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CONTENTS

FLOODS , FLOOD HAZARDS AND HAZARD REDUCTION MEASURES : A MODEL -THE CASE IN THE LOWER DAMODAR RIVER

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Abstract

Floods once the basis for the hydraulic civilization might translated into social disaster due to negative interaction between human use system and flood at a particular historical juncture within specific economic and social conditions. The same phenomenon becomes less significant if a community with a rational approach looks on bright side of the event and fortifies accordingly against such oddities. The paper makes a general review of the hazard reduction measures adopted by a migrated community for hazard reduction and resource evaluation in the riverbed. Over utilization and stabilization of the sandbars have become detrimental for the river itself.

INTRODUCTION AND OBJECTIVES

Natural phenomena with potential risk are often translated into social hazards due to lack of objective judgement of physical parameters of specific phenomenon and lacunae in the social cultural and technoeconomic systems as well . The question to be addressed here is what measures economic and cultural do the communities adopt for specific hazard reduction measures and corollary to this question is how spatial data help ascertaining such policies. This paper selects flood hazards in the alluvial controlled sector of the Damodar a subsystem of mighty Ganges system. The sandbar selected is Rangamatia Kenety mana situated below the Durgapur barrage within the Bankura district. The communities selected are a group of East Bengali refugees mostly scheduled caste and local scheduled and non-scheduled population.

The objective of this paper is to find out a testable hypothesis for hazard reduction measures taken by affected communities and whether these measures taken by the affected communities are beneficial for the Lower Damodar River or not.

DATA BASE AND METHOD

The strength of geographical method , the author believes lies in its ability to use spatial data . These data help in gaining knowledge and formulating principles which can be applied in planning and management of energy and resources in general and specific objective oriented programs in particular. Here statements are based on field data, cadastral maps, SOI maps, Geocoded map and landsat imageries.

THE DAMODAR RIVER :

The Damodar river, a subsystem of the mighty Ganges system flows through the urban industrial sector of Durgapur, Asansol and Raniganj coal field area and comes under the states of West Bengal and Bihar of India. The river rises from the Khamarpat Hills(1,068m) of Bihar. The river flows in a generally

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southeasterly direction and enters the plain of West Bengal near its confluence with its principal tributary the Barakar. The river follows the same general course till it reaches the vicinity of Barddhaman where it abruptly changes its direction to the south near Palla village. A little below Jamalpur it bifurcates into Kaki Mundeswari and Amta channel and debauches into the Hugli river , some 48.3 Km downstream of Calcutta. The Lower Damodar i.e. the reach between the Panchet reservoir and the Falta point exhibits an extensive system of embankments. These were constructed in the historical past to protect land and property from flood disaster. Attempts were also made to transfer excess water from the Damodar to some of the decaying drying distributaries through Jujuti sluice and Eden canal in 1881.In 1933 at Rhondia , the Anderson weir was constructed to regulate the flow. Finally after the Independence of India in 1947, the Damodar Valley Corporation was constituted in 1948, with the idea of several multipurpose projects on the Damodar and its tributaries was conceived. The Panchet dam was constructed on the main Damodar in 1959 and a barrage was constructed near Durgapur in 1958. In the Damodar river training is an ongoing process.

The studied section is the upper sector of the Lower Damodar between Panchet reservoir in the west to the Palla village on the east (Fig 1.1).

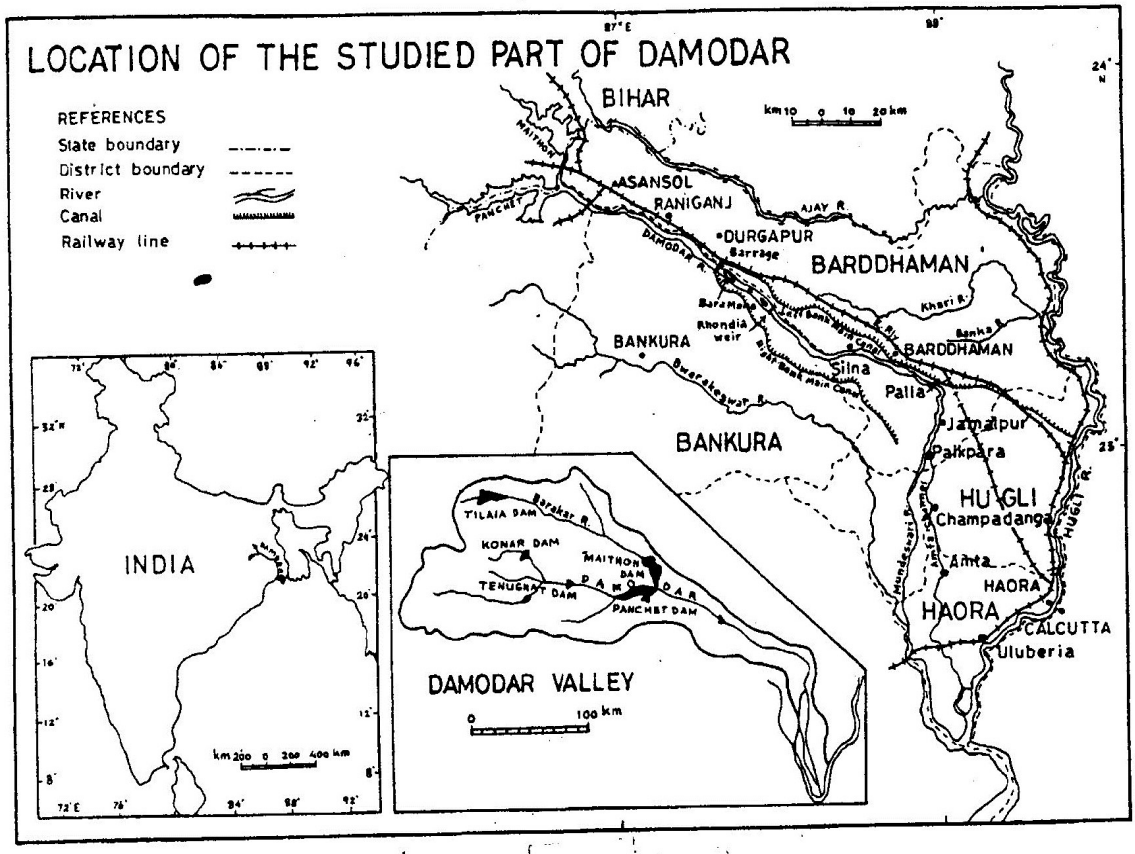

Fig. - 1.1

THE DAMODAR FLOOD : A PHENOMENON WITH POTENTIAL RISKS

Records on the flood fury on the Damodar river extends from the year 1730 to 1999.The first recorded flood was in 1730 (Voorduin, 1947). Since, 1730 floods of different magnitudes have occurred every 8 to 10

years. Floods with peak flow of 8,496 or more cumec occurred in the year 1823, 1840, 1855, 1860, 1864, 1865, 1866, 1877, 1913, 1916, 1917, 1935, 1938, 1940, 1941, 1942, 1946, 1950, 1951, 1956, 1958, 1959 and 1978. The flood of 1823, 1840, 1913, 1935, 1941, 1958, 1959, 1978 had peaks of more than 16,992 cumec. A peak flow about 18,678 cumec has been recorded thrice in August 1913, August 1935 and October 1941 (D.V.C 1995 , Bhattacharyya , 1998).

The Flood history during the period 1857 to 1917 can be traced from the E.L. Glass report submitted to the then Bengal Government as observed at Raniganj, a few Kms upstream of Durgapur (Sen, 1962). Corresponding data for the period between 1933 and 1957 and 1958 and 1999 at Rhondia were also processed (Bhattacharyya, 1998).

Flood History of the Damodar

	Table 1.1a Raniganj	
During 61 years (1857-1917)		
No of extremely abnormal floods	(above 12,744 cumec)	1
No of abnormal floods	(above 8,496 cumec)	12
No of normal floods	(between 5,664-8,496 cumec)	33
No of subnormal floods	(below 5,664 cumec)	15
	Table 1.1b at Rhondia	
During 23 years (1933-1956)		
No of extremely abnormal floods	(above 12,744 cumec)	2
No of abnormal floods	(above 8,496 cumec)	7
No of normal floods	(between 5,664-8,496 cumec)	11
No of subnormal floods	(between 2,472- 5,664 cumec)	3
	Table 1.1c at Rhondia	
During 41 years (1959-2000)		
No of extremely abnormal floods	(above 12,744 cumec)	0
No of abnormal floods	(above 8,496 cumec)	2
No of normal floods	(between 5,664-8,496 cumec)	2
No of subnormal floods	(between 2,472-5,664 cumec)	22

During the period of 1857 - 1917 the number of normal floods (between 5664-8496 cumec) was 33 which was reduced in later periods (1935-1956) to 11 and (1959-1999) 2 respectively. In the post dam situation i.e., after 1958 only two high floods have occurred, one in October 1959 and the other in September-October 1978.By these 1978 flood merits special mention. This was the gravest disaster of the century (Bhattacharyya 1998). From the very beginning the embankments on the Damodar could not protect the invasion of floods. The Damodar breached its embankments in 1770, 1787, 1789, 1823, 1835, 1840, 1845. Atleast 25 breaches took place in 1847, 14 in 1849, 56 in 1850, 45 in 1852 and 28 in 1854 (O'Mally and Chakravarty, 1912). In 1840 the town of Barddhaman was laid under water three times in one year due to breaching of the left bank embankments in 113 places (Hart, 1956).According to Sir William Willlcocks (1930), an Egyptian engineer these were all secretly breached by the peasantry to take the silt laden flood water into their field. This secret breaching is still practiced by the villagers in the lower Damodar River . During floods coarse bed materials, the characteristics of the Damodar sediments are also deposited making

extensive areas infertile for months. Non cohesive bank materials often collapse .On the basis of the above findings an assumption can be made that the Damodar flood has hazard inducing capacity.

Impact of Lower Dams(Maithon and Panchet) on the river: a brief resume

Due to the construction of storage reservoir in the upstream sector 34 percent monsoon discharge below the control points has been reduced. The average peak flow at Rhondia in the pre-dam period (1933-1956) was 9,606 cumec, which has been decreased to 3517 cumec in the post-dam period (1959-1999). Under the natural flow conditions of the catchment, the mean annual flood (q 2.33) and most probable annual flood (q1.58) were of the order of 8,087.99 cumec and 6,424.54 cumec respectively . The bankfull stage of 7,080 cumec had a recurrence of 1.8 years. Return period of flood of bankfull capacity has been increased from 1.8 in predam to 14.81 years in post-dam period.(Bhattacharyya ,1998). In the post-dam period number of extreme and normal flood has been decreased whereas number of sub-normal flood has increased from 3 in pre-dam (1933-1956) to 22 in post-dam period (1959-1999). Magnitude of design flood from the Maithon and Panchet has been reduced by about 57 percent (Bhattacharyya, 1998) (Table1.1). After the devastating flood of 1959 the Government of West Bengal pressurized the D.V.C. to adopt a new water release schedule in 1961 which meant heavy encroachment on the flood reserves of the D.V.C. reservoirs. In this new method, for the months of June, July, August, September, an out flow of 5,660 cumec can be released only when 70-100 per cent of the available flood reserve i.e., 740-1050 million cu.m. has been used up. The outflow is to be limited to 3,400 cumec till 50 per cent of the flood reserve i.e., 500 million cu.m. is used and it is to be increased to 4500 cumec when 50-70 per cent of the flood reserve i.e., 500 to 750 million cu.m. has been used up. In October, the outflow is regulated even more strictly (D.V.C., 1966; Bhattacharyya, 1973 : Bhattacharyya ,1998).

The above does not hold good for the whole stretch of the Damodar Valley. The Mundeswari river can hardly carry 2,264 cumec (D.V.C. 1995) and the Amta channel practically nothing except during high releases; so. any flow above 2,832 cumec at Durgapur can cause flood downstream. The primary consideration in the flood control aspect of the D.V.C. dams is to provide adequate protection to the left bank embankment along the Damodar river, as it protects the mining, industrial area and important towns as well as railways and roadways. But the rural and undeveloped lower reaches of the valley covering about 780 sq. km. were neglected (Bhattacharyya, 1973, Bhattacharyya, 1998). The inadequate capacity of the Maithon and Panchet reservoirs has necessitated high water release during high rainfall condition (Sen, 1985) and the uncontrolled run-off in the catchment below dams may augment this discharge at Durgapur and Rhondia by more than 2,832 cumec. Floods are generally associated with the release of water from the upstream dams and barrages at a rate of 2,800 to 4,200 cumec. In the Trans-Damodar distributary channels, the subsurface water yield is very high in case of excessive rainfall. There are other contributory factors like spilling of the Dwarakeswar river, flood in the Rupnarayan and also conditions of the Hugli river including the temporary factor as the occurrence of a high tide coming up from the Bay of Bengal (Bhattacharyya, 1973, Sen, 1985., Bhattacharyya, 1998). At present whenever there is any discharge from Durgapur barrage exceeding 1,400 cumec the lower part of the Lower Damodar gets waterlogged. So before the dam closure floods of the order of 10,000 cumec used to come in every 3.78 years and were tolerated but after the dam closure a flood of the order of 2,471.73 to 3,546.44 cumec creates all the problems in the lower part of the lower reaches but it can be stated that after dam closure a reasonable flood protection has been achieved in the upper part of the Lower Damodar Valley (Bhattacharyya ,1998).

Table 1.1 Combined Moderation by Maithon and Panchet Dams of the Damodar River (In thousand cusec)

Date	Peak Inflow	Moderated Outflow	Flood Moderation	Date	Peak Inflow	Moderated Outflow	Flood Moderation
4.7.58	228	30	198	12.9.72	124	24	100
12/13.8.58	126	32	94	23/24.9.73	211	80	131
16/17.9.58	555	175	380	12/13.10.73	588	175	413
11.7.59	134	71	63	16/17.8.74	133	67	66
21/22.7.59	137	90	47	29/30.9.74	232	50	182
10.9.59	137	101	36	17/19.7.75	275	100	175
13.9.59	137	56	81	20.8.75	170	51	119
1/2.10.59	623	288	335	26/27.9.75	344	111	23
25/26.8.60	119	72	47	17/19.9.76	297	163	134
30.8.60	173	104	69	15.7.77	126	48	78
27.9.60	348	92	256	28/30.7.77	291	102	189
22/23.8.61	110	64	46	6.8.77	111	100	11
10/11.9.61	118	44	74	27.9.78	774	163	611
2/3.10.61	516	161	355	27/28.8.80	341	149	192
25/26.7.62	117	44	73	4/6.9.80	240	120	120
22/23.9.62	152	45	107	9.10.83	139	61	78
28/29.9.63	216	41	175	23/24.6.84	246	105	141
2/3.10.63	451	121	330	26/27.6.84	276	100	176
24/25.10.63	465	91	374	7/9.8.84	157	70	87
29./30.7.64	373	78	295	27/28.8.80	145	107	38
24/25.9.64	200	69	131	4/6.9.84	117	85	32
19/20.8.65	200	54	146	1.7.85	138	14	124
26/27.8.65	156	75	81	17.10.85	183	86	97
30/31.8.65	101	71	30	29/30.6.86	152	14	138
4/5.9.67	182	52	130	7/9.7.86	155	100	55
17/18.9.67	170	102	68	5.8.86	109	70	39
16/17.6.68	219	88	131	6/7.10.86	152	76	76
2/4.8.68	203	82	121	26/29.8.87	214	20	94
12/13.8.68	140	101	39	11/14.9.8	242	160	82
9.8.69	189	11	178	28/29.9.89	101	38	63
3/4.9.70	292	80	212	5.7.90	105	13	92
10/11.9.70	154	101	53	31.7.90	112	60	52
12/13.7.71	113	50	63	2.8.90	107	81	26
16/18.7.71	424	181	243	21.9.90	148	39	109
26/27.7.71	148	90	56	5/6.10.90	134	96	38
3.8.71	110	50	60	4.9.91	110	64	46
11/12.8.71	170	99	71	29/30.6.94	196	9	97
29.8-1.9.71	226	98	128	31.7.94	135	81	54
5/7.9.71	154	77	77	29.9.95	613	250	363
				9.8.96	209	103	106
				23.7.97	203	60	143
				11.9.98	200	120	80

Source: D.V.C 1995 and K. Bhattacharyya: 1998)

HISTORY OF COLONIZATION IN THE RIVER BED

Utilization of flood plains for agriculture and human habitation dates back to 3000 BC. The flood plains are the containers of ancient civilization. But are we aware of the facts that the river bed itself becomes site for settlement ? In tropical Africa and Asia alluvial bars are used for agriculture in case of seasonal rivers when bars are exposed due to lowering of river level. This is a common practice throughout Indian sub-continent. Emergence and submergence of riverine bars particularly in the deltaic tract are common phenomena and there are often disputes over the occupation of this bar particularly in the border districts and states. For reasons obvious, the riverine bars are preferred sites for agriculture, though the extent of agricultural season depends on the survival potentiality of these bars. These bars have also provided temporary shelter for war victims (Semple, 1911). These are used as campsite in the Colorado River (Schmidt and Grag, 1990). It has been noticed that throughout West Bengal the riverine alluvial bars provide shelters for millions, and these millions are Bengali refugees who came from the erstwhile East Pakistan (present Bangladesh) mostly after1947 and again during Bangladesh war in 1971. They are not only political economic victims but social victims also. Several government sponsored refugee colonies were set up where these refugees had to accept a dole-sustained existence. A sizeable number of these refugees coming from the farm sector rejected such an existence and preferred the riverine islands in the Ajay, Damodar and Hugli-Bhagirathi for self-sought settlements. These rivers are now dotted with such settlements and some of which look quite prosperous also (Basu, 1988; Bhattacharyya, 1995., 1997., 1998). foreign country. Moreover, the refugee problem, which started almost 50 years ago, still plays a crucial role in Indian politics particularly in the eastern part of the country where constant infiltration of Bengali refugees in the Border States create political tension. The problem aggravates when the question of granting of 'patta' or land deeds in the self-sought settlements comes in forefront. The question has taken a different dimension in the Damodar Valley Corporation (D.V.C.) command area where there are several self-sought refugee settlements in the riverine sandbars. Most of the riverbed settlements in the Lower Damodar are refugee settlements but colonization started much before 1946-47. The studied section is a part of the Raniganj coalfield above Durgapur and coal seams are exposed along the river courses. By 1820 open pit mining started in the Raniganj coalfield and from 1930 onwards several collieries were opened (Hunter , 1877).The first migration started with the labor migration from the Chotonagpur plateau , though they are very few in number. The second phase was initiated by decolonization and partition of India in 1947.This is the beginning of involuntary migration of political refugees. Most of them are Bengali Hindus, mostly scheduled caste. The tract, which was settled first, was the stretch between Durgapur barrage and Jujuti sluice. A wide-bed with less mobile alluvial bars covered with grass jungles was the primary factor behind colonization in the riverbed. Secondly, unwarranted flood risk have been reduced due to water retention behind the Durgapur barrage and the Panchet reservoir, thirdly controlled release of water with prior warning and fourthly release of water through definite channels were other controlling factors. There was a noteworthy socio-political factor also. In order to trace the phases of refugee influx, the policy adoption by the West Bengal government needs to be mentioned here. The refugees were classified as 'old migrant' if they had come in between 1946 and 1958; 'in-between migrants' if they had migrated between 1958 and 1963 and 'new migrants' if they had crossed the border after that period. Unlike 'old migrants' the 'in between migrants' were not eligible for any assistance for rehabilitation. The 'new migrants' were eligible for rehabilitation benefits if they had opted for resettlement outside the state (Chakrabarty, 1990). This policy was adopted to discourage large number of emigration but the problem is difficult to be solved and this problem has taken a new dimension since the Bangladesh War of 1971. The refugees who fled from government sponsored camps and colonies and those who were in the category of 'in between migrants' or 'new migrants' preferred to stay away from the main stream of influx, so that they could remain unidentified. They opted for a location away from main transport routes

and urban centers. The very locational disadvantage was one of the factors why the refugee settled sandbars are away from Barddhaman town. The most prosperous settlement, the Bara Mana, the largest sandbar of the Damodar is located in this part. Gradually the Bengali Hindu refugees mostly occupied other parts of the Lower Damodar bed. Third phase of immigration and consequent riverbed colonization started during Bangladesh war and liberation of Bangladesh as a sovereign state in 1971. As the eastern border is neither well defined nor well guarded millions again crossed the border though apparently India and Bangladesh had a friendly cordial political relation at that time. The established refugee clusters in the Damodar riverbed colonies were extended. The third phase is marked by the September flood of 1978, which initiated a desperate immigration of locals from the flood-affected areas of Medinipur and Hugli districts to the adjacent riverine bars. They purchased land from the refugees and have set up new colonies in Rangamatia, Fatehpur and Kasba Mana situated between Durgapur barrage and Jujuti sluice. Flood-distress generated local migration from nearby flood-prone districts is still to be experienced. Thus, riverbed population is numerically increasing. The control structures on these rivers have brought several changes in the riverbed environment, and the refugees are constantly struggling with this changed environment for their survival in a foreign country. The local people did not identify the resource potentialities of these sandbars or char or mana . These were remained as a stock of material. The refugee people with their sense of vulnerability responded positively to analyze the physical space more objectively and rationally and looked at it as a challenge to their independent existence. From a chain of sandbars Rangamatia Kenety sandbar has been selected to explain my observation.

Rangamatia-Kenety Mana

Introduction and Locational Characteristics

Rangamatia-Kenety mana is under Sonamukhi Police Station of Bankura district. It is under the mouzas of Rangamatia, Kenety and some portion of the Nityanandapur mouza extending from 23° 22' 50" N to 23° 23' 30" N and 87° 26' E to 87° 28' 30" E. In this particular bar the width of the Lower Damodar is about 2.5 Km. in comparison to 0.7Km. upstream of the Damodar bridge site at Asansol and 0.5 Km. below the bifurcation point of the Mundeswari and Amta channel. There are four sandbars. First one is the Uttar Rangamatia sandbar, second is the Dakshin Rangamatia Kenety and some parts of Nityanandapur (R.K.N.) sandbar and third and fourth are small bars yet to be permanently settled. All these sandbars are situated in the dam area of the Rhondia weir (Fig. 1.1). Nearest town and railway station is Panagarh.

Hydro-geomorphological Characteristics

Fig. 1.2 shows the changing boundaries of R.K.N. mana. In 1920, there were fragmented transient sandbars, by 1957 there were shape distortion and size reduction in some portions of the bar but at the same-time there was addition of land to the existing bars. Some new bars have also appeared towards the left bank. Due to 1978 floods extensive damage was done to these bars and these bars were reduced in size as evident from Fig. 1.2. Bars have grown in dimension in 1996 but there are a few pockets of permanent bank erosion. Thalweg has changed its position several times between 1920 and 1999 but the braided channel pattern is still to be observed. Surface material varies from sand to clay as usual.

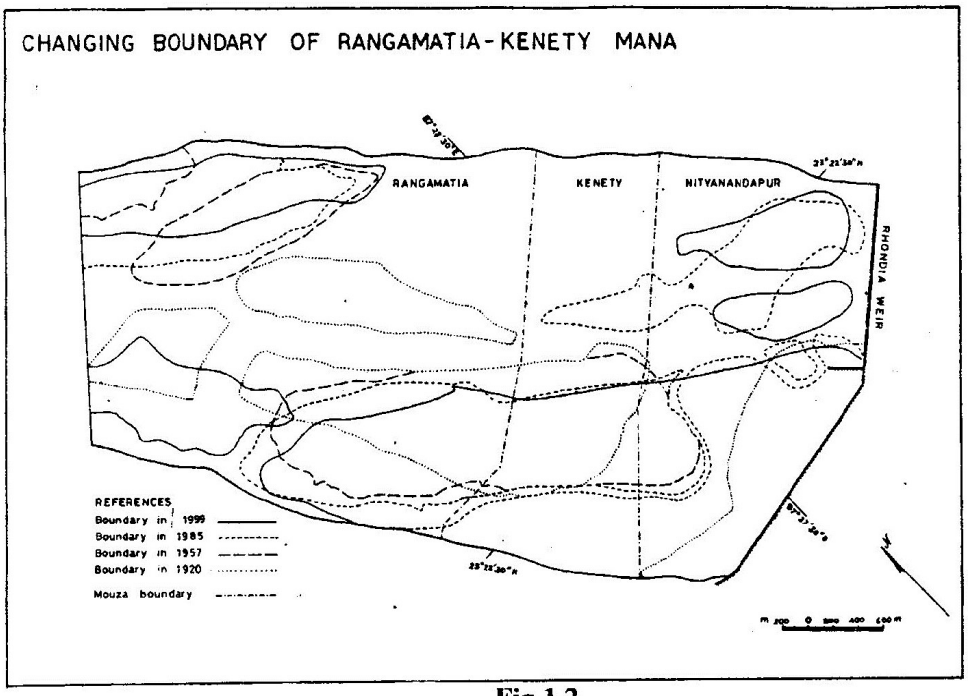

Fig 1.2

Population and Land Use Characteristics

Person displaced from erstwhile East Pakistan consequent to the partition of India in 1947 has been settled in Rangamatia-Kenety and in Uttar-Rangamatia Mana. The area was forcefully occupied in the year 1955, 1956 when they were deprived of their dole sustained existence. Mainly refugees had settled in Dakshin Rangamatia sandbar where as in the Uttar Rangamatia local people dominates. Refugee and local scheduled caste population as well are now occupying a small sandbar just upstream of the Rhondia weir. Number of household in Dakshin Rangamatia-Kenety, Nityanandapur sandbar is about 262. Total population is 1410. After the devastating flood year of 1978, people from Khanakul in the Mundeswari River of Hugli district and from Ghatal of Medinipur district came in the Dakshin Rangamatia sandbar and purchased land from refugees. Number of household in Uttar Rangamatia is about 100. Like other alluvial bars in the Lower Damodar Bangladeshi refugees had settled in the R.K.N.sandbars. Being situated within the Rhondia weir the bars are vulnerable to frequent inundation but land use is finely adjusted with the fluctuating water level and the land use is extremely flexible also. Floodable peripheral areas, particularly in the north are usually kept fallow. Extreme flood propensity at the margin does not allow to grow additional crops but that is compensated by intensive cultivation of rice in the inland areas. Almost all households have shallow tube-well facilities . Initially, sandbars were uneven in configuration but they have been leveled for agricultural purposes. Both in kharif and rabi season rice is the main crop. Jute is an important cash crop from the very beginning. Almost all types of vegetables are grown in this bar because there is a ready market for these vegetables at Sonamukhi in Bankura and at Panagarh in Barddhaman district. The migrated locals later introduced potato cultivation .

Settlements are strikingly linear and located at the highest part of the bar. What is to be mentioned specially is the shifting of settlement sites from the inundation and bank erosion-prone area i.e. from north to south. (Fig.1.3a, and 1.3b) Extension of settlement is taking place towards the Bankura side. Arquate shape of settlements (Fig. 1.3b) in Nityanandapur indicates that they were developed along some semicircular water channels which have nearly dried up. Some such channels are still to be observed in the eastern side of the Nityanandapur mana and are used for rice cultivation. Migrated locals have settled in isolated patches

south of the main South Rangamatia, Kenety settlements. Locals purchased land from the refugees and they did not have much options for settlement site. So the settlement pattern is rather amorphous (Fig. 1.3b).

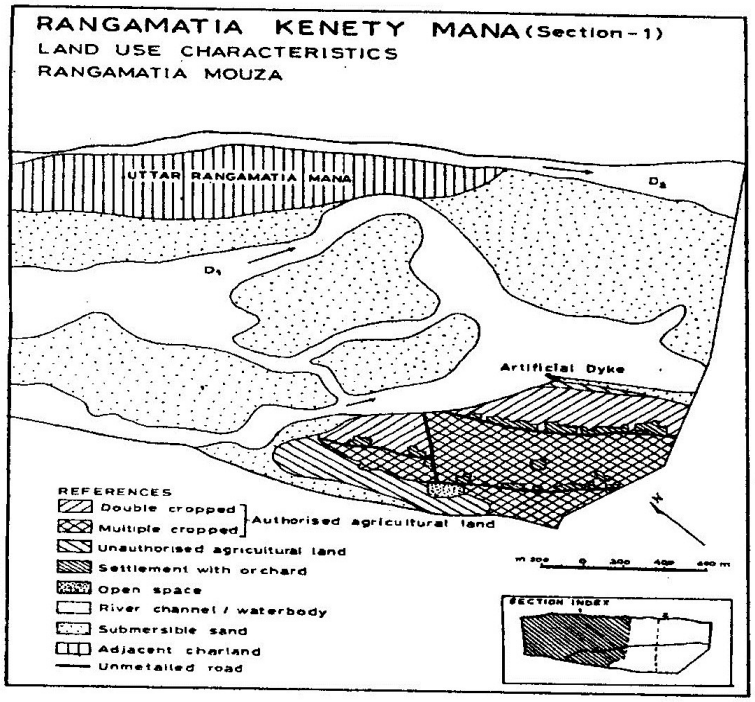

Fig. - 1.3a

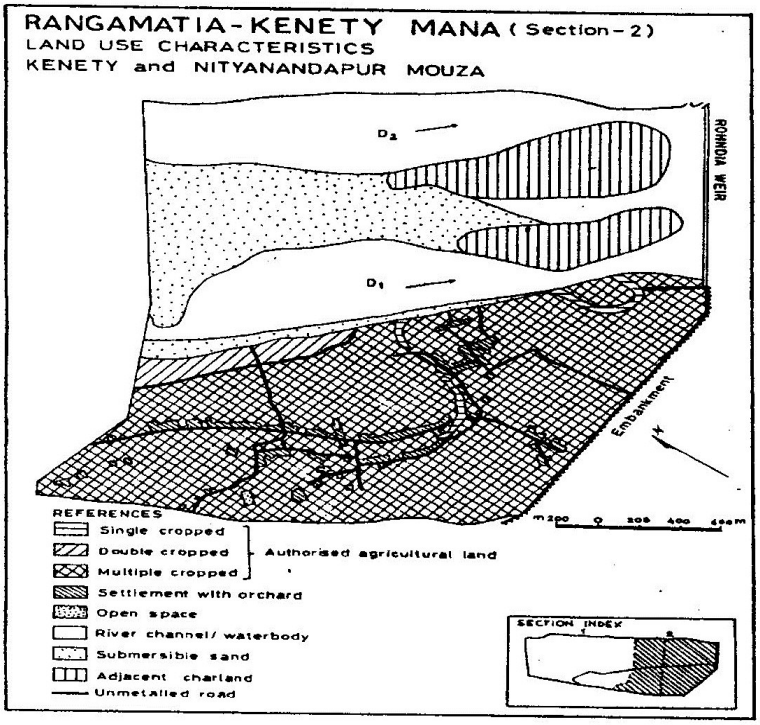

Fig - 1.3b

Because of high inundation risk individual houses are constructed on higher plinth above river water level. Inundation susceptibility is also reflected in the structure of individual buildings. Structure is made of bamboo and jute sticks. This structure is plastered with mud and other materials. If there is an unusual floods and mud are washed away, they remove the bamboo structure to a place which is comparatively safe. In this way they re-use the original structure for constructing individual houses. Newly constructed concrete structures are also found in Rangamatia . The most striking component in the R.K.N. sandbars is the Rangamatia dam or dyke. The main purpose of this dam or dyke is to divert the flow coming from the Durgapur barrage off the Rangamatia sandbars. It is believed that bank erosion will be arrested and there will be addition of land due to vertical and lateral accretion above the dyke .

HAZARD REDUCTION POLICIES:

Rangamatia Kenety mana are just a few examples of cultivated settled sandbars .The Lower Damodar is choked with settled sandbars. At their initial stage of colonization the sandy soil does not respond to the production of all crops. They were introduced with such tracts with their indigenous jute culture and non-irrigated wet rice culture ; with which they were associated with their previous habitat. From the very beginning of colonization the concept of flood zoning has been applied at micro level. Inundation prone peripheral zone is either left as fallow or devoted to grow additional crops of different types of gourds and melons which require little care and can be grown profitably on nutrient poor fresh sands. Grass covered fields are often used as grazing ground . The falling of leaves and animal droppings increase the fertility of the soil. In later periods these tracts have been put to cultivation of some quick growing vegetables and cash crops. Cereals are grown in the next zone. Cereals , vegetables and oilseeds are grown above inundation level. On the highest part of the bars perennial tree crops are to be observed. In that higher parts above inundation level settlement sites are to be found with individual house on the higher plinth.Decaying channel beds have been used for paddy crops.Wherever horizontal extension of existing resource base is not possible they use the land for multiple cropping thus extending resource base vertically. In some sandbar like Bara mana , Majher mana cocoon rearing mulberry plantation has been introduced after 1978 flood. The floods of 1978, 1995 and 1999 with a peak flow of 9,345, 8,495 and 6,192 cumec at Dugapur have made them more calculating. They follow the announcement and can calculate which part will be inundated and which will remain above it . So they have organized their space accordingly. The refugees have challenged negative connotation of flood. Since colonization the refugees have been struggling to fortify their forcibly occupied resource base in self-sought settlements but it is only after gaining land ownership rights they have taken the river bed as their own.The people of Rangamatia is fighting against the bank erosion by constructing a dyke in the river bed to protect their sand bars . A kind of allegiance or topophilia has developed among the refugees. To reduce flood hazard the local scheduled population in these sandbars either migrate temporarily to the safer zone or migrate permanently if economy permits.Instead of fortifying their environment they depend on aid agencies during calamity.But the same group when uprooted and attain the refugee status , may reject dole-sustained existence and colonize in barren areas, In the process of humanization they modify and fortify the vulnerable tract and gradually ramify the local resource base to reduce hazard loss. With restricted social and economic mobility and sometimes political also these self-settled refugees are forced to live within a closed system. This situation perhaps enables them to analyze physical parameters of a hazard more objectively . Therefore, the choice model of self-settled refugees is more rational than that of locals.

SUGGESTION AND CONCLUSION

The most crucial problem in the Lower Damodar, however, is that anthropogenic stabilization of the

bars by the riverbed occupiers. The problem has taken a different dimension, as most of the riverbed occupiers are Bengali refugees. Refugee issue is a very sensitive issue till today and this issue are always politicized. As many other riverbeds in west Bengal have become second homes of the refugees so colonization in the riverbeds and stabilization of bars due to year long cultivation are no longer local issues but have regional dimension also. Water-level lowering riverbed use for growing quick growing vegetables is a common seasonal practice through out India. A few huts of rudimentary structure are always to be seen when riverbeds are put to agricultural uses. It may not be a wild conjecture if some of the riverbeds of seasonal rivers of India is occupied permanently in near future due to population pressure and food crisis. Increasing demand for space creates a pressure to utilize hazard zones including flood- prone areas (Bird, 1980). So it is not unlikely that riverbeds in other countries particularly in tropical countries may be occupied for permanent settlements and transient sandbars may become immobile causing channel deterioration. Stabilization of bars may have fortified the resource base of riverbed occupiers but the Lower Damodar has deteriorated. Other riverbeds of the Ajay, Hugli etc., with settlements may meet the same fate today or tomorrow. That is why a question has been raised whether permanent use of the riverbed should be allowed or not. Re-location and re-settlement of displaced population for dam closure have always been a problem all over the world. Re-settlement problem of riverbed population is of equal significance if not more particularly when the riverbed users are refugees. When D.V.C was conceived these problems were not anticipated. It is not clear why the riverbed occupiers have been granted land-ownership rights despite D.V.C's objections. In the case of the Lower Damodar permanent use of sandbars has become detrimental for the river itself. To solve these problems, suggestions are :

i. A perennial thalweg must be maintained. For the maintenance of a perennial thalweg, there is a need for flushing floods. In fact, it was suggested earlier by the D.V.C. itself (D.V.C 1957). Perenniality of the thalweg can be achieved if a more uniform annual discharge pattern is maintained and extreme seasonal peaks are evened out. Perenniality of the thalweg can be achieved through creation of check dams or sub reservoirs, which can ensure perennial supply. Scientific storage, adequate management and proper distribution of floodwater should be given emphasis.
ii. Further encroachment on the active riverbed should be discouraged at any cost.
iii. Riverbed occupiers should be resettled outside the active bed and this has to be done at phases.

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