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IMPACT OF LATERAL CONTROL STRUCTURES
- A CASE IN THE LOWER DAMODAR RIVER

KUMKUM BHATTACHARYYA

***Abstract*:** The Domodar river, a subsystem of the mighty Ganges system used to share its notoriority as a disaster river with other rivers like the Hwang Ho of China and the Kosi of India. The river started losing its identity as a natural river since later half of the eighteenth century with the construction of embankments. The major findings on the selected hydro-geomorphic consequences of lateral control structure are noteworthy. River bed has been raised, soil composition in the adjacent riparian tract has been changed, cross sections have been increased, a number of *Hanas* or spill channels have been opened on the right bank, shifting of banklines and bank erosion are observed on the left bank.

INTRODUCTION

The Damodar river, a subsystem of the Ganges exhibits most of the characteristics of a seasonal tropical river. The river was well-known for flood hazard in its lower reach. In the same section the river shows an extensive embankment system, originally built up in the historical past by the local landlords to protect the riparian tract from flood disaster. From the very beginning these embankments raised several questions on social, economic and political issues. Controversy on the efficacy of the embankments led to the demolition of the right bank embankments in certain section for the safety of the continuous line of left bank embankment which affords a complete security to the town of Burddhaman, the East Indian Railway line and populous districts of Hugli and Barddhaman. The near gradation of the river was disturbed in different phases by artificial base levels created by weir, barrage and reservoirs (Bhattacharyya, 1998).

Culturally defined Lower Damodar with multitudes of control structures now demands reasoned and exemplified answers of the following questions:

- What are the hydro-geomorphological consequences of control structures?

- What is the socio economic relevance of such control measures on the adjacent riparian tract and on the riverbed itself?

When local landlords decided to construct embankments, their decisions were influenced by immediate gain i.e., to protect riparian tract from flood hazards. Side effects of such measures and wider physical consequences were never thought of. The Environmental Impact Assessment (E.I.A.) movement was a far cry when the Tennessee Valley Authority (T.V.A.) was conceptualized in 1933 and when Damodar Valley Corporation (D.V.C.) followed the U.S.A. model in 1948. Series of reservoirs and barrage have come up as a consequence of planning decisions taken by the engineers, planners and politicians to tame the Domodar but no attempt has been taken yet either by the Damodar Valley Corporation (D.V.C.) itself or by any other non-government agency to analyze the physical consequences of such control measures in a systematic manner. It is admitted, that for such impact analysis not only an inter-disciplinary approach is desirable but also team work is a necessary pre-requisite. Therefore, it is impossible for a single researcher to handle such crucial questions. Nevertheless, an attempt has been made to focus on these questions from applied geomorphological view points. This paper discusses the impact of lateral control structures though it is acknowledged that the impacts of embankments cannot be severed from those of reservoirs. However, control measures are treated as causes behind consequent hydro-geomorphic changes in the river-bed and in the adjacent riparian tract.

OBJECTIVES

Objectives of the present paper are to examine :

- the impact of embankments on the river bed.
- the changes in soil composition in the adjacent riparian tract.
- the consequences of the removal of the right bank embankment on river bed and spill channels.
- the impact of the left bank embankment on silt recharge and drainage conditions.
- the changes in regional slope due to removal of embankments.

METHODOLOGICAL ISSUES

In river training programmes, quantified data on hydro-geomorphological parameters of the river are of paramount importance but socio-economic demands of the community are prioritized in planning programmes. Similarly to examine the hydro-geomorphological consequences of control measures a set of quantified data is required which helps researcher to take a much desirable nomothetic method. In case of the river under consideration, the Lower Damodar, quantified data on the embankments are available partly. Mostly qualified archival data have been used. So, the nomothetic method has been selected partly for reviewing the impacts of embankments on selected hydro-geomorphological conditions.

Following King (1966) it may be said that method of analysis is inductive also. It is most probably justifiable if it can be stated that a historical method has been applied partly as the data base is historical also.

During floods like any other river, the Damodar used to cross its normal boundary in pre-embankment days. Part of the valley is still inundated in its unconfined sector and when embankments are breached or over-topped the river is extended. This extension of the river during floods needs to be considered while dealing with spatial scale of inquiry.

For impact analysis of the embankments the total time span is 147 years. i.e., from 1852 to 1999. It is already mentioned above that the data base is partly historical. Qualified data from old maps, government reports and records etc., have been generated. With these passive data, active field data have been used.

Techniques adopted are interpretation of historical data in geomorphological terms and field survey. Old maps as the basic tools have also been consulted.

SEQUENCE OF DISCUSSION

The controlled river bed is considered first. Secondly, fertility status of the adjacent riparian tract is reviewed. The consequences of the removal of the right bank embankment have been focused on. Finally, the discussion is centered on the impact of the left bank embankment.

IMPACTS OF EMBANKMENTS

An embankment is a cultural feature which becomes a viable component of a historically conditioned geomorphic landscape. How an embankment disrupts the physical process is discussed below. In the course of discussion the area outside the embankments has also been ventured on to strengthen some of the arguments.

RISING RIVER-BED

Like any other embankments, the lower Domodar embankments have interfered with the physical process of sediment transfer and deposition. The Damodar bed load is rich in sands as it flows through a quartz rich gneissic terrain in its upstream sector and sandstone rich Gondwana sedimentaries in the lower reach of the upstream sector. 'It is very hard to measure the bed load, or even to estimate it very closely' (Morisawa, 1968 : 46). But from the bed load characteristics it can be inferred that in the pre-embankment days the river became a wide shallow river with braided channels. As the river was extremely floodable, a sizable portions of the bed load used to be deposited in the immediate flood plain during floods. In the post-embankment phase flood discharge of the wide and braided Damodar is unable to spill and deposition takes place on the river bed itself. The most probable consequence, therefore, is the gradual rising of the river bed. Guliemini's (an Italian Engineer) statement cited in the report of Goodwyn (1854) that the river is deepened due to restriction but where the bed is wide and divided into branches, it's bottom will be raised, which can be applied for the Domodar. The river cannot be kept in a state of regime, neither can it be deepened owing to the sandy and unstable nature of it's bed (Bannerjee, 1943). The 1854 map of Dickens' shows Damodar with a large number of sand bars.

CHANGES IN SOIL COMPOSITION IN THE ADJACENT RIPARIAN TRACTS

In the report of the Embankment Committee 1846, there are some remarks on the produce of the land outside and inside of embankments. Landlords had a feeling that land protected by embankments were deprived of the fertilizing effects of the Damodar floods where as in the unprotected tract, in addition to the usual varieties of rice, mulberry, sugarcane, brinjal, Bengal hemp *(Crotolaria-juncca)*, *chorchorn-copsularis* (cultivated for its fibre), *Eeschynomine connbina* etc., could be raised. About 32.2 kms below Barddhaman, rice was the only crop within embankments where as outside the embankment Arun, *crotolaria Juncca* cotton could be cultivated (Sage et al., 1846). Embankments provide full protection upto a certain stage and they may be breached or over topped or collapse due to piping action near the toe of embankment (Ward, 1978). In the historical past long before the construction of reservoirs the

Lower Damodar breached its embankments in 1770, 1787, 1789, 1823, 1835, 1840, 1845. Atleast 25 breaches occurred in 1847, 14 in 1849, 56 in 1850, 45 in 1852 and 28 in 1854 (O'Mally and Chakravarty, 1912). Though these breaches are used to be interpreted as natural consequences of unusual floods but it was not unlikely that these were secret breaches made by the villagers for irrigation purposes. The common people used to believe that had there been no embankments, river water would have had free ingress in the rice land and the adjacent riparian tract would have benefited from deposits of the Damodar silt (Sage et al., 1846).

From the above discussion one has to conclude that soil composition in the tract protected by embankments changed due to entrainment of sediments in the river bed and lack of annual replenishment in the adjacent tract. Additional deposits of sediments on the river bed ultimately become socio-economically significant (Bhattacharyya, 1998).

CONSEQUENCES OF THE REMOVAL OF THE RIGHT BANK EMBANKMENTS

Before the flood season of 1959, a full extent of 32.19 Km of the right bank embankments and in 1889 another stretch of 16.1 Km of the right bank embankments were removed for controlling the Damodar floods and for the safety of the continuous line of the left bank embankment. Now situations in the pre-removal and post-removal of embankments will be compared.

CHANGES IN FERTILITY STATUS ON THE RIGHT BANK

Prior to the removal of the right bank embankment it was reported that 762 villages with a total of 619.13 sq. km. would be liable to floods if the embankments were removed. Of these 64.95 sq. km. were unculturable lands. But approximately 35.30 sq. km. uncultivated land would be benefitted by floodborne sediments and 222.71 sq.km. of cultivable lands would be injured, so, as a whole only 40 per cent would be rendered more or less unfit for cultivation (Young, 1861).

Removal of these right bank embankments initially created problems to adjacent villages. Loss due to periodic inundation of an appreciable amount of paddy lands, was assessed as Rs. 5 million. This was calculated on the basis of price behaviour prevailing in 1951 (D.V.C. 1995). But the only consolation for such periodic floods was the deposition of silt which enriched agricultural lands, facilitating production of splendid crops of rabi (winter crops, harvested in spring) and thus compensated for the loss of summer paddy crops (Sengupta, 1951). So, ultimately cultivators were benefitted by the removal of the right bank embankments.

CHANGING CROSS PROFILE

The right bank embankments were demolished in 1859. The Damodar Valley Corporation (D.V.C.) report of 1957 Vol. II, states that the arrangement gave relief for the certain number of years. By throwing away the embankments on the right side the cross sections of the flow must have been enormously increased and there was corresponding lowering of the level of high flow. But at the same time the velocity of the flow was considerably reduced and thereby increasing the rate of silt deposit in the bed and resulting in the raising of its level more rapidly than before. On this issue there were some controversies also (D.V.C., 1957, Vol. II).

AN INCREASE IN CROSS SECTION

The cross section of the channel at different points increased enormously between 1888–1943 (Fig. 2) and there was corresponding lowering of the level of high flow. In some places the cross sections are characterized by pronounced flood plains between embankments or between embankments and river levees. When these get inundated, velocity on the flood plains is lower than those in the thalweg itself. This causes the effective cross sectional area in the river to become smaller than the actual geometrical cross section (Report, 1983). The width of the river has been increased considerably, some narrow and a few ramain constant (Table No. 1).

TABLE NO. 1 : **WIDTH OF THE DAMODAR RIVER AT DIFFERENT PLACES BETWEEN 1888-1943 (IN MTRS.)**

Stations	1888	1913	1918	1943
Raghabpore	1097.28	2072.64	2072.64	1928.336
Jujuty	987.552	1298.448	1310.64	1524
Edilpur	1248.68	1245.41	1245.41	1127.76
Becherhat	1126.82	1164.92	1280.16	1173.48
Manikhati	853.44	853.44	835.15	1066.8
Salalpur	987.552	966.22	987.552	920.50

TABLE NO. 1 (CONTD.)

Stations	1888	1913	1918	1943
Palla	897.62	882.396	897.65	893.07
Serangpur	615.69	621.79	621.79	502.92
Jamalpur	396.24	345.34	345.34	403.56
Dhapdhara	386.24	384.05	396.24	365.76

Source : Sen., S. K. 1962, Bhattacharyya, K. 1998.

OPENING UP OF *HANAS* OR SPILL CHANNELS ON THE RIGHT BANK

A chain of *Hanas* or 'Spill Channels' opened up by breaching natural levees on the right bank. These breaches or spill channels are locally known as *Hanas*. A chain of spill channels serves as a spill ways for flood waters of the Lower Damodar to overflow into the low land through which runs the Deb khal and its ramifications. Entire lowlying area becomes a sheet of yellow water moving eastward and then south ward during rainy season. Thus the flood water unable to pass through the restricted channel of the main river find its way into the Deb khal (Bose, 1948, Fig - 3). In 1956 maximum discharge at Rhondia (at 24 hours) on the 26th September was 8694 cumec, maximum discharge at Jamalpur on the 27th September was 3002 cumec, maximum discharge at the *Muchi hana* or *khal* on that day was 7307 cumec and at Champadanga was 708 cumec on that very day. So, it appears that a discharge of about 5692 cumec passed over the right bank in the reach between Silna and Jamalpur (D.V.C., 1978). Due to such spilling over the right bank, the left bank embankments were not breached during major floods of 1959 and 1978 (Bhattacharyya, 1998).

This spilling over the right bank has decreased now as the river has formed a natural levee on the right side and most of the spill channels on the right bank are either closed or take lesser amount of water and leave sediments to be deposited within the channel itself. As a consequence, the river bed and the flood level have risen considerably. Previously the Damodar used to open up flood channels towards north east or south east. As the left bank is protected by embankment, spill channels in the historical past have opened up on the right side.

ORIGIN OF THE BEGUA AND THE MUCHI HANA AND DETERIORATION OF THE AMTA CHANNEL

A natural flood channel known as Begua hana was probably opened up in 1865. The river below Haragobindapur had already formed an acute bend, which was affecting the left bank embankments. By 1856 a well defined spill channel had formed on the right bank of the Damodar to relieve the pressure on the left bank embankments. In an old map as has been mentioned in the D.V.C. report of 1957 it appears that in 1857 a dyke was put up across the Damodar below this spill channel which had probably helped in the development of the *Begua hana*. Later on a cut-off known as the *Muchi hana* or *khal* was effected by joining the neck of the loop formed by the Begua hana at Muidipur under the Jamalpur police station. Locals believe that this artificial measure was taken to protect the settlements and the railway line on the left bank. Floods below the Muchi spill channel are now attributed to this artificially cut spill channel (Bhattacharyya, 1998. Fig. - 3).

Around 1865, a great Begua breach occurred and scoured out a channel parallel to the main Damodar known as the Kanki that eventually joins the Mundeswari river (D.V.C., 1957, Fig. 4). The combined stream falls into the Rupnarayan river. At this bifurcation point, formation of a high sand bank completely shuts off the flow of water into the Damodar known as the Amta channel below this bifurcation point. And newly scoured bed of the Muchi hana is lower than the sand filled bed of the main Damodar (Bose, 1948, D.V.C., 1957), which is now used as cultivated fields in non-monsoon period (Bhattacharyya, 1998).

The Amta channel i.e., lower most part of the Lower Damodar gets water through the Begua hana and this channel, due to reduced discharge has shrunk perceptively in size and volume as the downstream discharge in the lower reaches below bifurcation point into the Kanki-Mundeswari and the Amta channel share eighty per cent and twenty per sent respectively (D.V.C, 1995). Unfortunately the amount of discharge has not been mentioned. The Mundeswari channel hydrologically formed a much shorter route than the Amta channel route via Uluberia. Under these circumstances the old Damodar i.e., the Amta channel gradually deteriorated not only because of its longer hydraulic length but also because of its absence of spill area as this channel at present is embanked in both side excepting in few places on the right side and also due to gradual encroachment on the river bed (D.V.C, 1995). Bankful capacity of the Mundeswari is hardly 2265 cumec and the Amta channel can carry a little more than 566.4 cumec. From the IRS geo-coded imagery of 1999 (Fig. 3) it is evident that a small sandbar has been formed in the Mundeswari river, so during low water period, the Amta channel is getting more water than that flowing through the Mundeswari river. At present down stream discharge between the Mundeswari and Amta channel shares seventy percent and thirty percent respectively.

IMPACT OF THE LEFT BANK EMBANKMENTS

To save the town of Barddhaman, the G.T. Road, and the railway line from flood havocs the left bank embankment was not only strengthened but disjointed portions were jointed and in places a second line of embankments was constructed. The consequences often became hazardous. Secondly, changes have been observed in the regional slope also.

DRAINAGE CONGESTION

The district of Braddhaman is bounded by the Ajay to the north and the Damodar to the south. The watershed is ill-defined particularly in the east. The Khari and Banka drain this area. Previously much of the Damodar flood water used to pass through these two rivers, but roads, railways and embankments have severed these rivers from the mother stream. As a natural consequence both the rivers have deteriorated and have become flood-prone. Secondly, the water that used to flow into the Damodar now creates water-logging conditions in this low inter-stream area. This drainage congestion has been reported by Haig (1873) and by Biswas and Bardhan (1975). Water logged condition is conducive for breeding of mosquitoes and the region for decades has suffered most from Barddhaman fever, a kind of malaria. Water logged conditions affected agriculture and the region had to face fever, famine and depopulation in between 1850 and 1925 (Biswas and Bardhan, 1975). Though drainage conditions have improved in recent years but a few pockets still suffer from drainage congestion and its consequences. The area discussed above falls outside the study area but occasional trespassing becomes necessary to fortify some of the arguments against the unplanned chaining of the river.

REVERSAL OF SLOPE

Previously the regional slope was from Barddhaman side towards Bankura i.e., from north to south. Southern bank is not protected. Therefore, there is continuous siltation in flood plain of the south bank or right bank. As a consequence, right bank flood plain has become higher and it forces the thalweg to move northward creating pressure on the left bank embankment in some places. This reverse slope (Fig. - 5) is a noticeable consequence of the removal of embankments on the right and presence of embankment on the left. In 1995 floods, some of the abandoned flood channels on the left have been re-activated and the left bank embankment has breached in several places. The left bank is thus becoming vulnerable. Figures 6 and 7, show how bank line has shifted between Shrirampur and Kanthalgachi mouza near Palla village (Bhattacharyya, 1998).

SUMMARY

Flood prone Lower Damodar was chained with a series of embankments to protect adjacent riparian tract from flood hazards. To meet public demands part of the right bank embankment was demolished. Following are the consequences in a nut shell :

Gradual rise of the river bed.

Changes in soil characteristics in the adjacent riparian tract due to non-renewal of flood-borne silt.

Soil characteristics changed on the right bank due to removal of the right bank embankment.

Widening of the river between embankments.

Opening of spill channels on the unprotected right bank.

Opening of the Begua and the Muchi spill channels on the right.

Drainage diversion through the Kanki-Mundeswari.

Deterioration of the Amta channel.

Drainage congestion to the north of the left bank embankment.

Incidence of Barddhaman fever increased due to drainage congestion.

Shifting of thalweg towards Barddhaman side due to reversal of slope.

Shifting of bank lines on the left bank.

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REFERENCES

Bhattacharyya, K., 1998. *Applied Geomorphological Study in a Controlled Tropical River-the case of the Damodar between Panchet Reservoir and Falta,* Ph.D. dissertation submitted to the university of Burdwan, India., (unpublished).

Bannerjee, K. C., 1943. Regulation of river floods : the problem of Damodar rivers. *Geographical Review of India.,* 5(3). 107-110.

Bose, S. C., 1948. *The Damodar Valley Project.* Phoenix Press Ltd. Calcutta.

Biswas, A and Bardhan, S., 1975. Agrarian crisis in Damodar - Bhagirathi region 1850-1925. *Geographical Review of India.,* 37 (2), 132-150.

Central Water Commission Interim Report., 1983. *Mathematical Modeling for Flood Forecasting and Flood Control.,* Danish Hydraulic Institute, Danida., 5–19.

Dickens'. C. H., 1853. *Memorandum on the Survey of the Domodar and Question of the Abandonment of Bunds on the Right Bank to Accompany the Map Received with Superintending Engineer South Eastern Province's Letter No. 1473 13 July, Bengal Govt. Selection no. 15. 1854.* Bengal Military Orphan Press, Cal., pp. 68-125.

D.V.C : Damodar Valley Corporation, 1957. *Report of the Lower Domodar Investigation Committee,* D.V.C, Cal., 2, pp. 82.

D.V.C : Damodar Valley Corporation, 1978. *D.V.C. and its Flood Control Capacity, Past, Present and Future.* D.V.C, Cal., pp. 28.

D.V.C : Damodar Valley Corporation, 1995. *Data Book,* D. V. C, Cal., pp. 62.

Goodwyn, H., 1853. *Inspection Report on the River Damodar No 4005, Govt. Selection No. 15. 1954.* Bengal Orphan Press. Cal., 10-50.

Haig, Colonel, 1873, *Report on the Damodar of Hooghly District,* Cited In A, Biswas, and S. Bardhan 1975 : pp. 137-138.

King, C.A.M., 1966. *Techniques in Geomorphology,* Edward Arnold. London.

Morisawa, M., 1968. *Streams : Their Dynamic and Morphology.* Mc Graw-Hill Book Co. New York., 46.

O' Malley, L S. S. and Chakravarti, M., 1912. *Bengal District Gazetteers* (Hooghly). Bengal Secretariat Book Depot. Calcutta., pp. 159-166.

Sage, Wm., Simms, F.W. and M' Clellant, J., 1846. *Report on the Embankments of the Rivers of Bengal.* Military Orphan Press, Cal., 13.

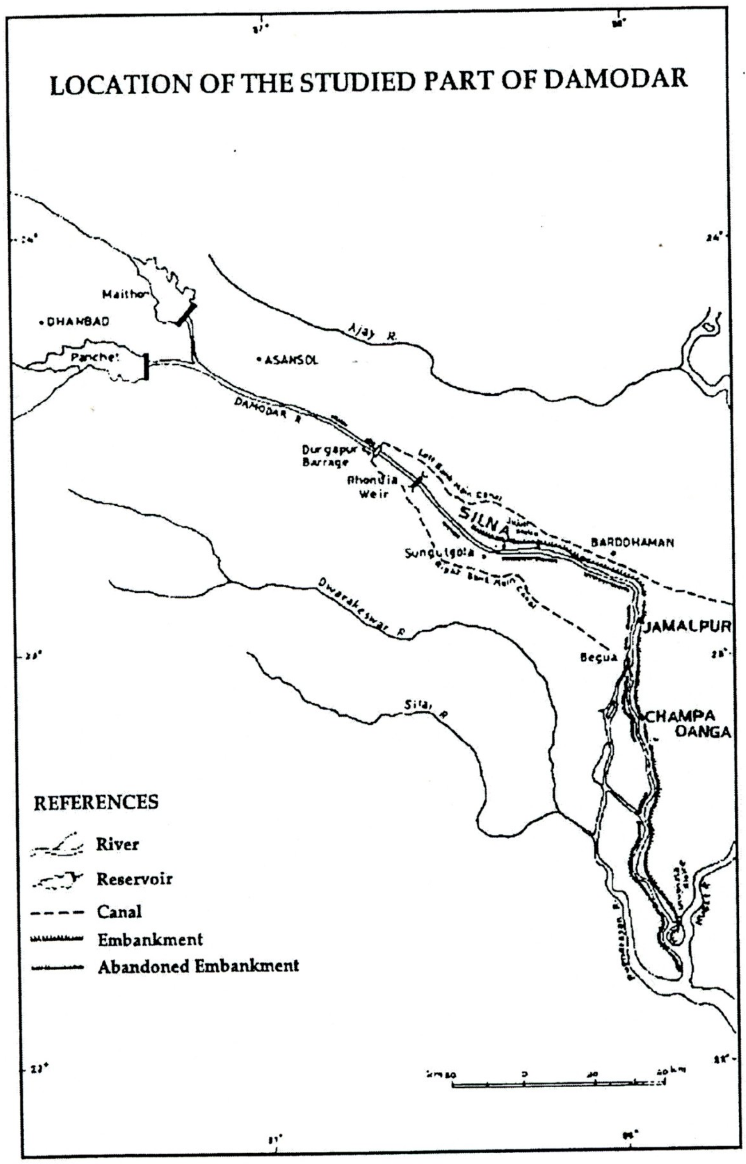
Sen. S. K., 1962. *Drainage Study of Lower Damodar Valley.* D. V. C. Publication Calcutta., pp. 65.

Sengupta, D.N., 1951. *An Outline of the River Problems of West Bengal.* Calcutta General Printers and Publishers Ltd. Cal., pp. 31-63.

Ward, R.M., 1978. *Floods : A Geographical Perspective.* Macmilan : London., 1-12, 145-156.

Young, C.B., 1861. *Memorandum Regarding the Removal of the Damodar Embankment. No. 899 dated the 8th June. 1861. Bengal Govt. Selection No. 40 1863.* Baptist Mission Press, Cal., 1-20.

Author's Address : Dr. Kumkum Bhattacharyya, Research Scholar, Dept. of Geography, The University of Burdwan, Barddhaman, 713104, West Bengal, India.



LOCATION OF THE STUDIED PART OF DAMODAR
Maithon
DHANBAD
Panchet
ASANSOL
Ajay R.
DAMODAR R.
Durgapur Barrage
Rhondia Weir
SILNA
BARDDHAMAN
Sungutgola
JAMALPUR
Begua
Dwarakeswar R.
Silai R.
CHAMPA DANGA
REFERENCES
River
Reservoir
Canal
Embankment
Abandoned Embankment

Fig. 1

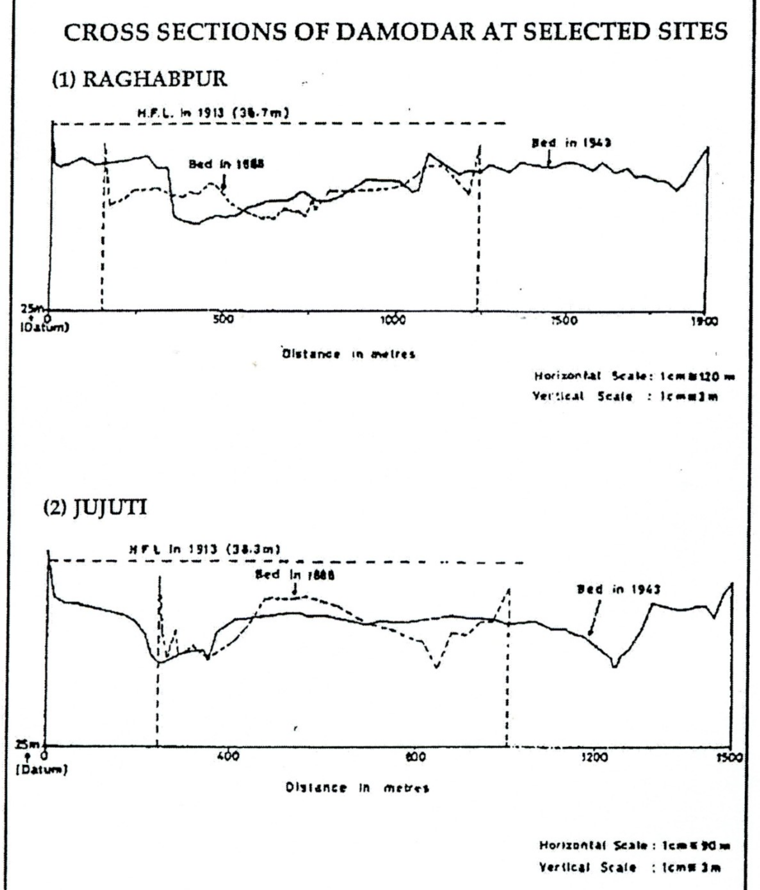


Fig. 2

Source: I & WD, W.B.

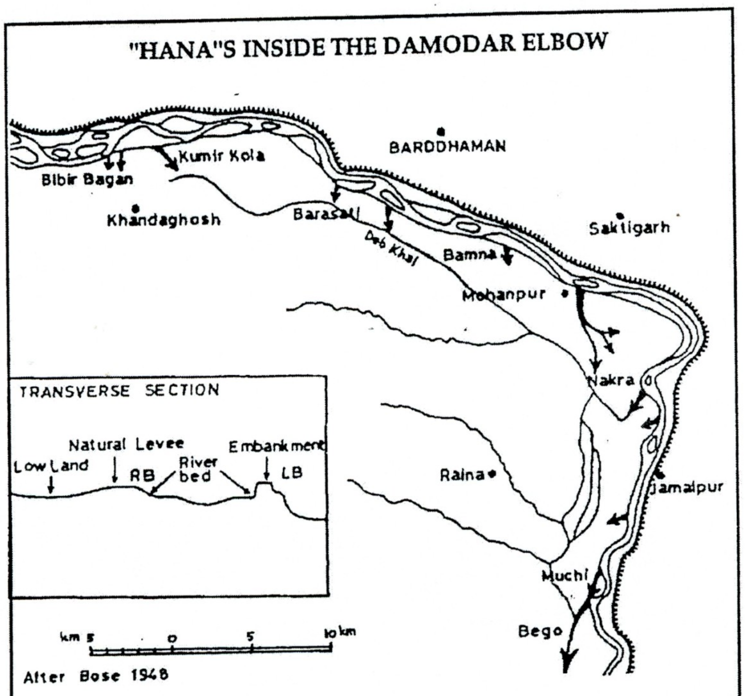

"HANA"S INSIDE THE DAMODAR ELBOW
BARDDHAMAN
Kumir Kola
Bibir Bagan
Khandaghosh
Barasat
Deb Khal
Saktigarh
Bamna
Mohanpur
Nakra
Jamalpur
Raina
Muchi
Bego
TRANSVERSE SECTION
Natural Levee
Embankment
Low Land
RB
River bed
LB
km 5
0
5
10 km
After Bose 1948

Fig. 3

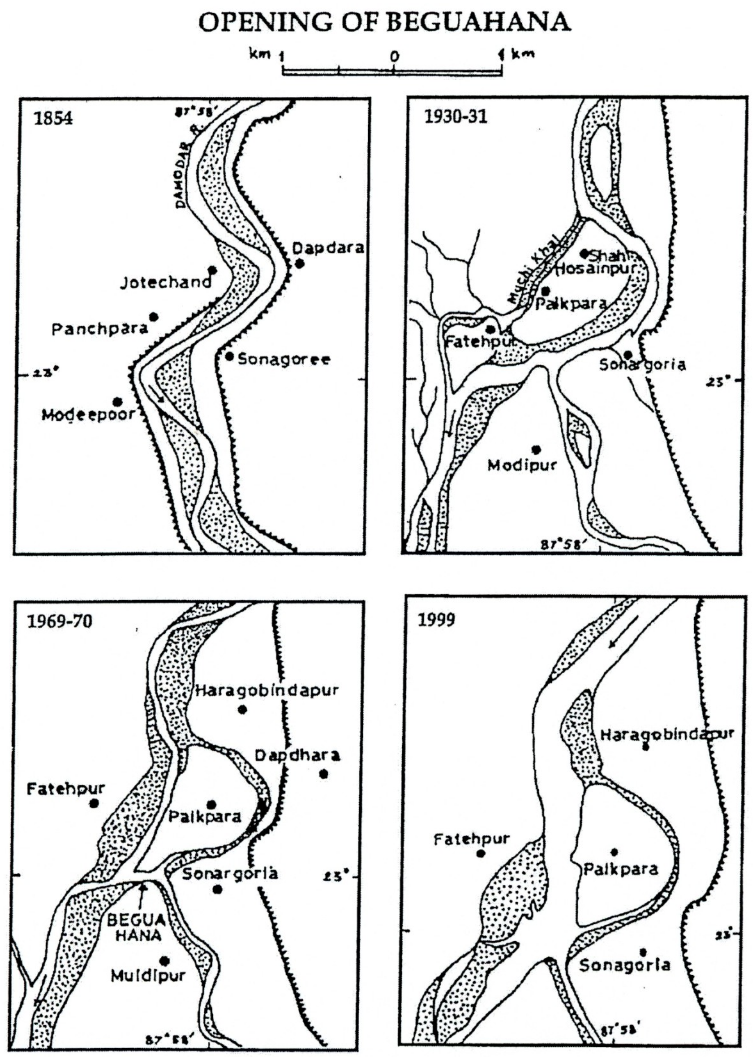

OPENING OF BEGUAHANA
km 1 0 1 km
1854
87°58'
DAMODAR R.
Dapdara
Jotechand
Panchpara
Sonagoree
23°
Modeepoor
1930-31
Muchi Khal
Shah
Hosainpur
Palkpara
Fatehpur
Sonargoria
23°
Modipur
87°58'
1969-70
Haragobindapur
Dapdhara
Fatehpur
Palkpara
Sonargoria
23°
BEGUA
HANA
Muldipur
87°58'
1999
Haragobindapur
Fatehpur
Palkpara
23°
Sonagoria
87°58'

Fig. 4

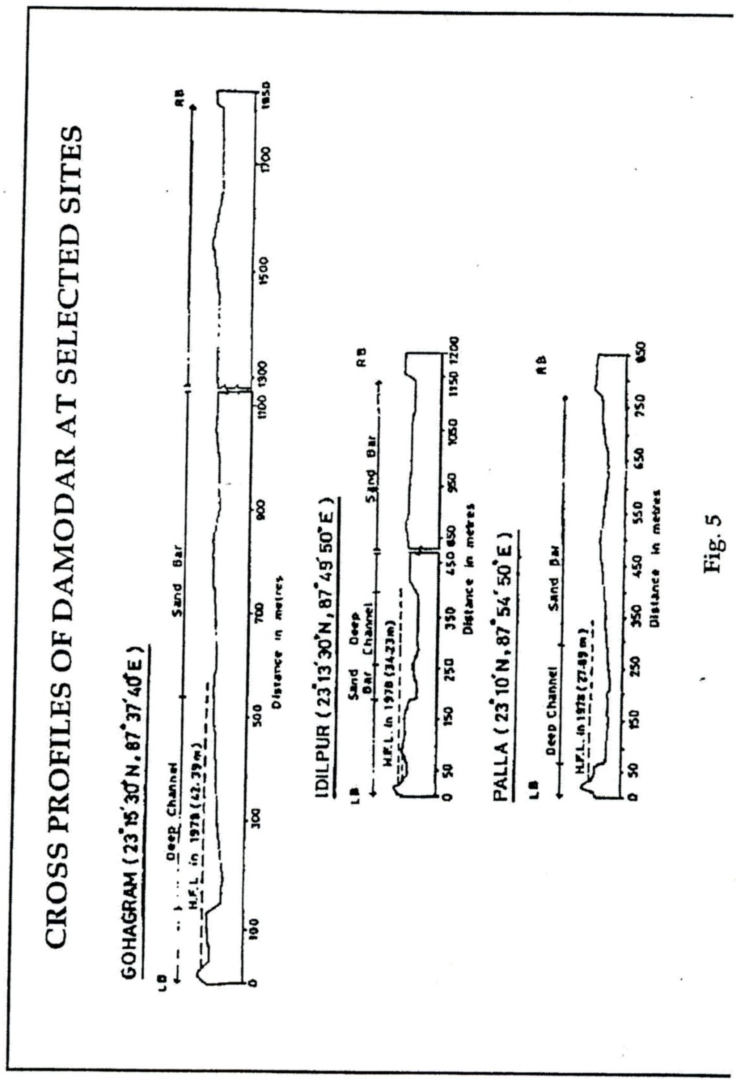

CROSS PROFILES OF DAMODAR AT SELECTED SITES
GOHAGRAM (23°15'30"N, 87°37'40"E)
LB
RB
Deep Channel
H.F.L. in 1978 (42.39m)
Sand Bar
Distance in metres
IDILPUR (23°13'30"N, 87°49'50"E)
Sand Bar
Deep Channel
H.F.L. in 1978 (34.23m)
Sand Bar
Distance in metres
PALLA (23°10'N, 87°54'50"E)
Deep Channel
H.F.L. in 1978 (27.49m)
Sand Bar
Distance in metres

Fig. 5

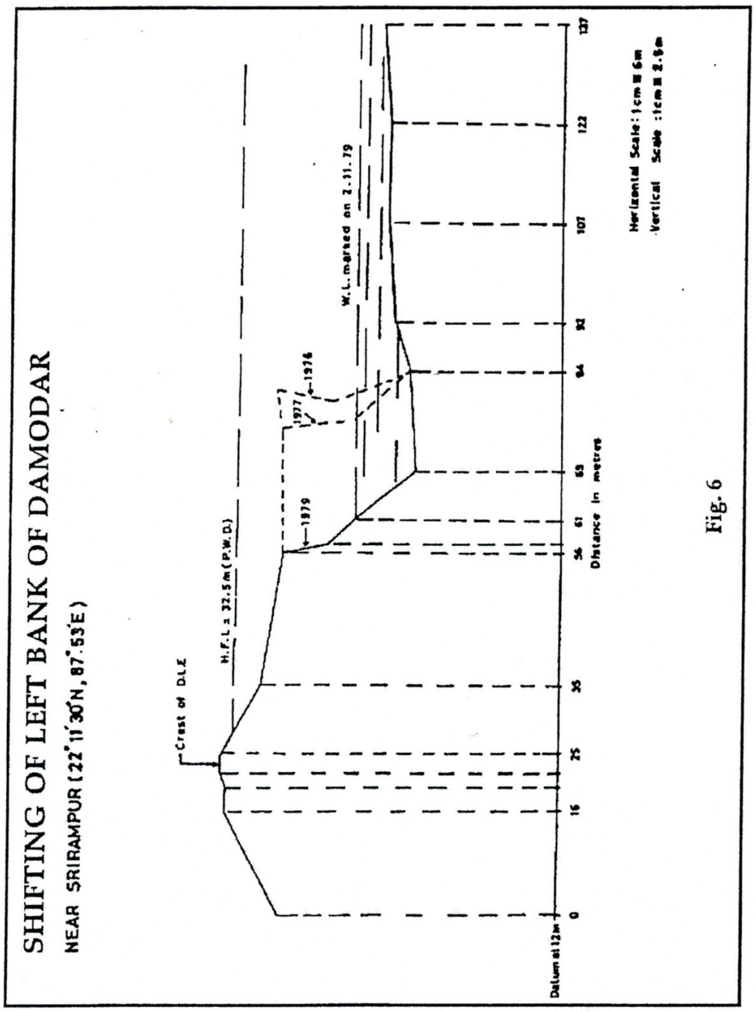

SHIFTING OF LEFT BANK OF DAMODAR
NEAR SRIRAMPUR (22°11'30"N, 87°53'E)
Crest of D.L.E
H.F.L = 32.5m (P.W.D.)
1979
1977
1976
W.L. marked on 2.11.79
Datum at 12m
0
16
25
35
56
61
63
84
92
107
122
127
Distance in metres
Horizontal Scale: 1cm = 6m
Vertical Scale: 1cm = 2.5m

Fig. 6

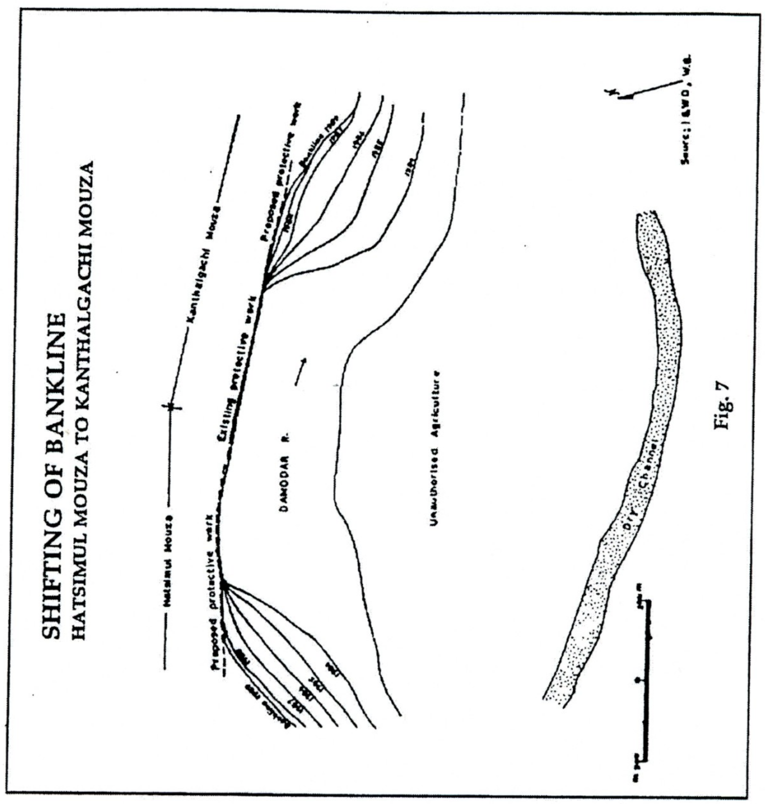

SHIFTING OF BANKLINE
HATSIMUL MOUZA TO KANTHALGACHI MOUZA
Hatsimul Mouza
Kanthalgachi Mouza
Existing protective work
Proposed protective work
DAMODAR R.
Unauthorised Agriculture
Dry Channel
Source: I&WD, W.B.

Fig. 7