CHAPTER 1 COUNTRY SETTING

1.1 Physiography

Situated on both sides of the Tropic of Cancer, Bangladesh lies within north latitudes 20º34 ′ and 26º38 ′ and east longitudes 88º01 ′ and 92º41 ′ and has a land area of about 147,540km^2.

Although the country is generally termed as a flat alluvial plain, the physiography presents a considerable geographical divergence with about half of its area below 25ft (7.62m) contour line. Geologically the land is classified under three broad physiographic regions: the Tertiary Hills 12% (Chittagong Hill Tracts), the Pleistocene Uplands 8% (Madhupur Tract, Lalmai Hills and the Barind) and the Recent Plains 80% (areas other than those mentioned).

1.2 Classification of Recent Plain

The Recent Plain is the floodplain that has the following physiographic sub-units.

Piedmont Plains: The piedmont (foothills) areas have the characteristics of gently sloping lands on the Terai zone at the foot of the Himalayas and adjoin the eastern and northern hills of Bangladesh.

Active river flood plains: The new alluvial land (chars) within the major rivers is known as active river floodplain. They are seasonally flooded from 2m to 5m depths.

River meander flood plains: The older alluvial land - formed by former river courses comprising of ridges, ox-bows, back-swamps and relic channels - is known as the river meander floodplain. These Lands are seasonally flooded on ridges and to a much greater depths in the low lying areas.

Major floodplain basins: The extensive depressions whose centers are never dried up throughout the dry season are known as the major floodplain basins.

Estuarine floodplains: Estuarine floodplains are almost level relief on deep silty alluvial soil with few thorough watercourses.

Tidal floodplains: Tidal floodplains are almost flat and have principally clay alluvium soils. Tidal creeks drain most of the floodplains. They experience shallow flooding in the rainy season and also at high tide in the dry season.

Within these physiographic units, flooding is not uniform and generally occur from March to September - from several different sources The marshes (haors) are occupying a considerable area in the floodplain having their major concentration in the SE region of the country. General gradients on the floodplain are gentle with average gradient from north-western part of the country to the southern coast being 20 cm per km. Near to the coast the gradients average 1.6 cm/km.

1.3 Soil pattern

Soil pattern and relief often present complex examples. Small variation in land elevation can be significantly crucial for crops. The land classification of Soil Resources Development Institute (SRDI) as amended by MPO (now WARPO) with percent of land area, according to depth of flooding is presented below:

description	**Depth flooded**	***Classification***	**% of total land area**
Highland	Intermittent, above normal flood level	Fo	17
Medium Highland	Seasonal, up to 90 cm	F1	40
Medium Lowland	Seasonal, 90-180 cm	F2	15
Lowland	Lowland, 180-300 cm	F3	9
Very Lowland	Perennial, (mainly flooded, > 300 cm)	F4	2
Settlements, water bodies			17

SRDI Classification as amended by MPO

1.4 The major river system in Bangladesh

Rivers are the most commonplace in Bangladesh and present a very significant feature of the physical landscape. Excepting the ones in the southeastern districts of greater Chittagong and the Hill Tracts, all rivers in the country belong to three major river systems - the Ganges, the Brahmaputra-Jamuna and the Meghna - having their origins in the neighboring upper riparian countries. Through these three major rivers, drainage of about 1.56 million km^2 (about 11 times area of the country itself) of rain-prone land is carried out . The basin areas of the three rivers within Bangladesh account for only 7.5% of the total and the remaining 92.5% of the catchment lie outside in the neighboring countries. It is therefore natural that - in addition to the annual normal and the medium floods occurring almost every 2-3 years - the country sometimes has to experience floods of devastating magnitude around a decade's interval.

There exist about 300 rivers and channels of different sizes in the country. All the 3 major rivers and 47 others originate in the neighboring countries and carry their drainage flows through Bangladesh territory. The yearly normal floods – including the severe ones occurring every 7 to 10 years – carry the monsoon drainage waters of the total catchment areas. The flood situation in Bangladesh worsens when the outside waters are supplemented by the local rainfall, which varies in yearly average from 5700 mm (Lallakhal Sylhet) in the east to 1500 mm (Chapai Nowabganj) in the west. The average rainfall of the country is considered 2300 mm. The flood goes to catastrophic proportions when the major rivers are in spate simultaneously combining widespread intense rainfall in the catchment areas during a spring tide.

1.5 People and the flood

Annual floods are part of the natural environment of Bangladesh and people have adapted their lifestyle to accommodate them. However, in recent years, the characteristics of flood have changed

for a number of reasons including change in landuse and man-made alterations to natural drainage systems. People's sorrows know no bounds when the severity of floods crosses the normal magnitude without some mitigation measures near at hands.

The low-lying regions of the country are worst affected in medium and severe floods due to disruption in communication, inundation of settlement areas, loss of properties, loss of crops and cattleheads, increased duration due to lack of adequate drainage etc. The Char areas of the major rivers are likewise extremely vulnerable to floods. Damage to crops and inundation of homestead associated with erosion, lack of normal facilities coupled with other constraints make their life miserable especially during a severe flood.

The floodwaters recede at a slower rate from the areas where land elevation is comparatively low. Due to the depressed land in the Haor areas the floodwaters remain for a prolonged period. In those low lying areas, at the onset of monsoon's first flood in March to May, the paddy fields - bearing Buro at the harvesting stage - are threatened to be submerged. In some years, the floodwater inundates and damages the only crop (Buro) just a few days before harvesting. A hurried cropping at an early stage may result in a poor output. During the entire monsoon period, people of the haor areas live a miserable life due to inundation of homesteads, roads, markets, and other infrastructure. Wave action from the vast mass of flood water cause erosion to the villages mounds, roads and other infrastructure during this period.

Not only the people of the haor areas suffer from floods, but also the people of the riverine Chars of the Brahmaputra, the Ganges and the Meghna are the usual victims. Increasing population in the mainland compels many of the disadvantaged to migrate in search of a livelihood to the riverine char areas where they face a tough situation for survival. During the normal floods, many of them must be evacuated to a safer place at least for a fortnight. In the event of a devastating flood, they loose their homes and lands to the devouring river erosion.

After the catastrophic floods of 1987, 1988 and 1991, the latest devastating one occurred in July 1998 inundating three quarters of the land of the country. This caused loss of life to the tune of hundreds and also serious economic hardship to the country. During these floods, the worst hit were the people of the low lying Haors and the Char areas. Under this background, the present Study lunched by JICA seeks to prepare a comprehensive Master Plan for the development of the rural community focusing on flood proofing in the haor and char areas of the specified districts.

1.6 Classification of floods

Flood in Bangladesh can be classified under 4 patterns:

(a) Flash flood during a short period due to heavy rainfall in hilly areas.

(b) River flood originated by rising of the water stage or overflow along the major river courses,

(c) Inundation flood in retardant areas due to lack of drainage of the rainfall waters and

(d) High tide flood nearby the coastal zone along the Bay of Bengal caused by the high tide of cyclones.

1.6.1 Flash floods

This type of flood occurs due to intense rainfall in the steep catchment of the neighboring northern and eastern hilly areas across the international border. The flash floods rise and fall very rapidly usually within a day or two and may flow rapidly along river channel and travel overland. In some rivers like Khowai in the district of Habiganj, water levels may rise several meters in 24-48 hours..

In the hoar areas, where normally only one crop is possible annually, rapid rise in waters from the early flash floods in March-May cause damage to the Boro crop mostly just before harvesting. Although the flash floods cause less damage during monsoon, but exceptionally high flash floods can damage aus and aman crop where they are grown. In the post monsoon period in September-November, flash floods may also damage transplanted aman.

During the exceptionally high flash floods, roads, railways, bridges, culverts, flood embankments and regulating structures along some eastern trans-boundary rivers are damaged almost annually. Arable lands near such breaches are often made infertile by sand deposit.

1.6.2 River floods

Heavy monsoon rainfall over the catchment areas of the three major rivers, the Ganges, the Brahmaputra and the Meghna and the snowmelt of the Himalayan ranges cause river floods in Bangladesh, which particularly affects the river flood plains. In the years when the rivers rise early, the neighboring meander floodplains - which are normally flooded by rainwater - are inundated by river flood.

The normal annual floods of the Ganges and the Brahmaputra-Jamuna rivers do not cause appreciable damage except by riverbank erosion. Generally, every 3-4 years, river floods go beyond their active flood plains and damage crops in the neighboring meander floodplains, primarily beside the distributaries. Ttiming, duration and height of water level of a flood are the important factors that determine the damages. The river floods bring with them sediments that are deposited in channels thus reducing the drainage capacity of the minor rivers, bridges and culverts on roads and railways and the drainage channels. Severe floods, which cause extensive damages to crops, properties and infrastructure, generally happen at intervals of 7-10 years. Ostensible catastrophic floods occur at intervals of 20-50 years and bring about devastating damages to crops, property and infrastructure on adjacent floodplains. The great flood of 1988 has been termed as a 1 in 50-100 year event.

The Brahmaputra-Jamuna flood peaks generally occur about one month earlier than that of the Ganges. High floods in either of these rivers may cause damages downstream along the Padma or lower Meghna. rivers. Overland flooding will become particularly severe in the years when the

peaks of the two river coincide, as happened in 1988.

1.6.3 Rainwater floods

This kind of flood is caused by the heavy rainfall over the floodplains and terraces within Bangladesh. Intense pre-monsoon rainfall (April-May) causes local runoff to accumulate in floodplain depressions. Subsequently, during June-August local rainwater is increasingly ponded in land by the rising water levels in the adjoining rivers. Depending upon the intensity of rainfall and the water levels on the major rivers which controls drainage from the land, the rainwater depth vary within the rainy season and from year to year.

Rainwater flooding is characteristics of the meander floodplains, major floodplain basins, and old piedmont and estuarine floodplains. Interior parts of the tidal and young estuarine floodplains are also flooded mainly by rainwater. Excessive rainfall occurring over the area throughout the rainy season mainly caused the serious 1987 flood in northwestern part of Bangladesh. The flooding was aggravated by the flash floods in the Teesta and other rivers and by the high river stage in the Ganges and the Jamuna rivers. Road and Railway embankments with inadequate bridges and culverts and silted-up minor drainage channels impeded drainage of overland flow.

1.6.4 Tidal floods /Storm surges

Storm surges are raised sea level caused by a combination of barometric depression and strong on-shore winds associated with tropical cyclones. Storm surges cause sudden temporary flooding of the coastal areas with seawater or brackish estuarine waters flowing inland for a few kilometers during the passage of a cyclone. During storm surges, water levels can rise 4 – 6 m above normal high tide within a few hours. Exceptionally, as in 1965, storm surges move to the interior of the country by passing up the Meghna estuary. Damages due to storm surges are particularly heavy, especially in terms of loss human of life.

In addition to the natural type of floods, there are floods caused by man-made interventions, which includes those resulting from breaches in embankments and also those resulting from water ponding behind the embankments. Embankments can be breached by erosion from adjacent rivers or due to cut being made by the people who consider that the embankment is aggravating their own flooding. Ponding of water behind road, railway and flood embankments following heavy rainfall is a common occurrence.

The scale of flooding and damage will vary with rainfall intensity and the extent to which the embankments are blocking the natural flood way.

1.7 Timing of the floods and their extent

At the advent of rainy season in pre-monsoon months of April-May, flash floods occur from the northern and eastern hills. The monsoon normally starts in June. The Meghna and the Brahmaputra generally reach their peaks in July and August and the Ganges river during August and September. If the peaks of the Ganges and the Brahmaputra coincide, severe flooding results. Floods in successive years with the coincidence of peaks of the major rivers, like those occurred in 1954 and 1955 and also in 1987 and 1988, are indeed rare events.

The difference in water levels of different return periods of a river flood in Bangladesh is not very high. However, due to the flat topography of the country, it can be seen that a small difference in flood level can be significant with respect to the area affected and hence the total damage caused.

1.8 Flood Proofing in Bangladesh

1.8.1 General

Flood proofing has been defined as "provision of long term non-structural or minor structural measures to mitigate the effects of floods". The flood proofing aims at lessening the chance of human death due to flood and reducing inconveniences to the daily activities of the people in a flood environment. It further provides people in the floodprone areas with the security against the inconveniences of flood and motivation necessary to make and sustain developments in their socio-economic well being and achieve prosperity. Further, it helps the flood affected society in their quick resilience to normalcy after the onslaught a flood.

1.8.2 Flood Proofing classifications

Flood proofing may be classified under the structural and the non-structural categories.

1.8.2.1 Structural flood proofing

The Structural flood proofing include small physical interventions like the raising of homestead, tube wells etc. above flood levels. Structural flood proofing also includes provisions of refuge areas or flood shelters, ideally with water supply and health facilities operating throughout the flood period. Flood proofing also includes raising of roads above peak flood levels, providing additional bridges and culverts to improve water flows across, stabilizing of village mounds, embankments and structures against chance of their being washed out. Structural flood proofing may also encompass the low height dry season roads that will be submersible during the flood period. The low height roads used during dry season will compensate to some extent for the absence of all-season normal roads above flood level in a technically or otherwise non-viable situation.

1.8.2.2 Non structural flood proofing

Amongst the non-structural measures under flood proofing, the following major items are included.

(a) the institutional measures that coordinate the activities related to the flood proofing, planning and development in flood prone areas, account for the prevailing hydrological conditions and ensure hydrological data and analysis are available to those involved with design and construction of infrastructure and other facilities,

(b) the evacuation facilities, community education for improved health etc,

(c) erosion protection by plantation and homestead gardening, plantation for nutritional support etc.

1.8.3 Flood preparedness

Flood preparedness, considered a part of the flood proofing, is the provision of short-term measures to be practiced by individuals, families and other institutions with the aim of reducing the disruption and damage caused by flood. Flood preparedness is essentially the services for the vulnerable mass before, during or after a flood event. The measures of flood preparedness include ensuring ability of a society to forecast and take precaution in advance of a flood. The measures also include securing capability to respond to and cope with the onslaught of a flood by administering and delivering timely and effective rescue, relief and other suitable post flood supports.

1.8.4 Flood protection

Compared to flood proofing, the flood protection projects in rural Bangladesh principally seek after improvement of the agricultural sector. They protect life and properties of the agrarian community living within the project areas. The utilization of the flood protection embankments as the shelter by those residing outside the protected area comes as a secondary significance.

Unlike flood proofing, the provision of flood protection ensures major long-term structural measures that allow the floodwater to enter an area only in a controlled way to suit the requirements of the area protected. This essentially includes the provision of drainage. In Bangladesh, flood control measures involve the construction of embankments, appurtenant structures and improving the flow of drainage channels. Excepting the limited provision of flood control facility associated with the Karnafuli Hydro-electric Project reservoir in the southeastern part of the country, there is perhaps little potential for mitigation of flood damage by storage reservoir.

1.8.5 Comparative discussion on mode of Mitigation Measures

Flood proofing and flood protection have a clear difference in the areas over which the particular measures are applicable. Flood proofing relates to local measures that affect a smaller area comprising of one or several households, a village, small urban or rural areas or specific infrastructure facilities; while flood protection ensures protection for all social and economic activities and infrastructure in larger areas that may encompass parts or whole villages, unions, upazilas or even districts. Although people's participation is an essential requirement for success of both flood proofing and flood protection measures, nevertheless flood proofing requires low capital input while flood protection tends to require high capital investment from the public sector.

Flood proofing and flood protection are complementary to each another. Flood proofing is applicable both within and outside the flood-protected areas. Furthermore, all flood affected areas may not be suitable for flood protection due to physical, hydrological, social or economic reasons where flood proofing measures may be applied to lessen the damage and disruptions. However, flood proofing and flood protection are not mutually exclusive. Flood protection measures are

designed to give protection from specific flood events, but homesteads and other essential social and economic facilities and infrastructure within a protected area may require protection from more extreme floods during which the protection measures may not be effective. The supplementary security necessary for particular facilities may be provided by appropriate flood proofing method. Further, in some instance the flood protection is planned for a particular reason to be useful up to a definite flood level. When this level is exceeded, the flood protection system comes to be completely unsuccessful when the flood proofing measures come to play. Example of this phenomenon is the function of low height flood control embankments of BWDB in the Haor areas, which is designed to protect Buro crops in April-May (pre-monsoon) till they are harvested. Measures relating to flood preparedness are essential for all flood-affected areas irrespective of availability of facilities for partial flood protection or flood proofing.

1.8.6 Present status of flood proofing practices in Bangladesh

In Bangladesh, people have always accommodated floods in their lifestyle and within the resources available to them applied the principles of the flood proofing. Generally, the villages are situated in the in the higher grounds; and houses, when built near riverbanks subject to erosion, are made easy to be dismantled. Flood protection is generally not available and therefore, for a survival people have to practice flood proofing in some form or the other. Due to lack of resources, their efforts are often inadequate.

The tidal zone in the southern Bangladesh has the ‘cyclone shelters’ which are used by the people in time of the tidal surges during the cylonic storms. In the other flood-affected areas, the GoB’s Relief and Rehabilitation maintain the ‘flood shelters’. Generally the flood affected people move to safe places, which include open-air raised areas like roads, embankments etc. where available. However, many of them would prefer to stay in their submerged homesteads, as they are afraid of loosing their belongings due to various factors in case they go to a shelter situated at a long distance away. Flood warning system is very inadequate. People has to infer from the radio/newspaper reports about an incoming flood, although, in some places local administration announce by loudspeaker.

Although the National Water Policy (January 1999) emphasize the flood proofing to become mainly a private sector activity, public funding will also need to be applied if the millions of people living in the flood prone areas are to be helped in their endeavor to reach a minimally acceptable standard of living.