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EMBANKMENT BREACH AND SANDSPLAY : A STUDY ON LOWER AJOY RIVER BASIN

Dr. Hasibur Rahaman Molla
Assistant Professor in Geography, Sivanath Sastri College, Kolkata.

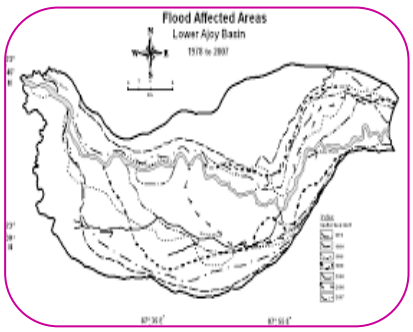
ABSTRACT:

River embankment is a quite prevalent flood protective measure being practiced since long time past. It is a simple and cost effective measure but the effectiveness and performance of the embankments vary from case to case. River Ajoy is an important right bank tributary of the river Bhagirathi. During peak discharge period, particularly in the month of September, embankment of Ajoy river breaches at a number of places which result widespread sandsplays on the agricultural land. The magnitude of flood caused by breach of embankment is far greater than a normal flood and as a post flood hazard and the sandsplays bring a long lasting socio-economic consequences in the concerned area. This paper deals with the breach of embankment and the impact of sandsplays on the micro-topographical feature of Lower Ajoy River Basin.

KEYWORDS: *embankment, tributary, flood, breach, sandsplay, micro-topographical features.*

1. INTRODUCTION:

Embankments are usually constructed along rivers of comparatively gentle gradient and are an age old and easy technique of flood protection in almost every country in the world (Ward, 1978). An embankment, as we know, is a natural or artificial levee or dike. An artificial embankment is usually earthen and parallels the river with an aim to cheek the excess flood water. In reality the main purpose of an artificial levee is to prevent entry of flood water. In its adjoining land. Lower Ajoy Basin is an important flood prone area in West Bengal. River Ajoy is one of the torrential rivers of Bengal that used to inundate the adjoining areas almost every year. A chain of embankments have therefore, been constructed along both sides of the Ajoy to control the flood. In the British period and even prior to that, embankment was looked upon as a safety measure to cheek the soil erosion of the bank area. At places, on the other hand, the rivers that flow through a flat alluvial tract, its excess water was also allowed to spill over its bordering land resulting in the widespread deposition of fertile silt. Farmers used to prefer to live with this natural oscillation of the river water that enriches their quality of land and quantity of production. But the construction of embankments restrict the free flow of river water and thereby the drainage characteristics and the morphology of the river undergo a great changes.



2. THE STUDY AREA:

The study area i.e. Lower Ajoy River Basin extends from 23˚25' N. to 23˚45' N. latitude and from 87˚ 16' E. to 88˚ 15' E. longitudes. The long profile of Ajoy shows a rapid change in channel gradient at the point of Pandabeswar. Average gradient above Pandabeswar is quite steep (1 in 713) that suddenly decreases (1 in 2273) downstream from Pandabeswar to Katwa. At Pandabeswar there is a fault line from which the geological formation has been changed and slope in the long profile of the river has also been decreased significantly. Therefore, the lower course of the river has been

determined below from 80 metres contour near Pandabeswar (23˚44' N, 87˚ 17' E) where abrupt change in the slope of the long profile is found due to differential geological formation (Mukherjee, 2002). Therefore, the Lower Ajoy Basin has been demarcated from Pandabeswar to Katwa. It covers an area of about 2816.65 sq.km. In Lower Ajoy River Basin there are 12 C.D. blocks which comprise 619 moujas. Out of 12 C.D. blocks 5 fall in Birbhum district and rest 7 blocks are in Burdwan district.

Table-1:
Administrative Boundaries Forming Lower Ajoy River Basin

Name of the C.D. blocks	Name of the district	No. of moujas		Total
		Entire	Partial	
Dubrajpur	Birbhum	16	7	23
Illambazar	Birbhum	52	4	56
Bolpur-Santiniketan	Birbhum	59	4	63
Nanur	Birbhum	64	5	69
Khoyrasole	Birbhum	20	3	23
Ausgram	Burdwan	94	9	103
Ketugram	Burdwan	73	8	81
Kanksa	Burdwan	51	6	57
Katwa	Burdwan	24	4	28
Bhatar	Burdwan	10	3	13
Mongalkot	Burdwan	74	9	83
Faridpur	Burdwan	16	4	20

Source: District Census Handbook – 2001, Burdwan & Birbhum.

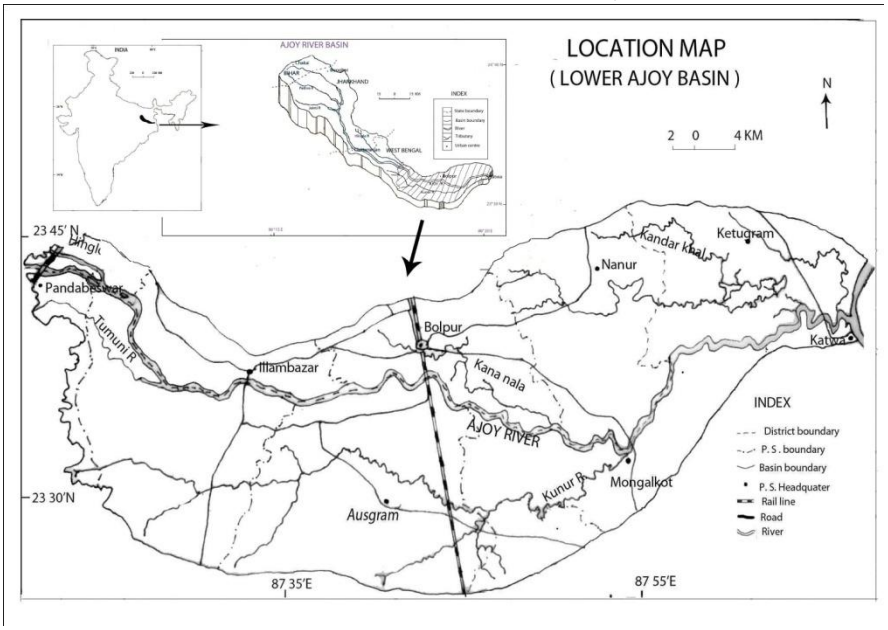


Figure: 1

3. OBJECTIVES:

- To find out the causes of embankment breach in the Lower Ajoy basin.
- To find out the spatial coverage of sand deposition in the basin.
- To evaluate the necessity of embankment as flood control measure.

4. METHODOLOGY:

- Survey of India's toposheets bearing the number of $73^{M}/_{6}$, $73^{M}/_{10}$, $73^{M}/_{11}$, $73^{M}/_{14}$, $79^{A}/_{2}$ have been consulted in the pre -field work stage.
- Data have been collected from the Zilla Parishad Office of Birbhum and Burdwan district.
- In the field work stage depth of sand deposition has been measured and questionnaire surveys have been conducted.
- In the post field work stage compilation of the data have been made and maps, charts, etc. have been prepared.

5. BREACH OF EMBANKMENT

There are various ways in which the term 'breach' can be used, but it typically refers to the failure of a flood defense structure, such as a flood embankment or the failure of a dam. Breach of a flood embankment occurs when water flows over or through the embankment at such a rate that the embankment is eroded and a hole created through it that permits flood water to pass through. In Lower Ajoy River Basin, breaching of embankment is very common in every major flood year. It causes a widespread and devastating flood in the basin and results sandsplays over the agricultural land.

There are several causes of breaching of embankments in Lower Ajoy Basin.

5.1. Siltation on river bed :

It is previously described that slope gradient of Ajoy river shows a rapid change at the point of Pandabeswar. Above Pandabeswar, the average slope of the river is about 1 in 713 but downstream of Pandabeswar, the average slope is about 1 in 2273. Therefore, due to steep slope differences, the Lower Ajoy Basin is characterized by high rate of silt deposition. Consequently the river bed rises and if once the embankment breach takes place during high flood period, the huge volume of silt, sand, etc. flow through the flood water and get deposited into the adjacent flood plain.

5.2. Meandering nature of the river :

The Lower course of Ajoy is characterized by meandering channel pattern. Meanders restrict the smooth flow of river water. During high discharge period, the river has a tendency to make erosion on its convex bend. Therefore, the embankment attached with the convex bend of the meander is subject to get erosion by direct flow of water. Gradually the earthen materials of the embankment is removed by the river flow and embankment breach takes place. Meanders of Ajoy river at the places of Kogram, Ghidaha, Narenga, etc are notorious for embankment breach due to heavy thrust of flowing water during peak discharge period.

5.3. Alignment of embankment :

Alignment of the embankment in Lower Ajoy river is also responsible for embankment breach and sandsplay. The alignment of the embankment at the turning point of the river should be characterized by long curvature. But at the turning places, instead of making curve like alignment, the embankment is aligned at 90^{0} angle. Therefore, during the peak discharge period, the river water put a tremendous pressure directly on the wall of the embankment and consequently breach takes place resulting massive sandsplays on the countryside areas. In the places of Nawapara, Hussainpur, Ghidaha, the alignment of embankment is more responsible for embankment breach.

5.4. Poor maintenance of embankment :

Inadequate maintenance of embankment is an important cause of embankment breach. Rill and gully erosion on the embankment make it more vulnerable to flood. During high rainfall period, gully erosion having different magnitudes are developed on the embankment. Side by side peak also flows through the

river. 'Seepage' process gradually becomes active in the gullied portion of the embankment. 'Seepage' is the primary stage of breach initiation process. So through the weak points of the embankment at Natunhat, Bhedia, Satkahonia, Natungram, Bakolsa, etc. places several gullies have been developed. But these are not repaired properly. The Irigation Department remains totally callus about the harmful effect of gully erosion on the embankment. But the weaker portions of the embankments draw attention of the Irrigation Department only after the breaching have taken place and resulting devastating flood. Only after that, the Irrigation Department becomes serious and takes necessary steps to repair the embankment.

5.5. Anthropogenic activities :

Human activities are to a great extent responsible for breaching of embankments. They deteriorate the embankments in a variety of ways. Firstly, the base of the embankment is being cut by the farmers to increase expand their agricultural. Secondly, the local people sue the embankment as grazing place for their cattle population. Thirdly, in some places, passages are constructed across the embankment to make communication between riverside and countryside of the embankment. In these places the topsoil of the embankment is removed to a certain extent. These activities are very much prominent in Ajoy embankment, particularly in the places of Mongalkot, Singhee, Natungram, Nurpur, Kherura, etc. All these anthropogenic activities culminately make the embankment more vulnerable to breach.

If we look into the previous records, we will find that breaches are historically known to occur within a certain river basin in a certain region and the records show the typical size of breach is fairly similar. In Ajoy River Basin, it has been found that the breaching tendency of embankment is more on the right bank from Illambazar to Bhedia and from Bhedia to downstream the breaching tendency is more on the left bank of the river. However, it is very important to understand the breach processes because this will allow emergency services to undertake the most appropriate actions in terms of warning and/ or evacuating people at risk from flood water.

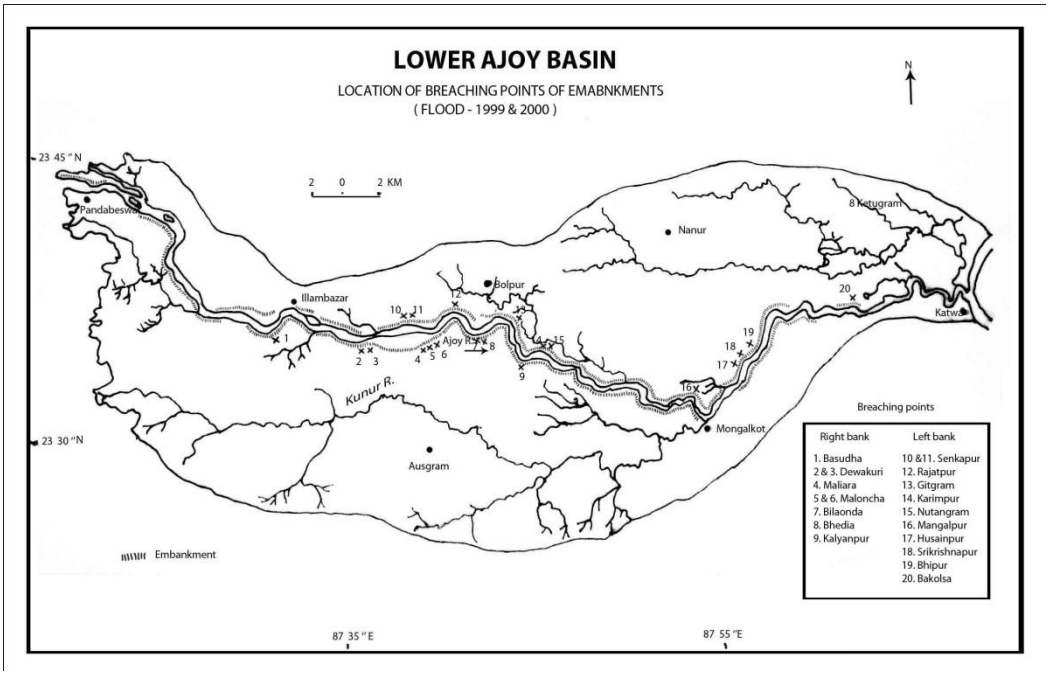


Figure: 2

6. SANDSPLAY

The most prominent effect of the breaching of embankment and the occurrences of flood is the sandsplay as post flood hazard (Mukhopadhyay, 2010). It is a serious environmental hazard that changes the micro-topographical features of the river astride areas particularly, in the places where sandsplays have

been taken place. In Ajoy river, the slope gradient above Pandabeswar is quite high (1 in 713) but downstram of Pandabeswar, the slope gradient is very gentle (1 in 2273) and a very little slope difference is found downstream of Illambazar. Therefore, downstream of Illambazar, the rate of siltation is very high, which consequently decreases the water accommodating capacity of Ajoy. In case of an unembanked river, the *river loads* especially sand and sediment get deposited into the extensive floodplain but due to construction of embankments along both sides of the Ajoy river, a huge volume of sand and silt are entrapped into the river water and carried downstream. During the peak discharge period, breaching of embankments take place and results sandsplays over vast tracks of the floodplain.

6.1. Spatio-Temporal Pattern of Sandsplay:

Spatio-temporal pattern of sandsplays give a terrific account of sand deposition over the river astride villages. Bhedia, Hussainpur, Maloncha, Maliara, Nutangram, Ghidaha, Narenga etc. are the notorious villages where thick deposition of sand have taken place on the agricultural land as a result of breaching of embankments. The coverage of sand laden areas in the respective mouzas are furnished in the Table No.2. The sandsplays occurred in all the places as the result of embankment breach except the places of Bakalsa, where the left embankment has terminated and sandsplay occurred only as a result of high flooding.

If we analyze the temporal pattern of sandsplays, we will find that the spatial coverage

Table: 2

Coverage of Sandsplays Area in Lower Ajoy Basin in major flood year (1956 – 2012)

Year	Area covered by sandsplay (hectare)		Total sand covered area (hectare)	Maximum extension of sandsplay from river embankment (distance in km.)
	Left bank	Right bank		
1956	102.20	119.25	231.45	0.38
1959	133.42	136.21	269.63	0.38
1970	248.76	444.72	693.48	0.47
1971	368.39	396.18	761.57	0.78
1973	497.66	695.54	1193.20	1.12
1978	1432.32	1989.0	3421.32	2.42
1984	335.23	530.30	865.53	0.68
1995	643.27	602.40	1245.67	1.40
1999	1097.74	1469.49	2567.23	2.12
2000	1478.98	2309.29	3788.25	2.57
2005	538.40	372.12	910.52	1.35
2012	596.52	618.46	1214.98	1.76

Source: Directorate of Irrigation and Waterways Department, Govt. of West Bengal -2010.

of sandsplays areas have gradually been increased from 1956 to 2000 and after that, till now, the trend has decreased (Table No.). In 1956, the total (including both left and right bank) sand cover area in Lower Ajoy Basin was only 231.45 hectares, where as in 1973, it was 1193.20 hectares. So from 1956 to 1973, the sand cover area has been increased by five fold. But the account shows that from 1973 to 1978, within a span of five years, the sand covered area has been increased by three fold. In 1978 the sand covered area was 3421.32 hectares. However, all the previous records has been exceeded by the notorious flood occurred in the year of 2000. Breaches of embankments have taken place at 20 places by the flood of 2000. This was the maximum number of breaching points than ever recorded in Lower Ajoy Basin. It caused a devastating flood in the basin and resulted sandsplays in areas of about 3788.25 hectares.

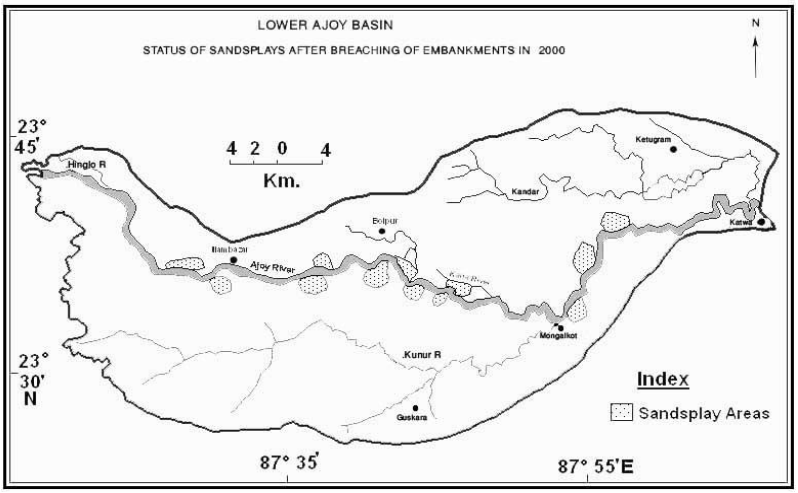


Figure:3

6.2. Sandsplay and Micro-Topographical Change:

Sandsplays bring about modification of the alluvial riverine land, both in short term and long term basis. Due to breaching of embankments thick deposition of sand takes place on the river astride areas. So the fertile alluvial land is converted into sterile sandy land. Along the both sides of the Ajoy river, particularly downstream of Illambazar, sand depositions have been taken place in isolated pockets as a result of breaching of embankments. Table 3 shows the name of different mouzas and their respective coverage of sandsplays areas. In Gitgram and Hussainpur mouzas, almost 50 % of the total mouzas were covered by sandsplays. The maximum thickness of the sandsplays has been found up to 1.5 metres. On the basis of field survey conducted at Hussainpur, shows that the depth of sand deposition is inversely proportional to the distance from the river bank. It has been observed that at the breaching place of embankment, the thickness of sand deposition is

Table : 3 Sandsplay covered land after the flood of 2000.

Name of the Mouza	Area covered by sandsplay (% to total area) Mouza	Name of the Mouza	Area covered by sandsplay (% to total area)
Bhedia	33.58	Itanda	42.43
Brahmandihi	21.66	Nabagram	16.43
Maloncha	38.08	Natunhat	18.60
Maliara	44.03	Bira	17.30
Basudha	32.07	Narenga	20.32
Gitgram	58.92	Srikrishnapur	38.20
Natungram	36.74	Hussainpur	48.25
Rasulpur	33.82	Vepura	44.46
Haripur	38.12	Pandura	21.39

Source: Burdwan and Birbhum Zilla Parishad Office – 2001.

not considerably higher, but immediately after the breaching place at about 50 – 100 metres distance towards countryside, the thickness of sand deposition is maximum and the thickness gradually decreases afterward. From the laboratory analysis of the samples collected from the field, it has been found that about 90% of the sand varies its grain-size from 0.1 mm to 1 mm The grain-size of sand become coarser near breaching places of embankment and become finer towards the countryside.

7. CONCLUSION:

Embankment is supposed to be an important structural measure of flood control. But the construction of embankments leads to change in the natural course of the river and therefore the flow

characteristics and flow conditions are bound to change (Mani, et.al, 2006). Therefore, it puts a question regarding the long term viability of the floodplains. The river channel geometry, longitudinal profile, river morphology, etc. are bound to change. By confining the flow within the embankments, the floodplain storage is prevented and the total discharge is constrained to flow within the confinements. It leads to increase in the velocity and water level. Gradually the embankments become vulnerable to breach and during the peak discharge period in every major flood year, the embankments of Ajoy river subject to breach due to heavy pressure of water. The breaching of embankments result large scale sand deposition on the river astride alluvial tracts. The fertile agricultural land is converted into sterile waste land. It brings far reaching socio-economic consequences in the villages adjacent to the river.

As flood cannot be totally controlled and it is not possible to provide protection against all magnitude of flood , we have to adjust with the flood and implementation of proper flood management programmes become very much necessary (Molla, 2010). It is a best temporary measure, where river water carries a heavy silt charge and the embankment by shutting off the spill areas on either side hastens raising of river bed with consequent rise in flood levels. This phenomenon creates potential danger of breach of embankments. A vicious race starts at that stage between the rise of the river bed and raising of the embankments in which the latter has not even a remote chance to win. Therefore, the traditional sectoral planning approach for complete flood control should be changed to sustainable flood plain development policy.

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Dr. Hasibur Rahaman Molla
Assistant Professor in Geography, Sivanath Sastri College, Kolkata.