Chapter 1
Basics of River Flood

Key Word: Phases of Flood, Flood Scenario of Bengal, Historical Back ground, Location of the study area, Hypothesis, Importance, Methods of Study

1.1 Introduction

Flood is simply defined as spilling of water body over normal level of discharge. In other word flood refers as discharge of water above stream capacity. Flood is a natural hazard which occurs in response to heavy rainfall but now a day due to extreme human interferences the intensity of flood has increased many times. Ven Te Chow (1956) defined floods as “a relatively high flow which overtakes the natural channel provided for runoff.” Ward (1978) defined a flood as, “a body of water which rises to overflow land which is not normally submerged.” The major characteristics of flood are follows-

(1) **Phase of flood:** according to Hoyte (1955) there are three phases of flood followed one by other, (a) land phase - during this phase precipitation and melting snow are absorbed in the surface storage. This phase works as the beginning of the (b) flood phase which quickly follows the (c) channel phase when additional amount of water falls directly into the river. During this phase the height of the runoff increases constantly.

(2)**Flood elevation** i.e. the height reached by excess flow during peak discharge.

(3)**Flood discharge:** the total amount of discharge of water of the channel is maximum.

(5) **Flood volume:** it can be determined by measuring the difference of the amount of water in the storage in the beginning and the end of the flood plus the volume of water which passes through the dams and reservoirs during the same period.
(4) **Duration of flood**: it is the time taken by the flood. Mainly in the confluence catchment area where drainage condition is very poor the duration of flood is more and effect of flood in surrounding area are wide spread.

The recurrence of the extreme precipitation anomalies that result in floods or droughts is a normal component of natural climate variability. The adverse effects of floods and droughts often entail far-reaching socio-economic and environmental implications, and may include loss of life and property; mass migration of people and animals; environmental degradation; and shortages of food, energy, water and other basic needs. The degree of vulnerability to such natural hazards is high in developing countries where necessity tends to force the poor to occupy the most vulnerable areas. The vulnerability of developed countries increases with economic growth and the accumulation of property in flood-prone areas and in highly urbanized settings.

Natural disasters cause much misery, especially in developing countries where they cause great stress among low-income economies. Approximately 70 per cent of all global disasters are linked to hydro-meteorological events. Flooding poses one of the greatest natural risks to sustainable development. Flood losses reduce the asset base of households, communities and societies through the destruction of standing crops, dwellings, infrastructure, machinery and buildings, quite apart from the tragic loss of life.

There are beneficial reasons to living in the vicinity of a stream or river that is prone to flooding. The water can provide a means of transportation for both commercial and recreational purposes. The river provides both a source of water, and a means of simple waste disposal. These areas also provide valuable resources in terms of fish and other natural resources. The nearby soil is often very fertile, allowing for easy and efficient agricultural production. In many instances, the environmental and demographic pressures upon the landscape simply make it impossible to settle in any other area (Kundzewicz et al. 2002, Philippi 1996). Because of the fact that people have settled in, and continue to occupy these vulnerable areas, flooding has been a problem in the past, and will continue to persist as a hazard in the future.
In some cases, the effect of extreme flooding is dramatic, not only at the individual household level, but in the country as a whole. While the 2005 floods in Switzerland, representing the worst single loss event in the country since systematic records began, amounted to less than 1 per cent of gross domestic product (GDP), this figure regularly rises above 10% in developing economies, especially when floods occur as part of tropical cyclones (Federal Office for the Environment of Switzerland, 2007). In addition, the assessment of floods on a piecemeal basis, rather than holistically, may limit the usefulness of the effort.

The National Commission on Floods (1980) assessed the flood prone area in India as 40 million ha (12% of the total area). Out of the total area liable to floods, about 80% (32 million ha) could be provided with reasonable protection, and about half of this surface has so far been provided with a reasonable protection through various means of flood management measures.

An understanding of the interplay between floods, the development process and poverty is vital in order to ascertain the way in which current and future development processes can and do increase flood risk. A population might be poor because it is exposed to flooding or it might be exposed to flooding because it is poor and occupies the most vulnerable land. The appropriate method of intervention will differ according to which diagnosis is correct. Further, a community with a weak asset base and few multipliers of community well-being is exposed to many different disturbances, some of which may have a greater impact than floods. Decision-makers and development planners at all echelons need to be sensitive to this prospect. Risk is a amalgamation of the chance of a particular event, with the impact the event would cause if it occurred. Risk therefore has two components, the chance (or probability) of an event occurring and the impact (or consequence) associated with that event. The consequence of the event may be either desirable or undesirable.

Flood is undoubtedly the most awful natural calamity of Eastern India where it becomes almost an annual phenomenon. The worst affected state of this part of India is West Bengal where 55.43 percent of total geographical area is flood prone. According to the Government report 2000, the most remarkable flood, about 2.21 crores of population was affected and the total estimated loss was Rs. 5660.65 crores. It is important to note that spatial dimension of the flood affected area is being increased significantly and the damages they render are pervasive and long term. Flood
devastation and flood loss of Mayurakshi, Ajay, Damodar etc. neighbouring river of Birbhum, Burdwan and Murshidabad districts of West Bengal stimulates this state to be one of the top rankers flood propones state.

From the early ages large number of flood controlling measures has been taken in the river valleys of Eastern India but now a days people feel that human intervention in the river valley have changed the hydrological regime of the rivers of South Bengal and these may be the cause of the flood related disasters of Bengal. The present alleviation measures like the increase of the height of the embankment, repairing of embankment, aforestation in the upper catchment, adopted by the local governments turns into failure and it seems to give a false security to the bank dwellers. Sir William Wilcox (1930) accused the riverside embankments as satanic chains and proposed canal for draining out the floodwater. Prof. M.N.Saha (1935) was also concerned about the effect of embankments on the hydrological character of the rivers while explaining the causes of the flood of Bengal, Mr. S.C. Majumdar (1941), the eminent engineer warned about the long term effect of embankment and stated “construction of embankment as flood controlling measures would be like mortgaging the future generations to derive some temporary benefits for the present generation”. But at the present 21st century dams and embankments are considered as flood relieving measures, often these are designed abysmally poor knowledge of the hydrological character of the rivers (Pearce, 2001). Flood effect not only disturbs the immediate human settings, but it also disturbs the human activities bringing the some post flood hazards like sand splay, sand terrace, wetland clogging, loss of soil fertility and damage of productivity etc.

In west Bengal the intensity of flood in southern and middle portion is more because of increase of height of channel bed due to huge deposition and poor drainage condition and constriction of dam and barrage along river. In northern portion the frequency of flood is very low.

There are many instances of floods that have modified river channels and flood plains in significant ways (Kale, 2003). On some rivers the effects of large floods tend to persist for longer periods. Several recent studies have described the geomorphic effects of monsoon floods in terms of bank failure and channel widening, avulsion and large scale sediment transport (Kale, 2003, Kotoky, et.al., 2003; Mitra, et.al., 2005; Sinha 2005; Sarma 2005).
The efficacy of extreme flood of three extraordinary floods of the 20th century in the Indian peninsular was evaluated by Kale (2007). The estimates indicate that the peak unit stream power values and the total energy expended during each flood were respectively in the range of 290-325 Wm^-2 and 65-160 mega joules. The average and peak flood powers were found to be higher or comparable to those estimated for extreme palaeo or modern floods on low gradient alluvial rivers.

1.2 History of Flood of Mayurakshi River Basin

L.S.S. O'Malley recorded some historically important events of flood in the Bengal District Gazetteers for the districts of Murshidabad and Birbhum. For the district of Birbhum, O'Malley has noted "in 1787 there was a high flood which it is said, in some places swept off villages, inhabitants and cattle, the crops on the ground, with everything that was moveable." O'Malley also recorded that "in 1806 the Mor (Mayurakshi) had a sudden extraordinary rise and floods washed away whole villages." This flood occurred between 28th to 30th of September. In September 1902, because of heavy rains in the preceding 24hrs the Bramhani and the Mor rose rapidly overflowing their banks and inundated the surrounding country in some places to the depth of 2.5 m. to 4m. All these incidents were recorded by O'Malley in the District Gazetteer of Birbhum.

On Murshidabad flood situation, O'Malley states that the earliest recorded flood in Calcutta Gazette was on 29th September 1785. Serious floods have occurred in the years of 1823, 1834, 1838, 1848, 1856 and 1866. There were heavy floods in 1885 and 1890. According to him in 1885, the embankment breached (Bhagirathi Embankment at Lalitakuri) on 23rd August and water passed through it until end of September. After that unusual high flood occurred in 1913, 1914 causing serious loss of life and property, damage to standing crops, seeds and houses. Some other consequent flood events were 1932, 1956, 1978, 1985, 1992, 1995, 1998, 1999, 2000, 2002, 2006, 2007 etc. The English district officer took immediate steps to help the people, suspension of revenue collection was ordered in all the flood-affected areas. In the nineteenth century some embankments were scatteredly constructed by the then zamindars but that were not technically maintained. During zamindary period silt and clay laden floodwater have brought into the agricultural field
by cutting of embankment for maintaining natural fertility. But now the flood magnitudes and damages have severe effect on the dwellers especially at the breaching point of the embankments.

The above history recorded here is comparable to flood 2000 of this region and dispels doubts raised by recent propaganda about causes of flood 2000 particularly in the districts of Murshidabd, Birbhum and Nadia.

1.3 Origin of the Research Problem

Man exists in an essentially ecological relationship with his environment and has to live with a variety of natural hazards, which threaten life and property. So such hazards are the function of both geophysical world and human society. Physically, river floods represent the most common global hazard encompassing a wide range of events like largely unpredictable, highly localized flash floods to anticipated and widespread floods.

A flood may be defined as a discharge, which exceeds the channel capacity of a river and then proceeds to inundate the adjacent floodplain. Since man is unable to control the basic atmospheric processes that produce most floods, he has attempted to adjust to the hazard by means of flood abatement projects by the application of high technology and investing the huge capital.

Now a days the river geomorphologists are trying to reveal that along with the physical factors human interferences into the riparian corridor have direct and indirect impact on the increasing rate of downstream peak flows which leads to substantial increase in the annual damage caused by floods. The last decade of the twentieth century witnessed major flood hazard zones over the countries of Asia, in which India, along with Bangladesh, is one of the worst flood affected countries of Asia, the annual debility of floods claims on average of Rs. 7.7 billion.

Annually the state of West Bengal of Eastern India is hit by flood from numerous rivers, which have crisscrossed the state to high degree. This flood quite naturally arises from huge fluxes of water due to monsoonal rain; moreover, pre and post monsoonal cyclones pose considerable threat to this flood situation. The human intervention in the river regime is also considered as the
major factor of the menace flood situation of the state. River-side embankments not only create sedimentation in the riverbed but also the spilled flood-water cannot be drained out by these channels even long after the flood period. Along with the above problems due to the gradual decreasing of the water storage capacity the excess water is allowed to flow downstream from the dams & barrages during monsoonal season.

Every year the state of West Bengal spends cores of rupees in the annual flooding of the state. In 1950s areas within 55 ft contour were flooded. In 1978 areas enveloped within 85 ft contour were flooded. But now (2006) the flood level reached on alarming height of 225 ft. This expansion of flooded areas continues unabated in the face of steadily increasing expenditure on the flood management.

The Mayurakshi river basin of West Bengal has experienced devastating floods since time immemorial. The nature and extent of present flood is changed as well as its magnitude getting increased significantly. The existing flood abatement strategies of this area are not sufficient enough to mitigate the devastation of the floods and the bank dwellers felt insecure during the monsoon season. In the second half of the nineteenth century, like all other parts of India, many large engineering schemes like Massanjore dam (constructed on 1954) and Tilpara barrage (constructed on 1971) and long embankments have been implemented on the river which led to intensive modifications of river flow. But actually the dynamic nature of the flood character of the river Mayurakshi and the underlying causes of the flood hazards are yet to be examined thoroughly.

The political economic imperative of constructing embankments as common measures for flood control has often increased the period and extent of inundation. Serious gaps in scientific knowledge like underestimation of sediment load in river, have led to the reduction of the wetted perimeter and major changes in river cross-section. This has led to the decreasing of the carrying capacity and efficacy of the embankments resulting in a new genre of flood hazards like frequent breaching of embankment. The extensive water logging has reduced both the arable land and abets epidemics in the lower reach of the river basin.
1.4 Interdisciplinary Relevance

The present study requires an interdisciplinary effort for the development of a widely acceptable strategy, in which economists, sociologists, agronomists, hydrologists and Earth scientists all participate to expand the interdisciplinary perspectives to provide sustainable solutions to the complex challenges of water management. For the designing of the flood control measures it is necessary to acquire the basic concept of dynamic hydrological character of the rivers in response to the changing meteorological condition. So, in this field the responsibility of the hydrologists, climatologists and river geomorphologists with technical scientific background can not be ignored. Understanding flow related links between the hydrological cycle and riparian ecosystem is a prerequisite for implementing practical actions on flow management. Along with the structural schemes of the engineers some non-structural or behavioral group of schemes are generally required for the investment of more active policies that need the expert views of the sociologists. The most important contributions, both good and worse, of the annual inundation episodes are on the agrarian economy of the villages; the involvement of the soil scientists and the agronomists cannot be ignored. The emerging philosophy of science will consider the traditional practices, perception of the people and the psychology of the bank dwellers for reaching the solution of flood management problems.

1.5 Literature Review on Flood Related Issues

Assessment of hydro geonomic characteristics of flood is an extremely broad topic, and there exist numerous facets and foci to the discipline. The structure of this literature review follows a track from a broad discussion of the discipline in general, to a more narrow focus upon the study area of this research. I will begin with the concept of flooding as a natural process, and transition into the impacts of flooding in terms of hydro morphological character of the river and the human occupation of the floodplain. Then, I will briefly cover a few flood abatement strategies in structural and non structural way that are of importance to this research.

Floodplains are the lowland areas adjoining the channels of rivers, streams, and other watercourses (Dunne and Leopold 1978). There are two major mechanisms that work conjointly to form floodplains. As a river flows, it shifts horizontally across the landscape, in the process creating a series of bends, or meanders in the channel. The water velocity in the channel is fastest
along the cut bank, or the outside bank of the meander, thus causing bank erosion. Conversely, the velocity is slowest along the inside bank, or point bar, allowing for the deposition of sediment. The continued deposition of sediment over time, along with the associated growth of the point bar, forms the floodplain. The second impetus for floodplain formation and growth occurs when a watercourse overflows its channel during times of high flow. As the water spills over the channel banks and inundates the surrounding lands, it deposits sediment onto the floodplain (Leopold 1994). Since these areas are periodically inundated by high flows of water, they provide a number of important ecological functions. These functions include contributing to the physical and biological support of the ecosystem, providing natural flood and erosion control, sustaining high levels of water quality, and recharging groundwater supplies (Kusler and Larson 1993). Floodplains contribute greatly to the physical and biological support of ecosystems. From an ecological standpoint, these areas act as an ecotone, or boundary, between terrestrial and aquatic ecosystems. They contain greater numbers of species of plants and animals than any other ecosystem, due to the high biological productivity of the nutrient-laden soils. In semi-arid regions, floodplains provide a vital source of water for sustaining vegetation, along with functioning as a stopover for migrating species (Tocker and Stanford 2002). Floodplains also provide natural flood and erosion control. They contain floods during periods of high flow, and the continuous deposition of sediment by the watercourse acts as a natural barrier against erosion. Additionally, floodplains increase groundwater quality by acting as a natural filter against both man-made and natural pollutants such as sewage and nitrogen. Finally, these areas serve as a vital source of groundwater replenishment in areas where the subsurface is not conducive to percolation and recharge. It has been estimated that the total value of ecological services provided by floodplains in the United States is $19,580/hectare/year (Tocker and Stanford 2002).

A flood is defined as a high flow of water that overtops either the natural or artificial banks of a river or other watercourse, and inundates the floodplain. When the water surface in a channel is at the level of the floodplain, it is termed to be at bankfull discharge. This is the discharge that is most effective in terms of channel formation for the watercourse, and has been empirically determined to have a 1.5 year recurrence interval. Hence, from a geomorphic standpoint, a flood occurs when the river is flowing at a greater rate than bankfull discharge (Leopold 1994, Dunne...
and Leopold 1978). Although local topography and geographic characteristics can play a major role in the creation of flooding, from a hydrological standpoint, excessive rainfall is the most influential mechanism of flood generation. All soil has a specific infiltration capacity, or the maximum rate at which the soil can absorb water. If precipitation rates exceed the infiltration capacity of the soil, storm runoff is generated. The volume and timing of storm runoff dictates the type of flooding that will occur (Dunne and Leopold 1978). Precipitation-based floods can be generated in two ways. As commonly occurs in large watersheds, a low-intensity long duration rain event can create flooding. This is flooding that occurs over weeks, and in some cases, even months. The flood hydrograph (the ratio of stream discharge over time) is fairly flat, implying that the waters rise and recede slowly. Floods of this variety are often predictable seasonal events, closely following the yearly precipitation characteristics of an area (Smith 2001). For the purposes of this research, this type of flooding will be referred to as riverine flooding.

The second catalyst for the creation of a flood event is a high-intensity rain event occurring over a short temporal scale. Events such as this create an extremely sharp flood hydrograph. Stream discharges can be just as great as in a slow-onset flood, but the flooding occurs over only a matter of hours or days, and is normally confined to a much smaller spatial scale (Smith 2001, AMS 2000). Floods such as this are termed flash floods, as the drainage basin is said to be flashy if the peak discharge of the river rises extremely rapidly (Tobin and Montz 1997). Loss of life is often higher in flash floods due to their fast onset, and the lack of warning and preparation time for those in the affected area.

From the very early ages geographers, economist, agronomist, ecologists have given much attention on the causes and abatement strategies of flood both national and international level. During the end of 1950 and early 1960 US senate selected a committee on National Resources and published many reports on Water Resources Activities in the monograph U.S : Future needs for navigation (from 1956 to 1960) U.S Govt. printing office, Washington DC. Discussions on the various multipurpose river valley projects of US were made in the proceedings of the WMO/UNESCO symposium on Hydrological Forecasting (1967), World Meteorological Organization. Research articles on the various flood problems of US including the effects of urbanization, changing land use problems, dearth of hydrological knowledge etc. were published
by the University of Chicago (1961). Along with the published books since 1970 so many research articles on the causes and effects of floods of different small and large basins have published in different journals of Hydrology, Meteorology, Water Engineers, Institute of Civil Engineers, Geography. Ward R.C. (1978) has identified the various causes of floods and the nature of flood processes that vary spatially and temporally within a drainage basin with their locations and magnitudes.

After 1980 various research papers on flood warning systems and methods of hydrological forecasting were published by the World Meteorological organization. The Inter-agency Flood plain Management Committee was established in 1994 and formulated some post flood policies after a prolonged and huge flood of Mississippi river in 1993. Their main focus was to make a comprehensive flood reduction plan through watershed management programmes. But gradually the concept of abatement strategies is being changed. Along with the study of structural and nonstructural strategies another branch of study becomes dominate that is the human responses to flood.

International Geographical Union established a commission on ‘Man and Environment’ in which they constantly maintained an attitude of social involvement in hazard management programmes. Now a days stresses have given much more on the public participation in decision making procedures. Common Implementation Strategy for the Water Framework Directive (2000/60E-C) has established at U.K. An organization in the name of Flood Plain Management Association (FMA) of U.K. provides link between the research data and information on river flooding and the public opinion regarding the management programme. A Contextual model of hazard response decision making was stated by Penning Rowsell, Parker and Hardings (1996) in an article ‘Flood hazard response in Argentina’, The geographical Review 86,(1), New York.

Currently it is proved by the river geomorphologists that encroachment of the human beings on flood plain and different land use activities have significantly disturbed the ecosystem of the flood plains. E.E. Wohl (2000a) in his article ‘Anthropogenic Impacts on flood hazards (Ed book Inland Flood Hazards- human, riparian and aquatic communities, Edinburgh Cambridge University press) has given stress on the anthropogenic alterations of river regime and morphology. According to him flood - mitigating measures must have interconnections between floods, river channels and riparian corridors.

Z.W. Kundzewicz (2002) has explained the causes and effect of some major flood hazards of some countries of South Asia. According to him the last decade of the twentieth century witnessed about two dozen flood disasters which resulted in loss of more than one thousand human lives or in material losses exceeding US$ one billion. He viewed flood not as a hazard but as a natural process and the managements of flood waters should be treated by the interdisciplinary perception.


Najing Hydraulic Research Institute of China has suggested (2004) some measures as flood management programmes for a country like China where the densely inhabitation in limited flood prone areas develop social conflicts. Participatory planning approach in flood mitigation has been proposed by Zang Hailun and Weng Kang in article (2008) on ‘Flood control and management for larger rivers in China’. The new fund raising system has been approached by encouraging the investment from the enterprises, private sectors, foreign investors and the peasants in the form of labour contribution. People in lowland of Bangladesh have developed many virtual coping strategies through their enduring experiences of living with annual normal floods or severe floods. Some experiences have discussed by M. Nasreen (1999) ‘Coping with floods: structural measures or survival strategies’ and by N. Islam (1999). The new evolving concept of living with floods represents a holistic, locally based, participatory and integrated approach that recognizes the importance of floods in maintaining ecosystem and their role in human society.
So in this international context the present research programme is a relevant concept that removes the gap between the technological knowledge and the sufferings of the flood victims.

Flood is undoubtedly the most dreadful natural calamity in India, specially in Eastern India. In order to ensure sustainable development of national economy a nationwide flood control management as well as flood disaster reduction system must be introduced.

From the early ages large numbers of academic articles have published in renowned books, scientific as well as popular journals on the hydrological problems of the rivers, pattern of regional variability, review of the existing management programmes, future needs of flood management etc.

Some noted Govt documents on the floods and river systems of West Bengal are very relevant in the present context. W.A Ingles (1909), Chief Engineer, public works Dept has vividly described the conditions of the then existing various schemes of canals at Bihar, Bengal and Orissa in a famous article ‘The canals and flood banks of Bengal’, pub by the Bengal Secretariat Press (not for sale). He made a discussion on the embankment of Damodar citing the views of Lieutanant Beadle, Secretary to the Military Board, Mr. E Drummond, Collector of Burdwan on the removal of right embankment of the river.

In the writings of James Fergusson (1912) “a picture of the changing courses of the Ganges delta and the report of some old floods” has unveiled, published by Bengal Secretariat Press. Human interventions in the river valley have changed the hydrological regime of the rivers of South Bengal and may be considered as the principle causes of the flood hazard of Bengal. Sir William Wilcox (1930) while dealing the flood problem of lower Damodar accused the river side embankments as the ‘Satanic chains’ in his article ‘Ancient System of Irrigation in Bengal’, pub. by University of Calcutta, and proposed the canals for draining out the flood water. Prof.M.N.Saha (1935) was also concerned about the obnoxious effect of dams and embankments on the hydrological character of the rivers while explaining the causes of the flood problems of Bengal (Collected Works of M.N.Saha Vol I).

Mr. S.C. Majumdar (1941),the eminent engineer, warned about the long term effect of embankment and he stated “….construction of flood embankment as a flood control measure
would be like mortgaging the future generations to derive some temporary benefits for the present generation”, Rivers of the Bengal Delta, Calcutta University. He also asserted that no river can be permanently maintained by dredging especially the tropical rivers with high ranges of flood discharge. Approving the memorandum by the Central and State Govt. of West Bengal and Bihar, Damodar Valley Corporation came into existence on July 7, 1948. This was the first attempt of the country and Pandit Jawarlal Nehru referred it as the ‘Temple of India’. But due to several causes this scheme has not given the expectable result for protecting the lower valley from flood ravages and the area lies expose to flood to almost every year. K.G. Bagchi (1942) has an excellent work on ‘The Damodar Valley Development and its impact on the region’, Mc.Grew Hill, New Delhi.

It must be kept in mind that floods are perceived as hazards in modern societies where men invite risk upon themselves through the encroachment of floodplains for settlement, industry and infrastructure. The earliest human settlements on the foothills and the fertile floodplains evolved intelligent ways of adapting to the wide variation in the river flows (J. Bandyapadhyay & D. Gyawali 1994, Himalayan Water Resources, Ecological and Political Aspects of management, Mountain Research and Development 14, 1).

Dams and storage reservoirs are chosen to perform multiple functions but the questions of viability have arisen (Report on the Rashtriyo Barh Ayog, National commission on Floods, Vol I, New Delhi, Govt of India, Ministry of Energy and Irrigation). Dams are often designed based on abysmally poor knowledge and information about the long term hydrology of the rivers which develop the need of development of the database for each and every river basins of our country. So, despite the remit to guard against flooding, even specially designed large storage reservoirs like those on the Damodar system, the Ukai, the Kangsabati, the Hirakud etc may not eliminate floods altogether (N.R. Sengupta, R. Rangachari, P. Banerjee, S. Singh, 2000, Large Dams: India’s Experience, Report on World Commission on Dams). A number of large storage reservoirs in India have been predicted to become inoperative by the year 2050 owing to high rate of sedimentation. The loss in live storage capacity of 46 reservoirs surveyed by Central Water Commission 1990 is thus estimated to be 65 km³, which is 17% of the total storage.

For centuries flood protection embankments have been constructed in the densely populated delta areas of Godavari, Cauvery and Krishna in south India, in the Gangetic plain extending from north to east India. But these embankments not only confined the voluminous flood flow reducing the river’s natural spill area, but also entrapped the enormous sediment load within the river bed. This has reduced the carrying capacity and efficacy of the embankments resulting in a new genre of flood hazards by frequent breaching of the embankments. Resulting effects are the sudden encroachment of flood water within the villages, prolonged retention of flood water and formation of extensive water logging areas as occurred in riverine region of Bengal and Bihar.

At present, with the aid of GIS and Remote Sensing techniques flood hazard mapping, sedimentation study of the reservoirs, flood morphological studies with its changing hydro-morphological patterns have been going on for creating long term data base on flood proneness, risk assessment and relief management. Various private and Govt. organizations are involved in such work sporadically. A study on the floods of 2000 on West Bengal using Remote sensing satellite data was done by S.K Bhan & the team. (Jr. of Indian Society of Remote Sensing, Vol. 29, No 1 & 2, 2001)

In this context it can be stated finally there is an urgent need to store systematically the available flood related data through computerization and also to make updating of the data. Some flood related studies on the neighbouring river basins like Damodar river, Ajoy river of Rarh Bengal have done but no such in depth study on the hydrological characters of the river Mayurakhshi has yet been done.

Following the present international trend of research a perception study along the river Mayurakshi on flood was done by Prof. M. Mukhopadhyay (River floods: A socio technical Approach, Ed. Vol. 2005 Visva-Bharati). Common people’s active participation in flood management is highly accepted by all the countries of south - East Asia.

In addition to the above mentioned studies and management programmes the present geoeconomic approach will lead us to a synergism system of management programme through
people participation. This study will enhance the self-confidence and the admiration on the indigenous environment of the bank dwellers.

1.6 Location and Extension of the Study Area

The Mayurakshi River, a tributary of Bhagirathi is a well known name in the river scenario of West Bengal and Jharkhand. In our reverie country though Mayurakshi river is not so-long in its length (288 Km) but it has great impact on plateau region of Jharkhand and plain land of West Bengal. The river regime of Mayurakshi is very interesting. Its changing characteristics within a year with seasonal variation are very notable. Mayurakshi River emerges at Jharkhand from Trikut Hills' (Near 10 km south of Devghar in Santal Pargona District) at an elevation of 400 meters, flows down through a large part of Eastern India. Its snake movements towards south-east along with the tributaries of ‘Motihari’, ‘Dhobi’, ‘Pusaro’, ‘Bhamri’, ‘Tepra’, and ‘Sidhweswari’ from Jharkhand and ended with the mixing of Bhagirathi near Kaliganj and Ajimganj at Murshidabad District of West Bengal. Before mixing with river Bhagirathi two major tributaries river 'Kuye' and the river Dwarka mixed with Mayurakshi near 'Chiruti' and near Talgram in the state of West Bengal. Geographers think this river originates from a spring onto a stone peace which looks like an eye of peacock and carries the name 'Morakhi' or Mayurakshi (ref. Bengal District Gazetters by L.S.S O'Malley). In some particular regions it is familiar as 'Motihara' and 'Mor' river.

Mayurakshi river basin covers about 5325 Sq.Km. The river with a length of about 288 Km constitutes on the transitional zone between the mega physiographic provinces of the Chhotanagpur peninsular massif and the Bengal basin. From the absolute point of view the study area is located between 23°15' N to 24° 34'15''N latitude and 86°58' E to 88°20' 30''E longitude. Some relics of age old settlements on its bank denote the history of region. The upper catchment area concentrated with the tribal population. Important settlements like Devghar, Dumka, Massanjore, Suri, Sainthia, Kandi have taken shape within the basin area over decades.

River Mayurakshi is gradually loosing its age-old glory as well as importance for its wide spear flooding and long duration water-logging in the lower reach of its basin. Today the river has become polluted due to urbanization wastes and chemicals affecting the aquatic
ecosystem, behind that non-perenniality are now becoming the disappointing features of the river Mayurakshi.

Flood is more or less regular menace in all the districts of West Bengal except Bankura and Purulia. It is estimated that about 55.43 percent of total geographical area of this state is flood prone. Mayurakshi River has been suffering from floods since immemorial. Normally floods occur during the month of September, flood water would not last for many days but it ravaged all kinds of assets and habitats in the extension part of the lower basin of Mayurakshi river.

Administratively, the study region includes Santal Pargona, Jamtara and Dumka Districts of Jharkhand and Birbhum, Murshidabad and Burdwan Districts of West Bengal. There are 17 CD Blocks (Kandi, Burwan, Bharatpur-I and Bharatpur-II of Murshidabad; Rajnagar, Khayrasole, Dubrajpur, Mahammadabazar, Muyureshwar-II, Suri-I, Suri-II, Bolpur-Sriniketan, Illambazar, Nanoor, Sainthia, Labpur of Birbhum and Ketugram of Burdwan), are suffering for flood on the study area. There are 4 urban centers (Dumka, Suri, Bolpur and Kandi) within the study area.
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REFERENCES MAP

INDIA

GANGA RIVER BASIN

Fig. 1.1
Table 1.1: State and District wise distribution of catchment area of Mayurakshi River

<table>
<thead>
<tr>
<th>State</th>
<th>District</th>
<th>Area (Square Km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jharkhand</td>
<td>Devghar</td>
<td>346.125</td>
</tr>
<tr>
<td></td>
<td>Dumka</td>
<td>2183.25</td>
</tr>
<tr>
<td></td>
<td>Jamtara</td>
<td>133.125</td>
</tr>
<tr>
<td>West Bengal</td>
<td>Birbhum</td>
<td>2343.0</td>
</tr>
<tr>
<td></td>
<td>Murshidabad</td>
<td>292.875</td>
</tr>
<tr>
<td></td>
<td>Burdwan</td>
<td>79.875</td>
</tr>
</tbody>
</table>

Source: calculated from Basin Map with the help of Toposheets of S.O.I.

1.7 Hypothesis of the Present Study

1) The nature and extent of present flood is being changed as well as the magnitude getting increased significantly.

2) The existing flood abatement strategies in this area are not able to mitigate the devastation of flood and bank dwellers are feeling insecurity during the monsoon season.

3) Though flood is being threat towards socio economic life of people, but they have not tendency to shift their settlement from the flood hit region due to the positive effect of it.

1.8 Objectives

Major objectives may be drawn in the following way

- To make an outline on the nature and extent of floods in the basin area since the period of fair records.
- To make investigations on the probable causes of the occurrences of floods in this basin area with special emphasis on the changing spatial pattern of the flood.
- To examine the frequency, magnitude and probability of floods for different periods.
➢ To assess potential risk of flood in different parts of the basin.
➢ To make a review on the existing flood alleviation measures.
➢ To suggest some flood abatement strategies, both structural and nonstructural, through geo-economic management programmes.
➢ To assess the economic impact of the bank dwellers related to the flood problems.

1.9 Database

Field study related spatial and statistical data have collected from different primary and secondary sources.

The Secondary source -

(i) Toposheets of the Survey of India (SOI) scale 1:50,000 (Toposheet No.- 72L/14 72L/15 72L/16 72P/2 72P/3 72P/4 72P/7 72P/8 72P/12 73M/1 73M/5 73M/6 73M/9 73M/10 73M/12 73M/13 78D/3 78D/4 79A/1 79A/2 etc.), SRTM data (LISS III Image, 2008) for demarcate the river basin, settlement and land use mapping etc.

(ii) Geological Quadrangle Map of Geological Survey of India; Soil map and other resource map of N.A.T.M.O also have been used for my study.

(iii) District Statistical Handbooks of Murshidabad, Birbhum, Burdwan and Dumka District.

(iv) Climatic data of Dumka, Birbhum and Murshidabad District.

(v) Flood related data from Disaster management cell, Suri; Jalasampad Bhavan, West Bengal; River Research Institute, Kolkata; Irrigation and Waterways Department, Suri, Birbhum and Kandi, Murshidabad.

(vi) Collection of Flood related data from different administrative offices such as Block Development Office, Panchayet Office, and District Relief Department Office etc.

The primary source -

(i) Measurement of river morpho attributes and channel hydrological regime through field work.

(ii) Micro level data regarding flood characteristics have collected from field study.
(iii) Geonomic data have collected on the basis of scheduled questionnaire from door to door survey.

1.10 Methodology
The entire work has been carried out after following the phase-wise works –

1.10.1 Prefield Work
Topographical sheets of 1:50,000 of SOI, satellite pictures (IRS LISS II P6 data), previous literatures etc have collected and systematically arranged in proper methods. Published data regarding hydrological, climatic, land use, flood condition, loss of public assets etc have been collected from the respective offices. Consultation of geological maps in Geological Survey of India has done.

1.10.2 Field Work
To determine the process valley relationship cross sections of the river as well as the discharge measurement will be done at 22 sites from source to confluence.
To identify the channel character, flow character, channel bed character measurement of length, width, depth etc. have done, sand sample have collected in different sites to indentify the impact of hydrological extremities.
Velocity of river flow both during monsoon and post monsoon period have done to calculate the normal seasonal discharge variation.
To get the perception of flood affected people primary data on different flood issues has collected from the village survey with scheduled questionnaires.
Effect of flood on the geo-economic setup of the villages has also been studied during the field work through door-to-door survey.
1.10.3 Post Field Work

1.10.3.1 Data Analysis

For data processing SPSS 14.0 software has used. Data matrices, regression, Dimension indexing the said software has used. Micro soft Excel soft wares have used for simple tabulation, calculations.

1.10.3.2 Data Plotting

Map Info Professional, Super map, Surfer 8, Arc GIS soft wares have used to plot the data by scientific cartographic techniques. Details of particular methodologies have described prior to result analysis in each chapter individually.

1.11 Importance of the Study

The study of hydro geonomic characteristics of flood in Mayurakshi River basin has immense importance to academician, planner and local people.

To academician:

a) It will provide knowledgebase about Mayurakshi River to the academician.
b) It will also provide knowledge about the flood characteristics of Mayurakshi River basin.

**To Planners:**

a) The planner can be used this study as database for integrated flood management.

b) Spatial flood intensity zoning, risk zoning etc. will provide basic foundation from where plan for basin management, habitat management etc. can be done.

c) It will also help to the planner to take suitable plans for flood abatement.

**To local people:**

a) The common people can get accountability about what kind of flood are experiencing, the nature and extent of flood, economics losses etc.

b) For preparedness plan, settlement structurization and site selection for settlement they can get a brief outline.

Previous literature has shown that Mayurakshi River Basin has one of the greatest flood hazards of any area in the country, and yet there is a need for additional scholarly work concerning the hydro geonomic characteristics of flood of this basin. This study is of great importance to the region, as the results could be used by governmental entities to manage flood prone areas in various strategically programmes to reduce future flood losses. Almost all countries which have a major or several river systems experience flooding, though the magnitude and frequency of floods may vary. Indian economy is pumped by the power of agriculture and the riverine West Bengal, this study area, is no exception. As the lower West Bengal is crisscrossed with numerous rivers quite normally it experiences flooding almost every year. Despite national assistance and several flood management programs the flood damages are increased year after year. So the present study can provide valuable information and genuine views, which is particularly applicable to the study of the affected villages and their people as in most of the cases the importance of such grass root level study has ignored. In the present context peoples’ participation has been considered as the important strategy along with the instrumental data.