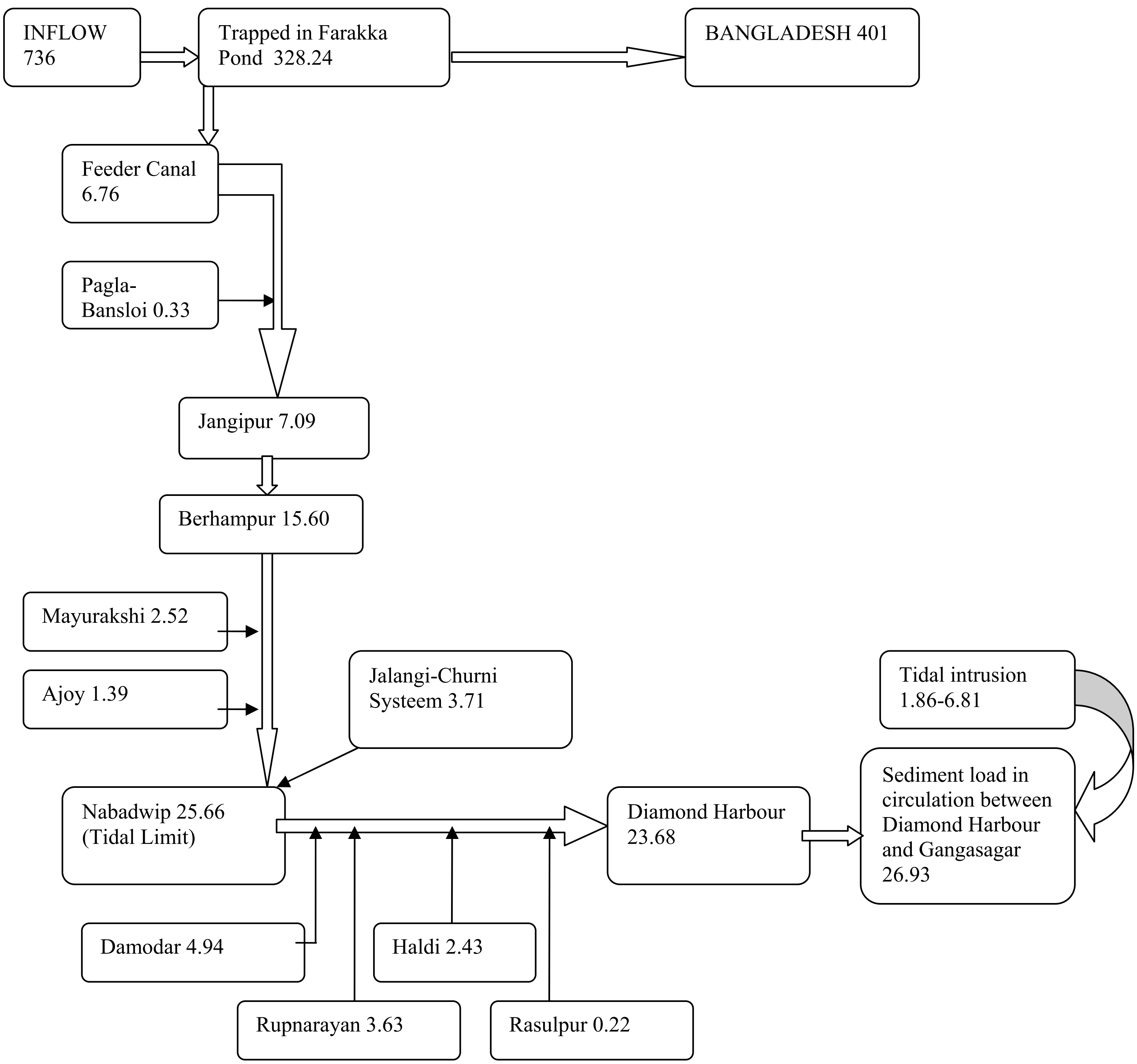
Fig.-3: **Peak Discharge and Pond-Level at Farakka**



The outliers of Rajmahal hills along the right bank aggravated the situation. It is the geological node where the river strikes and the deflected flow impinges opposite bank with immense force. The tendency of eastward migration of the river was observed long before the construction of the Farakka Barrage but the situation deteriorated further when the construction of the barrage started with partial blockade of the river by coffer dams in early 1960s. The river has now formed a mighty bend between two nodal points - the Rajmahal and Farakka. While the former is a geological node, the latter is an artificial node. Any artificial structure across the river, be it a dam or barrage, accelerate the problem of sedimentation on the river bed. The Farakka barrage is no exception.

Fig.4: Annual Sediment Flow in Lower Ganga System.

(in million tons)



Geomorphic Processes of Bank Failure

The deltaic rivers have the tendency to oscillate with wide limit. The swatch of meander sweep is proportional to the discharge flowing through of the river. The principal river also throws off distributaries to facilitate delta-building operation. The distributaries may be alternately rejuvenated and decayed with the passage of time. In an uncontrolled situation, the rivers enjoy the opportunity of free swing. But in this densely populated part of the World, the human intervention exerts immense influence on the river system and interrupts its natural behaviour. The Ganga system in West Bengal has some unique characteristics in respect of its fluctuating discharge, sediment load, tidal intrusion in the lower reach, role of western tributaries, diminishing slope of the *thalweg*, reversible hydraulic gradient with high and low tide and neo-tectonic of the delta. The various river training works exert large influence on the fluvial dynamics of the delta. Apart from the 2.64 km. long Farakka barrage which was built across the river during 1962-1971, the flood-control embankments, bank revetment with boulders, construction of the spurs to deflect the impinging current, enormous exploitation of the ground water causing substantial reduction of the effluent seepage into the river- are all combined to interrupt the fluvial dynamic of the delta. The encroaching Ganga during the monsoon causes damage to human settlement. This is particularly conspicuous in the upstream of the Farakka barrage in Malda district. The problem of erosion and population displacement is of no less magnitude in the down stream section of the Farakka barrage in Murshidabad. (Rudra, 1996).

Plate-1: Bank stratigraphy exposed near Panchanandapur,Malda.

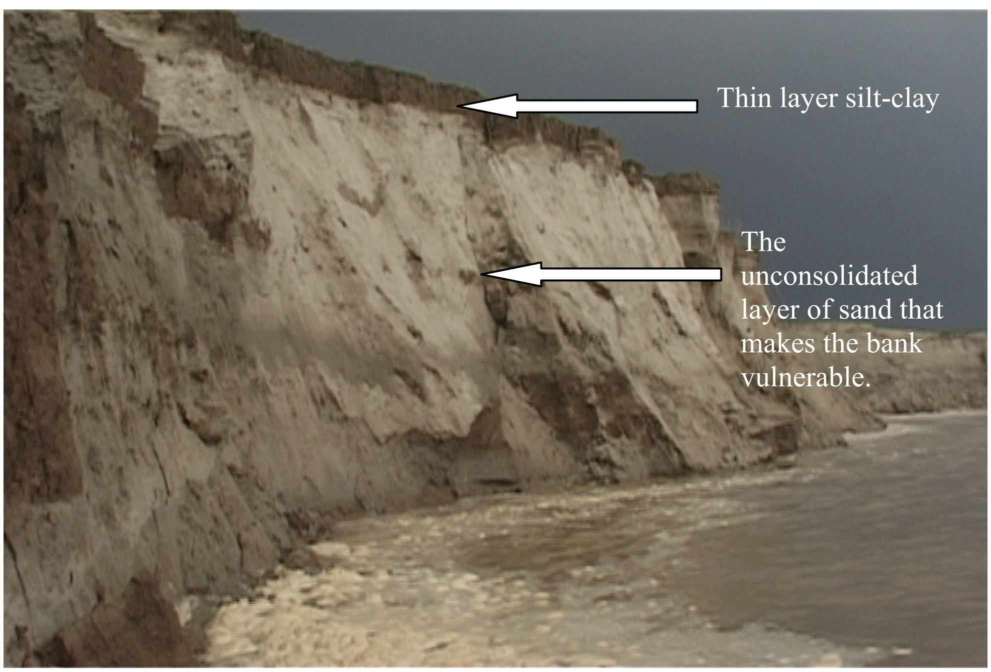


Plate-2: Shelving Bank at Nirmalchar where thin clay-layer overlays unconsolidated micaceous sand-layer.

The erosion along the bank of the Ganga is the phenomenon of the monsoon months (June – September), and it has two distinct phases: the pre-flood and post-flood erosion. The fluctuation of discharge and stratigraphy of the bank are two major factors contributing to the bank erosion. The peak discharge of the river may be to the tune of 75.90×10^3 cumec, as was observed in September 1998. The fast moving current during the rising stage of discharge removes unconsolidated sediment from the base of the shelving bank which ultimately collapses. The stratigraphy c of the bank, being composed of micaceous sand at the bottom and silt-clay upon it, appears to be responsible for this process. The post-flood erosion is related to the effluent flow of the ground water into the river. This occurs during the falling stage of the discharge. The flow of the ground water toward the river leads to liquefaction and flowage of basal sediments of the bank. However, in both cases a linear crack, often 100 metres in length, develops along the bank and the edge of the bank collapse into the river along this line.

Plate-3: Linear cracks developed along the bank due to undercutting of basal sand-layer.

These types of erosion are common in any uncontrolled channel of the deltaic tract. But the case Ganga in West Bengal is quite different. The river in the stretch upstream of Ganga is so clogged with sediment that river is compelled to alter its course. The mighty river even threatens to outflank the Farakka Barrage and open a new route through the presently moribund channels of Kalindri and Mahananda. The eastward encroaching river while forming a mighty meander bend in Malda has left behind four moribund channels which are now flowing sluggishly through the newly emerged *char*. The most prominent of these channels is identified as mid-channel in official records.

Plate-4: The breached embankment near Panchanandapur. Here the encroaching river threatens to outflank the Farakka Barrage.

Plate-5: The gnawing river engulfs all natural resources.

Myth of Dredging:

The engineers of Irrigation Department are of opinion that dredging of mid-channel and diverting the main flow towards opposite bank can be the best technical solution of preventing erosion in Malda. The experts of the Central Water and Power Research Station declined to corroborate such view in 2002. They apprehended that the mid-channel would be naturally rejuvenated within next two seasons and would carry major share of the discharge thereby reducing the attack on left bank near Panchanandapur region(Vendre,2002). Two years have already elapsed but such apprehension proved futile.

The most important question is whether it is possible to dredge the sediment that has hitherto been trapped upstream of Farakka since 1975.The first condition of such massive project is that the amount of spoil to be lifted must be twice the amount deposited in a year, if the project is to be completed within thirty years. Otherwise there would be no appreciable positive impact. Even a conservative estimate reveals that if a truck carries seven cubic meter of sediment, number of trucks required to dispose the lifted sediment load would be so many that their total length could encircle the equator 126 times. At least a fourteen-lane dedicated highway would be required to build between Malda and Gangasagar to transport the sediment to the estuary. Only the transport cost may be twice the revenue that Government of India earns in a year.

The most serious challenge of taming the river is to make the flow co-axial to the barrage. It was once thought that the diversion of more water towards the left-hand side of the barrage can be achieved by the regulation of the western gates. But such an attempt would result in the rise of the water level to the tune of 61cm. at Farakka and 23 cm. at Rajmahal (Singh et al, 1980 & Keshkar et al, 1996). It was further proposed by the experts that the excavation of an 18 km. long pilot channel might make the flow again co-axial to the barrage. The proposed pilot channel might be excavated along the abandoned path of the Ganga, which is locally known as *"Bohudubi Danra"*. The State Irrigation Department apprehended in1999 that old channel would be rejuvenated (GoWB, 1999), but no such sign was observed by this author during the recent field visit. The design of Farakka Barrage is unique in nature having unilateral feeder canal towards the Bhagirathi. The extensive deposition and resultant formation of shoal along the left-hand side has further complicated the situation. The old railway line, which was laid before the construction of the barrage, is now masked by superficial sediment deposition. This seems to be another cause of deflection of the current towards the right hand side of the barrage.

The Earlier Course of the Ganga in Malda:

The Ganga enters the state of West Bengal dashing the Rajmahal hills of Jharkhand along the right bank and flows for about 72 km. before it approaches the Farakka Barrage. The river does not get the opportunity of free swing downstream of the Rajmahal hills as the outlier of hard rock along the right bank does not allow the river to encroach westward. In the second decade of the Twentieth Century, the course of the Ganga between Rajmahal and Farakka was straight and aligned in a south-easterly direction. This course is described in the topographical sheet bearing No.72 P/13 (1:63360), surveyed in the year 1922-23. This was not the course of the river during the earlier centuries when Ganga flowed along an altogether different course dashing Gour, the mediaeval capital town of Bengal.

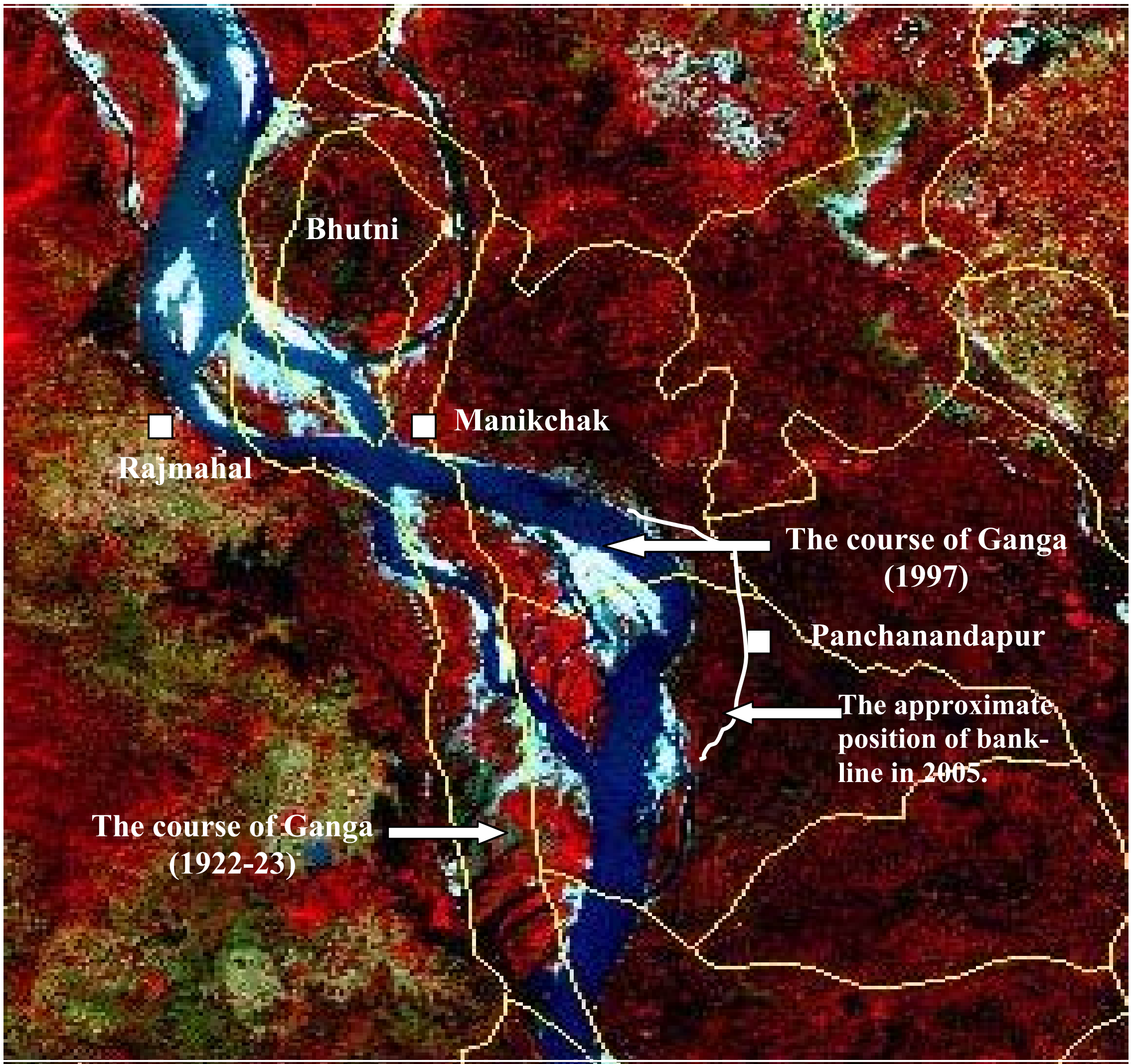


Image-2: The recent course of the Ganga in Malda

Rennell (1788) wrote that, "Gour, the ancient capital of Bengal, stood on the old bank of Ganges: although its ruins are 4 or 5 miles from the present bank." Prof.R.K.Mukherjee (1938), the eminent historian, noted in his book entitled "The Changing Face of Bengal", that, "Leaving the hills of Rajmahal, Ganges seemed to have passed northwards through the modern Kalindri and then southwards in the lower course of Mahananda, east of the ruins of ancient Gour". Sir J.N.Sarkar (1973 reprint) in "The History of Bengal: Muslim Period 1200-1757" also corroborated the view expressed by Mukherjee. Sarkar noted that, " Time has levelled to the dust the glories of the Gauda under Hindu and Muslim rule and the ruins of their capital lies scatterred in heaps for miles along the eastern bank of Kalindri river through which flowed the main current of the Ganges down to the close of the Thirteenth Century." Major Hirst (1915) attributed the subsequent changes of the course of Ganga to the tectonic causes. He opined, "There was a severe earthquake in 1505 A.D. and shortly after it, the Ganges left its old course past Gour and retreated southwards." There were two other distributaries of the Ganga namely Choto Bhagirathi and Pagla which joined each other near Mehdipur and flowed southeast to join Mahananda. The latter subsequantly discharged into the Padma near Godagarhi Ghat of Rajshahi (Bangladesh). In the process of this migration, Kalindri, Choto Bhagirathi and Pagla were left moribund. The capital town of the Gour, which flourished to its peak in the 15th and 16th Century, was located on the interfluve between Kalindri and Bhagirathi. The decay of these two distributaries might have been a slow process covering several centuries. There are historical references of mediaeval riverine route between Chittagong and Gour (Ray 1999). One cannot sail up the present river course of deltais Bengal from Chittagong to Gour. The medieval navigation route must have been through Padma-Mahananda-Kalindri or Choto Bhagirathi. The bulk of the waters of the Ganga must have flown through this course, otherwise it could hardly facilitate navigation. The lower Mahananda below old Malda must have been a part of the Ganga. The present course of the Ganga between Manikchak of Malda and Godaghari Ghat of Rajshahi was either non-existent or insignificant. The decline of Gour after 1575 A.D. may be attributed to the changing course of the Ganga system. These changes must have taken place much before Rennell pursued the survey during 1764-1777 as his map depicts the course of Ganga flowing far south of the Gour. The researches on the river system of medieval Bengal suffers from non-availability of true and correct map as the first systematic survey and publication of map was done by Rennell in the second half of the Eighteenth Century.

The Ganga maintained its southeasterly course between Rajmahal and Farakka till the fourth decade of the Twentieth Century when it started to migrate eastwards (Singh et al, 1980). Banerjee and Chakrabarty (1983) measured the eastward migration of the Ganga near Panchanandapur based on multidated maps and aereal photographs. The objective of the study was to measure the gradual erosion of the Ganga-Pagla interfluve. It was estimated that the distance between two rivers along a fixed line was 8.53 kms in 1923, 2.05 kms in 1966 and 0.95 km in 1975. It was reduced to 300m in 1998. In the month of August 2001, the encroaching Ganga swallowed the narrow interfluve between two rivers. The flood control embankment (Bund No.8) which was built along the bank of Ganga and across off-take of Pagla was breached during the July,2003.

Plate-6: The relic of Embankment no.8 stands on the river (September,2004).

The gnawing river has so far breached eight embankments. The official records regarding the land erosion in Malda is available since 1931. It was observed that 14335 hectares of fertile land was eroded from the left bank of the river from 1931 to 1978 and the total eroded land during the period 1979 to 2004 was measured to be 4247 hectares. More than 200 sq.km. of fertile land was swept away till 2004 and almost equal extent of *char* has emerged along the opposite bank (Maitra,2004)

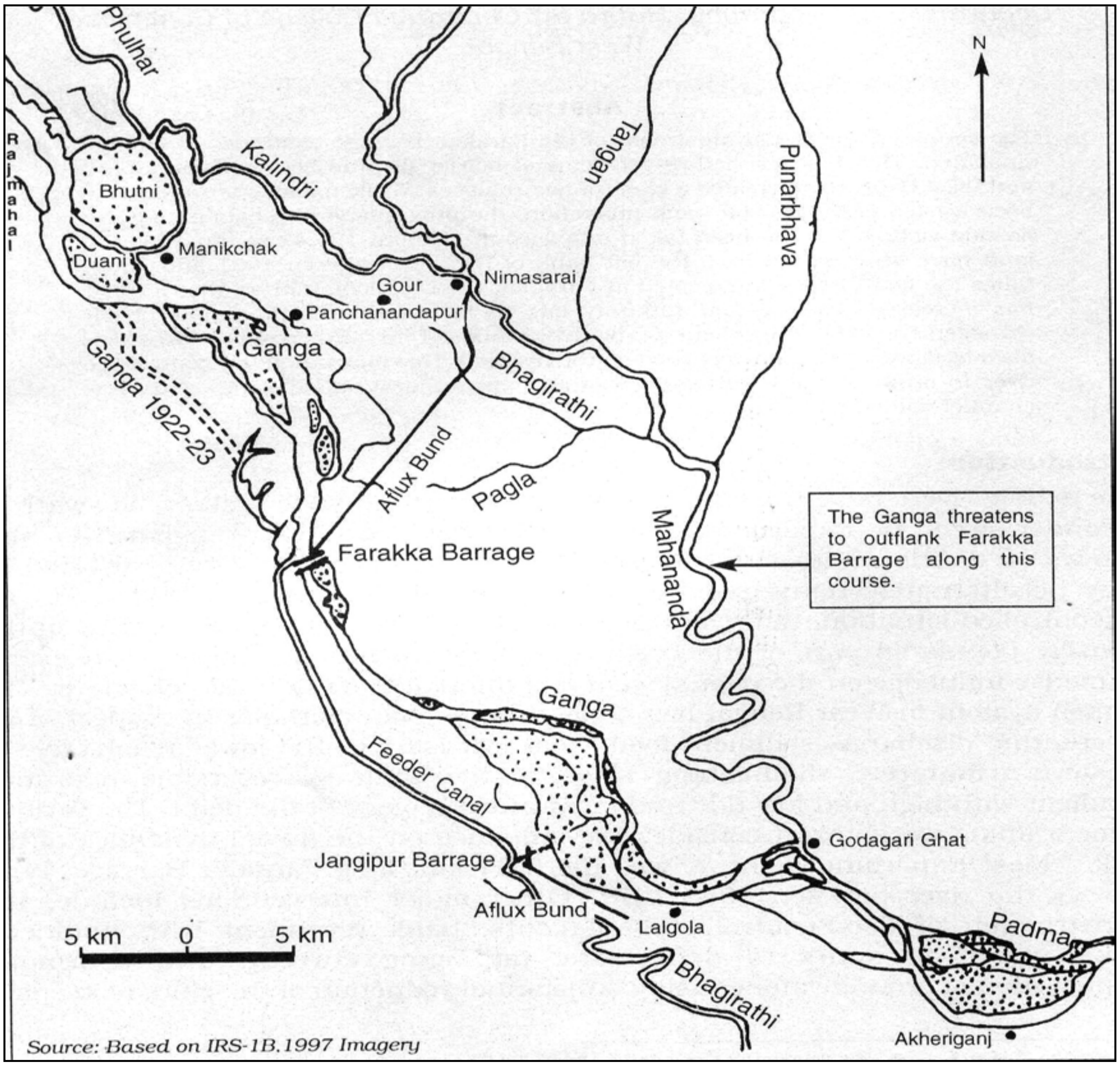


Fig.5:The Drainage Map around Farakka Barrage.

The uninterrupted encroachment of the river towards left bank has posed the problem of interstate boundary between Bihar and West Bengal. During the British rule the course of Ganga was accepted as border between Santhal Pargana of Bihar and Malda district of Bengal. It was noted in the topographical sheet bearing No. 72 P/13 surveyed in 1922-23 and published in 1924 (reprinted in 1946) that, *" the province and district boundaries in the Ganges river follow the main deep water channel and will vary as the course of deep water channel changes",* The area was subsequently surveyed in 1970-71 and the map was published in 1975 with a footnote that, *"Owing to changes in the course of Ganga river, the state boundary between Bihar and West Bengal and the district boundary between Malda and Murshidabad should not be accepted as authoritative."* The matter was also discussed in the Ganga Erosion Committee (Singh et al, 1980). The representative of Bihar in the Committee raised his voice against the proposal of constructing two long spurs near Manikchak Ghat of Malda to deflect the fast flowing current to the opposite bank, as it was likely to aggravate the problem of erosion thereon. The matter was referred to Survey of India and the then Director, Eastern Circle opined, *"The boundary in this portion of the Ganga follows the deep water channel and varies as the course of the deep water channel changes."* The note surprisingly contravenes the earlier note of the Survey of India expressed in the map 72P/13 published in 1975. Since the territorial boundary of West Bengal is fixed according to constitution of India, the Survey of India has no authority to issue such note. One of the representatives of the West Bengal Government declined to accept the opinion of the SoI and intimated the Committee that, *"The boundary between Bihar and West Bengal in this reach is under dispute."* More than two decades have elapsed since the Pritam Singh Committee submitted its report but the problem still remains unsolved. The district map of Malda published in 1994 by SoI described the border as unauthenticated. While the Indo-Bangladesh border has been declared fixed irrespective of any change in the course of Ganga in accordance with the award of the Bagge Tribunal (1948), the interstate boundary should not be oscillatory with the changes in deep water channel.

Cost and benefit of the Bank Protection:

The cost involved in the anti-erosion work is monumental. The total expenditure incurred in anti-erosion works during 1977-78 to 2001-02 is stated to be Rupees 206.83 crores (GoW.B,2003). The revetment of one meter length of the bank with boulder may require Rs.1,00,000. The cost of the construction of a spur may be Rs.13 crores. These types of engineering measures are expensive but do not offer any guarantee against erosion, rather intensity of erosion increases in the upstream of the protected stretch. Since the scour depth is observed generally 20-30 metre below the bank level, any superficial measure cannot be effective to protect the bank. This is the lesson we have learnt during the past decades.

After the commissioning of the Farakka Barrage, Pritam Singh Committee was entrusted with the task of finding a remedial measure to erosion and the committee submitted its report in 1980. Considering the huge expenditure, the committee reported that erosion-control work for the entire vulnerable stretch would not be cost-effective. It can be done where it is absolutely essential to protect any national assets like highways, railways or urban centres. The experts recommended erosion-control measures at eight vulnerable stretches and the cost was estimated to have been Rs. 2.94 billion.

The second committee (1996) also recommended same measures as suggested earlier committee. The total cost sort and long term measures was estimated to be Rs.9.27 billion. The subsequent palliative measures of bank protection were sporadic and largely based on local demand having no relation with the recommendation of expert committee.

Plate-7: Akherigang(2000)- the boulders did not ensure protection against erosion.

The bank protection work is so expensive that it often involves Rs. 100000 to protect one metre stretch but it offers no guarantee against erosion. The Government spent sixty million rupees to protect two kilometers long river bank at Akheriganj in 1991 but the newly constructed embankment was washed away in the very next rainy season. Yet bank protection is a popular demand. In some stretches bank restoration and monitoring are important. In Fazilpur, where the encroaching Padma threatens to unite with the Bhagirathi and may jeopardise the main purpose of the Farakka Barrage Project, the preventive measure is of real necessity. But in many areas bank protection works proved futile.

Unfortunately, those non-effective measures of bank protection are still practised by the State Irrigation Department. This has become an annual ritual, which benefits none other than some contractors. Comptroller & Auditor General of India, in his Report for the year ended in March 1999 noted, *"Implementation of anti-erosion scheme sufferred all through from recurring weakness in planning, execution and monitoring at senior level of the Department and also the Government. Disregard of the recommendation of the Experts' Committee, absence of master plan, delayed tendering, non-testing of soil before execution of work, hasty execution of work, appointment of large number of small contractors and* *work during full monsoon in unfavorable weather condition resulted in frequent and repeated failure of the work leading to wasteful and unfruitful expenditure". (CAG, 1999).*

Imminent Danger:

The changing course of the Ganga has posed a serious threat to the Farakka Barrage. The uninterrupted encroachment of the river towards left bank may outflank the barrage and open a new course through the present Kalindri-Mahananda route. Since the programme of silt management was totally denied, the riverbed continues to be elevated and opening of a new course in no distant period cannot be ruled out. Such a possibility is also admitted by State Irrigation Department. In an unpublished Report, the Department expressed its anxiety saying that, *"The continued swing of the river Ganga on the left bank in the district of Malda upstream of the Farakka Barrage is not only eroding densely populated villages, fertile cultivable lands, roads and communication systems and causing floods almost every year, but also holds a possibility of the Farakka barrage being outflanked once the Ganga if allowed to avulse into one of its abandoned paleao-channel on the left bank."* (Report of the Irrigation Dept for 1997-2001). Such an event would make the Farakka Barrage Project redundant and lead to the desiccation of the Bhagirathi. Both the Singh and Keshkar Committees recommended in favour of dredging of the river upstream of the Farakka Barrage. But the project remains undone apparently because of non-availability of funds. But State Government continues to incur crores of rupees every year on the futile attempt of bank protection.

The millions of erosion victims have so far been denied of the right to rehabilitation. While it is admitted in the official records that, *"the severity of erosion has increased after the conctruction of Farakka barrage"* GoWB(1997), the affected population can rightly be treated as enviornmental refugees and the demand of economic rehabilitaion cannot be called unjustified. If the Ganga is allowed to swing freely as was proposed by the irrigation department in a Report published in 1999, money allotted for the protection work can be utilised for the rehabilitation programme. The piecemeal programme of bank protection caused nothing but wastegae of money; we need a holistic and positive approach to tackle the problem. The important question is whether we should wait further to witness the imminent disaster or do something positive to save the millions of people from the danger at the doorstep.

Erosion in Murshidabad:

The course of the Ganga along the northern river-front of West Bengal has been fast changing due to unabated bank erosion, especially over the last few decades. The rotational bank failures between the

Plate-8: The deserted house leans towards the Padma at Jalangi.

Farakka Barrage and Jalangi, a stretch of about 100 km has become a matter of serious concern. The physical processes, associated with instability along this stretch of the Ganga have already been discussed. However, the overall impact of erosion and the human response to this menace have hardly been taken into account in ant geographical studies. Recently Das and Dasgupta (1992) reported on threat to land resources from erosion by the Bhagirathi and the Ganga. But their work now seems back dated as the Ganga has remarkably changed its course since they submitted report in 1992. The Ganga was chosen as the international boundary in this stretch of land in 1947, at the time of partition of India. Since then, rapid growth of population, large-scale human migration from the then East Pakistan (subsequently also from Bangladesh), and unplanned expansion of habitation as far as the bank of the Ganga, wrong alignment of roads and railways within the meander-belt of the river, and above all the layout of the Farakka Barrage Project have drastically changed the landscape of the area. The recurrent bank failure and encroachment of the Ganga upon the Indian territory has often taken a disastrous magnitude and threatened the possible benefit of Farraka Barrage Project (Banerjee and Chakraborty, 1983) and the possibility of delinking of the North and South Bengal can not be riled out. At present the Ganga has approached very close to the National Highway No. 34 and the railway track. The erosion has created a class of neo-refugees. The erosion has not only uprooted them but has also compelled them to indulge in smuggling activities which has now become an organized business along the Indo-Bangladesh border. Thus agrarian economy has

Plate-9: Dhulian, an important trading centre in Murshidabad may disappear in near future.

been seriously affected by the loss of fertile land. The Government has invested millions of rupees in erosion control works, but many such ventures have proved futile against the impinging fury of the Padma and truly so, the river has been known as *Kirtinasa* or the destroyer of creative works.

Land Reallocation and Population Displacement

It seems to be a matter of paradox that human life in an area, which is geomorphologically marked as depositional, has been threatened by erosion. While about one million people are displaced every year by the flood and erosion in Bangladesh (Elahi and Rogge, 1990); it is no less than 10,000 people who are evicted every year from their homelands by erosion in Murshidabad district alone. The erosion and land reallocation is an age-old problem along the bank of the Ganga. The erosion of vast stretches of land and subsequent emergence of *Chars*[1] have been in progress for last 200 years or so. Major Colebrooke, in his paper 'On the courses of the Ganges through Bangal' (1801), described the devastation caused by the Ganga in the Murshidabad district. He noted: *"The quantity of land, which has been destroyed by the river in course of a few years, will amount, upon most moderate calculation, to 40 square miles, or 25,600 acres: but this is counter-balanced, in a great measure, by alluviation which has taken place on the opposite shore."* In the late 19th century, Hunter (1876) observed that an acre of land was engulfed by the gnawing Padma within half an hour. Captain Sherwill (1858) witnessed the emergence of *Charlands* which became inhabited, cleared and cultivated, the population increased, large village started up, land revenue was collected for ten or twelve years, and then the whole fabric disappeared within one rainy season'.

It has been observed that since the beginning of construction of the Farakka Barrage in 1962 the intensity of erosion has increased. Dhulian and its adjoining areas were severely affected in mid 1970s when about 50,000 people became homeless. The present site of Dhulian is reportedly the fourth site (Bhattacharya, 1978). The encroaching river wiped out 50 mouzas and engulfed about 10,000 hectares of fertile land. A large part of the interfluve, lying between the Bhagirathi and Padma with an area of about 77km^2 between Nayansukh and Giria, disappeared for ever between 1925 and 1974 (Rudra, 1992). Thus the map of this area has been changed beyond recognition, which is ostensible by comparing the older topo-sheet published by Survey of India in 1925 and the recent satellite images.

The erosion is a seasonal phenomenon experienced during the monsoon months (June to September) every year. The erosion has been the cause of major distress of the people living along the river-front of Murshidabad for the last two centuries, and the ravages caused by the mighty Padma at Akheriganj in 1989 and 1990 surpassed all previous records. Akheriganj, which literally means the last settlement, virtually disappeared from the map. The nostalgic people still describe a retreated cluster of settlement as Akheriganj. The disastrous erosion engulfed 2,766 houses and left 23,394 persons homeless. Many erosion-victims migrated to the newly emerged Nirmal *Char* along the opposite bank. The southward encroachment of the river reached the limit of meander belt in 2002 when principal flow started to migrate towards opposite side. The recent satellite image shows that the channel flowing along the northern boundary of Nirmal char is being rejuvenated.

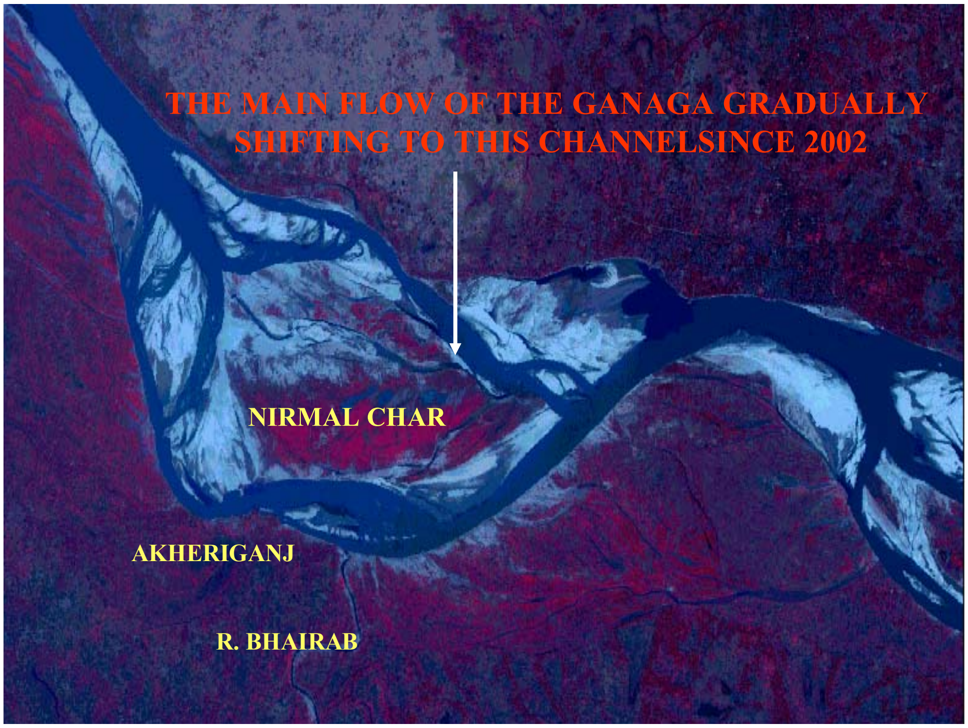


Image-3: The oscillating Padma at Akherigang

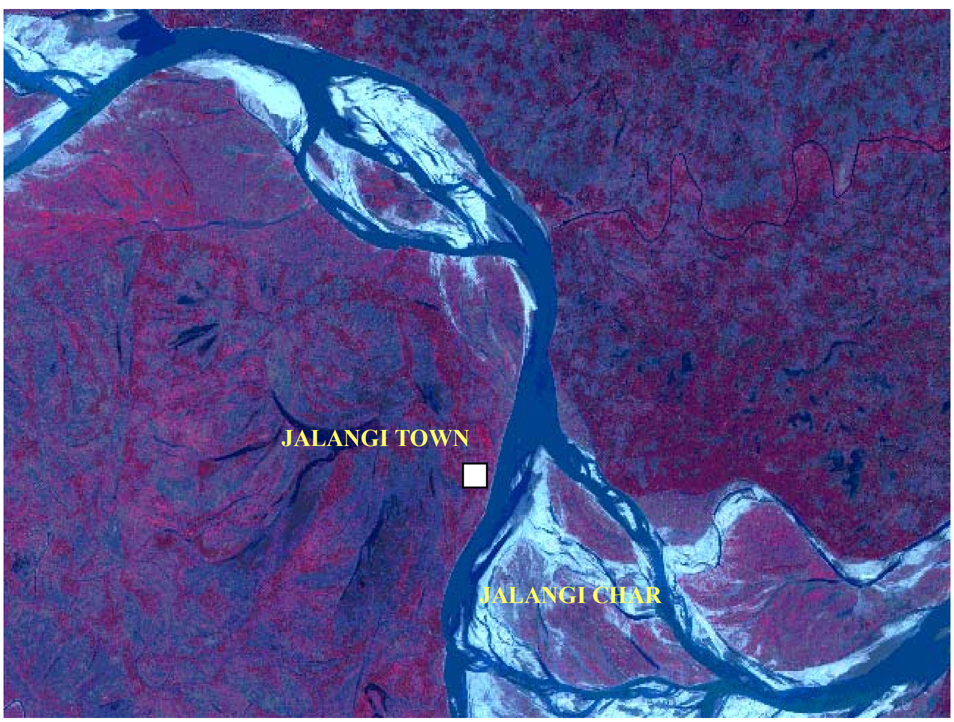


Image-4: The Course of river at Jalangi of Murshidabad.

As the intensity of erosion subsided at Akheriganj, the Padma, attacked human settlements at Jalangi in September 1994 with immense power. In 1990 when this author first visited Jalangi, there was an extensive *Charland* in front of the town and the river was about a kilometre away from the market area. Subsequently, the mighty river changed its course southwards and engulfed high school, police station, panchayet office, market area and as many as 450 houses were submerged (The Statesman, 1994). Even the Behrampur-Karimpur road was delinked and at least 12,000 people became homeless (GoWB Report, 1995). The erosion is nothing new at Jalangi. Rennel (1788) in his 'Memoir of a Map of Hindustan' noted : *"During eleven years of my residence in Bengal, the outlet or head of the Jalangi river was gradually removed three quarters of a mile further down and by two surveys of a part of adjacent bank of the Ganges, taken about the distance of nine years from each other, it appeared that the breadth of an English mile and a half has been taken away."*

The following table (Table 1) presents a comprehensive picture of the land loss and population displacement during 1988-1994 in Murshidabad District.

Table 2 **: Land Loss and Population Displacement During 1988-1994**

Year	**Eroded in Km²**	**Families Affected**	**Population Displaced (Projected).**
1988	4.35	872	4,360
1989	107.00	8,875	44,475
1990	7.50	612	3,060
1991	8.90	763	3,815
1992	34.00	1,197	5,985
1993	19.00	1,099	5,495
1994	25.85	818	12,000
Total	**206.60**	**14,236**	**79,190**

The Changing Course of Ganga-Padma vs. Border Dispute

In recent years possession of some *Charlands* have become an issue of controversy in Indo-Bangladesh relationship (Rudra and Rudra, 1990). When India was liberated in 1947, the course of the Ganga was accepted as the international boundary between Rajshahi District of East Pakistan (Now Bangladesh) and Murshidabad District of West Bengal (India). Subsequently, when the Ganga continued to encroach towards Indian territory and eroded extensive areas, *Charland* of almost equal areal extent emerged along the opposite bank. These *Charlands*, being attached with the mainland of Bangladesh, are difficult to approach from India. The erosion wiped away boundary posts at many places, where the border is now merely an imagination. The matter was raised in the Parliament and the members expressed their serious concern over the issue. The Minister concerned assured the house that the boundary was fixed on the map and the erosion of Ganga would hardly affect it. (The Hindustan Times, 1986)

Whatever be the assurance from the Ministry, the infiltration and illegal occupance on *Charlands* by Bangladeshi nationals have very often been experienced. The *Charlands* of opposite, Jalangi, has been cultivated by the Bangladeshi nationals in spite of strong protest by our Government. In April 1993, a joint survey was conducted to ascertain the boundary on the *Charlands*, but Bangladesh subsequently declined to accept this newly identified boundary. Certainly, Bangladesh has a better access to the *Charlands*, and also it is often difficult for the district authorities of Murshidabad to provide proper security to the new settlers there.

Endangered Communication Lines

The encroaching river very often engulfed important roads and railways, as had happened in mid-1950s when the railway track near Dhulian station collapsed into the advancing river and train services remained delinked for about a decade. It was realigned to the further west and normal services were resumed not before 1965. The alarming rate of encroachment continues near Sankopara halt station where river is now only 165 metres away from the railway track. The National Highway no. 34, the only road to connect North and South Bengal was also realigned in 1966 in view of the threat of erosion. In June 1990, this author observed the collapse of about 20 metres of metal road into the Padma at Akheriganj and in 1994 the road to Karimpur was delinked at Jalangi. The following table presents the diminishing distance between the railway and the Padma at some important stations, as measured from older maps of Survey of India and the map recently prepared by the Public Works Department of West Bengal.

Table 3: **Decrease in distance between the railway track and the Ganga river from 1925 to 1995**

(Measured from multi-dated maps)

Serial No.	Location	1925	1974	1995	Decrease of distance from 1925 to 1995
1.	Nayansukh	5.12 km	2.50 km	1.30 km	75 %
2.	Sankopara	4.00 km	0.50 km	165 m	96%
3.	Dhulian	7.52 km	2.50 km	2.40 km	62%
4.	Nimtita	4.80 km	3.00 km	1.84 km	62%
5.	Suti	4.48 km	2.90 km	1.73 km	61%
6.	Sajanipara	6.72 km	4.00 km	2.88 km	57%
7.	Ahiran	5.60 km	4.80 km	3.34 km	40%

Both the National Highway and the railway track extend through a narrow stretch of land before approaching the Farraka Barrage and the river is not too far away from this stretch. The Padma in between Farakka and Dhulian flows through a narrow channel, and with highly concentrated hydraulic energy, it attacks the right bank with immense force especially during the monsoon months. So the possibility of disconnecting the communication links between the North and South Bengal in near future cannot be ruled out.

Human Life on Charland:

There is hardly any official records regarding the number of people living on the *Charlands* at present. But even at a very modest estimate it is no less than 50,000 and the number is increasing every year. The erosion-victims migrate to *Chars* losing everything into the river. The skill and experience of the displaced population in agriculture help force to start a new struggle for existence. Evidently, the neo-refugees lead their life under the shadow of poverty and insecurity. The erosion and resultant homelessness cause an oversupply of agricultural labour. The labourers are often engaged at a wage lower than the minimum fixed by the Government.

Plate-10: The newly developed settlement at Nirmalchar.

Unfortunately, even after the five decades of independence, there has been no master plan to reduce the distress of the afflicted community living far away from the main crowd of the city of Calcutta. The neo-refugees survive on the *Chars* with their improvised strategies. When the *chars* first emerge above the water level of the Padma, it is sandy, and not habitable. With the passage of time, the finer sediments of silt and clay are deposited and make the land fertile and cultivable. The conflict over the possession of land is a common feature in the social life on *Chars*. Paddy, pulses, vegetables, water- melons etc. are the main agricultural products. The natural pastures help to rear cattle and goats.

The displaced persons rebuild their huts with corrugated tin sheets, bamboos and mud, and thatch the roof with straw. These materials, being light and not very costly, are brought from the mainland. The country boats are the main mode of conveyance, while on land bicycles and bullock-carts are used.

The human life on *chars* lacks facilities of sanitation, education, medical, market, and even drinking water. The residents prefer to go to Bangladesh for treatment or marketing to avoid the trouble of crossing the Padma. Thus they virtually enjoy dual citizenship. The article -21 of the Indian Constitution have ensured right to life for every citizen. The Supreme Court of the country has stated in a landmark judgment that *"The right to life under article 21 means something more than survival or human existence. It would include the right to live with human dignity. It would include all those aspects of life which go to make a man's life meaningful, complete and worth living…any act which offends against or* *impairs human dignity would constitute deprivation pro tanto of right to live".* (Supreme Court,1981). But erosion-victims of Malda and Murshidabad are denied of this right. They are compelled to live in a subhuman condition. The two committees formed earlier; one in 1980 another in 1996, to explore the possible remedial measures of erosion paid no heed to the question of rehabilitation.

Plate-11: Where sky is the roof- Panchanandapur, Malda.

Plate-12: The flood is an annual event on the *Char* of malda.

Human Preparedness to Combat Problems of Erosion

The erosion has taken an alarming magnitude because of low level of technological adjustment and ill-directed planning, especially during post independence period. Commercialisation of agriculture started in this subcontinent with the introduction of permanent settlement scheme in 1793 and the Bengal Tenancy Act of 1885 under the British rule. Since then an exploited and marginalised class, who have had very limited control over the means of production has been created. Since 1947 the demographic transition, resulting from high birth rate, comparatively low mortality rate and large scale human migration from East Pakistan, brought about a changed socio-economic scene in deltaic West Bengal. In the river- front of Murshidabad erosion acted as an added force for marginalisation.

When the roads and railways were aligned through the meander belt of the Padma during the first half of this century, the engineers failed to foresee that the gnawing river would encroach upon that limit. Dhulian, Suti, Akherganj and Jalangi; all developed as important trading centres after the partition of India. No one took into account that the process of delta-building involves oscillation of distributaries within a wide limit. In this age of the application of remote sensing techniques and quantitative geomorphology, identification of the meander belt, which is prone to rotational bank failure and annual flood, has become easy.

While the total river taming is hardly possible, considering a tremendous eroding force of the Padma, the local people have to learn to live upon continuous adjustment with erosion. The response of the Government should be proactive. The low-cost house building, with easily detachable and movable materials, like corrugated sheets, bamboos, wood etc. may be provided on the *chars*. The futile ventures of bank restoration spending a large sum of money every year should also be avoided. The Government pays more attention to protect non-displaced, and the relief generally provided for the displaced persons seem to be meagre.

The minimum facilities for living, like drinking water, sanitation, school, medical centre, market etc. should be provided to the erosion victims on the *Charlands*. Establishment of police outposts or B.S.F. camp may also develop a sense of security among the settlers. As the extensive areas of the *Chars* remain submerged during the rainy season, arrangement for elevated flood shelter is of absolute necessity. The school buildings may be so constructed that it can serve the dual role. As land is the most important life-supporting resource the displaced persons may be granted their rights (*Pattas*) without any delay, so that the conflict over the possession of land may be reduced.

The engineering measures, which involve huge capital investment, can partly or temporarily protect the non-displaced persons. But better preparedness and scientific resettlement strategies may improve the socio-economic status of the thousands of erosion-victims living a threatened life on the *Charlands*.

Acknowledgement: The author is grateful to thousands of erosion-victims in Malda and Murshidabad who shared their experiences and rendered hospitality during field work. Thanks are due to Saurav Sarangi who has taken all the photographs. The author is also grateful to Dr. Abhijit KarGupta, of the Department of Physics, Panskura Banamali College for having discussion on the tidal propagation in the estuary.

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