WORLD METEOROLOGICAL ORGANIZATION Global Water Partnership

THE ASSOCIATED PROGRAMME ON FLOOD MANAGEMENT

INTEGRATED FLOOD MANAGEMENT

CASE STUDY

BANGLADESH: *FLOOD MANAGEMENT*

September 2003

Edited by

TECHNICAL SUPPORT UNIT

Note:
Opinions expressed in the case study are those of author(s) and do not necessarily reflect those of the WMO/GWP Associated Programme on Flood Management (APFM).
Designations employed and presentations of material in the case study do not imply the expression of any opinion whatever on the part of the Technical Support Unit (TSU), APFM concerning the legal status of any country, territory, city or area of its authorities, or concerning the delimitation of its frontiers or boundaries.

BANGLADESH: *FLOOD MANAGEMENT*

A.N.H. Akhtar Hossain[1]

1. Introduction

Bangladesh is one of the most flood prone countries in the world, which is situated in south Asian sub-continent. A location map of Bangladesh is given in fig. 1. Because of its unique geographical location and to[1]pography, flood of different magnitudes and types occurs every year. During the last half century at least 8 nos. of extreme flood events occurred affecting 50% of land area. Since early sixties of the last century the country has adopted different kinds of measures for flood management with mixed experiences.

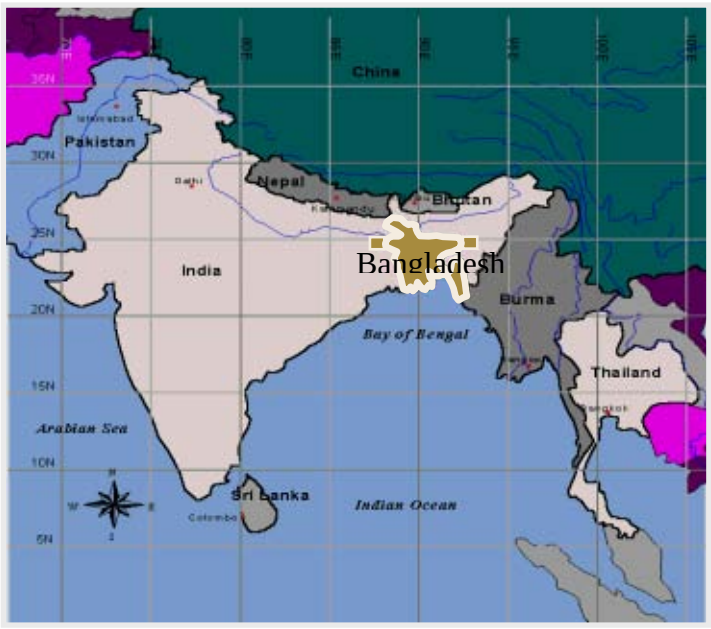


Fig. 1 Location of Bangladesh

2. Physical Features

2.1 Climatic Condition: Bangladesh lies between 20° 34′ and 26° 38′ north, between 88° 01′, and 92° 41′ east. Its climate is tropic and humid. It has mainly four seasons, e.g. Pre-monsoon (March to May), Monsoon (June to September), Post-monsoon (October to November), Dry (December to February). Its climate is influenced by the Indian monsoon. Average rainfall is 2200-2500 mm but the range of which is between 1200 to 6500 mm. 80% of the rainfall occurs during monsoon i.e. from June to September. Average temperature is around 30 C except during the dry season.

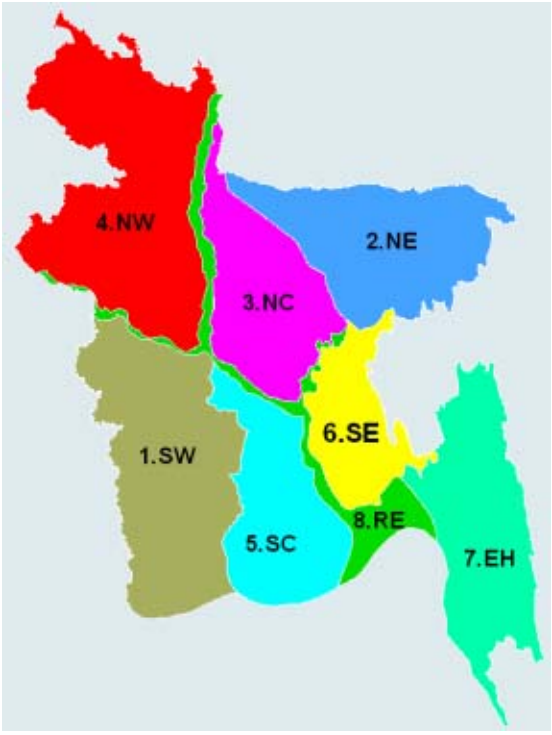


Fig. 2 Hydrological Regions of Bangladesh

2.2 Topography: Topography is mostly flat excepting some part in the northeast and southeast, which are hilly. Entire country was formed due to sedimentation of the large river systems e.g. Ganges, Brahmaputra & Meghna. Land Elevation

[1] Bangladesh Water Development Board (BWDB)

ranges from -3m to 60 m in the plains and in the hilly areas land elevation varies from100 to 1000 m.

2.3 Hydrology: Bangladesh has unique hydrological regime. It has been divided into 7 hydrological zones. Hydrological zones are shown in fig. 2. It has 230 nos. rivers of which 57 are trans-boundary Rivers. In all most all cases Bangladesh is a lower riparian country. A picture of its river network is also given in the fig. 3. Three large rivers systems e.g. Ganges, Brahmaputra and Meghna, in the world covering a combined total catchments area of about 1.7 million sq. km. extending over Bhutan, China, India and Nepal, flow through this country. Out of these huge catchments only 7% lies in Bangladesh. Rivers are classified into three broad categories depending on the flow range and are as follows:

i) Major Rivers: 300 to 120,000 cumec e.g Ganges, Brahmaputra, Padma, Meghna
ii) Semi major Rivers: 100 to 15000 cumec e.g. Old Brahmaputra, Dhaleswari, Gorai, Arial Khan, Surma, Kushiyara, Teesta etc.
iii) Minor River: 1 to 1000 cumec e.g. Sitalakhya, Buriganganga, Khowai, Manu, Gumti, Dharla, Dudkumar, Karnafuli, Halda, Sangu etc.

Rivers of different morphological characteristics e.g. meander, braided, incise etc. are found in this country. Major rivers having length of 500 to 2500 km and width range from 1km to 20 km can also be found in this country. Water surface slopes of the major rivers are also very flat e.g. av. slope of Ganges is 5-6 cm/km, av. slope of Brahamaputra is 8-9 cm/km and av. slope of Meghna is 4-3.5 cm/km. Annual flow volume of the rivers is to the tune of 1200 billion cum. Rivers of Bangladesh carries huge sediment annual amount of which is between 1.8 to 2.0 billion tons. A picture of annual flow cycle of three major rivers at three selected

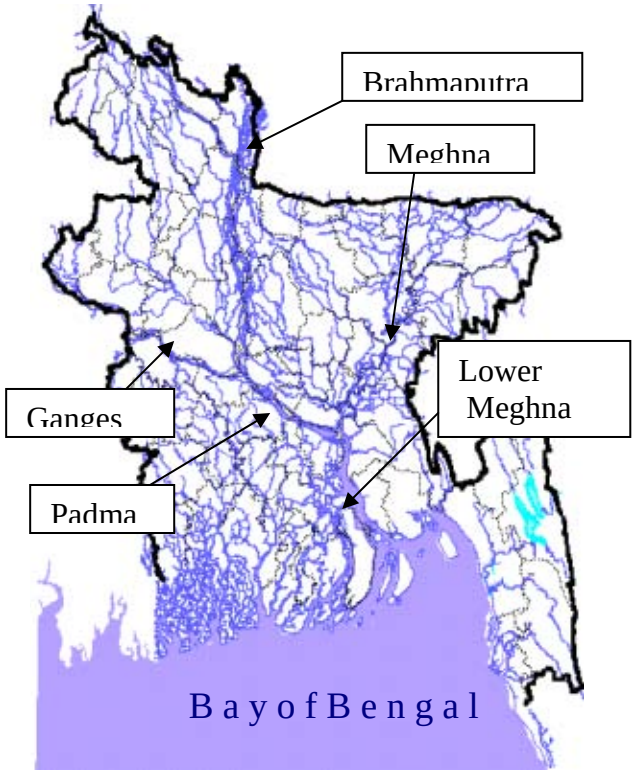


Fig. 3 River system of Bangladesh

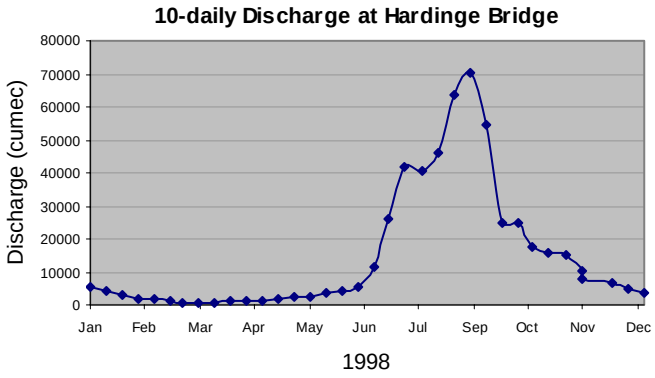


Fig. 4. 10-daily discharge at Hardinge Bridge on the Ganges

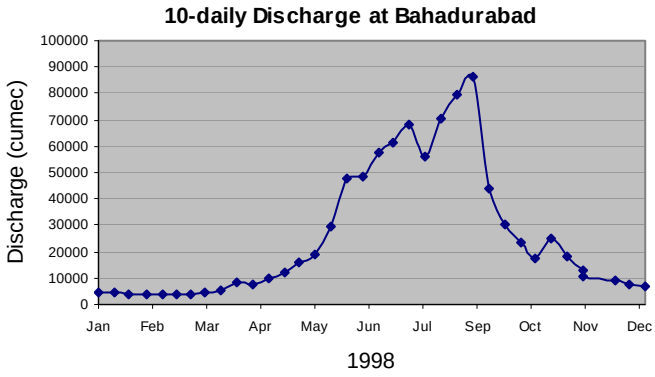


Fig. 5. 10-daily discharge at Bahadurabad on Brahmaputra

locations e.g. Ganges at Hardinge Bridge, Brahmaputra at Bahdurabad and Meghna at Bhairab Bazar are presented in the fig. 4, fig. 5, fig. 6 respectively.

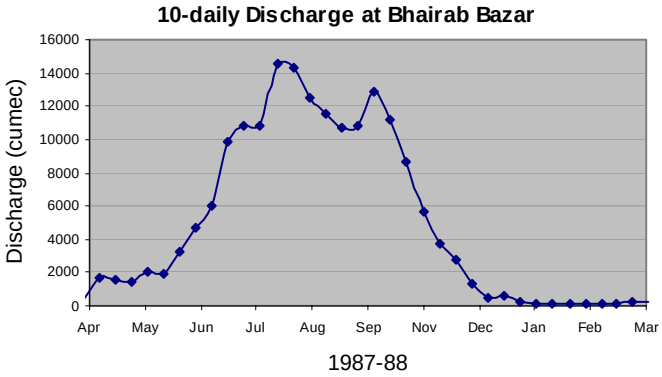


Fig. 6. 10-daily discharge at Bhairab Bazar on Meghna

2.3 Soils: A total of 483 soil series was identified and described in the Soil Reconnaissance Survey of Bangladesh. It does not include Sunderban, a mangrove forest, and Chittagong Hill tracts. General soil types are differentiated into three physiographic groups, e.g. floodplain soils, Terrace soils and Hill soils. Floodplain soils have been formed in alluvial sediments from a few months to several thousand years. General pattern of floodplain soils is of sandy or loamy soils on higher parts of floodplain ridges into clay in the adjoining basins. Terrace soils comprises of a wide range of soils formed over the Modhupur Clay. Soil differences are due to differences in drainage and in depth and degree of weathering. Hill soils include a wide range of soils formed over consolidated and unconsolidated sandstones, siltstones and shale.

2.4 Land Types: In order to understand the flooding and flood management, it is better have look into the land types. Seasonal flooding regime has been characterized by means of inundation land types. Usually, it is classified into 5 categories and detailed description of land type with the area coverage is given in Table 1.

Table 1: Land Types, Description & Area

Land Type	Description	Area in ha	% Area
High Land	Land above normal inundation	4 199 952	29
Med. High Land	Land normally inundated up to 90 cm deep	5 039 724	35
Med. Low Land	Land normally inundated up to 90-180 cm deep	1 771 102	12
Low Land	Land normally inundated up to 180-300 cm deep	1 101 560	8
Very Low Land	Land normally inundated deeper than 300 cm	193 243	1
Total Soil Area		12 305 581	85
River, Urban etc.		2 178 045	15

From the land types it is evident that except high lands all other land types are subjected to flood inundation to different degrees. Normally, 20-25% of the country is inundated during every monsoon from June to September. In case extreme flood events 40-70% area can be inundated which was amply proved during the extreme flood events of 1954-55, 1974, 1987-88 and 1998. All kinds of land type are distributed all over the country. High lands are situated in some parts of the western, south central, northeastern and southeastern regions of the country. Excepting very low lands, human settlements can be found in all other land categories. Of course population density is high in the Medium High and Medium Low Lands. People live in the Low Lands building earthen mounds.

3. Floods

Bangladesh generally experiences four types of flood and those are as follows:

i) Flash Flood
ii) Rain fed Flood
iii) River Flood
iv) Flood due Cyclonic Storm Surges

Area affected by these four types of flood is shown in fig. 7.

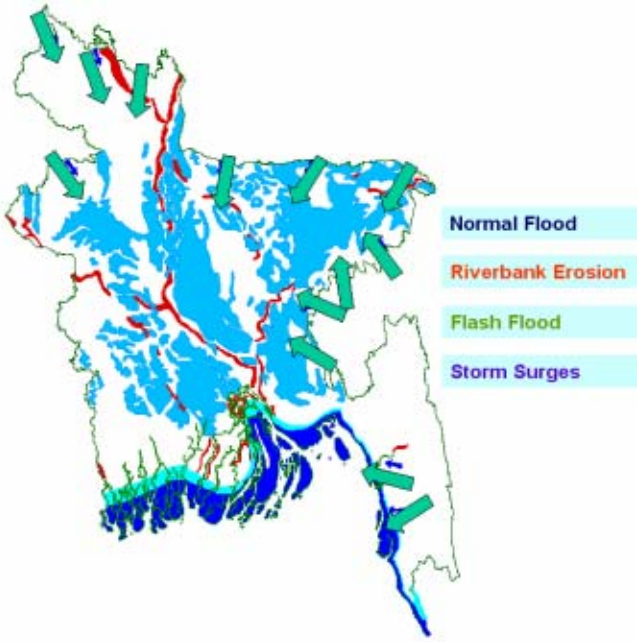


Fig.7: Areas of Four flood types

3.1 Flash Flood: This type of flood is characterized by rapid rise and fall in water levels. Flash flood can occur within a time-period between few minutes to few hours. This type of flood occurs mostly in some northern most area, north-central part, northeastern part and southeastern part of the country. Northern most, north-central and northeastern parts land areas are lying mostly at foothills but most of the hilly catchments in India. If it rains heavily in the Indian parts of the catchments the run-off quickly accumulates and flow to Bangladesh. Flash flood starts occurring in these areas from mid-April i.e. before the on-set of the southwesterly monsoon. Whereas, in the southeastern areas it starts with the on-set of the southwesterly monsoon.

3.2 Rain-fed Flood: This kind of flood generally occurs in the moribund Gangetic deltas in the south-western part of the country where most of natural drainage systems are being deteriorated due to fall in up-land inflow from the main river Ganges. It also occurs in the flood plains where natural drainage systems have been disturbed due to human interferences mainly due construction of unplanned rural roads and illegal occupation of river courses. When intense rainfall takes place in those areas, natural drainage system cannot carry the run-off generated by the rain and causes temporary inundation in many localities. This kind rain induced flood has on increase in the urban areas also. Urban population is increasing very fast and to create their new habitats low lying areas and natural drainage systems are being filled up continuously. More over, while new settlements are constructed, the issue of drainage is not always considered judiciously. As a result, in the urban areas flood has become very common phenomenon.

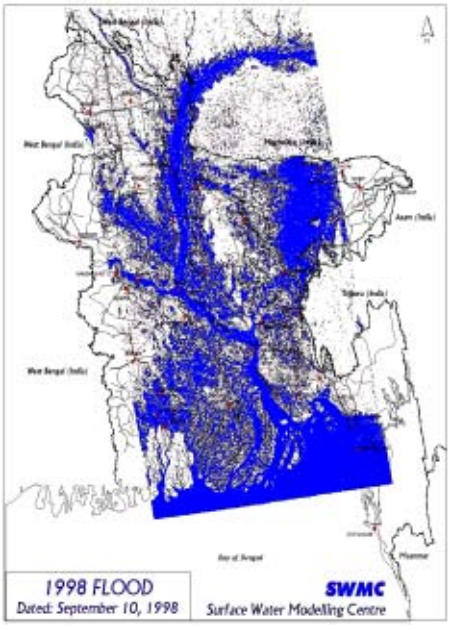


Fig.8 Area affected by 1998 flood

3.3 River Flood: The word flood is generally synonymous with the river flood. River flood is a most common phenomenon in the country from time immemorial. Normally, 25-30% of the area is inundated during monsoon season along the river. In case of extreme flood events 50-70% of the country are inundated extending the areas far beyond the riverbanks. The worst floods experienced by the country in last 14 years in 1987, ’88 and ’98. Flood of

1998 was the severest one in terms of magnitude and duration. The area affected by flood in 1998 is shown in fig. 8.

3.4 Flood due to Storm Surges: This kind of flood mostly occurs along the coastal areas of Bangladesh which has a coast line of about 800 km along the northern part of Bay of Bengal. Continental self in this part of the Bay is shallow and extended to about 20-50 km. More over, the coastline in the eastern portion is conical in shape. Because of these two factors, storm surges generated due to any cyclonic storm is comparatively high compared to the same kind of storm in other parts of the world. . In case of super cyclones hitting coast of Bangladesh maximum height of the surges were fond to be 10-15 m, which causes flooding in the entire coastal belt. Worst kind of flooding occurred on 10 Nov. 1970 and 30 April 1991 caused loss of 300,000 and 130,000 human lives respectively. Apart from the effect of cyclone, coastal areas are also subjected to tidal flooding during the months from June to September when the sea is in spate due to southwesterly monsoon wind. Incidence of this kind of flooding is now on increase.

3.5 Incidence of Extreme Events and Cause: It was observed that extreme flood events occurred due to excessive rainfall in the catchments. When WLs in the three major rivers systems rises simultaneously and crosses the danger marks extreme flood situation usually occurs all over the country. This was observed during the three flood events occurred in 1987, 1988 and 1998. Water Levels crossing the danger marks starts occurring from mid-July and continue till mid-September. Inundated area during 1987, 1988 and 1998 are 66%, 68% and 70% respectively. Duration of the extreme flood events usually extends from 15 days to 45 days, the longest one occurred during 1998.

A picture of water level hydrographs of three major rivers at selected points e.g. Ganges at Hardinge Bridge, Brahmaputra at Bahadurabad and Meghna at Bhairab Bazar are presented in fig. 9, fig. 10 and fig. 11 respectively. A picture of cumulative rainfall hyetographs for June, July, August and September at selected stations within the catchments of these three major river systems for 1987, 1988, 1998 are presented in figs. 12, 13 & 14. Sometimes, Individual River may also experiences extreme flood events due to excessive rainfall in the respective river catchments independently.

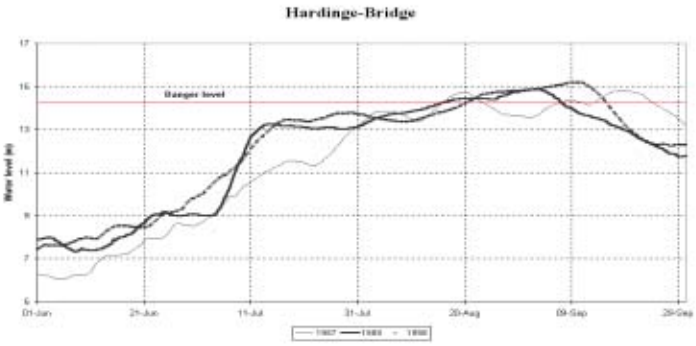
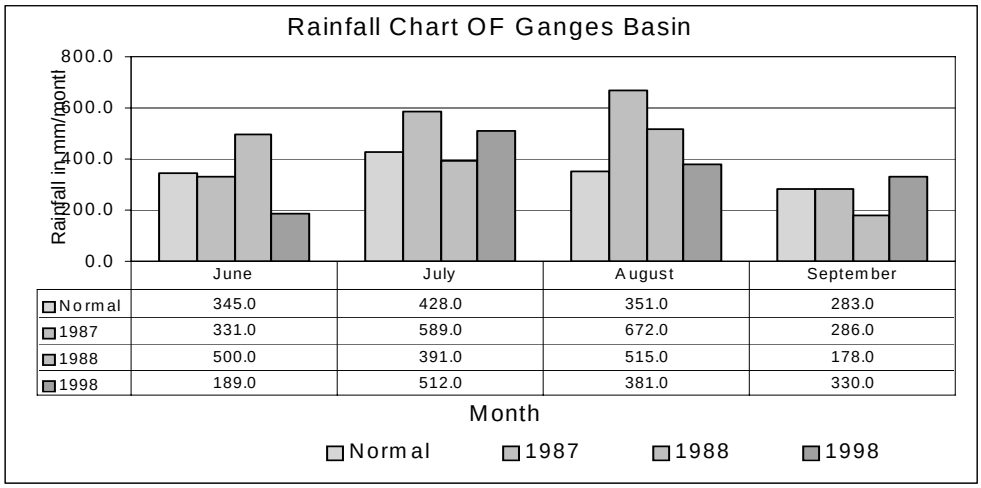


Fig. 9 Water level at Hardinge Bridge (Ganges)

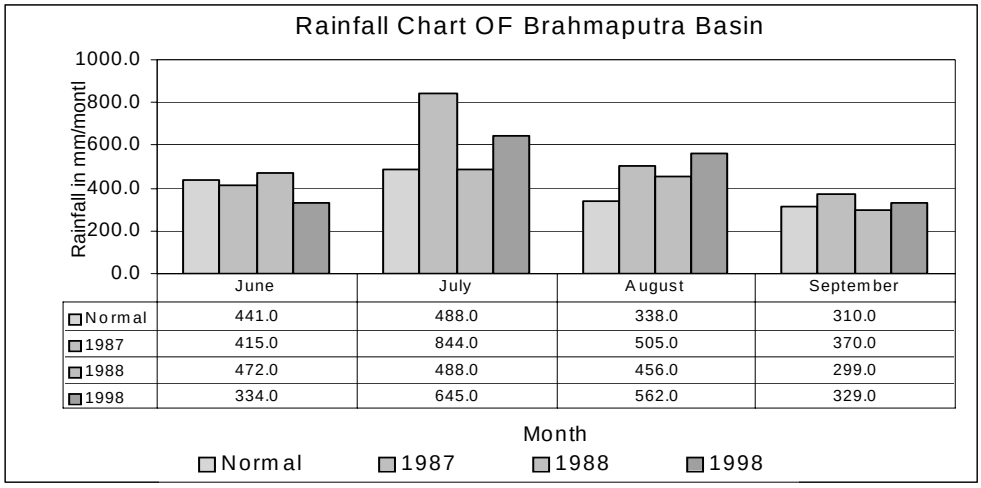
Fig. 10 Water level at Bahadurabad (Brahmaputra)

Fig. 11 Water level at Bhairab Bazar (Meghna)



	June	July	August	September
Normal	345.0	428.0	351.0	283.0
1987	331.0	589.0	672.0	286.0
1988	500.0	391.0	515.0	178.0
1998	189.0	512.0	381.0	330.0

Fig.12 Rainfall hyetograph of Ganges basin



	June	July	August	September
Normal	441.0	488.0	338.0	310.0
1987	415.0	844.0	505.0	370.0
1988	472.0	488.0	456.0	299.0
1998	334.0	645.0	562.0	329.0

Fig.13 Rainfall hyetograph of Brahmaputra basin

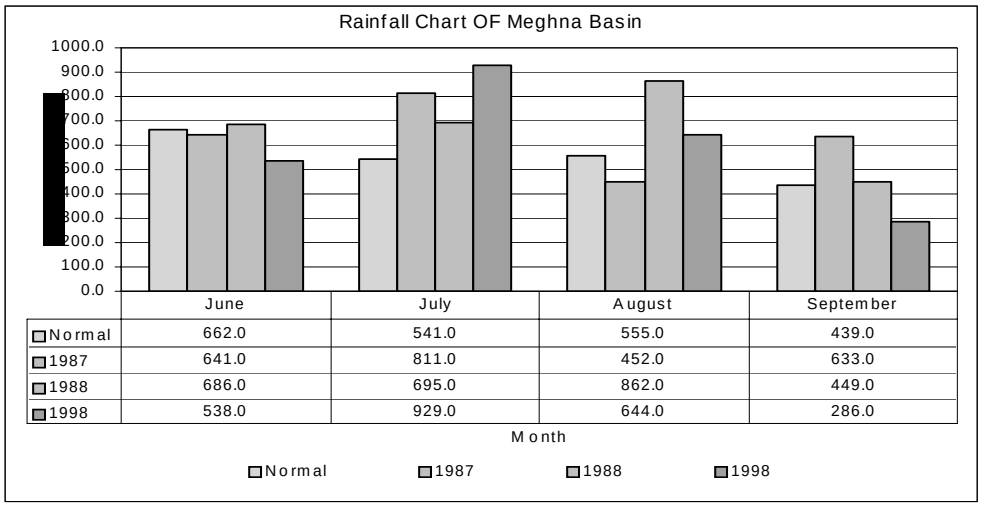


Fig.14 Rainfall hyetograph of Meghna basin

4. Flood Management Strategies

4.1 Flood Management Strategy has been under continuous change since early sixties of the last century. Flood Management strategies can be divided into three distinct phases of its development, which are as follow:

i) Phase-I: 1960 to 1978
ii) Phase-II: 1978 to 1996
iii) Phase III: 1996 to 2000 onwards

4.1.1 Phase-I: Just after the two consecutive disastrous floods of 1954 & 1955, United Nations commissioned a Mission led by Mr. Krugg to look into the problems of flood in this country and to suggest remedial measures. In 1956 the Krugg Mission finalized its Report and submitted it to the then Government of Pakistan. Principal recommendations of Krugg Mission were following:

i) To formulate a Master Plan for Water and Power Development;
ii) To constitute a statutory body to deal with water and power development;
iii) To conduct intensive hydrological survey and investigations.

Krugg Mission mainly focused on protecting the agricultural lands from the flood because of the fact that at that time agriculture was the mainstay of economy. More over, self-sufficiency in food was the cornerstone of the Government policy. As a result, a Water Development Master Plan was prepared in 1964 where structural options having large project portfolios were given priority. Accordingly, Government started implementing large projects with the objectives of providing flood protection, improving drainage and providing irrigation. Implementation of large and medium FCD projects were time consuming and during the implementation of these projects some medium scale flood occurred specially one in 1968 which caused lots of suffering to the people. As a result the Government realized that only through structural measures flood problems couldn't be solved or mitigated. In 1972 the Government decided to also go for non-structural measures also developing e.g. flood forecasting and warning system to mitigate flood problems.

4.1.2 Phase-II:

With the implementation of some large Flood Control, Drainage and Irrigation (FCDI) projects, the Government came to realize that the implementation of large projects involves large investments as well as longer duration; as a result it takes long time to derive benefits. Government then opted for implementation of small and medium scale FCD projects to provide early benefits. While all these projects were implemented the Government came to realize that water resources development should not be focused only on agriculture rather it should take into account other sectors related to water resources utilization and development for economic as well public goods. Environmental protection also came to the fore. As a result the issue of formulation of a National Water Plan (NWP) came to the notice of the Government. The Government took initiative in 1982 to formulate a NWP looking into various aspects of water use and the demand and interest of different stakeholders involved in the water sector. NWP was finalized in 1986 but it did not receive Govt.'s approval due to some of its drawbacks. After disastrous floods of 1987 & 88, formulation of a National Water and Flood Management Strategy came to forefront again for obvious reasons. All the international Development Partners supported a project entitled Flood Action Plan (FAP) from 1990 to 1996 to formulate a national Flood and Water Management Strategy. FAP was mainly a study project involving 26 components. On the basis of FAP activities the Government formulated Bangladesh Flood and Water Management Strategy (BWFMS) in 1996. In BFWMS some policy guidelines for water resources development and management were envisaged i.e. Peoples Participation, Environmental Impact Assessment (EIA), Multi-Criteria Analysis during planning process were made mandatory in all future water sector projects.

4.1.3 Phase-III:

At the end of FAP studies, Government realized that all the issues concerning the water resources development and utilization have not been addressed in the light of Integrated Water Resources Management (IWRM) in these studies. Then the Government again embarked on formulating a National Water Management Plan (NWMP) cross cutting different sectors of national economy in the light of IWRM in 1998.In order to guide the preparation of NWMP, the Government formulated a National Water Policy (NWPo) in 1999. NWMP was prepared in 2001 with 25 yr projection. Program period was divided into three phases e.g. short term for 5 yrs., medium term with 10 yrs. And long term with 25 yrs period. It was formulated with a program approach, not with a project approach. This is no doubt a shift in the Government policy. It identified various conflicting water needs and to ensure equitable water use and balanced economic growth. NWMP has 84 programs cross cutting 11 different sectors of economy. Access to Safe Drinking Water and Sanitation has been given topmost priority. In the NWMP the issue of poverty reduction has not been addressed explicitly, but the Government wants to put it as a top most economic goal. NWMP is now awaiting Governments approval.

4.2 Efficacies of Strategies:

Structural options being the principal strategy in all the above phases provided some benefits, specially increase in agricultural production at earlier period but some adverse effects were observed latter on. Specially, the construction of high embankment along the both banks of the rivers in some cases resulted in rise in bed levels and obstruction to drainage. In the coastal areas, although the construction of polders prevented salinity intrusion, but resulted in restriction of the movement of the tidal prism, sedimentation of tidal rivers and obstruction to the gravity drainage. Another important impact on agriculture was found to be that the crop diversification was seriously rather the farmers in most cases opted for production of cereal crops, especially HYV rice enjoying a flood free situation. Structural measure caused many adverse effects on the aquatic lives especially on open water fisheries. Fish resources have been depleted rapidly. Introduction of non-structural option i.e. Flood Forecasting and Warning System as a secondary strategy started from early '70s and

contributed to the improvement of the capacity for flood preparedness and mitigation of flood losses. The importance of this strategy has been realized after the floods of 1987, '88, '98.

4.3 Flood Mitigation Strategies

4.3.1 Structural Measures:

Considering the issues of securing peoples' life and property, livelihood, food etc. the Govt. put emphasis on protecting Medium High and Medium Low Lands from floods through construction of embankments. Since 1960s Bangladesh has implemented about 628 nos. of large, medium and small-scale FCDI projects. Total investment was to the tune of US$ 4.0 billion. It provided flood protection to 5.37 million ha of land, which is about 35% of area. A picture flooded, non-flooded and flood protected area is shown in fig. 14. A picture structural measures works are given in table 2.

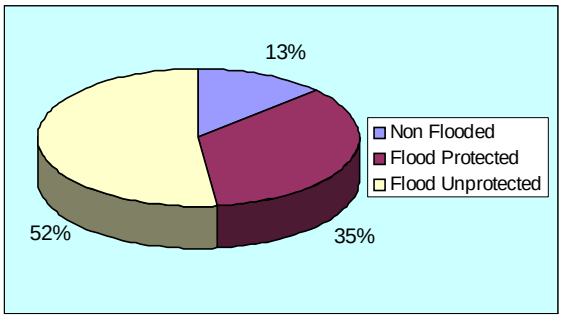


Fig. 14 Present flood status

Table 2: Picture of Structural Measures for Flood Management

Item	Quantity
Embankment	10,000 km
Drainage Channel Imp.	3500 km
Drainage Structure	5000 nos.
Dam	1 no.
Barrage	4 no.
Pump House	100 nos.
River closure	1250 nos.

4.3.2 Non-Structural Measures:

In spite of all the structural activities, it was found that the people living in the Medium High and Medium Low Lands are not immune to flooding during moderate to extreme flood events. Government considered that the minimizing flood loss through non-structural means is also very important. Earl warning on flood can save life and property. With this end in view, Flood Forecasting and Warning System (FFWS) was established in 1972 with 10 Flood Monitoring Stations on the major river systems. After disastrous floods of 1987 & '88 the Government realized the importance of FFWS and took steps to modernize the system. New FF model was developed on the basis of Mike-II hydrodynamic model and flood-monitoring stations were increased to 30 in1996. In 1998 flood FFWS was found to be very useful providing the early warning and information on the flood. With the experience of 1998 flood the Government decided to improve it further to cover all the flood prone areas of the country under real time flood monitoring. A project was under taken from Jan., 2000 to improve the FFWS further. It now covers the entire country with 85 Flood Monitoring Stations and provides real time flood information with early warning for lead-time of 24 and 48 hours. FFWS currently, helping the Government, the disaster mangers and the communities living in the flood prone areas in matters of flood preparedness, preparation of emergency mitigation plan, agricultural planning and rehabilitations etc.

4.3.3 Relative Importance of Structural and Non-Structural Measures:

Structural measures provide direct protection against flood for varying degrees. Major embankments are designed for 1 in 25 years and other embankments are constructed for 1 in 10 years flood frequency. Some time floods of higher frequency levels may also hit but protection against those kinds of flood may not be economically viable. FFWS provides early information on the flood so that the vulnerable communities can have the time for advance preparation to face it. FFWS is also important for operation and maintenance of flood control facilities, e.g. monitoring of embankments and operation of pump houses etc. before and during the flood. Besides, FFWS is essential for near real time flood management in the areas where flood protection is already in place but in case of extreme events exceeding the frequency limit for which it was designed. Both the structural and non-structural measures are necessary for flood management.

4.3.4 Modification in Flood Management Strategies:

After the disastrous floods of 1987 & '88 the Government brought many changes in the flood management strategies. Most important change was in the development policy for different infrastructures. The Government decided to build all structures of strategic importance above the flood level of 100 yr frequency. Government also decided to construct school building in the flood prone areas with the provision of using them as temporary flood shelters. As a result all the national high ways were raised to meet the new standards. The Government also decided to stop encroachments on the flood plains and passed legislation controlling the developments in the flood plains and wet lands. In spite of legislation the Government could not effectively control the encroachments in the flood plains. Recently, the Government has taken very strong measures to implement the legislation especially in and around the capital Dhaka city as a result of strong citizens movement to protect the environment. Government is also seriously considering further legal instruments to implement the legislation effectively all over the country. The Govt. decided to strengthen the FFWS also. Besides the Govt. introduced a new concept of control flooding as per desire of the stakeholders instead of making some areas completely flood free. A pilot project was constructed on the basis of this concept, which is known as Compartmental Pilot Project (CPP), Tangail. The project is divided in to several units on the basis of land topography and micro-hydrological zoning. In this pilot project flooding is allowed in each unit as decided by the stakeholders through consultation among themselves in the Water User Groups (WUG). WUG is responsible for operating FCD facilities by themselves. It is being thoroughly studied for its replication in all future projects and in other areas. After 1998 flood the Government adopted a policy of IWRM in NWPo and NWMP. Government is now putting more emphasis on non-structural means for flood mitigation. Specially, the Govt. adopted a policy of involving communities in flood management. Flood management is now considered as an indispensable component of poverty reduction strategy.

5. Flood and Water Management Instruments

5.1 Since ancient time legal instruments were used for flood management in the country. During middle part of the British Rule, i.e. latter part of 19th century, the then colonial Govt. introduced many acts and rules for flood management e.g. Embankment Act, Drainage Act, and Canal Act etc. From the early sixties the Govt. introduced some more acts to manage flood. Recently, the Govt. has taken an integrated approach for flood management and introduced National Water Policy (NWPo). In the light of NWPo the Govt. has prepared a draft National Water Management Plan in July 2001 for ensuring proper flood and water management in the country.

5.2 Bangladesh has developed a good system of hydrological data collection all over the country. It has also developed an integrated hydrological database with about 40 yrs of data. It has the system of real time Water Level and Rainfall data collection from a selected nos. of

stations all over the country for FFWS during monsoon months. All these data are used for NWMP, planning and design of different types of hydraulic structures, construction of different infrastructures.

5.3 During last 40 years the Govt. has invested approximately Tk 200 billion (US$ 4 bllion) in the water sector mainly for FCDI projects. Annually the Govt. spends about Tk. 10 billion (US$ 200 million) in the water and flood management. IWRM is a very new concept in managing water resources. Proposed NWMP has been prepared in this setting where all the water related sectors e.g. flood management, river development, navigation, environment, water supply & sanitation, fisheries. Water induced disaster management etc were taken into account. In the NWMP allocation for IWRM is about Tk. 840 billion (US$ 17 billion) over period of 25 years. Bulk amount will go to water and sanitation sector. Water and flood management sector will receive 23% of total allocation.

5.4 Mechanism for Effective Use of Flood Waters and Flood Plains:

It has already been mentioned that annual surface water volume is to the tune of about 1200 billion cum and 80% of them flow during the period from June to September. Country being a flood plains having a low topography, it is difficult to conserve such a huge volume of water anywhere in the country. Flood has some positive contributions apart from its detrimental effects, e.g. it improves the ground water recharge, soil-moisture and washes toxic materials, which is built up due to use of chemical fertilizer and pesticides. It has already been mentioned that a pilot project on controlled flooding, an innovative project, to make best use of the floodwater instead of completely restricting its entry to the flood plains.

5.5 Enforcement of Relevant Laws for Flood Plain Management:

Bangladesh has many laws enforced at different times for flood plain and flood management. There are some inconsistencies found in these laws. Considering the importance of brining harmony and consistencies among the laws the Govt. has decided to promulgate a unified law and work is now going on in this direction. Work is now going on framing a National Water Code.

6. Policy

Government of Bangladesh has introduced National Water Policy (NWPo), which guides all the activities in the water sector. Moreover, Govt. has prepared a National Water Management Plan (NWMP), which has been prepared considering long term need, management and utilization of water resources cross cutting all the sectors. NWMP includes the issue of management of water induced disasters e.g. flood, erosion, drought etc. also. Government has recently prepared a Comprehensive Disaster Management Plan (CDMP). Earlier, Govt. also circulated Disaster Management Guide lines in which the responsibilities different agencies involved in disaster mitigation activities are delineated during pre-disaster preparedness, rescue & evacuation operation during disaster and post-disaster relief & rehabilitation. Since 1987 & ‘88 and after the devastating flood of 1998, the Government is putting more emphasis on Flood Management issues especially on the early warning, preparedness and response activities. In NWMP flood management issues have been focused in the light of IWRM.

7. Institution Responsible for Flood Management:

7.1 About 53 central government organizations and 13 ministries are identified to be involved in flood and water management. Principal national institution involved in the flood management is the Bangladesh Water Development Board (BWDB). Besides BWDB, many

organizations are also involved in the flood management activities involved at different stages of flood management. Organizations and their responsibilities as regards flood management is given below:

- *Water Resources Planning Organization:* Macro planning of water resources management;
- *Bangladesh Water Development Board:* Feasibility Studies, Implementation, Operation and Maintenance of Flood Management Projects, Real Time Data Collection for Flood Forecasting and Warning Services, Dissemination of Flood information at national and regional levels;
- *Joint River Commission:* To conduct negotiation for data and information exchange on Trans-boundary rivers;
- *Bangladesh Meteorological Department (BMD):* Long, medium and short range weather forecasting and dissemination.
- *Local Government Engineering Department:* Implementation. O&M of Small Scale FCD projects;
- *Disaster Management Bureau (DMB):* Dissemination of all information on natural disaster including flood information at community level, Flood Preparedness awareness building etc.
- *Directorate of Relief:* Conducting Relief and Rehabilitation operation in flood hit areas;
- *Local Government Institutions (LGI):* Implementation and O&M of small scale flood management project, Flood Information Dissemination, Relief and Rehabilitation of flood victims;
- *Non-Government Organizations (NGO):* Advocacy for flood management, Relief and Rehabilitation of flood victims.

7.2 The JRC and BWDB carry out International and Regional data and information exchange. BWDB disseminate all kinds of flood information to all related Govt. Departments, Organization. Over all coordination during the flood event is the responsibility of the Ministry of Disaster Management and Relief and Inter-Ministerial Disaster Management Committee.

7.3 The changes as regards the organizational policies and behavior are very much spectacular after the floods of 1987 & '88. For better flood information dissemination Flood Forecasting and Warning Center of BWDB has updated its Flood forecast model and opened a web page. FFWC is trying to disseminate the flood information in user-friendly manner. DMB is now putting more emphasis on the community level dissemination of flood information and preparedness. Both the print and electronic media are very keen on publishing and broadcasting flood information almost every day during flood season. With the experience the Govt. has realized that complete flood control may not be possible and has taken policy of near real time flood management incase of extreme events where some areas will be allowed to be flooded to save areas of high investments and large population.

7.4 Flood Management has two different aspects, one relating to national water management and the other relating to national disaster management. Flood Management relating to Water Management at national level is co-coordinated by the National Water Council and particularly by the Ministry of Water Resources. Flood Management relating to Disaster Management is co-coordinated by National Disaster Management Council particularly by Ministry of Disaster Management and Relief. Both activities are also coordinated at local levels by appropriate bodies.

7.5 The Government has made flood management as a participatory one. To involve all kinds of stakeholders both at national and local levels Govt. has recently up-dated Guide Lines For Participatory Water Management. From now on public consultation has been made compulsory for any flood management project. Some pilot studies have recently been completed to ensure effective peoples' participation in dissemination as well as in flood preparedness activities at the community level. Three Pilot thanas (sub-district) were selected in the flood prone of the country, Sudeganj in the northern part, Chouhali at the middle part of Brahmaputra and the Louhajang at lower part of the combined flow of Ganges and Brahmaputra. In these areas initially base line surveys were conducted to understand the perception of the people regarding the flood, flood information and preparedness. On the basis of baseline surveys methodologies were developed for constituting Community Based Organization (CBO) for flood management. Intensive consultation and training were conducted for the local people to develop their capacity for dissemination of flood information and preparedness. It was found that pilot area studies are very useful to develop nationwide flood preparedness program.

7.6 All the project activities in the water sector are supposed to be co-coordinated under NWMP. National Water Council (NWC) was set up by the Government to coordinate all the various activities of the Agencies and Departments involved in the water sector. WARPO has been designated to act as the Secretariat for the NWC. WARPO, BWDB, RRI and JRC are the line Agencies under the Ministry of Water Resources. Coordination at district level are conducted both bilaterally and muti-laterally. The same is the case at the national level. All these co ordinations are usually guided by the Guidelines for Participatory Water Management (GPWM).

8. Lessons Learned

Bangladesh has learnt many lessons from its experiences of last 50 years in flood management. Firstly, flood management activities should not be standalone approach rather an integrated approach in line with IWRM. Secondly, flood management should a combination of both structural and non-structural measures. Thirdly, the process of flood management should be participatory especially community should be pro-actively involved. Fourthly, flood management activities should be sustainable. Fifthly, technical considerations should not preclude socio-economic considerations. Finally, flood management should directly contribute to poverty reduction or alleviation in the developing countries.

References:

1. Water and Power Development Master Plan, EPWAPDA, 1964
2. Water Sector Study Report, IBRD, 1972
3. National Water Plan, MPO, 1986
4. Flood and Water Management Strategy, FPCO, 1996
5. National Water Policy, Ministry of Water Resources, 1999
6. Draft Development Strategy, National Water Management Plan, WARPO, 2001
7. Inception Report on Consolidation and Strengthening of Flood Forecasting and Warning Services Project, March 2000.
8. Information for Flood Management in Bangladesh: Main Report, Riverside Technologies Inc. and Environment and GIS Support Project for Water Sector, Dec., 2000
9. Summary Report Based on Studies carried out under the Flood Action Plan, FPCO, December, 1995