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Need for Integrated River Basin Management in the Context of West Bengal Floodplains

Sujit Choudhury[*], Girija Sankar Chattopadhyay[**] & Deepankar Chakrabarti[***]

Abstract

Integrated river basin management is a very important issue across the globe for water conservation and sustainable development. The rivers in India are very critical for the development of the country for meeting the water requirement and maintaining the ecological balance. West Bengal, a state having large numbers of rivers, is facing problems associated with the vast floodplains of these rivers. During the last fifty years various riparian systems and their parts in West Bengal are getting affected by different developmental activities. The river floodplains are the worst effected parts in West Bengal with rapid changes of land use characters of younger and older floodplain areas. For meeting the water demand and flood control purpose number of structural measures like large dams and reservoirs are built on these rivers. This has reduced the periodic floods in downstream areas and provides irrigation in the fertile floodplain areas. But these are leading to the rapid changes of the land use characters of the floodplains of West Bengal. These measures and water withdrawal in different rivers of Bengal results in reduction of flow amplitude, increase in base flow variation, alteration in temperature regime and decline of mass transport of materials. With this the overall connectivity between upstream and downstream reaches are compromised. This has a detrimental effect on biodiversity and ecological processes. Sophisticated studies of the dynamic interrelationships among topographic, hydraulic, hydrologic, agricultural, and economic factors are necessary for immediate impact assessment. Formulation of a comprehensive policy based on such detailed analysis on the deterioration of these floodplains is necessary to avoid future disasters and availability of water maintaining the ecological balance.

Keywords: Integrated River Basin Management, Floodplains, Ecological Balance

Introduction

The conflict of development and ecology and its impact on the larger society is becoming prominent every day across the globe. Rivers, the integral part of the earth's hydrologic cycle and cradle of civilization are continuously under pressure from various anthropogenic activities. Historically the impact of such developmental activities is more on river floodplains, an important part of the riparian system. The reasons are availability of water, plain land and their fertile nature. The Bengal basin in which West Bengal is situated is mainly constituted of the

[*] Director, PAN Network Pvt. Ltd. Kolkata, India
E-mail: sujit@panindia.net
[**] President, Integrated River Basin Management Society, Kolkata, India
E-mail: riverbasinsociety@gmail.com
[***]Professor & Dean, Apeejay School of Management, New Delhi, India
E-mail: dchakrabarti.asm@gmail.com

floodplains of different rivers. These are part of the largest delta of the world, the Ganga-Brahmaputra Delta. An agriculture based society grew here since last 4000 years. Presently in many of these floodplains development for agriculture, industry, transportation and housing is taking place at a rapid pace. Still housing, industry, transportation, and infrastructure development cover only a minor part of the floodplain area on most rivers. By far the greatest percentage of the area is covered by agriculture, in which cropland is greater in area than pasture, woodland, or wetland.

Riparian system like all natural systems has interacting components that together perform work like transport sediment, water, and energy. The system also forms physical structures like floodplains or channels, and form biological communities and new energy outputs. The West Bengal River floodplains are a very important part of different riparian systems originating from Himalayan mountain range in the north and Chotanagpur plateau in the west. In a natural system, interactions make the whole greater than the sum of its parts. As a result, floodplains cannot be seen in isolation of the system, although in West Bengal these parts are getting disturbed without taking into consideration the system. The drainage network development and channel development are functions of erosion and the redeposition of sediments on floodplains that rejuvenates soils and influences the productivity and diversity of stream corridor ecosystems. In these rivers and streams even floods are critical for several reasons. Floodwaters play a major role in shaping the physical environment of the stream channel and floodplains and they redistribute organic material and living organisms downstream and create an opportunity for exchange of sediment and nutrients with the downstream and the coastal area. Variation in flow on a seasonal and interannual basis is a primary selective force for organisms living in rivers and the associated estuary and coastal system.

Origin of these rivers and development of the riparian system takes place over 60 million years in geological time scale where floods are periodic natural events. But the problem of sustainability of modern economic process arises in the context of operation in human time scale which is at variance with the above geologic time scale. The mismatch of time rates of economic and ecological variables is visible in these floodplain areas. With rapid change in land use due to developmental activities during last 300 years many floodplain forest and wetlands are irreversibly lost, while they perform specific ecological functions in purifying air and water, conserving soil and controlling climate change. Presently the faster urban growth, industrial affluent and indiscriminate use of agricultural chemicals causing accumulation of pollutants in many floodplains of Bengal in access of absorptive capacity of the local ecosystem leads rapid degradation of the environment.

Floodplain & Management

The floodplains are the lateral extent of the rivers where water reaches during maximum flood. The sands and silts are deposited along the floodplains of the rivers. Floodplains are divided into two parts 1) lower or younger floodplains, which are flooded frequently once in two to three years in average and 2) higher or older floodplains which are rarely inundated three to four times in a century. Floodplains consist of two types of materials- channel deposit and overbank deposits laid down on the floodplains when the stream overflows its banks and all the flood plain deposits can be grouped either as meander belt deposits, point bar deposits, abandoned channel

fillings, natural levee deposits, back swamp or flood basin deposits etc. All these are common in West Bengal.

The younger floodplains constituted of younger alluvium are less dissected, less matured, and contain less oxidized sediments, the litho-members are characterized by very feebly oxidized or unoxidized sand of various grades at the top with a thin or no soil profile. These formations have been grouped under middle to late Holocene age [560 to 7980 YBP]. This younger landform is still in the process of formation and development are as well prone to natural hazards like flood, river erosion river migration, marine erosion, lake erosion etc.

The older floodplain deposits, on the other hand, have a wide areal extent, well dissected and matured terrain. This flood plain is widely developed in all the river basins of West Bengal. The litho members constituting this landform are characterized by khaki colored pedocalcic soil at the top followed by light yellow sticky clay with Caliche nodules often transgressing into Sandy Clay.

The younger floodplains of West Bengal are affected annually by flood during peak monsoon and water logging even long after the recession of floods. Many wetlands in south Bengal are the result of such regular inundation. During flood, the river brings a huge pile of sediment load. Due to gradual rising of riverbed due to sediment deposition, the bankful discharge of water puts a tremendous pressure on the embankments, an important structural measure man has adopted since long to contain the flood in different parts of West Bengal. But precipitated water from the inland in the floodplain fails to join the main river due to these embankments built on natural levee. The transportation network like Highways, Roads and Rail line in floodplain areas also create barriers within floodplain about the movement of the water flow during the flood. Henceforth problems of management of flood in downstream floodplain areas are manifold – in one way structural measures like embankment is needed to protect the flood plain from flooding due to bankful discharge; on the other way the embankment itself is creating problems for outlet of precipitated water from the inland. For remedial measures, rising of embankments higher than the high flood water level have been adopted in many areas– but higher the embankment; more is the risk of its failure.

The older floodplains are normally not affected by flood hazards – but there is possibility of water logging during heavy precipitation period when the ground water table reaches to the ground level– as the constituents of this flood plain is mainly of clay which has more water retention capacity than sand .The situation is completely different in drought period when the ground water level goes down and there is acute scarcity of water mainly for irrigation purposes. To overcome this problem, the local farmers use electricity operated shallow tube wells in their fields. But the use of large number of shallows are done so unsystematically in these floodplains that it affects the groundwater level which falls to such an extent that acute shortage of water occurs. This is a very common picture in different older floodplains of West Bengal. Further, deforestation in the older floodplain areas leads to huge soil erosion. In one way, the eroded landforms loss their productivity in terms of agricultural yields; on the other way, the surface run-off carry the eroded sediments over the croplands in lower reaches, thereby affecting their productivity.

Now floodplain land uses on all these deposits are different due to various physiographic and anthropogenic reasons. It is also true that the actual use is determined by the desires of landowners, by the nature of the soil and the topography, and by the perceived degree of protection from flooding. It is influenced by land values, by available infrastructure, and by historical events. Common floodplain land uses such as agriculture, urbanization, and transportation along the river basin area change runoff and flow in significant indirect ways. It is true that in the matter of floodplain management, combinations of structural and nonstructural methods are probably a better approach than the existing complete reliance on dams and embankments. Such combinations of use of structural and nonstructural measures vary from river to river. In fact in all the flood prone areas in West Bengal the two common programs in structural programs are reservoir-dam and embankment. But so far for nonstructural measures particularly for landuse management of the West Bengal floodplains there has been little study of the details of how floodplain areas can be used under present levels of development maintaining the ecological sustainability.

Situation in West Bengal

Large part of West Bengal particularly south Bengal is situated on the floodplains of rivers like Bansloi, Pagla, Brahmani, Dwarka, Mayurakhsi, Ajoy, Damodar, Dwarakeswar, Kangsabati, Subarnarekha , Jalangi, Ichamati and of course river Bhagirathi-Hugli. All these rivers have very significant floodplains. In West Bengal the river floodplains are less significant in Western plateau region and North Himalayan mountain areas. These areas are having low concentration of population whereas the river floodplains of central and south Bengal are having highest population density in the country with high economic importance. The high agricultural productivity of the West Bengal is due to the fertile soil of these floodplains. Along these various Rivers farmers grow field crop, cash crop, vegetables and flowers in the rich soils on different physiography of the floodplains. At the same time they are the victim of natural disaster like flood. Out of West Bengal's total area of 88,752 sq. km. 42.3% area is flood prone spread over 111 blocks. The river floodplain area is much larger than the common flood prone area, which is over 50% of total area.

Presently these areas show higher agricultural productivity due to high soil fertility and better irrigation facility through large canal network from different reservoirs. Although agricultural productivity depends on various factors like agricultural practices but on an average in West Bengal higher productivity is mainly noticed in the districts situated on the downstream younger floodplain areas of major rivers. During the course of the study it has been observed that Barddhaman district situated in the floodplains of Damodar, Ajoy and Hugli rivers shows high agricultural productivity in important crops like Rice, Wheat, Potato etc. over the state average, refer table-1. This is also true for other south Bengal districts situated in younger floodplains.

Table-1 ***Agricultural Productivity In Barddhaman District against West Bengal***
(Kg/Ha)

Crops	2001-02		2002-03		2003-04		2004-05		2005-06	
	Dist	State	Dist	State	Dist	State	Dist	State	Dist	State
Rice	2925	2514	2983	2463	3063	2504	2985	2574	3081	2509
Wheat	2365	2215	2260	2189	2447	2315	2055	2103	2119	2109
Jute	3852	2440	3312	2407	3294	2428	3222	2484	3307	2572
Potato	29966	26090	27748	19761	27135	24711	26703	22170	21249	21053

(Source: District Statistical Handbook, Govt. of West Bengal)

The high fertility of these floodplains soil has led to the settlement of large number of villages since long. At the same time, periodic floods in these rivers were common, which prevented the people from using the low lying areas of the newer floodplains. But during last forty to fifty years a number of Dam, Reservoirs and Barrages of major rivers like Damodar, Ajoy, Mayurakhsi etc.(refer table-2) are built with huge water diversion capacity for flood moderation as well as irrigation, Domestic and industrial purpose. These reservoirs with irrigation canals for these fertile younger and older floodplain areas enhanced the agriculture productivity. This has resulted people to use the low lying younger floodplain areas more and more causing rapid land use changes.

The first integrated river basin plan of India in Damodar, resulted the formation of Damodar Valley Corporation (DVC). Examination of actual inflow and outflow data for the two terminal dams of DVC at Maithon and Panchet show that significant flood moderation has been achieved during the past years due to the construction of the dams, reservoirs, barrage in Damodar- Baraka river system. It has been noticed from the available data that the performance of these reservoirs in terms of flood moderation has been achieved to the extent of 53 to 80% in the high flood years. Detailed examination of flow data as available at Rhondia, near Durgapur revealed that maximum flow of 650,000 cusec (18406 cumec) had occurred twice in August 1913 and August 1935 before the implementation of DVC. The data from two terminal reservoirs show that major floods nearing or exceeding this maximum observed flow of 18406 cumec occurred only in 1959,1978 and 1995. During 1959, the peak inflow into the reservoirs was 17,641 cumec which was moderated to 8155 cumec. It has been estimated by DVC that had there been no dams, below Durgapur a flood of 22,937 cumec would have been experienced which was much higher than the highest recorded i.e.18406 cumec till that date. The 1978 was an all-time high with a combined inflow peak of 21,900 cumec. If this peak was allowed to pass without any flood moderation, it would have generated a probable peak of 33,414 cumec at Durgapur barrage.

Table-2 ***Dams having impact on important West Bengal Rivers***

Name of dam	Year of Completion	River	Length of Dam	Reservoir area	Effective Storage Capacity	Purpose
			M	10^3 m^3	10^3 m^3	
Tiliya	1953	Barakar	360.00	12460.00	75000.00	I/H
Konar	1955	Konar	3806.00	24030.00	236920.00	I/H
Maithan	1957	Barakar	4789.00	107000.00	605100.00	I/H/S/C
Panchat Hill	1959	Damodar	6777.00	153000.00	250900.00	I/H/S/C
Tenughat	1978	Damodar	6494.00	64780.00	999920.00	I/S/H
Massanjore	1955	Mayurakshi	661.00	22070.00	549130.00	I/H
Kangsabati Kumari	1965	Kangsabati Kumari	10400.00	124320.00	900400.00	I

(Source: National Register of Large Dams 2002. Govt. of India, Central Water Commission.)

Abbreviation :,Irrigation : I Hydel : H, Flood contrl : C W.Supply : S , Navigation : N, Pisc.culture : F

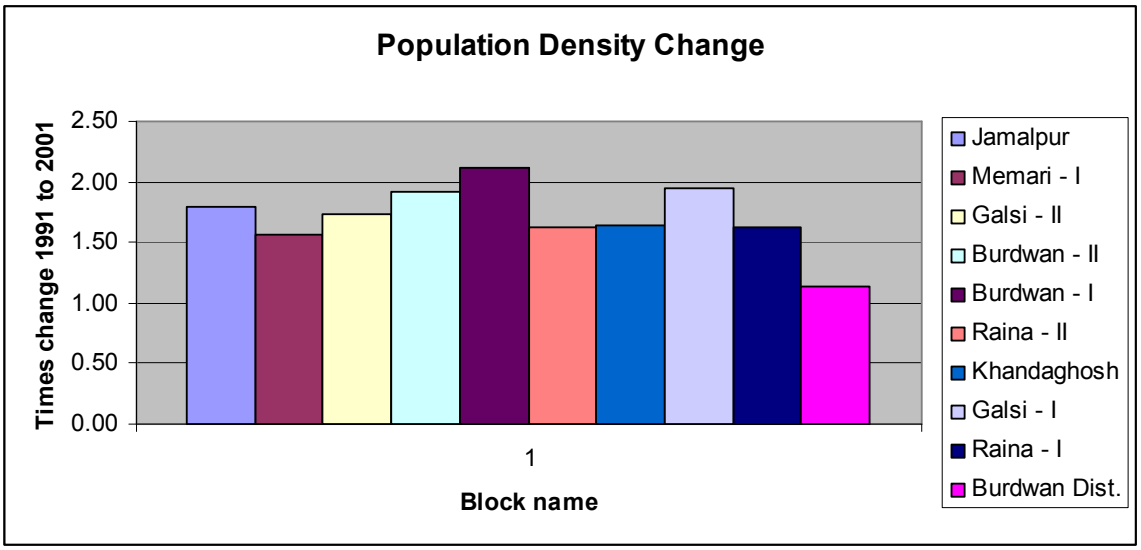
Due to the high fertility and canal irrigation in the Damodar downstream floodplain area coupled with above flood moderation shows high population growth rate resulting rapid changes in landuse pattern. In the study, the population growth on the nine blocks situated in the Barddhaman District in Damodar floodplain areas, Map-1, shows the rapid population growth. In 1991 Barddhaman district population density was higher than all these nine blocks but in 2001 all these blocks shows higher population growth rate from 111% in Barddhaman-1 block and 55% in Memari-I block whereas in Barddhaman district decadal population growth rate is only 14%, refer table-3.

Table-3 ***Population Density in selected Blocks of Barddhaman District***

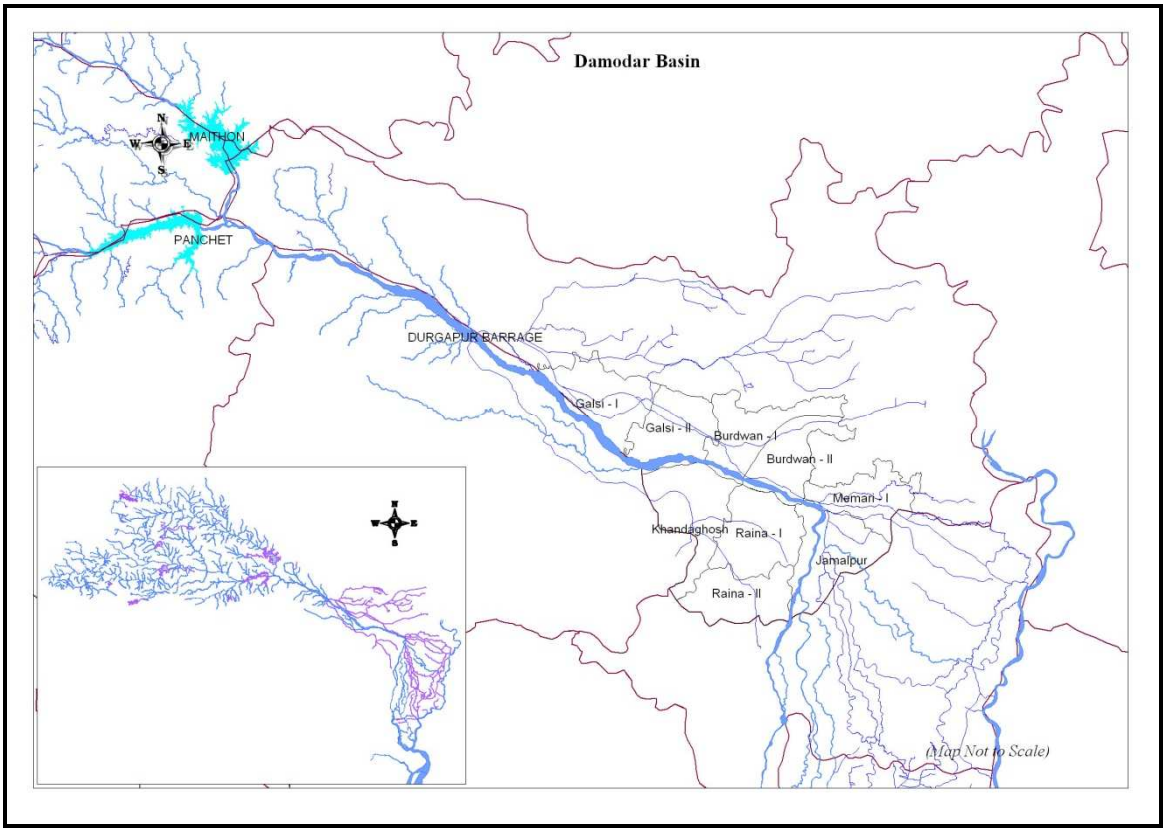
Name of the Block	Area Sq km	Population 2001	Density /SqKm 2001	Population 1991	Density /SqKm 1991	Decadal Population growth % (1991-2001)
Jamalpur	263.02	243397	925	135670	516	79
Memari – I	186.91	198278	1061	127249	681	56
Galsi – II	219.09	133977	612	77426	353	73
Burdwan – II	189.57	138897	733	72603	383	91
Burdwan – I	250.41	179828	718	85190	340	11
Raina – II	227.28	137337	604	84342	371	63
Khandaghosh	265.23	170331	642	103343	390	65
Galsi – I	257.37	174123	677	89665	348	94
Raina – I	266.07	162923	612	99913	376	63
Barddhaman Dist.	**7024**	**6895514**	**982**	**6050605**	**861**	14

The analysis also shows that the decadal change of population density of Barddhaman district is 1.14 times where as all the nine blocks shows huge changes from 2.11 times in Barddhaman-1 block to 1.56 in Memari-1, refer Figure-1.

Figure-1



Map-1



It is true that due to structural interventions flood moderation has taken place during last 50 years but it has not been able to contain flood completely. On the other hand the statistics of flood that occurred during last 41 years (from 1960 - 2000) in West Bengal shows that only on 5 occasions the state has not faced any severe flood. The total devastated area crossed 20,000 sq. km in 4 different years and the flood of medium magnitude i.e. between 2,000 to 10,000 sq. km. occurred on 10 occasions refer table-5 below:

Table-5 ***Year wise Flood impact in West Bengal***

Flood affected area (in sq. km)	Years during which the flood occurred
Below 500	1985, 89, 92, 94 & 97
Between 500 – 2000	1962, 63, 64, 65, 66, 72, 75 & 96
2000 – 5000	1960, 61, 67, 69, 70, 74, 76, 80, 81 & 82
5000 – 10000	1973, 77, 93, 95 & 98
10000 – 15000	1968, 79, 83, 90 & 99
15000 – 20000	1971, 86, 87 & 88
Above 20000	1978, 84, 91 & 2000

Source: (Irrigation and Waterways Dept. Govt. of West Bengal Website)

The highest affected area of flood as recorded in 1978 is about 30,607sq.km. About 23,970 sq.kms of area were devastated by flood in 2000.

From the above it is clear that flood is a natural event in geological time sale on the riparian system. To avoid the flood hazards in human time scale mainly structural interventions like dam, reservoirs and embankments are built along these rivers during last few decades. This has moderated the flood to certain extent but this has also changed the sediment water balance of the river system due to less flow in downstream areas affecting various downstream ecosystems including wetland and estuary. With less flow in the river channel and high fertility of younger floodplains in the downstream areas the rapid population growth with huge developmental activities has taken place in the absence of any Govt. level policy on floodplain landuse. Rapid encroachment of river beds/ drainage channels there by obstructing the natural path of the river/ drainage artery has become a common phenomenon in West Bengal. The changes of the Ichamati river floodplain and encroachment of its channel is a glaring example. The reduction of Damodar water flow in downstream of Durgapur created large channel bar like 'Bara Mana' which during last two decades turned out to be large human settlement. But the flood in different rivers continues and the capacity of the reservoirs are slowly reducing with higher rate of siltation as well as the effective river channels are reduced due to low annual stream flow and human encroachment. Such changes are leading towards larger calamity and damages in future high flood situation which has already has been emphatically underlined during West Bengal flood 2000.

Floodplain & Water Policy

From the above analysis it is evident that an immediate strategy supported by state and national level water policy is necessary to prevent further disasters. In any national water policy it is important to incorporate the economy-ecology relationship in the time perspective. It is

important to note that necessity of development is very important for growing Indian economy but conservation of ecology and environment is also equally important. Striking a balance between these two is the key of any water policy. Water Framework Directive (WFD) is the most influential piece of water policy in Europe. This policy, for the members of the European Union, has shifted the policy from addressing individual problems to integrated river basin management. At the heart of the directive, detailed plans are being made to fix and achieve the objectives for the water bodies within each river basin. The WFD does not address the flood management directly but, due to the link between the ecological status and the hydro-morphological structure of a river, the WFD will in many cases require the restoration of river and coastal hydro-morphology. This provides a unique opportunity for the restoration of floodplain areas as well as moderation of flood effects. In the West Bengal and many other state context such approach is necessary for the restoration of healthy river system.

National Water Policy, 2002, India is based on two objectives viz. conservation of water to its maximum as per availability and proper and needful utilization of this very important renewable natural resource. In India water is a state subject except in the case of dispute among states sharing the water of an interstate river. Incidentally most of the large rivers are interstate and transnational rivers. Proper scientific conservation needs the larger ecological support. In the policy proper emphasis on River basin Management with holistic approach on sustainable ecology is necessary. Under section 3.1 of the National Water Policy it is stated clearly that 'Water resources available to the country should be brought within the category of utilizable resources to the maximum possible extent'. In section 4.2 it also specifies that 'Appropriate river basin organisations should be established for the planned development and management of a river basin as a whole or sub-basins, wherever necessary. Special multi-disciplinary units should be set up to prepare comprehensive plans taking into account not only the needs of irrigation but also harmonising various other water uses, so that the available water resources are determined and put to optimum use having regard to existing agreements or awards of Tribunals under the relevant laws. The scope and powers of the river basin organizations shall be decided by the basin states themselves.' The policy neither is looking the river basin from part of holistic riparian system approach nor does it specify how such plan will be integrated with the participating states various plans across the river basin particularly for extensive development plans in floodplain areas. Flood prone states like West Bengal also have not adopted any such comprehensive river basin policy at state level to counter the future disasters whereas they have formulated a disaster management policy based on primarily the flood hazards common in West Bengal.

A National Programme of Flood Management was launched in India after the disastrous flood of 1954. The flood control measures adopted in the programme include structural measures like construction of reservoirs, embankments, drainage improvement works etc., and non-structural measures like flood plain zoning, flood proofing, flood forecasting etc. But unfortunately in successive years the structural measures got importance the table-2 shows the Dams and Reservoirs built in post independent India which has direct impact on West Bengal rivers. The problems related to the land use of floodplain areas are well known to the authority. The National Commission on Flood (Rastriya Bar Ayog), 1980 in its recommendation suggested that there has to be a legislation delineating the areas likely to be flooded according to its likely

chances of occurrence (return period) and its measurable intensity i.e. the depth of water that is likely to be accumulated over the marked area. Based on this data a list of developmental activities will be identified as restricted and not to be taken up in that area because of flood proneness. On this issue, Government of India, long back suggested a model bill. Till date no progress could be achieved on the same. The absence of such measures shows lack of awareness of stakeholders resulting lack of political will. Flood plain zoning another important nonstructural measure is necessary in categorizing various zones based on administrative legislations for planning and development of the flood plains for various purposes such as agricultural activities, play fields, industrial areas and residential areas etc. Preparation of flood plain zoning maps takes into consideration the inputs from flood inundation, flood hazard and flood risk zone maps (NIH, 1988-89). The important aspect of zoning is that it can be used to regulate what uses may be conducted and how uses are to be constructed or carried out. Zoning is also used to restrict riverine or coastal areas to particular uses, specify where the uses may be located and establish minimum elevation or flood proofing requirements for the uses.

From the WFD policy guidelines we observe that economy has been considered as part of the total system and the policy was guided accordingly. The suitable emphases on the downstream ecologies are not addressed properly in our national policy but many peoples' livelihood is based on these ecologies like downstream fisheries, wetland and estuary. The 17th directive of the WFD says that 'An effective and coherent water policy must take account of the vulnerability of aquatic ecosystems located near the coast and estuaries or in gulfs or relatively closed seas, as their equilibrium is strongly influenced by the quality of inland waters flowing into them. Protection of water status within river basins will provide economic benefits by contributing towards the protection of fish populations, including coastal fish populations.'

The rapid changes are taking place in the floodplains of West Bengal in a very short span of time but no proper planning and management practices are present to counter the impact of these changes on a large number of riparian systems. It is necessary to formulate a well thought out strategy about the floodplain management policy immediately. A water policy covering Integrated River Basin Management philosophy balancing the developmental need and ecological sustainability is the need of the hour.

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