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Factor Analysis of Water-related Disasters in Bangladesh

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Synopsis:

Vulnerability to disaster differs considerably depending on natural exposure to hazards and social conditions of countries affected. Therefore, it is important to take practical disaster mitigating measures which meet the local vulnerability conditions of the region. Designating Bangladesh as a research zone, this research aims to propose measures for strengthening the disaster mitigating system tailored to the region starting from identifying the characteristics of the disaster risk threatening the country. To this end, we identified the country's natural and social characteristics first, and then analyzed the risk challenges and their background as the cause to create and expand the water-related disasters. Furthermore, we also analyzed the system of the socio-economic structure, the evacuation behavior of the affected people and related experience to disasters.

Key Words: water-ralated disaster, risk management, case study, disaster prevention plan

Abbreviations

BARC	Bangladesh Agricultural Research Council
BBS	Bangladesh Bureau of Statistics
BDRCS	Bangladesh Red Crescent Society
BGD	Bangladesh
BMD	Bangladesh Meteorological Department
BNP	Bangladesh Nationalist Part
BWCB	Bangladesh Water Development Board
CPP	Cyclone Preparedness Programme
CRED	Centre for Research on Epidemiology of Disasters
DANIDA	Danish International Development Assistance
DHI	DHI Water & Environment
DMB	Disaster Management Bureau
FAO	Food and Agriculture Organization
FAP	Flood Action Plan
FFWC	Flood Forecasting and Warning Center
GIS	Geographic Information System
GWP	Global Water Partnership
IDA	International Development Association
IFRC	International Federation of Red Cross
JICA	Japan International Cooperation Agency
LGED	Local Government Engineering Department
NWMP	National Water Management Plan
NWPD	National Water Resources Database
SWC	Storm Warning Center
SWSMP	Surface Water Simulation Modeling Programme
UNDP	United Nations Development Programme
WARPO	Water Resources Planning Organization
WMO	World Meteorological Organization

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Figures and Tables

1. The profile of Bangladesh

1.1 General

The People's Republic of Bangladesh (hereinafter Bangladesh) is located at latitude 20°34'-26°-38' N and at longitude 88°01'-92°41' E, and the gross area of this country is 147,750 km2. The most of its west, north and east sides are surrounded by India, a part of its east side abuts Myanmar and its south side fronts onto the Bay of Bengal. Most of its territory is formed by the delta of the Ganges River. Its total population is 123,150,000 (in 2001) and its population growth rate is 1.48% per year (1991-2001). Its density of population is 834/km2; that is very high. Its territory is located on the world's largest Delta, the Ganges Delta, which is formed by the Ganges River running from the west and The Brahmaputra (Jumna) River running from the north-east and most of it is flat low-lands up to 10m above sea level. Only 13% of its territory, in the north and east, is hilly and high above sea level.

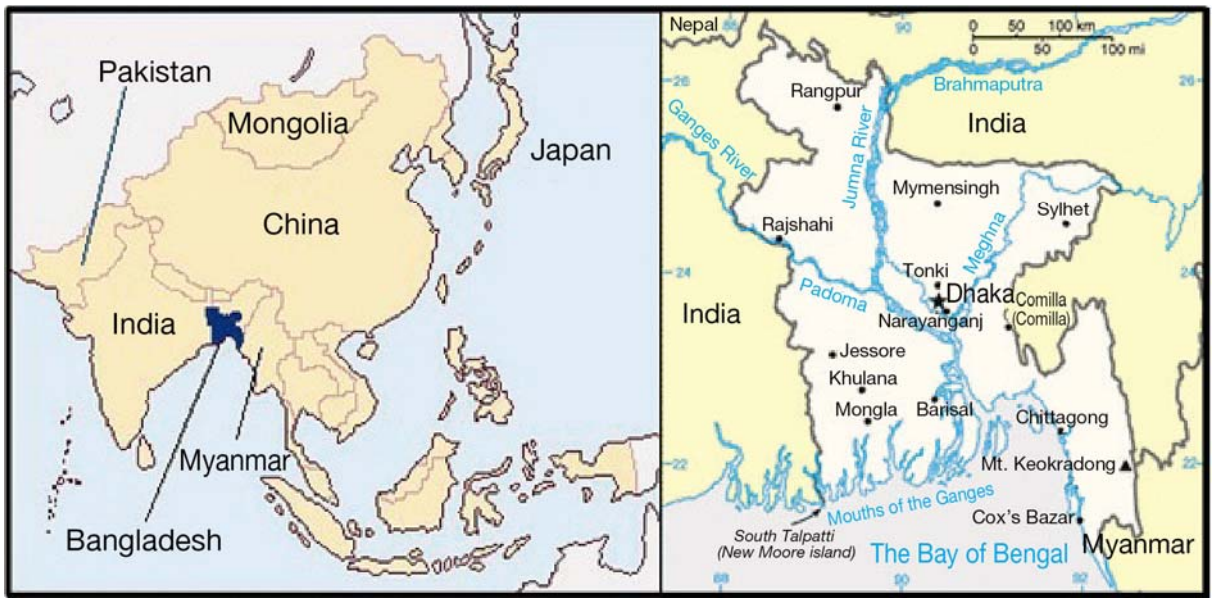


Fig 1: Location of Bangladesh

The climate of Bangladesh comes under a typical tropical monsoon climate and its characteristics are heat, humidity and heavy rainfall. The highest temperature in summer is 32-38 degrees, and the average temperature in winter is around 10 degrees. During a change of season that is between April and May, and October and November, the cyclones often attack this country. Its average annual rainfall is 1,200-6,000mm, varying in the different areas, and exceeding 10,000mm in some areas. The difference between the dry season (June-September) and the rainy season (December-March) is marked, and 80% or more of annual rainfall is concentrated in the rainy season. Therefore, in the rainy season with monsoons from the southwest, about half of the territory is submerged by floodwater inflowing from India. Conversely, in the dry season with monsoon seasonal winds from the northeast, drought damage occurs.

Most of the population is Bengalese and 88% of the nation is Islamic, followed by Hinduism, Buddhism, and Christianity. The population of rural areas accounts for 77% of the whole. More than 50% of those living in the rural areas do not own their own land and they are leasehold farmers.

The percentage of the population living below the poverty line in Bangladesh decreased to 50% in the year 2000, from 70% at the beginning of 1970s'. 90% of the people living below the poverty line live in rural areas. Employment opportunities are limited and wages are very low in rural areas, so that the population movements from rural districts to urban districts are considerable. The estimation of unemployment as at 1999/2000 is 1,800,000 people. The agriculture sector absorbs 36,220,000 people, equivalent to 62% of the labor force.

In rural areas, the differential between men and women is huge in living life. The poverty rate of households where the head of the household is a woman is higher than the rate where it is a man in an agricultural district. Also, there is a differential between genders over the completion rate of primary and secondary education. The economic activity of women (farm work in villages and factory work in cities) and the participation of rural women in support programs run by NGOs (meeting and study, training etc) have been increasing in the past 10 years, however women are still taking care of the whole of the household chores, childcare and rearing livestock.

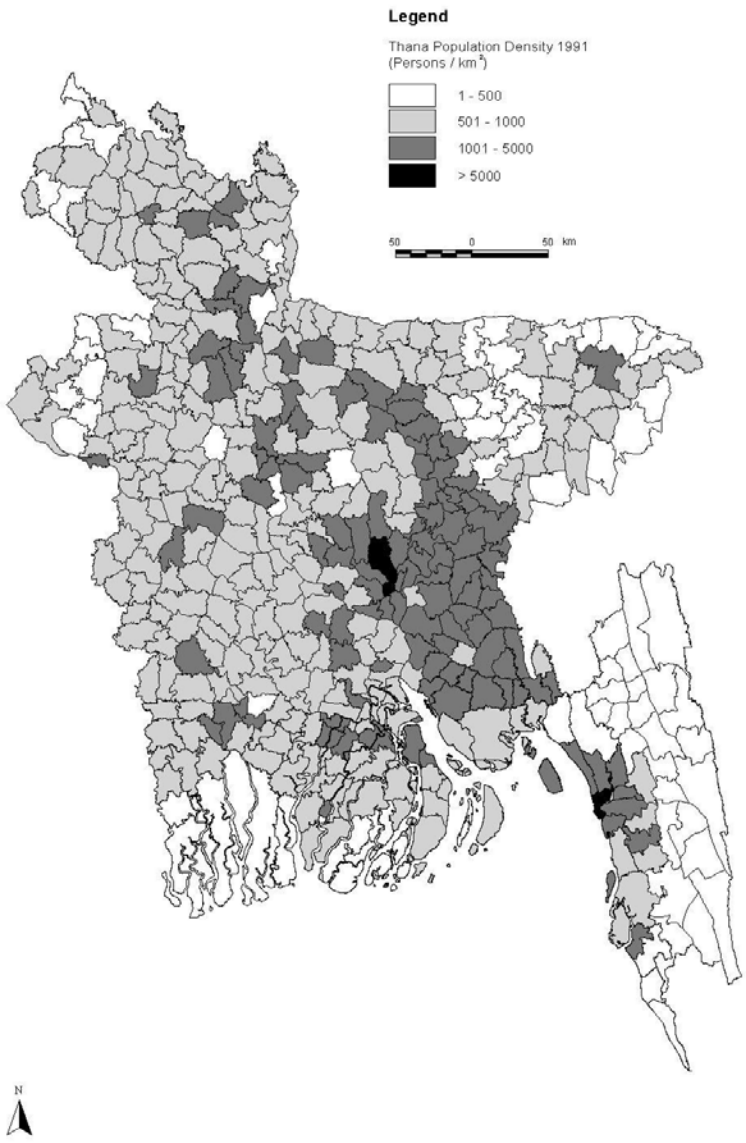


Fig 2: Population Density

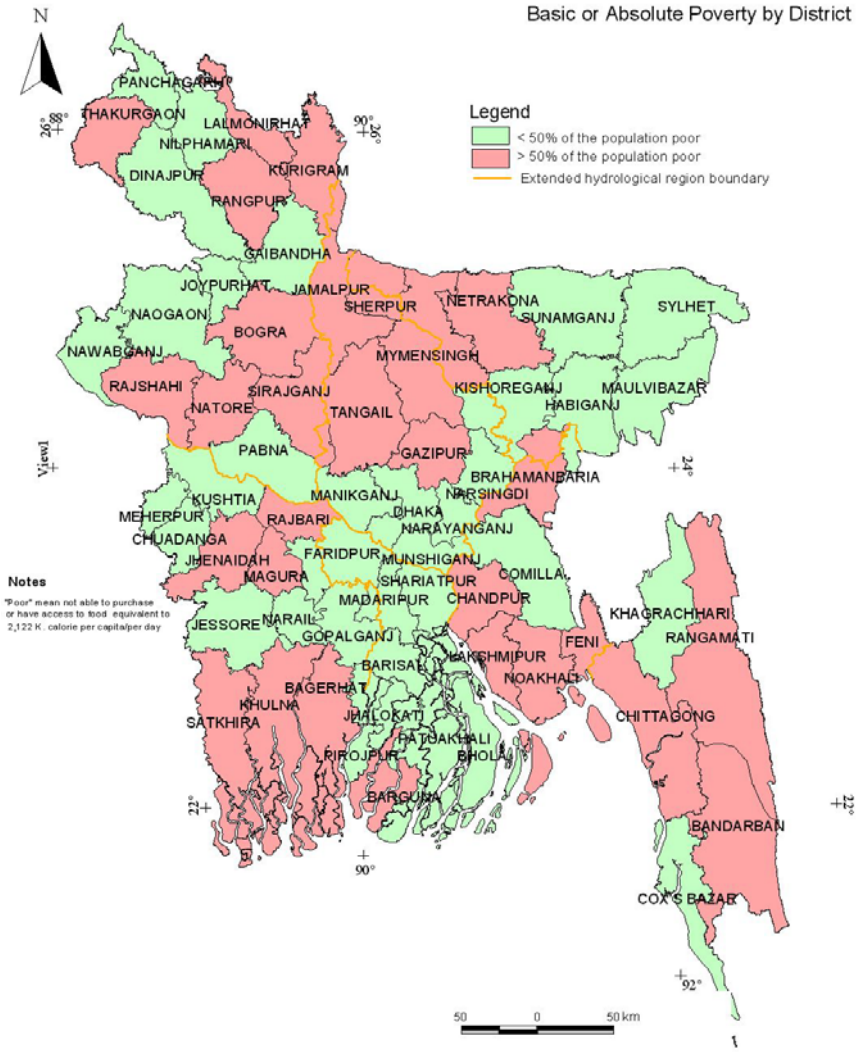


Fig 3: Poverty Conditions

4: North Center (NC) Area

The population is 26,300,000. The average annual rainfall is between 1,400 and 2,400 mm. It has major cities such as Dhaka、Gazipur. The incidence of flooding is comparatively low except in the southern part

Important development needs:

1) Maintain water supply to Dhaka-City, 2) precautions against a flood and drainage improvement, 3) a flood protection at Char of the Brahmaputra River and Padma River, 4) proposed dam construction at the Brahmaputra River and Meghna River.

3: North West (NW) Area

The average annual rainfall is approximately 1,700mm. Industries are not as developed as in the rest of the country. The driest area in Bangladesh. A major and long-running flood often strikes the southern part in the rainy season.

Important development needs:

1) A countermeasure for encroachment of the right bank of the Brahmaputra River, 2) precautions against a flood and improvements of drainage, 3) improvements of existing flood protection and drainage, and repairs of irrigation project, 4) countermeasures for water shortage in the western part, 5) a flood protection at Char of The Brahmaputra River and Ganges River, 6) proposed dam construction at the Brahmaputra River.

2: South Center (SC) Area

The population is 11,100,000. The average annual rainfall is approximately 2,300mm. Industries have not grown compared to other areas. They have no mangrove forests at the coastal region, so they don't endure cyclones. In the southern part, a tidal channel cuts the land. Padma River causes regular floods in the northern part.

Important development needs:

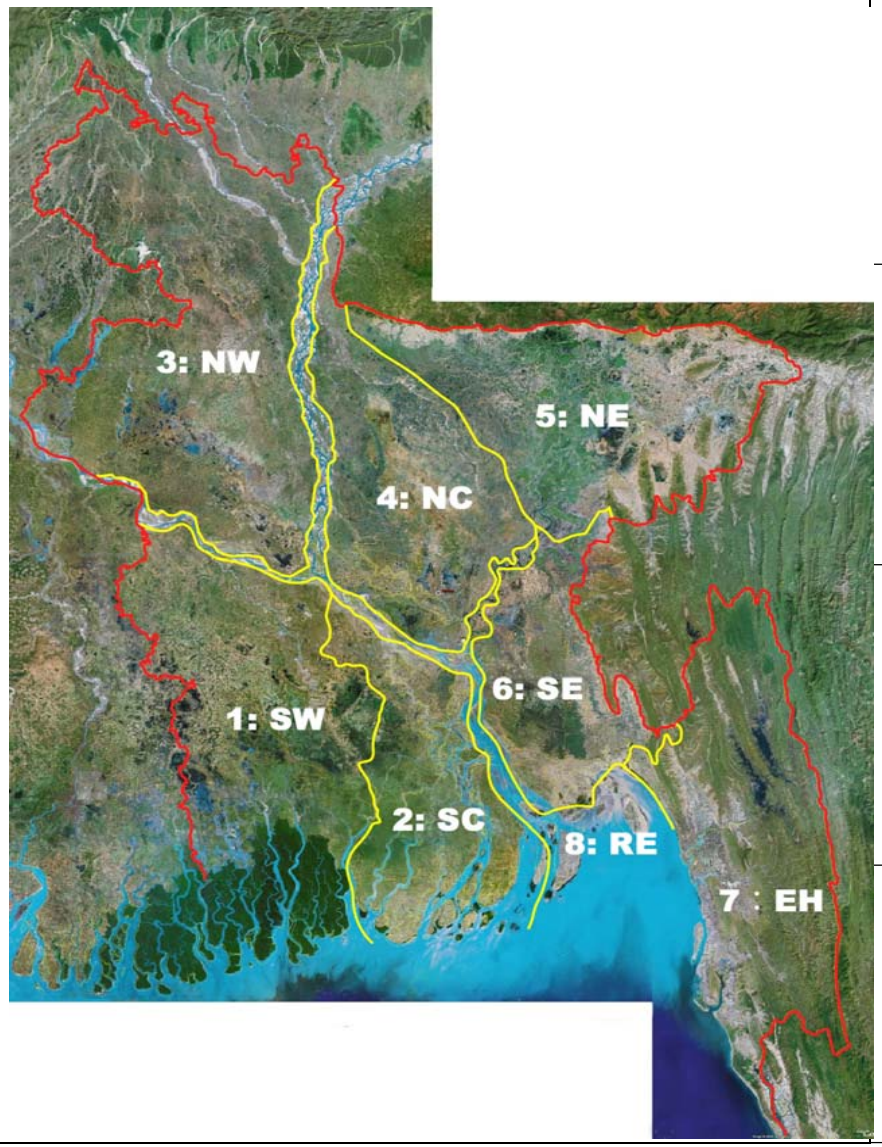
1) Countermeasure for arsenic-polluted groundwater, 2) maintenance of existing levees in the coastal region, 3) improvement of drainage obstruction caused by sediments building up in waterways. 4) Countermeasure for cyclones 5) a flood protection at Char of Padma.

1: South West (SW) Area

The population is 18,300,000. The average annual rainfall is approximately 1,700mm. Cyclone damage in Northern district is minimal. Cyclone damage is also eased by mangrove forest in Sandarban in the coastal region. Poor drainage within the ring levee at the coast is the problem.

Important development needs:

1) Countermeasures for arsenic-polluted groundwater, 2) maintain the flow rate of the Gorai River, etc in the dry season. 3) Improvement of a levee system and drainage at the coastal area. 4) Improvement of existing flood protections and drainage and repairs of irrigation project. 5) A flood protection at Char.



5: North East (NE) Area

The population is 1,410,000. 90% of it is an agricultural rural population. The average annual rainfall is 3,200mm. Large Haor region (low wetland) covers over 5,600km2. Urbanization and industrialization have not developed. A depth of flood is 5m or deeper; an ideal flood protection is difficult.

Important development needs:

1) Countermeasures for arsenic- polluted groundwater, 2) environmental management of the wetland in Haor region. 3) Repairs of existing flood protection and drainage improvement project. 4) Flood protections for villages located in Haor region. 5) Improvement of drainage capacity of major rivers, 6) development of irrigation system utilizing slope.

6: South East (SE) Area

Its population is 13,900,000. 90% of it is an agricultural rural population. They have problems of cyclone damage, poor drainage, etc in the coastal area. Although encroachment of a riverbank of Meghna River is a big problem, sediment is forming new land around the coastal region in the southern part.

Important development needs:

1) Countermeasure for arsenic-polluted groundwater, 2) dealing with an aquifer layer that contains gas, 3) countermeasures against cyclones, 4) improvement of drainage obstruction caused by the coastal levees, 5) protection of newly formed land from the tide, 6) improvement of existing FCDI project.

7: Eastern Hill (EH) Area

The population is approximately 8,900,000. Plains along the Chittagong coast and places between hills form this area. The average annual rainfall is approximately 2,400m. Chittagong urban area (its population is 3,000,000) and Cox's Bazar (250,000) are the main cities. Its coastal area is protected by levees, and prawn-culture and the salt industry are prosperous. The risk of cyclones is high.

Important development needs:

1) Development of small scale irrigation systems, 2) small scale hydroelectric power generation, 3) maintenance of existing levees in the coastal area.

8: River Estuary (RE) Area

The population is approximately 5,800,000. This area has a high frequency of flood occurrence, so residents are living unsettled lives. River bank encroachment of major rivers is big problem. Risk of cyclone is high on islands at the mouth of Meghna River, and there are repeated encroachments and formation of new sandbanks there.

Important development needs:

1) Low-cost countermeasure for river encroachment, 2) low-cost river improvement, 3) precautions against floods at Char, 5) precautions against floods at new sandbank, 6) countermeasure for arsenic pollution.

Fig 4: Condition of Each Hydrological Region Shown in NWMP

Bangladesh is an agricultural country, and its agricultural products are based on rice and jute. Aside from that, Bangladesh produces tea, sugar cane and breeds prawns etc. Its industries are light industries such as jute processing, making leather and sewing etc. Although it is the world's fourth-highest producer of rice, it is still importing food and its economy is largely dependent on working overseas and foreign aid as a result of its over-population and flood damages.

1.2 The Distinguishing Features of the District

(1) The condition of each Hydrological Region

In Bangladesh, the National Water Management Plan (NWMP) was decided on as a plan for national water resources development and management, including taking precautions against flooding, and it was approved in March 2004.This plan divides the whole country into eight Hydrological Regions by hydrological characteristics with a view point of development needs against water availability, and is investigating necessary developments and a management plan for each area. The conditions of each Hydrological Region in this plan are displayed in Figure 3. 4 and as below.

1) North West (NW) Area

The NW area is formed by 16 prefectures that make up the Rajshahi district and its boundaries are The Brahmaputra River and Ganges River. Cultivable area is 2,350,000 ha. Although average annual rainfall in this area is approximately 1,700mm, the Barinda region is located in the southwest which is the driest area in Bangladesh and its average annual rainfall level is below 1,400mm. The ground water level is high except in the part of the Barinda region where it is relatively high above sea level.

This area is advancing agricultural development and has the largest numbers of regions that operate agricultural irrigation in the whole of the 8 regions. Industries in this area are not as developed as in the rest of the country; however, future industrial developments are expected as a consequence of the opening of Jumna Bridge in 1998. Rajshahi is the one of major cities in Bangladesh and other urban districts are Rangpur, Bogra, Dinajpur, Pabna, and Sirajganj etc. The population of each city is approximately between 300,000 and 500,000.

A major and long-running flood often strikes the southern part in the rainy season because the water level of the Brahmaputra River and Ganges River gets higher than other inland rivers, and obstructs the drainage functions of the lower part of Atrai, Hurashgar, Bangali rivers. For this reason water is retained in the lower rivers. A major and long-running flood sometimes strikes the fairly dry region. This area carries out the leading major flood protections, drainage improvements and irrigation projects such as Teestaa dam, Pabna irrigation project, a levee on the right bank of The Brahmaputra River, Chalan Beel flood protection, drainage improvement and irrigation project, and Barind multi- purposes development project and so on.

NWMP shows the development needs of the NW area are as follows- 1) a countermeasure for encroachment of the right bank of the Brahmaputra River, 2) precautions against a flood and improvements of drainage, 3) improvements of existing flood protection and drainage, and repairs of the irrigation project,

4) countermeasures for water shortages in the western part, 5) flood protection at Char of The Brahmaputra River and Ganges River, 6) proposed dam construction at the Brahmaputra River.

2) North Center (NC) Area

The NC Area has an area of 15,950km2 and a population of 26,300,000. This area has the Brahmaputra River, the Padma River, the Meghna River, the old Brahmaputra River and the Lakhya River as boundaries and abounds with topographic variations compared to other areas except EH Area. Its cultivable area is 1,060,000 ha. The Madhupura plateau includes forest and stretches over 2,400km2 in the central part of this area, and the range of its average annual rainfall is between 1,400 and 2,400 mm. The groundwater lies in fairly shallow layers like NW Area. There is an arsenic polluted groundwater problem around major rivers in some parts.

Major cities in this area are Dhaka (its population is 9,000,000), Gazipur (80,000,000), Mymensingh (50,000,000) and Tangail (30,000,000) etc. The NC Area industrialization and urbanization is the most developed in the whole country, and rapid urbanization is also expected in future. The condition of its agriculture, except Madhupura plateau, is being improved similar to NW area. They operate irrigation systems using shallow pipe water wells and the ground water level drops seasonally. The incidence of flooding is comparatively low except in the southern part, and the scale of existing flood protection, drain improvement and irrigation projects is also small.

NWMP shows the development needs of the NC area as follows- 1) Maintain water supply to Dhaka-City, 2) precautions against a flood and drainage improvement, 3) a flood protection at Char of the Brahmaputra River and Padma River, 4) proposed dam construction at the Brahmaputra River and Meghna River.

3) North East (NE) Area

The NE area covers an area of 20,100Km2 and 90% of its 1,490,000 population is an agricultural district population. This area has distinguishing features that are different to NW and NC areas. Its cultivable area is 1,410,000 ha and average annual rainfall is high, at 3,200mm. Developable shallow layers of groundwater are limited, except in parts of the northwest, but there is a lot of surface water in the dry season, therefore a river irrigation system using low lift pumps, are mainly operated in this area. Major rivers of this area are Barak River, Juri Riverm Manu River and Khowai River.

The characteristic of this area is the production of tea and natural gas, and also the large Haor region spreading over 5,600km2. The Haor region includes 47 main Haors and 6300 Beels (approximately 55% of these floods year-round) and here are important habitats of fishing resources and water birds. Because the depth of flood is 5m or more, ideal flood protection is difficult. Therefore, partial flood protection is appropriate such as protecting crops from a flash flood coming from India between April and May and allowing a levee to be submerged in a flood in the rainy season.

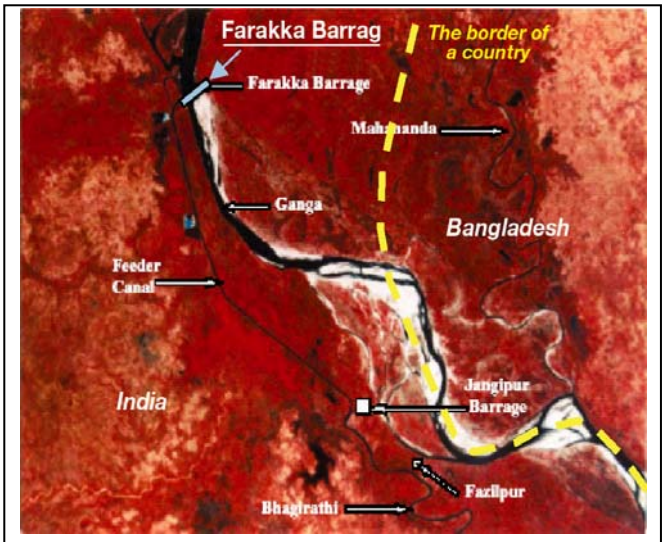
Urbanization and industrialization have not really progressed in NE area; even the biggest city, Sylhet, only has a population of 300,000. Other main cities in this area are Kishoreganj, Netrakona, Sunamganj, Hobiganj, Maulvibazar etc and the population of each city is less than 200,000.

NWMP shows the development needs of the NE area as follows- 1) countermeasure for arsenic polluted groundwater, 2) environmental management of a wetland in the Haor region. 3) Repairs of existing flood

protection and drainage improvement projects. 4) Flood protections for approximately 1,000 villages located in the Haor region. 5) Improvement of drainage capacity of major rivers, 6) irrigation development utilizing sloping surface in some regions, etc.

4) South West (SW) Area

The SW area covers 26,200km2 and its population is 18,300,000. It is divided roughly into the coastal area and inland area, which is from the Ganges River, Padma River to Khulna. Its cultivable area is 1,380,000ha. Its average annual rainfall is approximately 1,700mm and similar to NW area, the rainfall of the district along the border with India at the west is fairly low. Groundwater is polluted by arsenic in a large area mainly around major rivers.



Source : The Encroaching Ganga and Social Conflicts: The Case of West Bengal, India

With the effect of the Farakka dam on the upper Ganges River, the flow rate of the river is low in the dry season and that is causing damage to the mangrove forest in Sandarban assigned in the Ramsar Convention on Wetlands.

Irrigation systems using shallow pipe water wells are widely used in the northern part of this area and the level of salinity in surface water during the dry season is low. Cyclone damage in this area is generally minimal. On the one hand, cyclone damage is eased by the mangrove forest in Sandarban in the coastal region; on the other hand, environmental pollution caused by prawn cultures in the brackish water region is a big problem. In addition to this, poor drainage within the ring levee at the coast is also one of the major problems.

Khulna has a population of 1,000,000 people and major industries and a harbor, and there are also cities with a population over 200,000 such as Jessor, Bagerhat, Chuadanga and Jhenaidah. The height above sea level is comparatively high in the inland region and this region is generally unlikely to suffer flood damage, but the chance of damage is not zero.

The main flood protection, drainage improvements and irrigation projects of this area are a levee and a ring levee at the coastal region and the Ganges-Kobadak pump irrigation project in the northern part, constructed in the 1960s' and 1970s'.

NWMP shows the development needs of the SW area as follows- 1) countermeasures for arsenic polluted groundwater, 2) maintaining a flow rate of the Gorai River and other waterways in the dry season. 3) Improvement of a levee system and drainage at the coastal area. 4) Improvement of existing flood protections and drainage and repairs of irrigation project. 5) Flood protection at Char of Ganges River etc.

5) South Center (SC) Area

The SC area is located between the Padma River and Meghna River, its area is 15,400km2 and its population is 11,100,000. It is divided roughly into the inland area and the coastal, similar to SW area. Its cultivable area is 930,000 ha. Its average annual rainfall is approximately 2,300mm and there is no water shortage in the dry season like the SW area. But there are no mangrove forests along the coast, so they are exposed to storm surge of cyclones. In the southern part, the land is cut by a tidal channel.

Industries have not grown at the same rate as in other areas and the urban population is approximately 12% of the whole. Major cities in this area are Barisal; its population is 400,000, and Faridpur, Patuakhali and Shariatpur (the population of each of those is below 200,000) Irrigation systems with shallow pipe water wells and low lift pumps are operated. Flood protections, drainage improvements and irrigation projects are few apart from a levee in the coastal region and Brisal irrigational project

The northern part of this area is exposed to a regular flood caused by the Padma River. The Padma River is morphologically still young and unstable and is not suitable to have the banks strengthened.

NWMP shows the development needs of the SC area as follows- 1) countermeasure for arsenic polluted groundwater, 2) maintenance of existing levees in the coastal region, 3) improvement of drainage obstruction caused by sediments building up in waterways. 4) Countermeasure for cyclones 5) a flood protection along Padama River and at Char of Padma River etc.

6) South East (SE) Area

The SE area covers 10,300km2 and its population is 3,900,000, which is relatively small. The population of urban districts is approximately 11% of the whole. The leading city is Comilla with a population of 440,000. Other major cities are Brahmanbaria, Chandpur, Feni, Laximpur, Noakhali etc and the population of each city is between 200,000 and 300,000. Like the SW area and SC area, this is divided into the inland area and the coastal, and an irrigation system using shallow pipe water wells is operated in the inland area. They have problems of cyclone damage, poor drainage, salt content of surface water and groundwater in the coastal area. Groundwater arsenic pollution here is the most serious in the whole of the country. Shallow pipe water wells are widely utilized, so there is not a serious water shortage problem except in the southern part, however the total quantity of water available is still not enough.

Although encroachment of the river bank of the Meghna River is a big problem, sediment is forming new land around the coastal region in the southern part. Two major irrigation projects, Chadpur and Meghna-Dhonagoda, are being carried out as well as levees in the coastal area, and flood protections and drainage improvement projects in part of the inland area.

NWMP shows the development needs of the SE area as follows- 1) countermeasures for arsenic polluted groundwater, 2) dealing with an aquifer layer that contains gas, 3) countermeasures for cyclones, 4) improvement of drainage obstruction caused by existing coastal levees, 5) protection of newly formed land from the tide, 6) existing flood protection, drainage improvement and repairs of irrigation projects, etc.

7) River Estuary (RE) Area

The RE area is the estuarine area of three rivers, the Ganges River, the Brahmaputra River and Padma River. Its area is 8,600km2 and its population is approximately 5,800,000. This area has a high frequency of flood occurrence, so residents are living an unstable life here. The living standard of the residents of this

area is generally low. River bank encroachment along major rivers is a major problem, however, repairs are costly and difficult.

The cyclone risk is high on islands at the mouth of the Meghna River, and there is continuing encroachment and the formation of new sandbanks there.

NWMP shows development needs of the RE area as follow- 1) low-cost countermeasures for river encroachment, 2) low-cost river improvements, 3) precautions against floods at Char of the Brahmaputra River, Ganges River and Padma River, 5) precautions against floods at the new sandbank formed at the mouth of Meghna River, 6) countermeasures for arsenic polluted groundwater, etc.

8) Eastern Hill (EH) Area

The EH area has an area of 19,950km2 and a population of 8,900,000. Plains along the Chittagong coast and places between hills form this area. Its cultivable area is 480,000 ha and its average annual rainfall is approximately 2,400m. Places between the hills generally suffer no flood damage.

Chittagong urban area (its population is 3,000,000) and Cox's Bazar (250,000) are the main cities. The coastal area is protected by levees, and prawn-culture and the salt industry are prosperous. The cyclone risk is high. The groundwater contains salt, and their irrigation system uses low lift pumps.

NWMP shows the development needs of the EH area as follows-1) development of a small scale irrigation system, 2) small scale hydroelectric power generation, 3) maintenance of existing levees in the coastal area, etc.

(2) Char and Haor

1) Char area

Char is a sandbank formed on the channel, along the bank or the mouth of a large river and is massively affected by river flows, especially a flood, repeating a pattern of "washed away", "reappearing" and "getting bigger". Figure 5 displays Char.

Although the rise and fall of this area is dramatic and unstable, many residents still live in Char. (Its population is approximately 630,000) and basically agriculture is their means of living. In the situation where they need evacuation, when their land is lost to encroachment, residents show a strong tendency toward moving to another place in the same Char or moving to a different Tablehat which is growing and expanding, and it is rare for them to move inland in case they are not accepted there or because of uncertainty of employment there. Under the present conditions 100,000 people are losing their land to encroachment of the sand bank every year, it is thought that encroachment is a more serious problem than flooding in Bangladesh.

2) Haor Area

A flat lowland spreads across the middle of the Meghna River basin. Its height above sea level is approximately 3-6m and it is known as "the center basin" or "Haor area". (Refer to Figure 5) The upper part of this area in Indian Territory is a rainy region that has the highest rainfall in the world - its average annual rainfall reaches 11,117mm(even around the border it is 5,000mm), and massive effluent from this upper river region is temporarily accumulated in the Haor area. The volume of accumulated water in the Haor area at the peak of a normal year is approximately 100,000,000 t and the highest water level is

approximately 6m above sea level. Most parts of the Haor area continue to be flooded for 3-6 months a year. The area flooded in 1993 extended to 20,000km2.

Haor area has, A) Haor: many large-scale lakes or hollows where flood- water depth is high, and B) Beel: countless shallow lakes or ponds, surrounded by flooding fields. There are 47 major Haor, and 6 of them are ranked as internationally important wetlands. There are 6300 Beel, and 3,500 of them are permanent and 2,800 of them are seasonal.

Although their living conditions are harsh, the population of Haor area is not small and approximately 4,800,000 people are living around the island called Kanda within this area. Losing habitable land to encroachment by the wind and waves is a big problem in Kanda, however the population of the whole area is tending to increase every year. Transport in this area is mainly by boats in both the rainy season and the dry season.

Industries of the Haor area are mainly agriculture and fishing. In the Haor area, the water level starts rising from April, reaches its peak in July and falls in October generally. Residents do agricultural work during the dry season that is from the middle November to the end of April, and fish in September and December adapting to the life cycle of flooding inhabitant fish sorts. However, during the rest of the flood period in Haor, approximately 40% of the population engages in fishing while the others work as migrant workers or are unemployed.

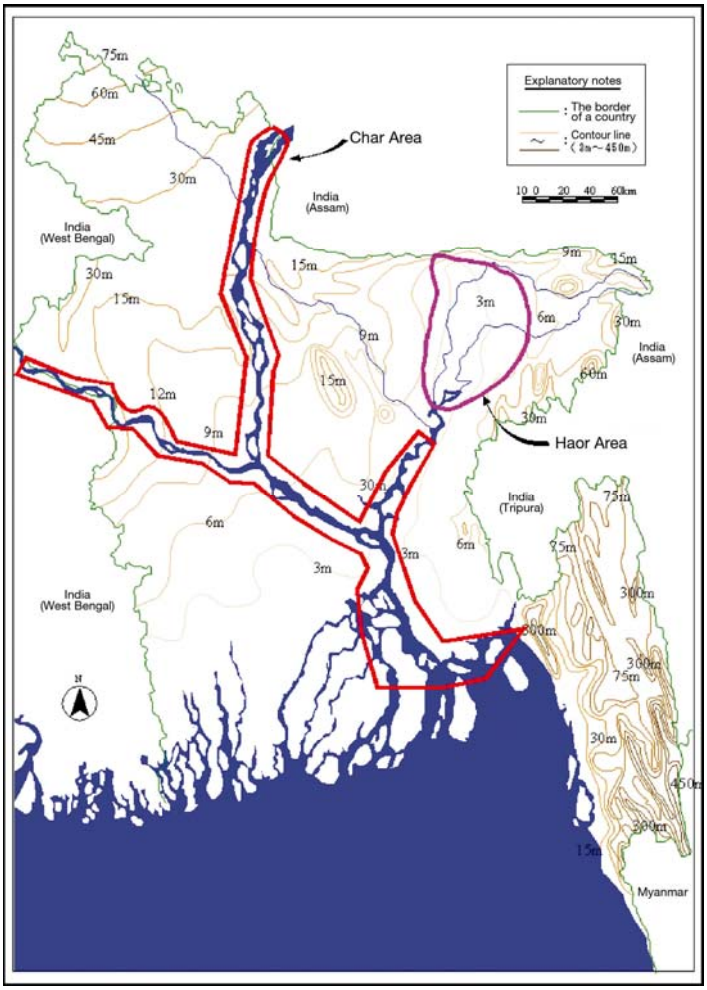


Fig 5: Char and Haor Area

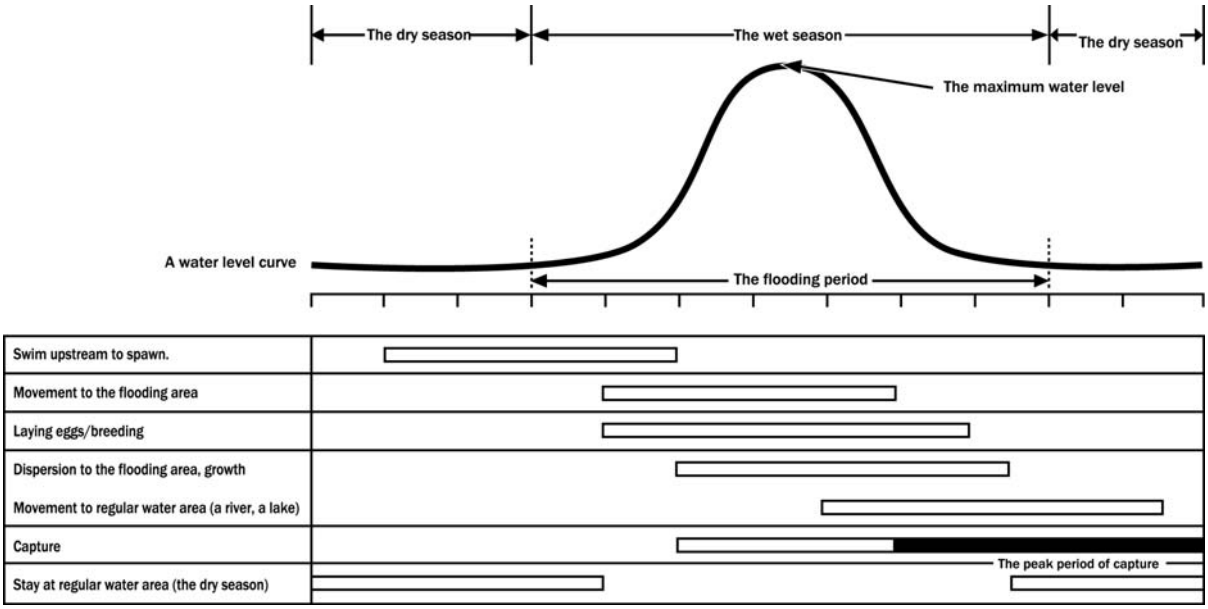


Fig 6: Lifecycle of Fish in the Flooding Area **Source:** Harza,1987a

1.3 Social Structure

(1) History of the foundation of the nation and changes of governments.

Bangladesh means "Bengal's Desh (people's native country)" and has been through two independences during 4 and half centuries. The magnificent delta zone that combined current Bangladesh and the West Bengal State of India, was once one governance unit called Bengal State of India. East Bengal district whose population contained many Islamic people, became independent of India as a part of Pakistan (East Pakistan) at the same time as the formation and separation of Pakistan from India in 1947.

Post-independence from India, East and West Pakistan, though the same nation, were not always placed on equal footing. The leading governance posts were taken up by people from West Pakistan which had the center of government, and the East was disadvantaged in respect of economic development. In the election of 1970, the Awami League led by Rahman Mujibur, which promised a local currency, and army, won most of the total East Pakistan seats. A suppression by the Pakistan government against this and military support from India for the liberation forces caused the war that led to the declaration of the independence of East Pakistan in March 1971. The war of independence ended in December 1971 and Bangladesh started under the leadership of President Rahman Mujibur.

Rahman Mujibur was assassinated in a coup d' Etat in 1975, and a military government and two major political parties (Awami League and Bangladesh nationalist party：BNP) fought for political power. The details of changes of government from Independence to now are stated as follows.

Table 1 : Changes of Governments after the Nation Foundation

Period	Government
1971～ 1975	Rahman Mujibur government (Awami League) Formed Bangladesh, Awami League. In 1975, assassinated by a young officer in coup d' Etat.
1975～ 1981	Ziaur Rahman government (BNP) In 1975, assumed the whole army by coup d' Etat. Attempted civilization with military leading. Assassinated in 1981.
1981～ 1990	Ershad government（A military government） Ershad, who was in West Pakistan at the war of independence, captured the reins of government by a bloodless coup d' Etat in 1981. Aimed strict military dictatorship. Planned to establish Islam as the state religion. Resigned December 1990.
1991～ 1996	Khaleda Zia government (BNP) The first lady of President Ziaur Rahman. The first woman prime minister. Presidential government was abolished and parliamentary cabinet system was revived.
1996～ 2001	Sheikh Hasina government（Awami League） The oldest daughter of president Rahman Mujibur. At the election in 1996, with this reappointment of Khaleda Zia by rigged election with 10% vote turnout, antigovernment campaign heated up. The government economy was paralyzed. In 1996, an election was held with overseas diplomatic corps and Awami League returned to the government for the first time in 21 years, and then Sheikh became a prime minister.
2001～	Khaleda Zia government (BNP) Reelected in October 2001.

(2) Industry and Employment system

Currently, the industry of Bangladesh is based on rice and jute, the production of tea, sugar cane and prawn culture. The manufacturing industries are light industries such as jute processing, leather and sewing etc. Bangladesh is the world's fourth largest rice producing country, however, it is necessary to import food because of over population and flood damage. Bangladesh is largely dependent on overseas migrant workers and foreign aid.

Although recently the agricultural sector's share of GDP and the proportion of labor employed in this sector has been decreasing, more than 60% of the available labor still works in the agriculture sector. 70% of the whole population lives in agricultural districts where their major industry is agriculture. Approximately 60% of all workers in various employment categories are self-employed or casual daily workers. Classifications of casual daily employment work are agriculture, construction and rickshaws etc, and employment of agricultural workers is closely linked to agricultural seasons, therefore, the movement of seasonal workers is expected, according to the season of rice planting and harvesting in each region.

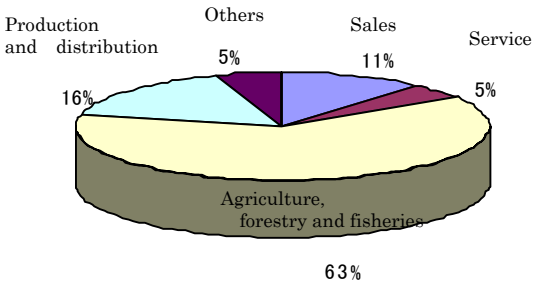


Fig 7: Labor Force Sector (1999-2000)

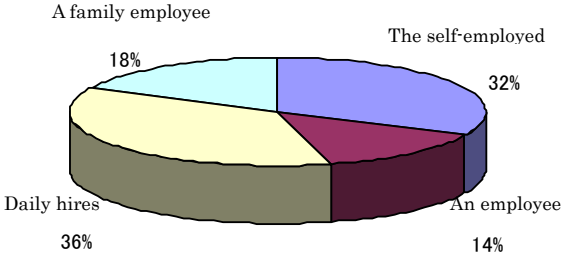
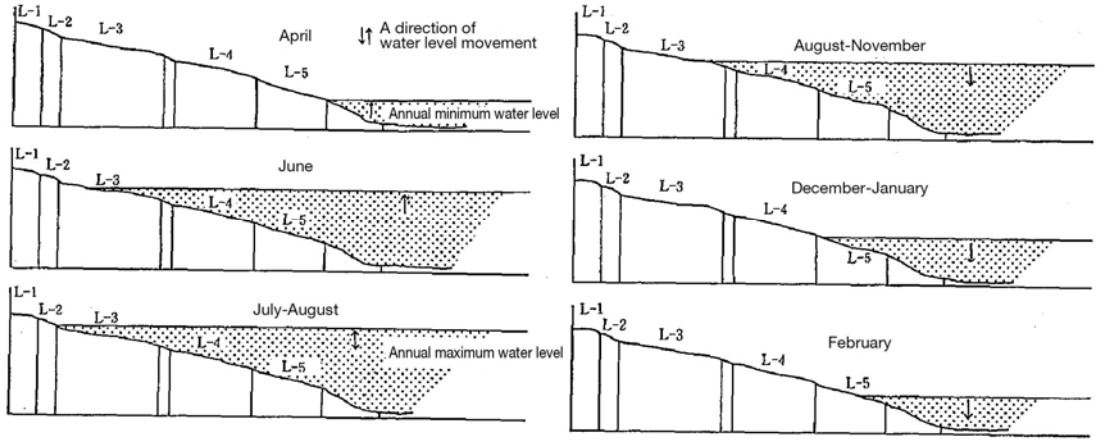


Fig 8: Labor Force Type (1999-2000)

(3) Traditional agricultural techniques and Green Revolution

Farmers of Bangladesh historically developed their own agriculture suited to the natural conditions of their region and have since been practicing it. The agricultural year in Bangladesh is divided into the first agricultural period (April-August), the second agricultural period (August-December) and the third agricultural period (December-April) according to the actual cultivation stage of rice and jute, and by cultivating appropriate crops in suitable places in each agricultural period, they may be planted and harvested in anticipation of the variation of a water levels resulting from floods coming every year. (Figure 9)



Cultivated Ground Agricultural period	L-1	L-2	L-3	L-4	L-5
Cultivation pattern before Green Revolution					
The first agricultural period April～ August	Aus rice	Aus rice	Aus rice Jute	Scattered Aman rice	
The second agricultural period August～ December	Transplanted Aman rice Greens The pulse family crops Seed crops	Transplanted Aman rice Greens The pulse family crops Seed crops	Transplanted Aman rice	Scattered Aman rice	
The third agricultural period December ～April	Greens	Greens The pulse family crops	The pulse family crops Seed crops	Sugar cane	Boro rice

Cultivation pattern after Green Revolution					
The first agricultural period April～ August	Aus rice	Aus rice	Aus rice	Scattered Aman rice	
The second agricultural	TransplantedAman rice	TransplantedAman rice	TransplantedAman rice	Scattered Aman rice	

period August～ December	Greens The pulse family crops Seed crops	Greens The pulse family crops Seed crops			
The third agricultural period December ～April	Greens	Greens The pulse family crops	Boro rice （Irrigation） The pulse family crops Seed crops	Boro rice （Irrigation） Sugar cane	Boro rice

Source: Partly created from "Motto Shiritai Bangladesh", (Usuda, et. al, 1993)
* Scattered Aman rice is spread to both the first and second agricultural periods and sugar cane to the first, second and third periods. Underlined are the major crops.

Fig 9: The flood level and the change of agriculture in Bangladesh

As in the past, the first and the second agricultural periods that were largely relying on the rainfall in the rainy season were central to the agriculture of Bangladesh while the third agricultural period in the dry season had low productivity and was less active. However, although the first and the second agricultural period had high productivity because of the abundant rainwater of the rainy reason, they were carrying the risk of damage to the crops if a flood occurred that was larger than the average. Because of this, the Bangladesh government has proceeded with large-scale FCDI (flood, countermeasure, drainage, irrigation) projects to achieve self-sufficiency in rice production for their rapidly increasing population.

In the mid 1960s', Bangladesh adopted the Green Revolution that improved food production by adopting High-yielding varieties (HYV), and it is widespread in growing Boro rice. By adopting HYV and irrigation projects, Boro rice that was grown only at the lowest level ground (L-5) in the past moved into the low ground (L-4) and the middle ground (L-3), driving out Aus rice that overlapped part of the same cropping season as Boro rice, and the dried up ground of the dry season became covered by a rich green carpet. The widespread usage of HYV accelerated, together with the increasing use of pipe-wells in 1980s', and this contributed largely to an increase in rice production.

On the other hand, the increased use of HYVs that need massive amounts of materials such as agrochemicals and chemical fertilizers etc, has led to the cash investment becoming incorporated into farm households that used to grow crops only for self-supply. It appears that the stereotype of massive rice production with massive material input is advancing the commercialization of agriculture and also contributing to expanding the differential between the poor and the wealthy along with that the fractionalization of agriculture is advancing with population increase.

(4) Governance Unit of Bangladesh and a social structure in the community

Bangladesh is divided into administrative units of 64 prefectures, 496 districts and 4,451 unions (administrative villages). The prefectures don't have assemblies, etc and parliamentary Vice-Ministers appointed by a government department administer prefectures, while the prefecture office of the central government ministries carries out various kinds of projects.

Districts were established to decentralize power in 1982 and most of the ministries and agencies' offices were stationed to work in direct contact with the public. Districts do not have assemblies etc; as with the

prefectures, district administration officers and district ministries and agency offices carry out various activities.

Administrative villages called Unions are different to other administrations. Each union has a council of 12 members of assembly (three of them are assembly women) who are elected at an election. Unions originated from the "Chokidar" ward system that took the responsibility of a part of the police system formed under the British government. At first, "Chokidar" wards were established in 1870 for the purpose of helping police (In Tana, their jurisdictions then, are operated as districts now.) within the jurisdiction of their police station, sot they could impose the cost of labor and supervision of village guards (Chokidar) on beneficiary districts. Thereafter, by the self-government of villages under laws of 1919, part of their function such as sanitation, roads, construction and maintenance of schools was transferred to the Union that took over "Chokidar", and that forms today's system.

The main roles of unions are in the taxation business and residents' registration, however, the taxation business is in fact not operating well. Although, as a representative of the residents, the chairman of the Union council is also a member of the district development committee that approves developments at the district level, a council itself has no power of execution of the budget. Therefore central government ministries are taking the lead in conducting developments. The Union itself has no administration team to take responsibility for district governance in direct contact with the public, but it has a relatively strong position as a representative organization.

Besides that, Bangladesh has traditional community units such as Gram, Shomaj, Bari and Gshutti aside from administrative units determined by the government, and each traditional unit (except Gshutti ie the paternal consanguineous family and relatives) has a traditional leader called Matabol. The Matabol takes a leadership role in the hearings called Bichal and settling disputes between villagers is his main role. Matabol has no legal involvement with the Union, the small unit of administration, but exists only as a traditional chief of the village who takes charge of decision-making for the village.

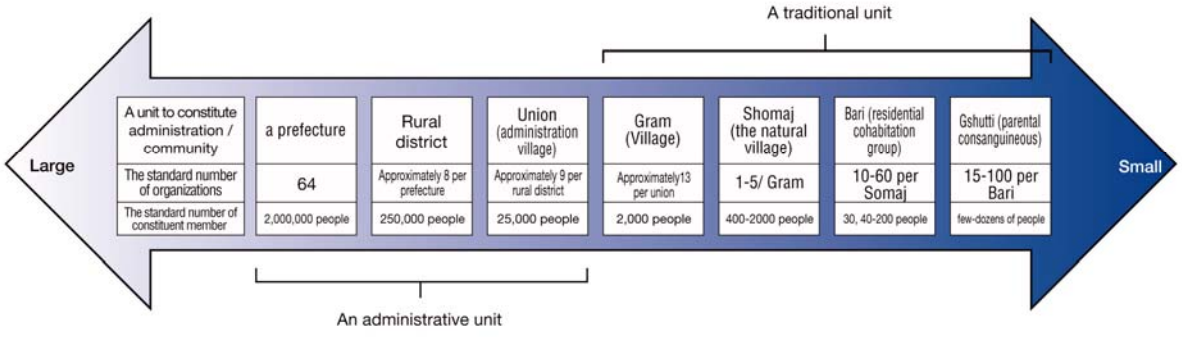


Fig 10: Image of Traditional Units and Administration in Bangladesh

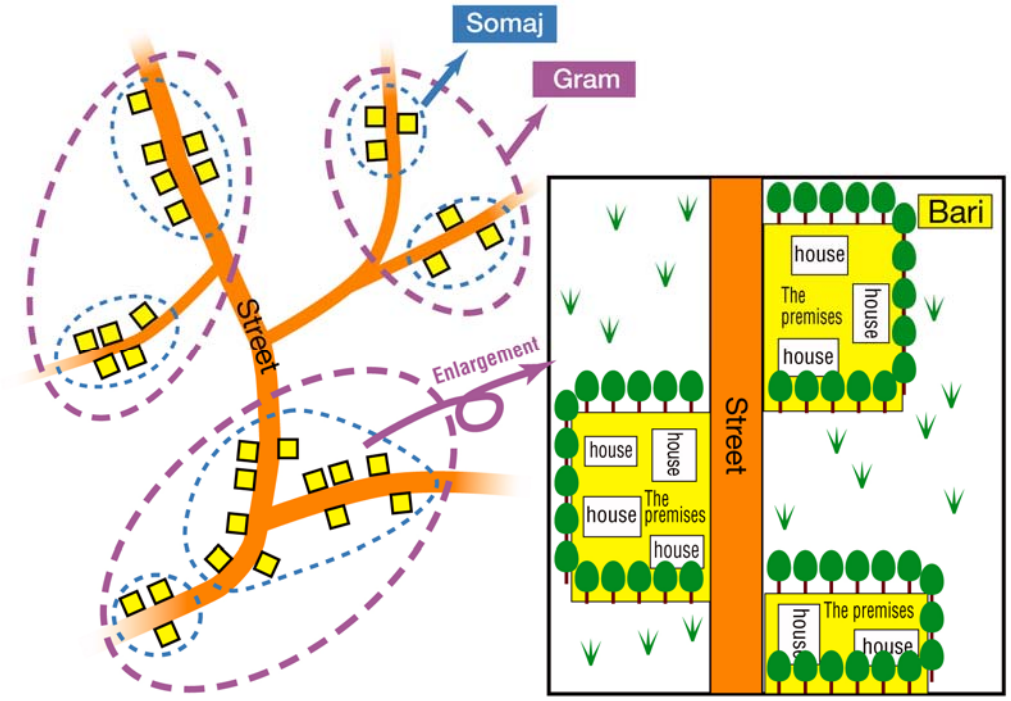


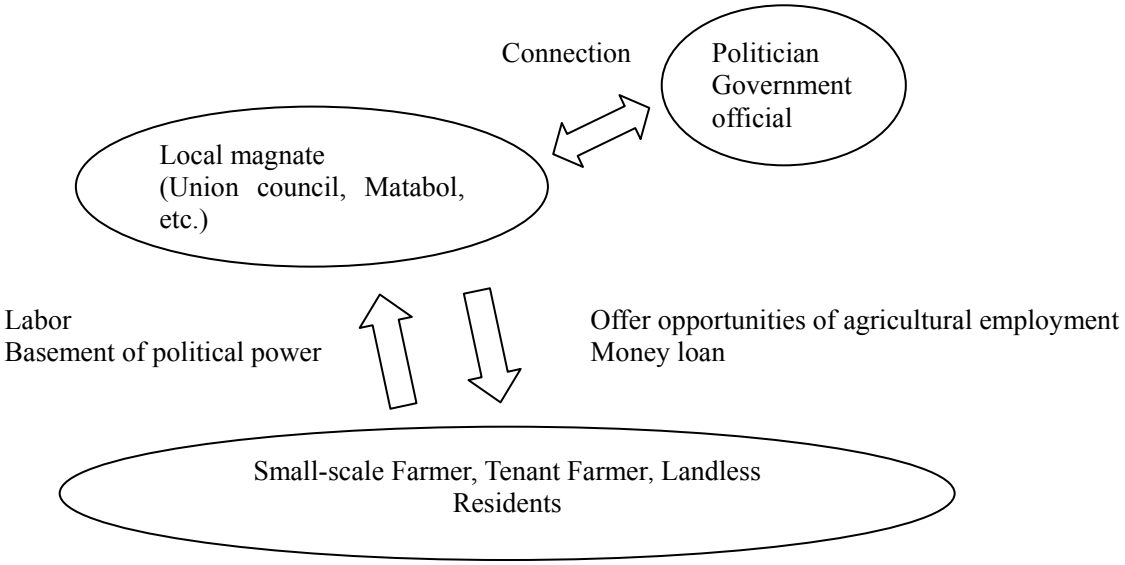
Fig 11: Image of Gram, Shomaj and Bari

The Independence of Pakistan in 1947 had a profound effect on the social structure of Bangladesh. When many Hindus who were living in the East Bengal region emigrated overseas, the government seized "zamindari" lands, the large-scale landlords of which were Hindus. The government was also influenced by an elite group and benefits earned by the government from this land were distributed favorably among this limited group. Rapidly developing urbanization and industrialization resulted a new middle class that had not previously existed in the social structure, seen in the center of prefectures. They strengthened financial and governmental power through commercial activities and eventually won political leadership after their independence as Bangladesh. Farmers in agricultural districts also began to develop differentially into capitalists, wealthy small farmers, and medium and small scale farmers, and farmers that didn't own their own lands, etc.

The Green Revolution that started in the 1960s' made great progress in the 1980s', it advanced polarizations of capital and contributed to expanding the gap between each social level. Capitalists were able to do large-scaled production by using modern agricultural machinery and employing labor. Wealthy farmers who had great financial and political influence had easy access to rights and interests obtainable through government systems and had advantages in many respects. On the contrary, those actions were not available for farmers who did not have great wealth, and eventually they lost the competitions, became poorer and relinquished their land after all.

The main factors that control power relationships in the districts are economic position, household finances, area of land owned and relationships with politicians or government officials, etc. Feudalistic patron-client relationships in districts also form the foundation of the government. The chairman and members of the Union councils and Matabol, as patrons, aided poorer people and poorer people strengthened their patrons'

political influence. The Zamindari system that was the traditional landlord-tenant farming system formed before the age of British possession was abolished completely during the time of East Pakistan, and the traditional zamindari who owned extensive lands no longer exists. However, a smaller similar version called Jotodal Praja 1) remains operative in some districts. It is said that the traditional system remains strong especially in the Char region compared to other regions, and Zaman (91) points out that local magnates who organize tenant farmers under their influence as private soldiers to control newly acquired rights and interests of Char, are sticking to the old social regimes similar to zamindari and Jotodal.



The structure of Patron=Clients relations in the district society

A sample survey in Char by Zaman (91) shows that 394 out of 619 (69%) lost their land more than once to encroachment, and moved. Approximately 90% of all who lost their land to encroachment do not move away from their region. Those landless farmers are able to make a living by following opportunities given by the local magnates: 1) free use of residential land, 2) offer opportunities of agricultural employment, and 3) tenant farming (they borrow the land to cultivate and receive a part of the yield from cultivated land.) Those bailouts strengthen landlord-tenant farming dependencies, and cause a similar situation to the zamindari system. It is also reported that under those circumstances, local magnates liken tenant farmers to private soldiers, and use them to take possession of other magnates' lands. (Zaman91) The landholding system in Char is less fair than in other regions; the high percentage of landless farmers is not always a result of unstable land conditions in Char, but related to social backgrounds.

Footnote:
1) A Jotodal is a farmer who collected tax under zamindari in the era of British rule and owned large areas of land. A Praja is a smaller scale tenant farmer.

(5) Minority

In Bangladesh where Islamic Bengalese make up the majority of the population, religious and language minorities still exist. Among the religious minorities, Hinduism makes up 10 % of the whole population and there is also some Buddhism and Christianity. Minority languages other than Bengali are spread, centering on mountains around borders. Approximately 45% of those minority people are Buddhists and they are classified as a language and religious minority. (Sato 1993)

Table 2: The number of households classified by religion in Bangladesh

Religious	Population (households in 1000s)	Percentage (%)
Total population	104,232	100
Islam	92,158	88.4
Hindu	10,992	10.5
Buddhist	581	0.6
Christian	303	0.3
Others	215	0.2

Source：2002 Statistical Year Book of Bangladesh, 2004, BBS

Table 3: The number of minority households and distribution

Prefecture	The number of house holds
Bandarban	21,704
Cox's bazar	3,708
Khagrachhari	33,508
Rangamati	40,387

Source：2002 Statistical Year Book of Bangladesh, 2004, BBS

Note: the number of average household members in Bangladesh is approximately 4.9.

Blatant racial conflicts like the Hindu and Muslim riots of India, in Bangladesh are considered to be few, however the minorities are still in an unstable position. Even Hindus, who make up most of the minorities, are considered to be treated unfavorably in imbalanced promotions of government officials, persons who are involved in the army, and administration of justice. (Togawa, 2004)

The minorities such as Chakma, Marma and Mru, etc spread from hilly Chittagong that has the only real mountainous landforms out of the whole level territory in Bangladesh, to Sylhet in the north. Those minorities who are Mongolian descendents whose native languages are Tibeto-Burman languages, were approved the right of self-government under British government. However, repeated disputes against the government since the era of East Pakistan and the Independence of Bangladesh, have led to a tense relationship which has not dissolved completely to this day.

(6) Gender

Although the political power of women Prime Ministers has continues in Bangladesh during recent years, the social position of women is still low because of the background of the Islamic religion and culture has an effect on this. From old times, under the code of conduct called Paruda for women, women have to stay home and they have been only allowed to contact limited men - family and relatives, even inside the house.

The economic strength of women is generally weak; therefore women have been forced to live their life economically relying on men. These past few years, women's economic activities are considered to be expanding by development of macro-finance and sewing industries, but the level of women's wages are lower than men's, and the poverty rate of households where the head of the household is a woman is higher than the rate where it is a man in agricultural districts.

2. Cyclone Disasters in Bangladesh

2.1 Overview of Cyclones

(1) Season and frequency of cyclones

Bangladesh is situated in the monsoon climate area. June to September is the rainy season with monsoon wind, October to May is the summer season. Cyclone seasons [i] are before and after the monsoon period (April to May and October to November). Cyclones before the rainy season tend to move along the southeastern coastal area and the ones after the rainy season tend to move along the west side of the Bay of Bengal near India. Average annual rainfall of Bangladesh is around 2,200mm, while annual rainfall in the coastal region along the Bay of Bengal is 3,000 mm (Fig 12), of which two thirds falls in four months of the rainy season, and the cyclone periods before and after the rainy season contribute to this amount of rainfall too. The number of Cyclones that affect Bangladesh yearly, between 1975 and 2000, that caused severe impact to human and livestock lives, and the economy is up to 14, which is on average every other year.

See Table 4 for History of Cyclone Disasters (Bangladesh)

(2) Characteristics of cyclone disasters in Bangladesh

The strength of cyclones themselves in the Bay of Bengal is not so different from the ones that occur in other regions, however, external forces created by triangular geographical features in the Bay of Bengal generate enormous tidal floods and they cause severe damage and loss of lives in the coastal region. Low-lying land in Bangladesh suffers greatly by cyclones at high waters, especially at spring tides, which cause tidal bores of 5-9 meters so the seawater enters 5-8 kilometers inland. Research reported that 97% of cause of death in cyclones is drowning in these tidal bores（BA_S_02）.

(3) Characteristics of cyclone stricken regions

1) Population

It is said that 15,000,000, 14.8% of the total population in Bangladesh live in the coastal and island region, of which 6,400,000 (BA_S_20, 2002) or 8,000,000 (BA_A_18, 2002) live in the highly dangerous area (prone to cyclones where sea level comes up more than 1meter, which causes great loss of life. see Fig 13 Area Table of Cyclone Risk).

Footnote:

（i）Wind scale for Cyclones in Bangladesh: 1) Low pressure (under 62km/h), 2) Cyclone storm (62-88km/h), 3) Severe cyclone storm (89-117km/h, 4) Severe cyclonic storm of hurricane intensity (over 118km/h)

2) Geographical division

The coastal region in Bangladesh is characterized by three distinctive features; a) Sunderban Region, b) Meghna Estuary, c) Eastern Region (Fig 14, Cyclone-prone Areas). a) Sunderban Region is characterized by deep forest (see Fig 15, Forest Distribution Map), c) Eastern Region by high elevation (Fig 16, Elevation Map) and b) Meghna Estuary by vulnerability to cyclones (BA_S_12).

Within the highly dangerous areas, population density (Fig 17, Population Density) is lower in a) Sunderban Region where the coastline is covered with woods when compared to b) Meghna Estuary and c) Eastern Region.

3) Industry in the coastal region

The main industry in the coastal region is farming to utilize the fertile soil in the area. In the most flood-prone b) Meghna Estuary deltaic area, 80% of labor is engaged in farming, 10% in the fishing industry (BA_S_14). Despite the small number of workers in the coastal region, fishery is a major business and some 600,000 out of 1,300,000 fish farms (0.3ha average each) of 150,000 ha (Bangladesh Bureau of Statistics, 2002) within the country are located in the coastal areas such as Barisal, Comilla, Sylhet, Chittagong, Noakhali district.

Adding to that, shrimp farming has been conducted since early 1970's at south and southeastern coastal regions. The total area of shrimp farms in 1980 was less than 20,000 ha, which grew up to about 140,000 ha in 1995 and is expected to expand to more than 200,000 ha by 2003 or 2004. It is especially widely spread in northern a) Sunderban Region. See Figure 18 Shrimp Aquaculture Distribution Map.

4) Population flow by seasonal labor

Internal migration of seasonal labor is common ii in Bangladesh and so the coastal region with fertile soil that is suitable for farming receives many seasonal workers during the cultivating and harvest times (see Fig 9 for detailed farming calendar). The cyclone seasons (April – May, October – November) coincide with these periods when the temporary population increases due to the seasonal work, which results in more victims in cyclone disasters.

Footnote:

(ii) 20% of households randomly selected from 62 villages in the country have reported to have a seasonal worker within the family (Rahman, 1996). Compared to the average family, the percentage amongst poverty-stricken households is 5% higher according to other reference sources.

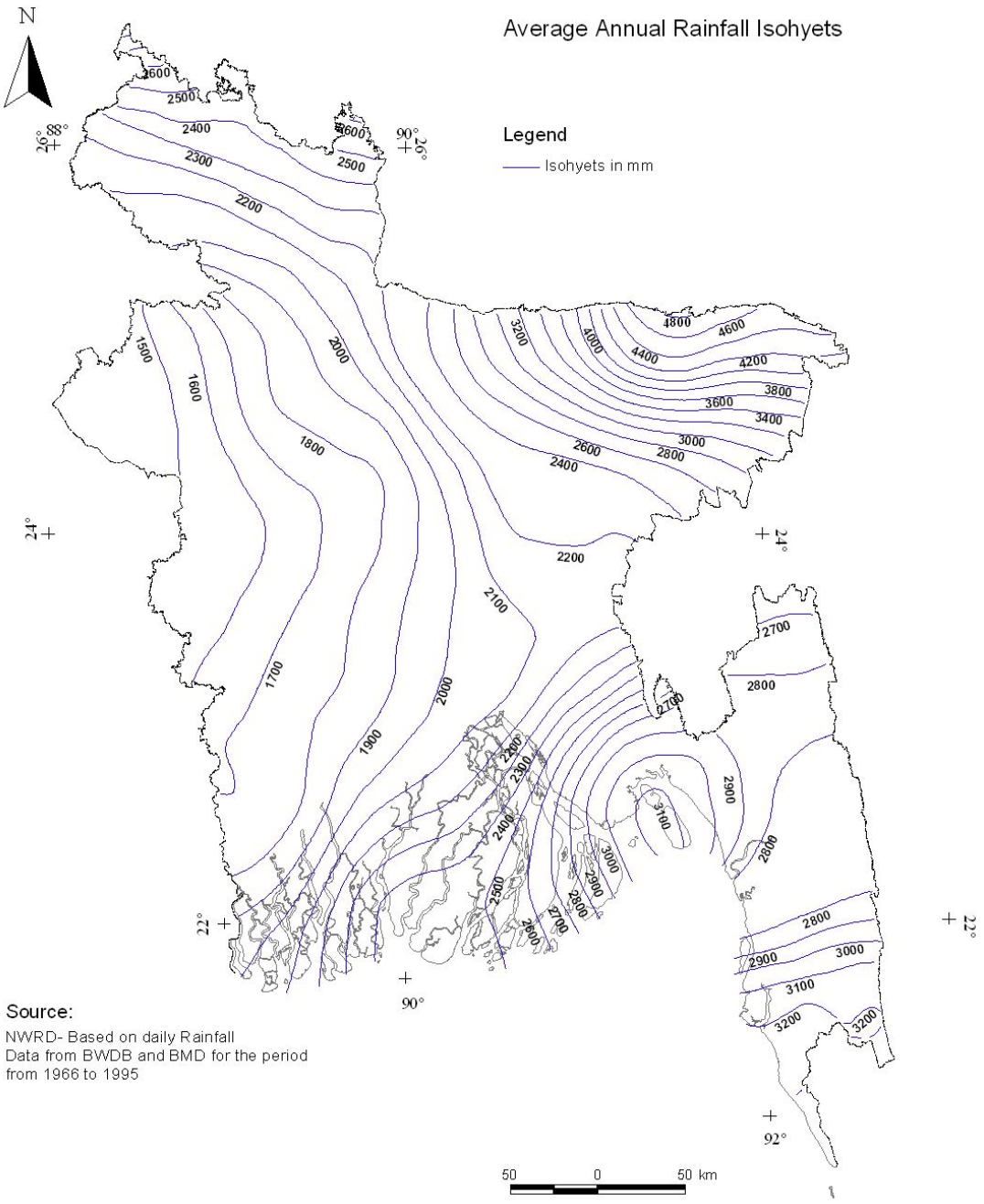
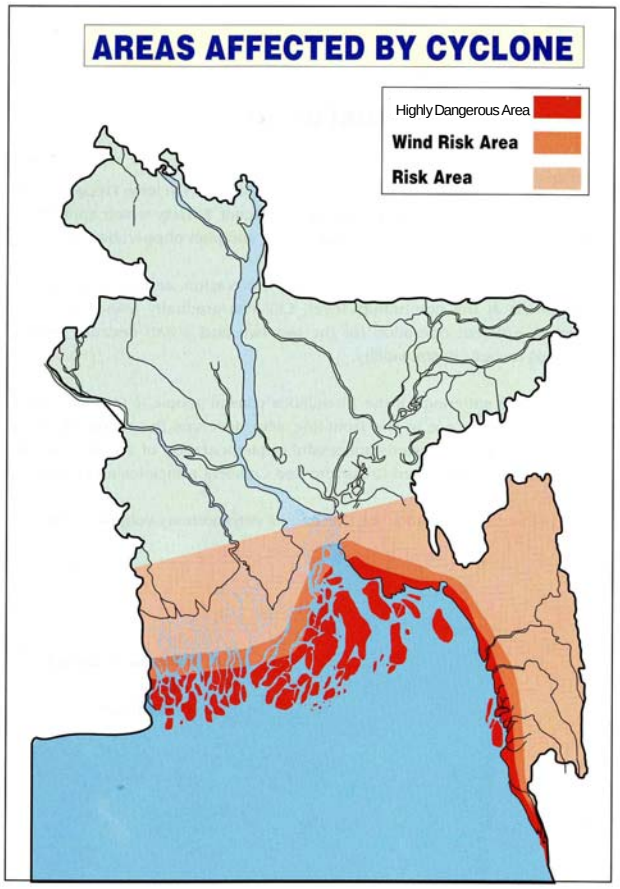


Fig 12: Average Annual Rainfall Isohyets (annual rainfall)

Table 4: History of Cyclone Disasters (Bangladesh)

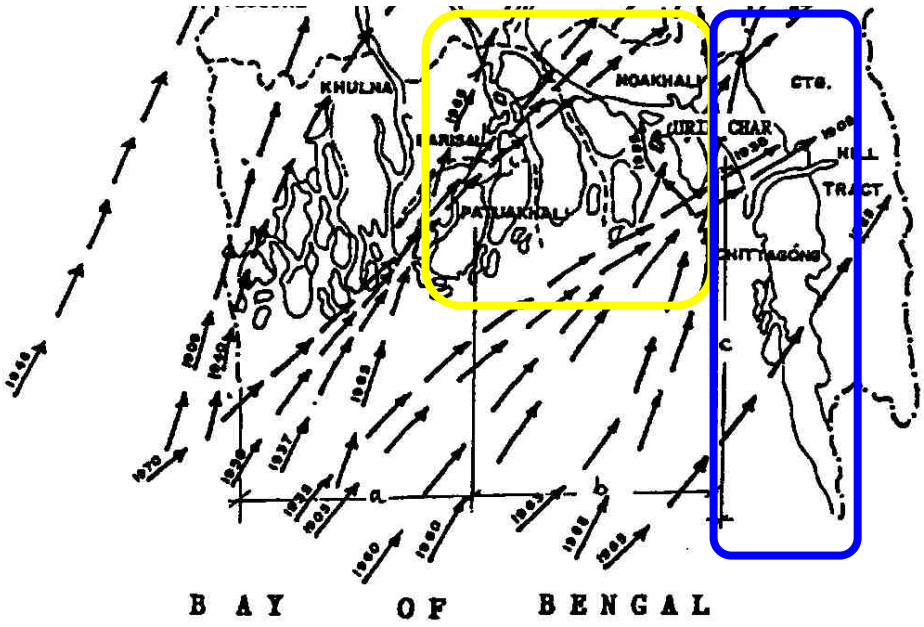
Source: CRED, wind speed record from Banglapedia

No.	Year	month	the striking date	The passing date	Damaged district	Wind speed	Killed	Injured	the number of influenced people	The number of people that became homeless
1	1904	11	-	-	Chittagong	NA	0	0	0	0
2	1909	10	15	15	Bakerganj	NA	172	0	0	0
3	1909	12	-	-	West Sundarbans	NA	0	0	0	0
4	1911	4	-	-	Teknaf	NA	0	0	0	0
5	1919	9	23	23	Bakerganj	NA	0	0	0	0
6	1922	4	19	19	Teknaf	NA	0	0	0	0
7	1923	5	7	7	Cox's Bazar, Chittagong	NA	6	0	0	25000
8	1926	5	19	19	Cox's Bazar	NA	0	0	0	0
9	1937	10	11	11	Noakhali	NA	0	0	0	0
10	1941	5	21	21	Bhola, East Meghna estuary	NA	5000	0	0	0
11	1942	10	-	-	West Sundarbans	NA	61000	0	0	0
12	1947	10	21	21	Cox's Bazar, Chittagong	NA	500	0	0	0
13	1958	5	-	-	East Meghna Estuary	NA	0	0	0	0
14	1958	10	20	20		NA	500	0	0	0
15	1960	10	9	9	Noakhali, Off-Shore Islands	The maximum wind speed 201km/h	3000	0	0	0
16	1960	10	30	30	Chittagong area, Off-Shore Islands	The maximum wind speed 210km/h	5149	0	200000	0
17	1961	5	9	9	Megna Eestuary	The maximum wind speed 161km/h	11000	0	0	0
18	1961	5	30	30	Chittagong	NA	0	0	0	0
19	1963	5	28	28	Chittagong, Noakhali	The maximum wind speed 203km/h	11500	0	1000000	0
20	1963	10	-	-		NA	79	0	0	0
21	1964	4	12	12	Jessore district	NA	300	0	800	0
22	1965	5	11	11	Barisal district	The maximum wind speed 162km/h	36000	600000	10000000	5000000
23	1965	6	-	-		NA	12047	0	0	0
24	1965	12	15	15	Chittagong to Teknaf	The maximum wind speed 210km/h	874	0	60000	0
25	1966	10	1	1	Chittagong, Sandwip	The maximum wind speed 146km/h	850	0	1500000	300000
26	1967	5	2	2	Dacca	NA	50	200	0	0
27	1967	10	0	0	South, near Cox's Bazar	NA	41	0	0	0
28	1968	4	11	11	Madaripur, Faridpur	NA	118	1045	15093	0
29	1969	4	14	14	Dacca, Comilla	NA	849	15530	160000	23943
30	1970	11	12	12	Khulna, Chittagong	The maximum wind speed approximately 222km/h	300000	0	3648000	0
31	1971	5	8	8	Coastal areas	NA	163	0	0	0
32	1973	12	9	9	South coast	NA	1000	0	0	0
33	1974	8	-	-		Wind speed 80.5km/h	2500	0	0	0
34	1974	11	28	28	Coastal areas, off-shore Islands	Wind speed 161km/h	0	0	0	0
35	1977	4	24	24	Mymensingh district	NA	13	100	0	0
36	1979	5	2	2	Eastern	NA	3	150	0	0
37	1979	8	17	17	South coast	NA	50	0	0	0
38	1980	4	-	-		NA	11	50	1000	0
39	1981	12	11	11		NA	1000	0	2000000	0
40	1981	3	6	6	Comilla	NA	15	0	0	25000
41	1983	3	21	21	South	NA	6	150	0	0
42	1983	10	15	15	Chittagong	Wind speed 122km/h	600	0	5000	0
43	1983	11	13	13	Chittagong	NA	67	0	0	0
44	1985	5	25	25	Urir, Jabbar, Bata, Darbesh, Clark, Sudharam, Hatia, Sand Wip Islands + Patuakhali, Bhola, North Chittagong, Feni, Noakhali districts	Wind speed154km/h (Chittagong)	10000	0	1300000	510000
45	1986	11	9	9	Bengal Bay (South-West)	Wind speed 110km/h(Chittagong)	25	100	0	0
46	1987	6	4	4	Hatiya, Swandwip, Patuakhali, Bhola regions	NA	12	0	0	0
47	1988	10	19	19	Patuakhali, Cox's Bazar	NA	31	0	0	0
48	1988	11	29	29	Bagherhat, Barguna, Bhola, Jessore, Khulna, Patuakahli, Pirozpur, Satkhira, Sundarbans	The central wind speed 110km/h	1000	0	8568860	2000000
49	1989	5	26	26	Manikganj, Tangail	NA	15	2000	0	0
50	1990	10	8	8	Chittagong	NA	370	0	13870	0
51	1991	4	29	30	Cox's Bazar, Chittagong, Patuakhali, Noakhali, Bhola, Barguna	The estimated maximum wind speed 240km/h	138866	138849	15000000	300000
52	1993	5	13	13	Begumgang, Thana Unions	NA	14	0	7500	0
53	1993	1	9	9	Sylhet	NA	50	500	0	2000
54	1994	5	2	2	St. Martins, Teknaf Upazila, Ukhia Upazila (Near Cox's Bazar), Kutubdia Isl., Moheskhali Isl., Bandarban	The maximum wind speed 210km/h	130	3559	450000	200000
55	1994	3	28	28	Mymensingh, Chittagong (North-East and Southern Bangladesh)	NA	40	150	0	0
56	1995	11	25	25	Gulf of Bengale	The maximum wind speed 210km/h	172	0	250000	0
57	1996	10	29	29	Chittagong, Patuakhali, Pirojpur	NA	24	100	0	0
58	1997	5	18	18	Banshkali, Anowara (Chittagong district), Cox's Bazar, Teknaf, Chokoria, Moheshkali, Kutubdia (Cox's Bazar district)	The maximum wind speed 225km/h	111	10000	2042738	1000000
59	1997	9	27	27	Bhola, Noakhali, Bagerhat, Khulna, Potuakhali, Sitakundu districts	Wind speed 150km/h	188	1529	750000	0
60	1998	5	20	20	Chittagong, Cox's Bazar, Sitakundu	Wind speed 150km/h	19	504	108440	0
61	1998	11	25	25	Sathkhira, Khulna district	NA	200	0	121000	0
62	1999	10	25	25	Satkhira, Khulna, Bagerhat, Pirojpur, Borguna districts	NA	0	0	0	0
63	2000	10	28	28	Barisal, Barguna, Jhalkahti, Bhola, Khulna, Pirojpur, Noakhali, Luxmipur, Cox's Bazar, Dhaka, Mymensingh, Chandpur, Shariatpur districts (coastal and central)	NA	15	200	0	0
64	2002	11	14	14		NA	49	0	0	0



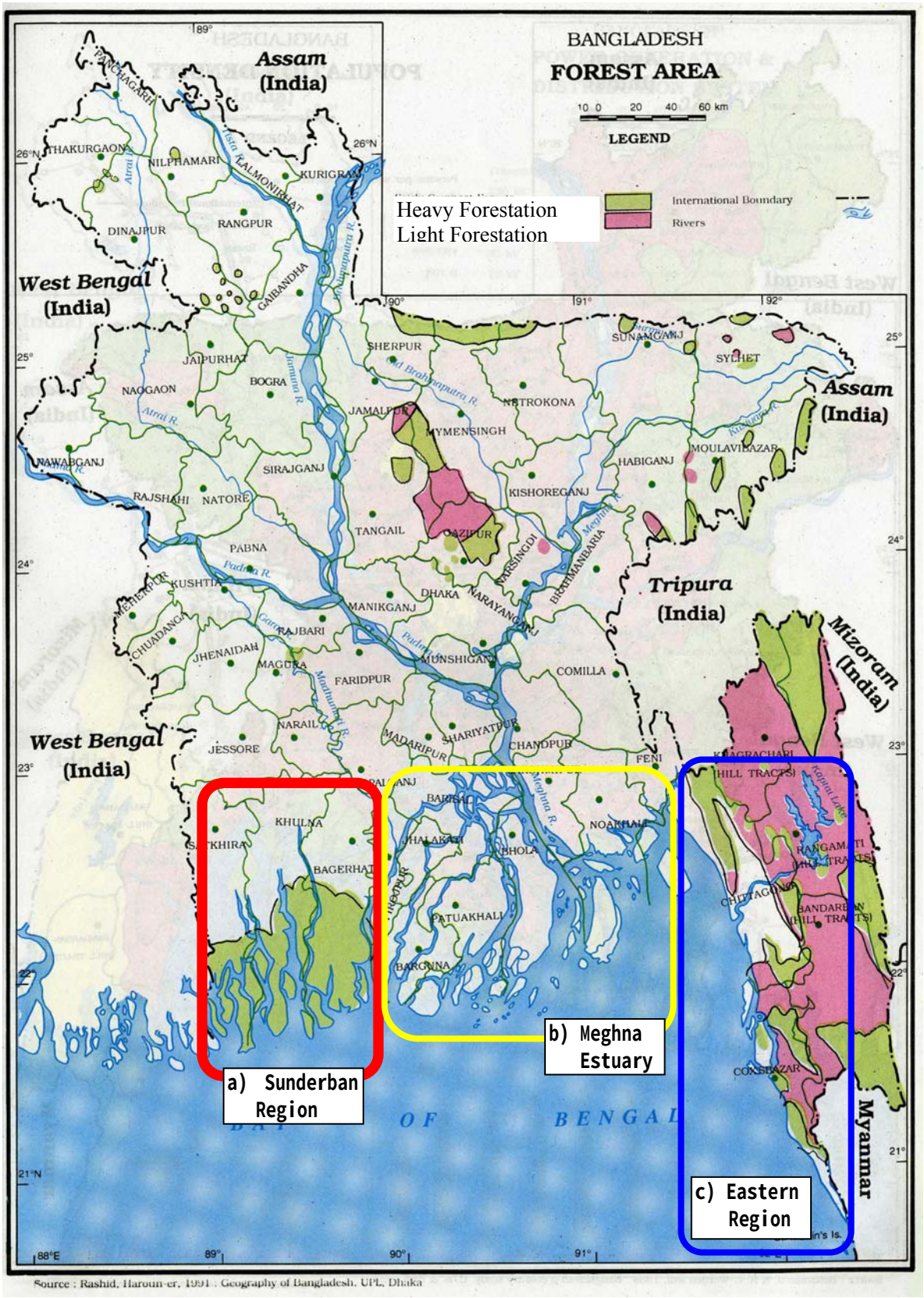
Source：CPP, At a glance (BA_S_18)

Fig 13: Area Table of Cyclone Risk



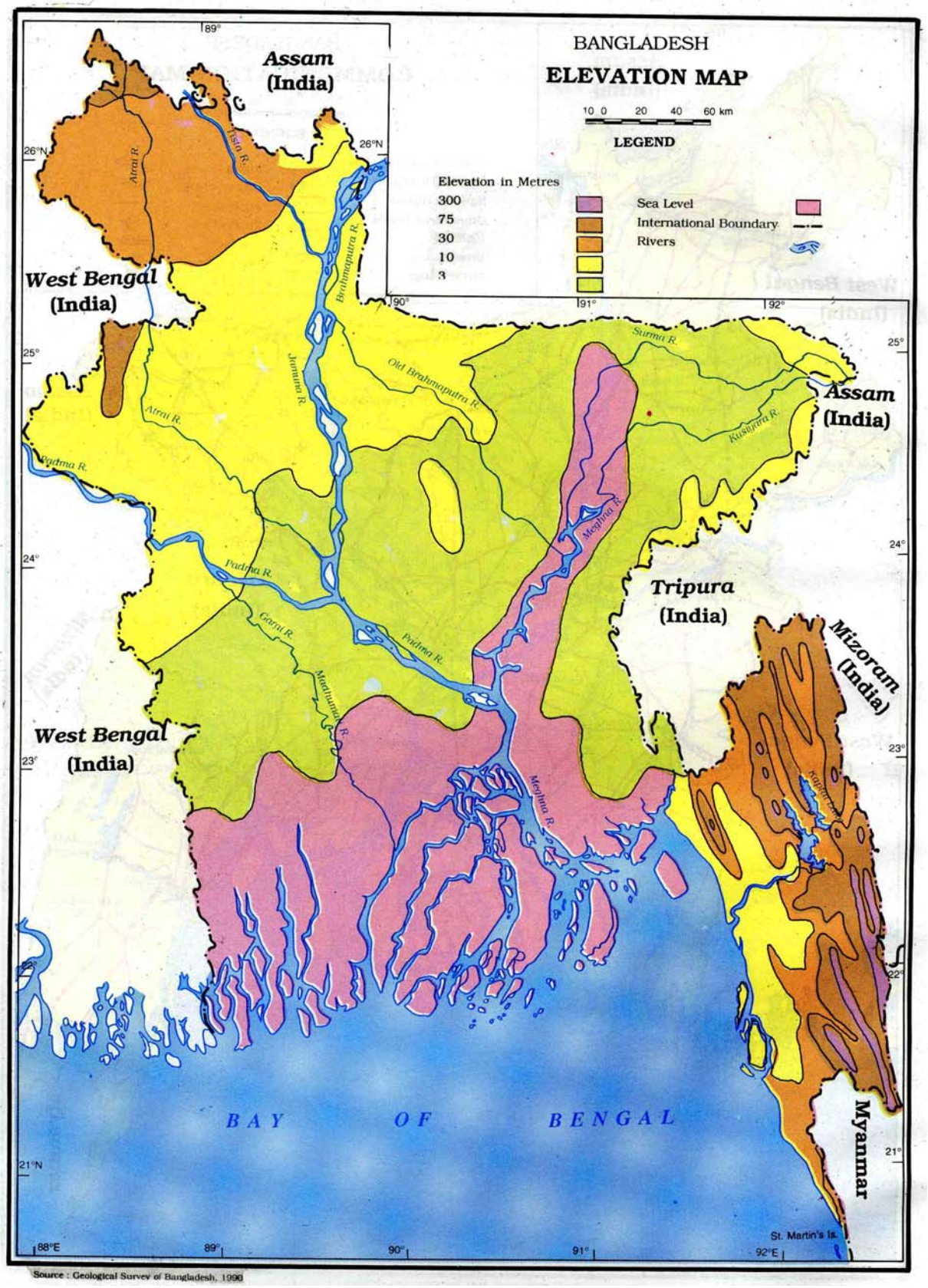
Source：Cyclonic-surge Resistant Housing in Bangladesh: The Case of Urir Char (BA_S_12)

Fig 14: Cyclone-prone Areas



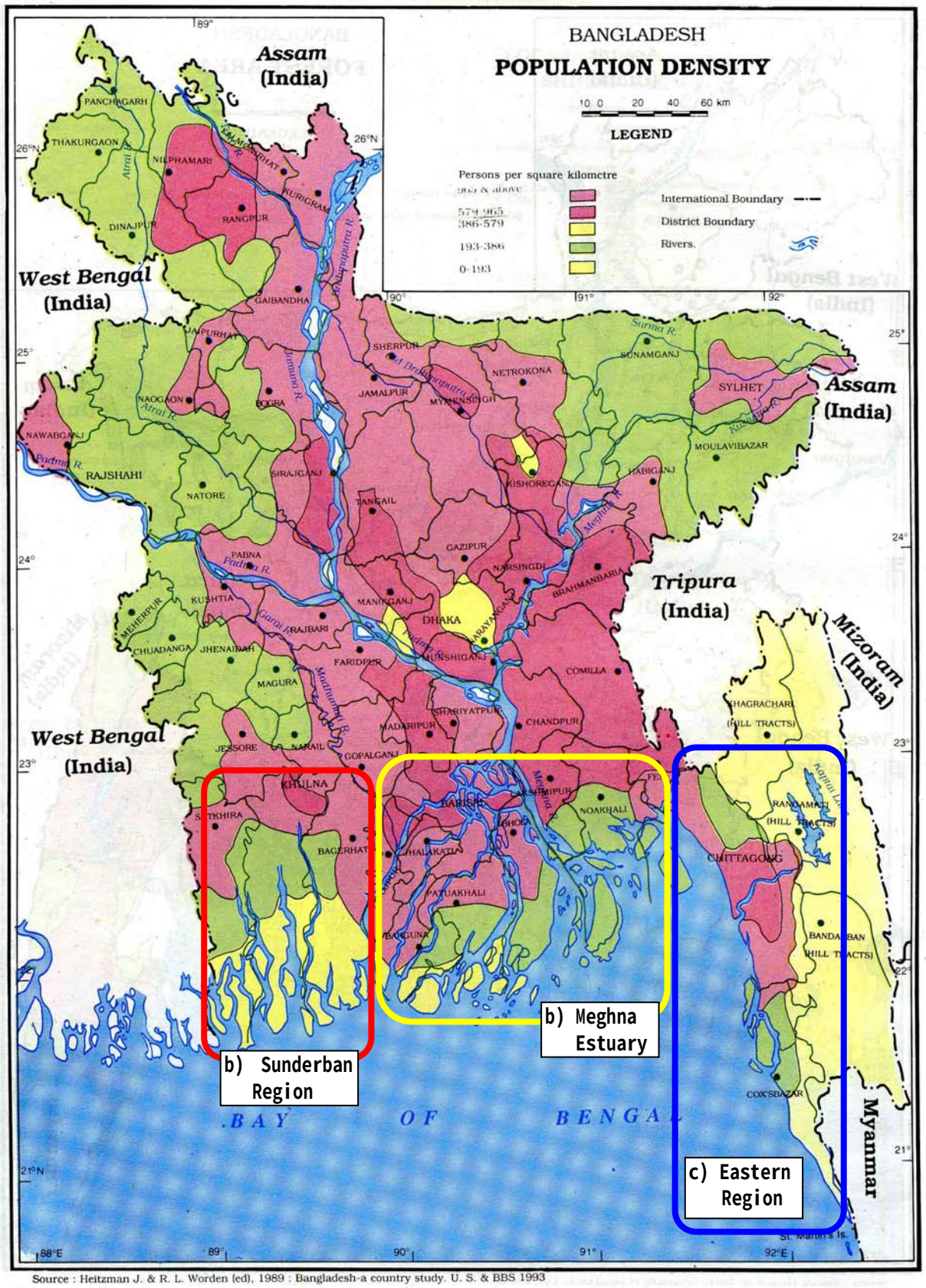
Source：JAHAN ATLAS

Fig 15: Forest Distribution Map



Source：JAHAN ATLAS

Fig 16: Elevation Map



Source : Heitzman J. & R. L. Worden (ed), 1989 : Bangladesh-a country study. U. S. & BBS 1993

Source：JAHAN ATLAS

Fig 17: Population Density

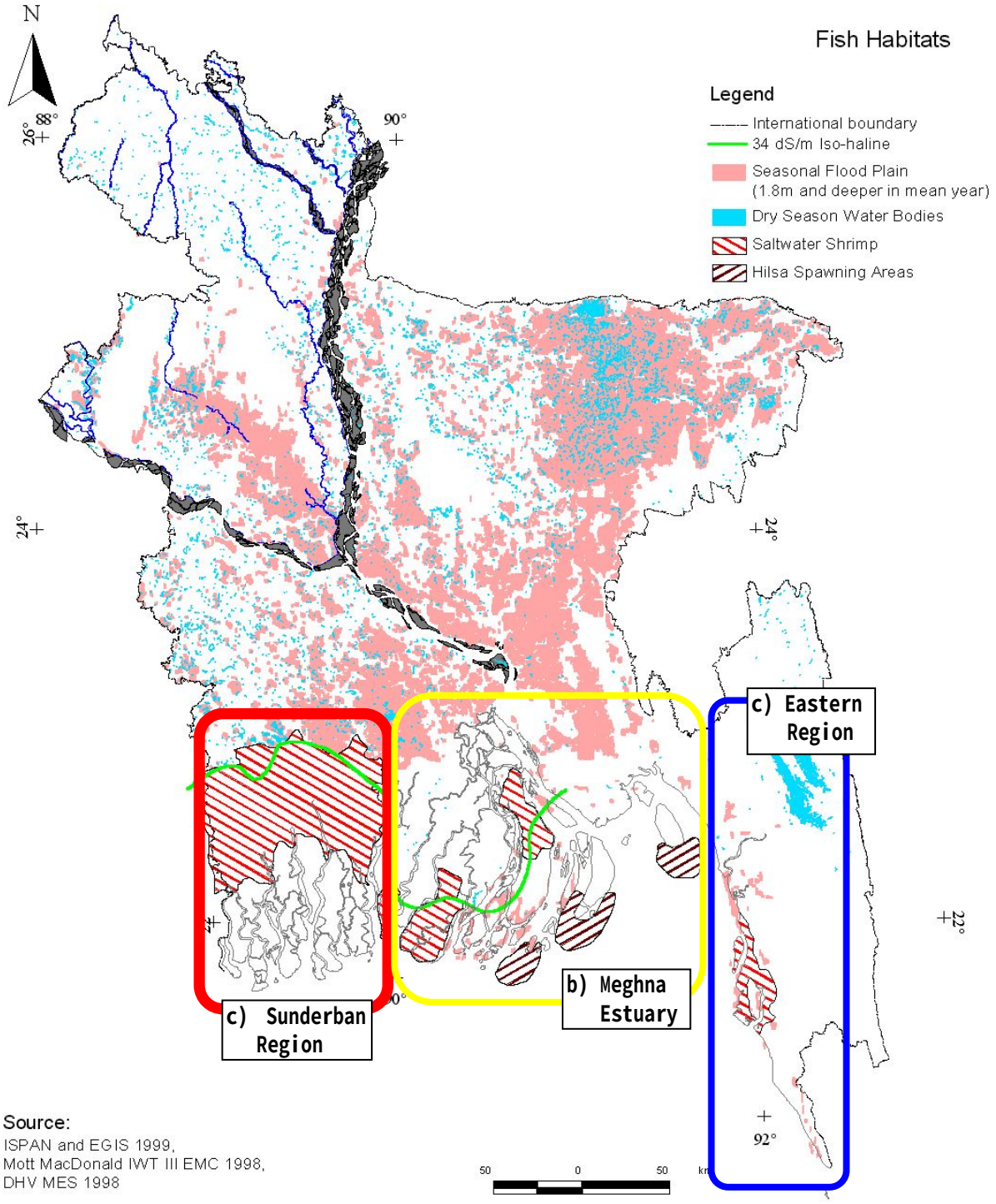


Fig18: Shrimp Aquaculture Distribution Map

2.2 History of Cyclone Disaster Mitigation Measures

Structural and non-structural measures against cyclones taken in the past are described blow. See Table 5 for major protection schemes and ravaging cyclones arranged chronologically.

(1) Infrastructural measures

1) Tide levees

The government of Bangladesh□ built a 4,000 km tide levee (tide barrier) against the tidal bores from 1961 to 1978 for the purpose of protecting the land to secure an increase in crop yields and road communication, which contributed to the improvement of the economy. The design height of the levee was about 4.5 meters and trees were planted for protection as well, however, it was basically designed against tidal floods so it was not so effective against cyclone surges and Tsunamis.

The coast levee had been damaged by successive cyclones, so restoration works for the Polder 11 of 120 km along the coast was conducted in 1991 according to the FAP-C7 (Flood Action Plan) Phase I, and reconstruction and tree planting for the Polder 12 of 440 km along the rivers were carried out in 1991 according to the FAP-C7 Phase II (BA_S_19、BA_S_46).

2) Tidal barrier forest (mangrove planting)

The tide levee construction mentioned above was followed by mangrove planting in 1966 which was expected to protect the levees. But while the mangrove planting was in progress, logging was also carried out as the country went through a development phase after independence when people needed wood for export or fuel as the population increased. Cleared mangrove forests were converted to shrimp farms.

This sort of large-scale logging had a big impact on cyclone disasters. 7,500 ha of mangrove forest between Chittagong and Cox's Bazar were converted to shrimp farms after 1985. Then in the 1991 a cyclone tidal flood devastated areas that had never been damaged before.

In response, mangrove reforestation has been promoted in these areas mainly by NGOs and is currently in progress.

As mentioned above in 1), the forestation project is under progress as a government scheme and is also in accordance with Phase II of FAP-C7.

Source：http://maps.google.co.jp/

Mangrove Forest along the Coast

Footnote:

(iii) Bangladesh used to be East Pakistan, a part of Pakistan. The country became independent from Pakistan in 1971 to be People's Republic of Bangladesh.

(iv) The basis for determining design height is uncertain. For reference, normal highest sea level at high tides in the Chittagong district is about 2.24 meters. The probability wave height in two decades in the area is estimated as 4.8±1.0 meters (BA_S_20).

3) Cyclone shelters

In response to successive cyclones in the 1960's (in the 5 years between 1960 – 1965, 9 cyclones struck the area which killed 50,000 people), the Bangladesh government developed and undertook a scheme to build 2,000 cyclone shelters to be used as community centers (union offices) normally. However, the construction was stalled due to financial difficulties when 132 shelters were completed. In the 1970's, 238 cyclone shelters (of which 196 were in high-risk area) were built funded by the International Development Association (IDA) but again the project was stalled.

Soure：http://www.oisca.org/project/bangla/suzuki.htm

Tree Planting Effort by Local Residents

Source：http://www.jica.go.jp/activities/jicaaid/project/ban/ban_003.html (BA_S_35)

Fig 19: Cyclone Shelter Established by JICA Grant Aid

After the 1985 cyclone, shelters normally used as schools were built at 400 points by NGOs, such as BDRCS (Bangladesh Red Crescent Society). After having the largest cyclone in history in 1991 causing 140,000 deaths, 1,400 cyclone shelters were built with the aid of donor countries, international organizations and NGOs between 1991 and 1999. 300 cyclone shelters were built or were under construction from 2000 to 2004, primarily supported by donor nations, international organizations and the government of Bangladesh.

As described above, the fact that different bodies conducted projects on their own since 1985 without having a shared understanding and adjustment created various problems such as building shelters in inadequate places, insufficient functionality of the buildings or varying specifications, etc. Therefore, a master plan for "Multipurpose cyclone shelter development" was established by the aid of UNDP and the

World Bank in 1993, with which subsequent cyclone shelter constructions complied. The master plan aimed to build 2,500 cyclone shelters with 1,750 person capacity per unit by 2002 to provide protection for 4,250,000 people without evacuation sites amongst the 6,400,000 population in the highly dangerous area designated in 2002.

By 2002, 1,300 out of 2,500 cyclone shelters required in 1993 were completed (BA_S_20).

(2) Non-structural measures (forecasting and warning, education and training, evacuation plan development)

1) Cyclone forecasting and warning

In order to minimize damage by cyclones in the coastal region and by river flooding inland, the government of Bangladesh has worked to install and improve the forecasting and warning systems with the help of western nations' aid since 1970's.

Meteorological analysis for cyclone disaster prevention has been carried out by the BMD (Bangladesh Meteorological Department) and the SWC (Storm Warning Center). SWC forecasts cyclones by obtaining the data not only from observatories in Bangladesh including 4 weather radars, but weather and river level data from India as well. Each observatory data will be transmitted to the disaster prevention center in Dhaka via telecommunication systems and then collated and analyzed by computer. When SWC weather analysis is complete, cyclone forecast and warning will be announced by BDM with the responsibility of the Minister of Disaster Prevention Management and Emergency Aid (as of 2003).

Warnings will be announced by wired telegraphy, telefax, telephone, teleprinter, radio and TV stations for people off shore, in outer and inland harbors, airlines, government bodies, residents and fishing boats/vessels. Among them, radio broadcasting is the most effective warning communication.

There are 11 warning levels for ocean and 4 for land so that people should know not only the estimated passage of a cyclone but also degree of risk in the area and evacuation procedure to take.

On the other hand, disaster prevention measures including forecasting/warning transmissions and evacuation training at the community level is carried out by the CPP (Cyclone Preparedness Programme). CPP was founded as a subsidiary organization of the BDRCS in the 1970's and has cooperated with disaster prevention governmental bodies to provide disaster-preparedness, warning transmissions and evacuation guidance against the arrival of a cyclone. Information from SWC will be transmitted to CPP and then forwarded to their local offices in cyclone-prone areas from the control center in Dhaka via their own HF radio network. The local CPP offices transmit the information to the community directly by VHF radio, announcement, flag signaling, sirens and human voice.

This information conveys the degree of risk and evacuation procedures to take as mentioned above, so this enables the residents to take actions like starting preparation or evacuation to the shelters. The communication method is designed to deliver clear information, for example, flag signals indicate the level of danger by number of flags so the residents can understand easily.

The core staff in CPP activities is about 33,000 of volunteers, of which 5,500 are women from the smallest groups like rural communities. They conduct activities such as passing warnings and also securing evacuation shelters, providing evacuation guidance, dispatching aid and rescue for the primary stages of

disaster. Each person does not take on all duties, but the members are clearly divided into groups and trained to be in charge of specific roles such as warning communication or securing evacuation shelters and so on. This enables prompt and appropriate action when disasters occur, which has successfully minimized the damage.

The following is the history before the establishment of the CPP. (BA_S_18)

1965: The Bangladesh Red Crescent Society requested the International Federation of Red Cross (IFRC) to support setting up the cyclone warning system.

1966: The IFRC and the Swedish Red Cross launched a pilot project (supplying radios and sirens, training the militia) for cyclone preparedness. Cyclone warning systems started operation at 299 points under the cooperation of 473 team leaders.

1970: After the 1970 cyclone, the United Nations requested IFRC to lead the disaster preparedness programme. IFRC and The Bangladesh Red Crescent Society evaluated the programme and decided on a new policy.

Feb/1972: The IFRC and the Bangladesh Red Crescent Society led the new programme and established a transceiver network that connects 22 stations in the coastal region with 20,310 volunteers between 204 unions (villages) in 24 upozilas (counties).

Jun/1973: The government of Bangladesh approved the new programme and financial support. The CPP officially started activities.

2) Disaster prevention education

While the CPP has been engaged in educational activities in cyclone-prone areas, the government has also been working on raising public awareness of the danger in cyclones and taking various approaches as described below to spread and improve knowledge for disaster prevention (BA_S_20):

・Provide disaster prevention training for 35,000 local leaders during the 1997 – 2002 programme

・Mandatory participation in 2-hour disaster prevention course once a year for public employees

・Incorporate disaster prevention education in primary school curriculum for children in the higher-grade

Footnote:

(v) "Warning", "Danger", "Great danger" will be announced at least 24 hours, 18 hours, 10 hours beforehand respectively.

(vi) No.1-3: Warning (low pressure stage, still far out to sea), No.4: Alert (large-scale low pressure), No.5-7: Danger (cyclone storm with wind speed of 62-88km/h), No.8-10: Great danger (severe cyclonic storm with wind speed of 89km/h or higher), No.11: Lose of communication

Table 5: Major Cyclones and Devastating Cyclones

	Cyclone countermeasure				Cyclone disaster			
Year	Project	Sea wall, tsunami control forest	A cyclone shelter	Warning, Disaster prevention education	The date of disaster occurrence	The number of killed (CRED)	The number of influenced people (CRED)	Cyclone scale / damage / remarks
1942					October 1942			
1961		BWBD started to construct high-tide-wall (1861-1978) (the total extension of 4,000km, its height is 4.5m, and planting trees to reinforce those.			9th May 1961			
1963					28th May 1963			80,000 killed (at risk)
1965			In 1960' , on the ground of that the cyclone damages occurred in rapid succession (9 cyclones, 50,000 people killed between 1960 and 1965), they started to construct community center (union office) –cum- cyclone shelters (the construction project targeting to built 2000 units), however, they only built 132units and gave it up by the reason of financial difficulties in 1960s' .	Bangladesh Red Crescent Society requested the support to construct cyclone-warning systems from IFRC. (An opportunity to establish CPP)	11th May 1965 July 1965			300,000 killed (at risk)
1966		Started planting mangroves to establish tsunami control forest.		IFRC and Swedish Red Cross started a pilot project preparing cyclones (warning equipments such as a radio and siren etc and training militia). From 1966, cyclone-warning systems were started to operate at 299 places under cooperation of 473 team leaders.	1st October 1966			
1970			In 1970s' , the Public Works Administration built 238 (196 out of them are HRA) cyclone shelters with the fund supported by International Development Association.		12th November 1970			Wind speed 241km/h, cyclone storm surge 5-10m(max10.6) Damaged fishing boats 20,000. Injured cows more than 1,000,000. Damaged houses 400,000 and damaged educational facilities 3,500.
1971				After cyclone in 1970, the United Nations General Assembly commissioned IFRC to take the part of the leader to establish the program of the disaster preparations plan. IFRC and Bangladesh Red Crescent Society decided the evaluation of program and a new policy, and drove new program from February 1972. This was supported by a transceiver network linking 22 coast bureaus and 20,310 volunteers of 204 unions of 24 Upazilla.				
1972								
1973				In June 1973, the Bangladesh Government approved new program and authorized its financial burden. CPP (Cyclone Preparedness Program) formally started to act.				
1981					11th December 1981			
1985	The Bangladesh Government introduced Standing Order for Cyclones.		After the cyclones of 1985(until 1990), BDRCS and NGO etc built approximately 400 of mainly school-cum-shelters.		25th May 1985			10,000 killed (at risk)
1986				The weather radar was installed in Cox' s Bazar with Japanese support.				
1988				The Bangladesh Government spent $3,000,000 to improve the warning system between 1985-1988.	29rh November 1988			
1989	Flood action plan(FAP) was drawn up. The construction plans of a cyclone shelter and a levee were suggested in FAP.							
1991		As phase of FAP-C (cyclone, protection, project), they restored 11 polders that its length of 120km along the coast.		From 1991 to 1988, each international organization, donor countries and NGO etc built approximately 1,400 shelters.	29th-30th April 1991			Core atmospheric pressure 938mb. The average wind speed is 260kph at the greatest. The maximum instantaneous wind speed is 315kph. Cyclone wind continues for approx 8 hours. A flooded area extends to 160km along the coast 460,000 injured besides 138,868 killed. A spread of a disease (general infectious disease, gangraenosa, diarrhea, respiratory illness) 25,850 diarrheal disease (6,500 of them dead) 4,500,000 people being affected. 522,000 completely destroyed houses, 431,000 partially destroyed houses. 440,000 injured cows. 100, 000 trees damaged. Destroyed levees 434km, 858km of levee that needed restoration. Damage to agricultural products 63,000ha (58,000 ha within Chittagong,). Prawn culture damage 16,000 ha. The total loss, private and public, $20,000,000,000.
1992				The weather radar was installed in Khepupara with Japanese support.				
1993	In July, master plan of "a multipurpose cyclone shelter project" was prepared under cooperation of UNDP and the World Bank.		"Multipurpose cyclone shelter project" was drawn up.					
1996		As phase 2 FAP-C7, they repaired 10 damaged polders including planting that its length of 440km along rivers (1996-2003)						
1997	The Bangladesh Government amended Standing Order for Cyclones.		As of 1997, the number of shelters was 1,921 in total	The weather radar was installed in Dhaka, Rangpur with Japanese support. DMTATF (Disaster Management Training and Public Awareness Task Force) came into effect. (1997-2002) The weather radar was installed in Khepupara with Japanese support.	18th May 1997			Was the same scale as cyclone in 1985 but; only 127 were killed.
2000	The Bangladesh Government introduced Standing Order for Disasters.		From 2000 to 2004, the International Organization, donor countries and the Bangladesh Government taking the lead, built or building approximately 300 shelters.					
2002			In time of 1993, the number of existent cyclone shelter being built was approximately 1300 units toward to the 2500 units that were newly necessary.					

*Published only the case that had more than 10,000 killed or more than 1,000,000 affected.

2.3 Analysis of disasters in the 1970 and 1991 cyclones

The cyclones in 1970 and 1991 caused the most severe damage to Bangladesh in the 20th century. The cause of death and the social background of the victims in these enormous cyclones are analyzed in this section. The following is the overview of the two;

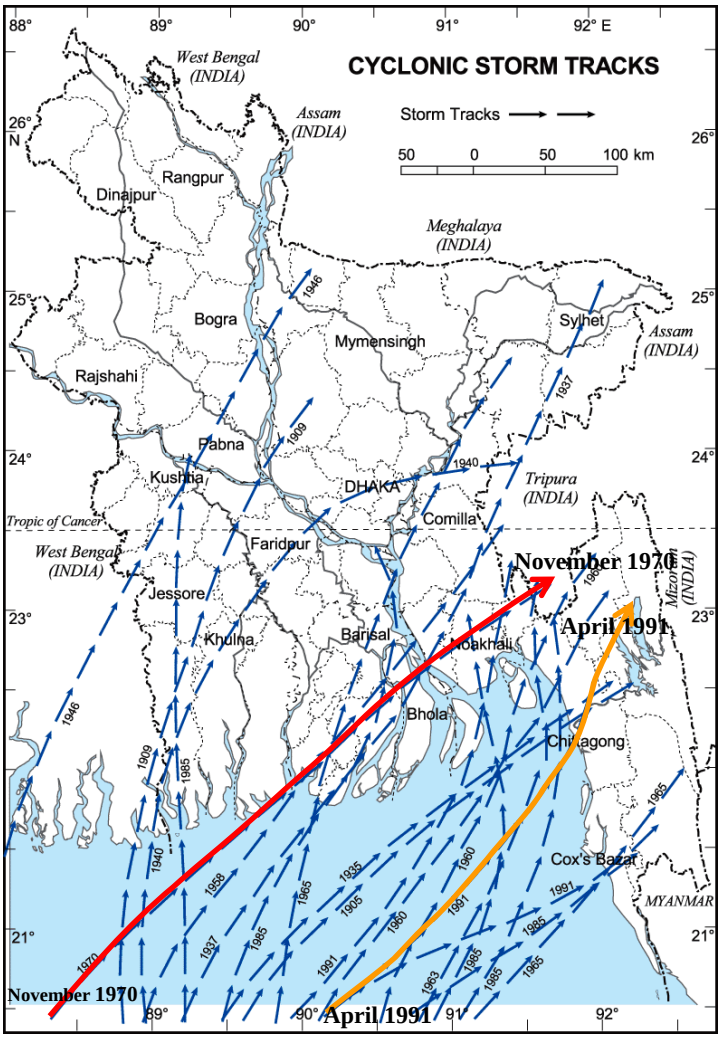
Table 6: Overview of the 1970 and 1991 Cyclones

	1970	1991
Duration	12th – 13th November	29th – 30th April (at high tide)
Landfall time	Night	Midnight
Cyclone storm size	Wind speed 241km/h Cyclonic surge height 6-10m (maximum10.6m)	Central pressure: 938mb Peak average wind speed: 260km/h Maximum wind speed: 315km/h Cyclonic storm lasted for 8 hours. Cyclonic surge of more than 6m (max 8m) lasted from midnight on 29th April to early morning on 30th April.
Disaster-affected region	Western coastal region, midland	Central coast area, eastern region （Chittagong, Cox's Bazar, Barisal, Bhola, Noakhali, Patuakhali, Barguna）
Population of disaster-affected region	6,000,000 people in 18,000km^2 of the coastal region	5,200,000 people in 8,093 km^2 of highly dangerous cyclone-prone areas
Number of deaths	300,000 – 500,000	138,868
Affected population	Millions of people were left poor and homeless, 3,500,000 people were affected.	460,000 injuries A spread of a disease (general infectious disease, gangraenosa, diarrhea, respiratory illness) 25,850 diarrheal disease (6,500 of them died), 4,500,000 people affected.
Disaster Toll	20,000 fishing boats, more than 1,000,000 cows, 400,000 houses and 3,500 educational facilities were damaged.	160km of coastline was submerged 522,000 houses completely destroyed, 431,000 houses were partially destroyed. 440,000 cows were injured. Hundreds of thousands of trees were damaged, 434km of levees destroyed, 858km required repair. 63,000ha of farmland were damaged (58,000ha within Chittagong). 16,000ha of damaged prawn farms. Total amount of public and private loss, $2 billion.

Note: maximum values are listed when the data varies from different sources.

(1) The 1970 cyclone

The 1970 cyclone's track in Bangladesh was from the western coastal region, it headed northeast along the shore and moved off to the Indian Sea as shown in Figure 20, Cyclonic Storm Tracks. It made landfall at night on the 12th November.



Source：Banglapedia（BA_S_19）

Fig 20: Cyclonic Storm Tracks

Figure 21 shows cities severely which suffered from the 1970 cyclone and the population distribution in 1961 (population per square mile). It tells us that severely damaged cities are concentrated in the middle of the coastal region, and all of them are in the areas with populations of more than 200/km^2 (1991), some of which have populations of more than 600/km^2. The population of Bangladesh in 1961 was 55,000,000 (BA_S_22) and was 77,000,000 in 1974 (BA_S_22) so the population of each disaster-affected site in 1970 is therefore expected to be much greater than that of 1961.

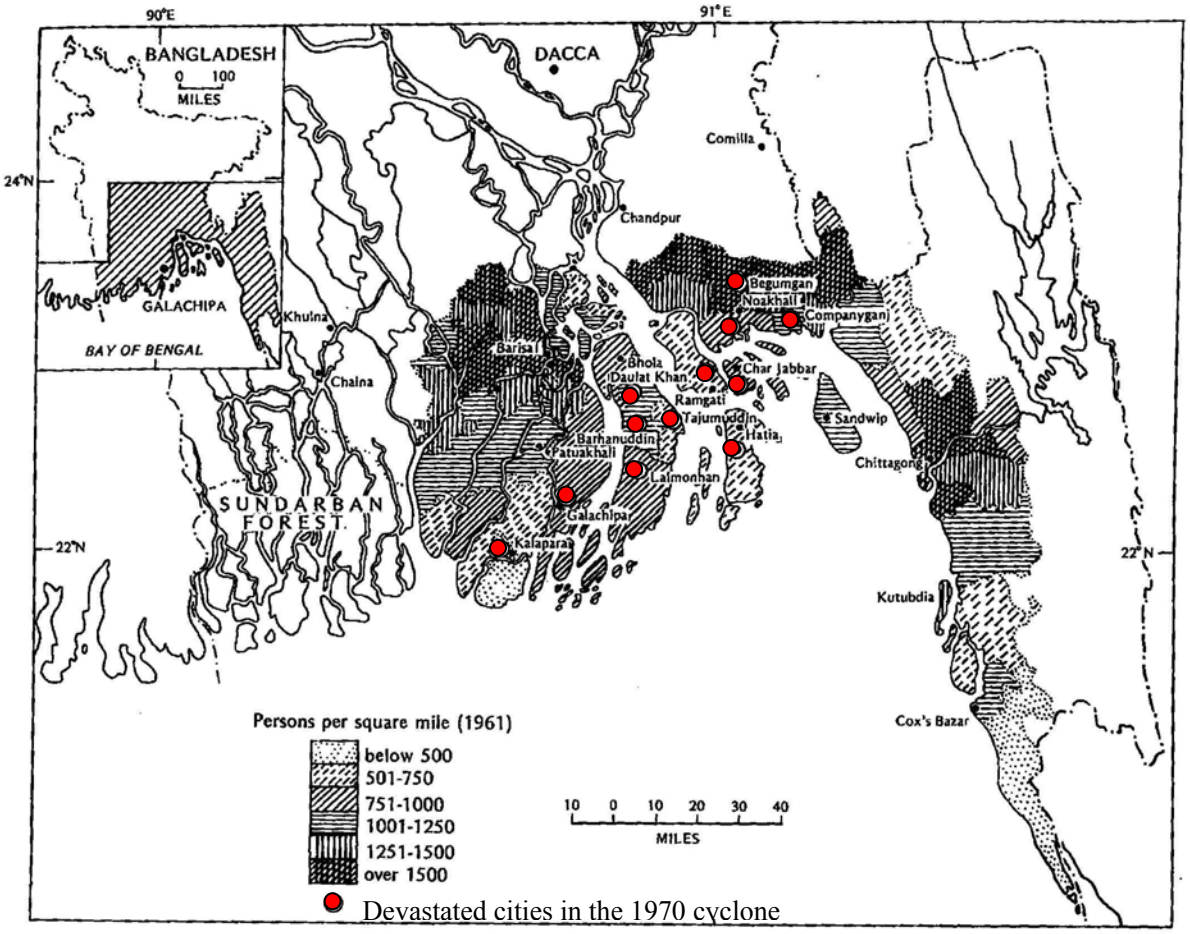


Fig. 2–1. Coastal areas of Bangladesh. Population density and major cyclone-affected areas, November 1970

Source：Tropical Cyclones: Coastal Bangladesh (BA_S_05)

Fig 21: Devastated Cities in the 1970 Cyclone and Population Density of the Coastal Areas in 1961

2) Cause of death amongst the victims

Associations between causes and factors that contributed to cyclone disasters (detailed in the footnote at the bottom of this page) are figured in Figure 22. Numbers in Figure 22 comply with numbers of the reference source and footnote.

The 1970 cyclone killed 300,000 people, most of which were drowned in the cyclone storm surge that was reported to be 6 – 10 meters high depending on the area. The levees under construction were 4.5 meters average, which were not high enough to prevent the tidal bores. Most of the victims were assumed to have failed to escape and then drowned or killed by debris.

Footnote:

(vii) The comments in the figure are extracted from reference sources with a view to illustrate sizes and causes of disasters, prevention measures, characteristics of Bangladesh society at the government/community level, basic data (geography, government, education, industry, aid, etc).

3) The social structure, evacuation measures to ease the sufferings in cyclone-affected areas

① Why the victims were in highly dangerous areas

Cyclones strike Bangladesh almost every year, large-scale ones alone hit the country at least every other year and the damaged areas are concentrated mostly in the coastal region. As shown in Figure 23, although many local residents know that these are highly dangerous areas, they do not relocate. Major factor for this situation are understood to be as follows:

● Rich soil suitable for farming, especially for rice cultivation.
● Dependence on government schemes (developing levees, forestation, warnings and cyclone shelters).
● Expectations for cyclone disaster aid (food aid, donation, and employment).
● Uncertainty about making a living at a new location

Alluvial soils of the chars (cays) in the coastal region are enriched by the fertile soils carried from upstream locations and are suitable for farming. Compared to the urban areas, education levels and the literacy rate in the rural areas are low and so many people, especially poorly educated people, show stronger hesitation to relocate due to anxiety in making a living at a new location. Social structures, such as commitment to communities and the landlord-tenant system are also observed, however, most people dare to live in these areas thinking that daily life is more important than the disaster risk. This attitude has arisen in the expectation that the disaster aid and cyclone countermeasures by the government may convert the areas to be more disaster-proof in the future.

As mentioned above, the fertile soils are ideal for farming in the coastal region and attract seasonal workers from outside the area during the cultivation and harvest times. The 1970 cyclone occurred in November and coincided with the harvest season when a lot of seasonal workers gathered and lived outdoors. These temporary residents were out of reach of the warning systems and were unaware of evacuation procedures due to non-integration in the local community, which resulted in greater damage.

②Countermeasures undertaken

Although construction of the coastal levees were in progress in the 1960's, the design height of 4.5 meters was not enough to prevent the enormous tidal surge of 6 – 10 meters in the 1970 cyclone. The external force of cyclones in Bangladesh is extraordinary, it can be concluded that disaster prevention by infrastructural measures is not effective and the only practical way to reduce the number of deaths is evacuation to safe areas. Forecasting/warning systems were being developed since 1965; however, the Cyclone Preparedness Programme including this, mainly by the Bangladesh Red Crescent Society, came into action only after 1972. Also, despite the government's efforts to have announced warnings when the 1970 cyclone was approaching, basic preparedness was not enough, for example, the radio stations were not in operation at night time and not every resident had a radio. In terms of evacuation measures, there were only 132 cyclone shelters in total within the coastal region, which was insufficient to protect all the population in the highly dangerous area. The lack of public awareness of evacuation can be said to be a cause, however, 38% of survivors escaped up trees planted near houses and 8% on the levees, and only 5% in cyclone shelters, according to a local report.

Considering these situations, the cyclone preparedness undertaken in 1970 can be concluded as insufficient.

③ Hesitation to evacuate among the residents

One of the major factors that caused greater damage was hesitation to escape amongst the residents although many of them knew the risk in disasters. As shown in Figure 23, the following reasons were linked with this:

● Fear of theft

● Fear of damage to livestock

● Religious background

● Fear of family separation during an evacuation due to large numbers in a family.

● The levee for normal tidal floods built by the government created a false sense of security amongst the residents

● The shelter usage fee (illegal. Not all shelters require charge)

The main reasons that caused hesitation to evacuate the danger area was the fear of theft, damage to livestock and religious beliefs.

The fundamental problem is the low level of social security. The fear of theft arises from the poverty that people are already suffering, which may deteriorate into a severer condition due to theft. Because of this and their limited income, they show a strong obsession for the protection of property. In terms of physical safety, many residents live in vulnerable houses, which contributes to the susceptibility not only to crime but to external disasters as well.

The fact that livestock animals are important property for the residents is also a big factor to stop people from evacuating. In evacuation to high lands like the levees, they can take the livestock animals as long as there is enough space, while evacuation with animals to the cyclone shelters is impossible as the space is too small. Trees are planted around houses so they protect the buildings and provide shelters in case of evacuation. As mentioned earlier on, the fact that 38% of survivors escaped up trees explains that people stayed in the houses to protect property and livestock and would not evacuate until the last minute.

Religious beliefs cause people to regard cyclone disasters as inevitable trials from God (embracement of disaster), and the Muslim policy also restricts women's from going out, both of which results in hesitation to evacuate themselves.

Not only insufficient development of forecasting/warning systems and shelter construction, but also these negative attitudes among the residents caused greater disasters impact.

④ Expectation from the government

The following is what people expected from the government according to the reference sources.

- Cyclone forecasting/warning announcement.
- Cyclonic surge prevention measures such as levees and tidal barrier forestation.
- Construction of cyclone shelters with Kira (Hill) for livestock evacuation.
- Securing social safety before and after evacuating

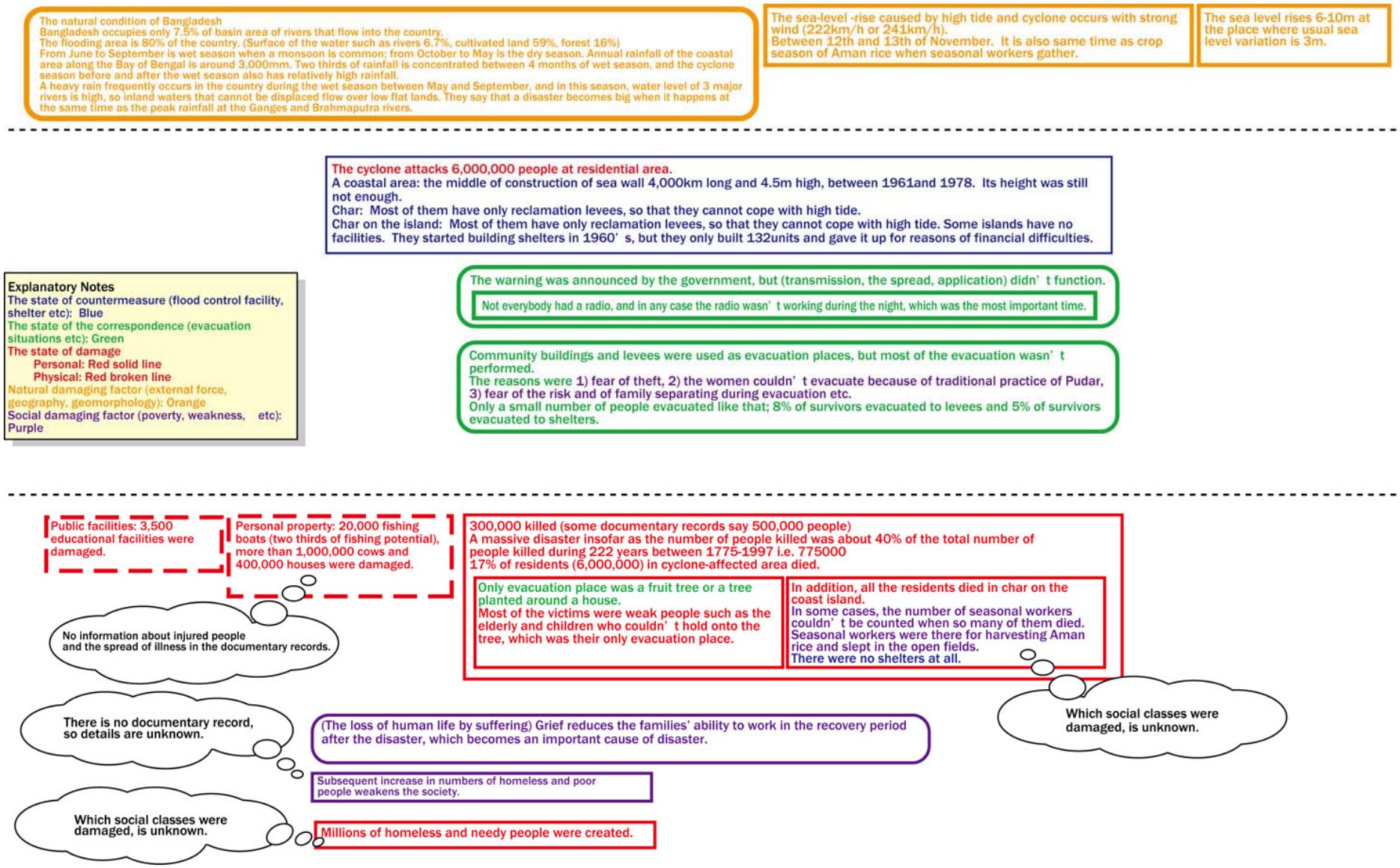


Fig 22: Summary(1970 Cyclone)

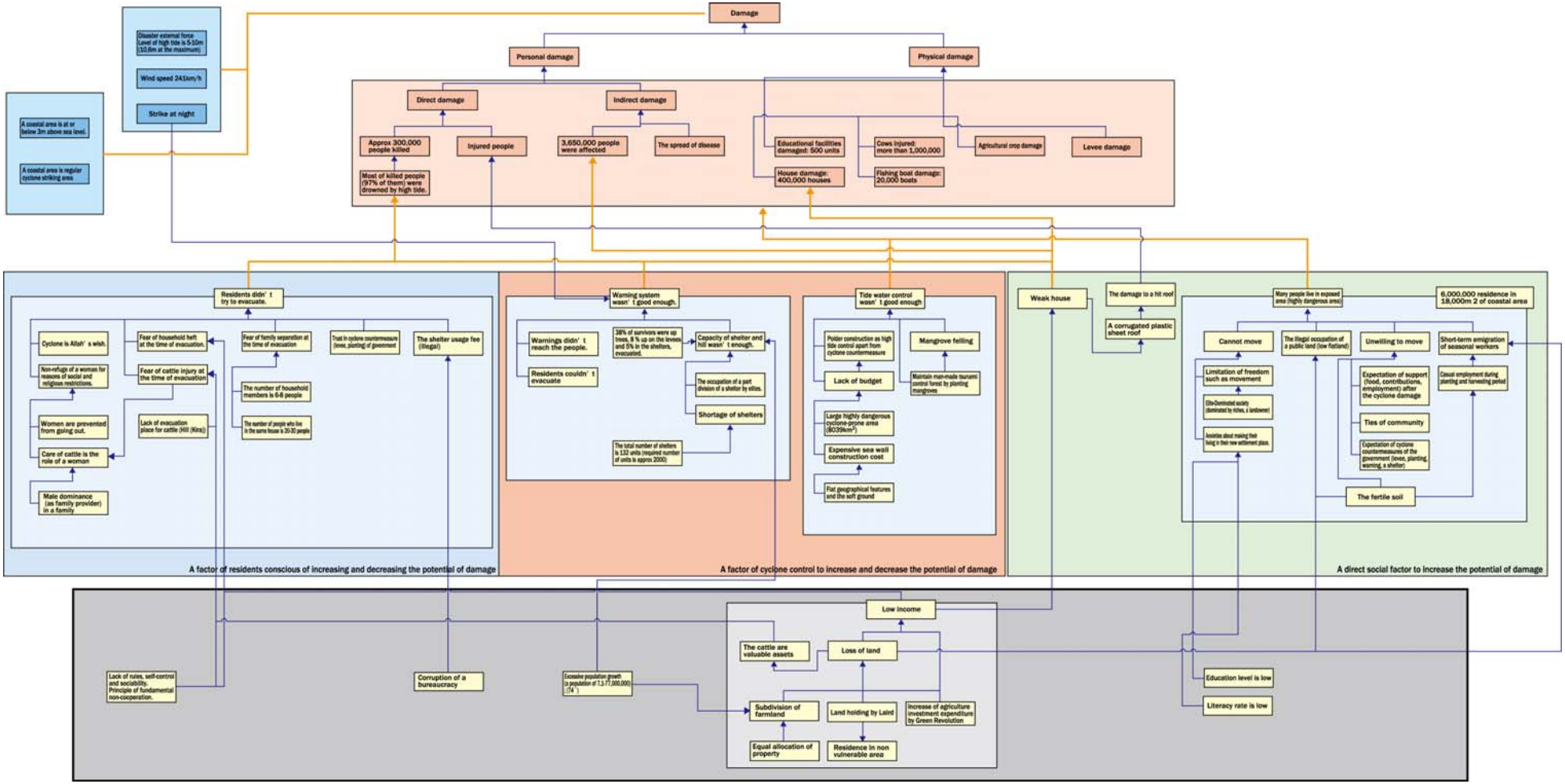


Fig 23: Factor Analysis of the 1970 Cyclone

(2) The 1991 Cyclone

1) Overview

As shown in Figure 20 and 24, the 1991 cyclone's track is from the eastern coast of Bangladesh (Chittagong), heading to the northeast and moved off towards India. It made landfall at midnight on the 29th April, and the eye hit Chittagong at 22:00 (GMT) on the 20th April.

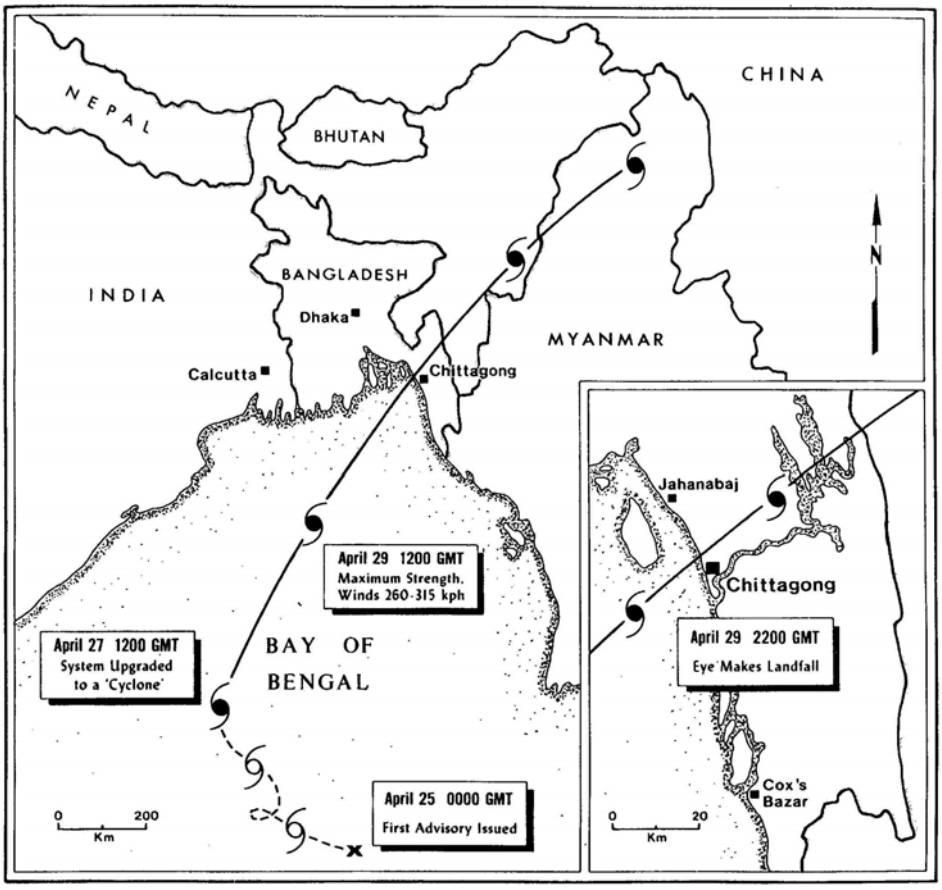


FIGURE 1 *Path of Tropical Cyclone 2B across coastal Bangladesh*

Source: Vulnerability to Tropical Cyclones: Evidence from the April 1991 Cyclone to Coastal Bangladesh (BA_S_02)

Fig 24: Path and Transit of the 1991 Cyclone

The disaster-affected areas are shown in Figure 25. The area in red is the most devastated area. Although the cyclone made landfall on the eastern coast, major affected areas extended to the middle of the coastal region as well. Precise numbers of population of the cyclone affected areas in 1991 is unknown, however, the population of the highly dangerous area (8,093km^2) in 1992 was 5,200,000. The major cyclone-affected zone does not overlap the western part of the highly dangerous cyclone-prone areas, while it overlaps the eastern part of the highly dangerous cyclone-prone areas and is extended further inland. Therefore, regarding low population density in the western region, more than 5,000,000 people were expected to live in major cyclone-affected areas.

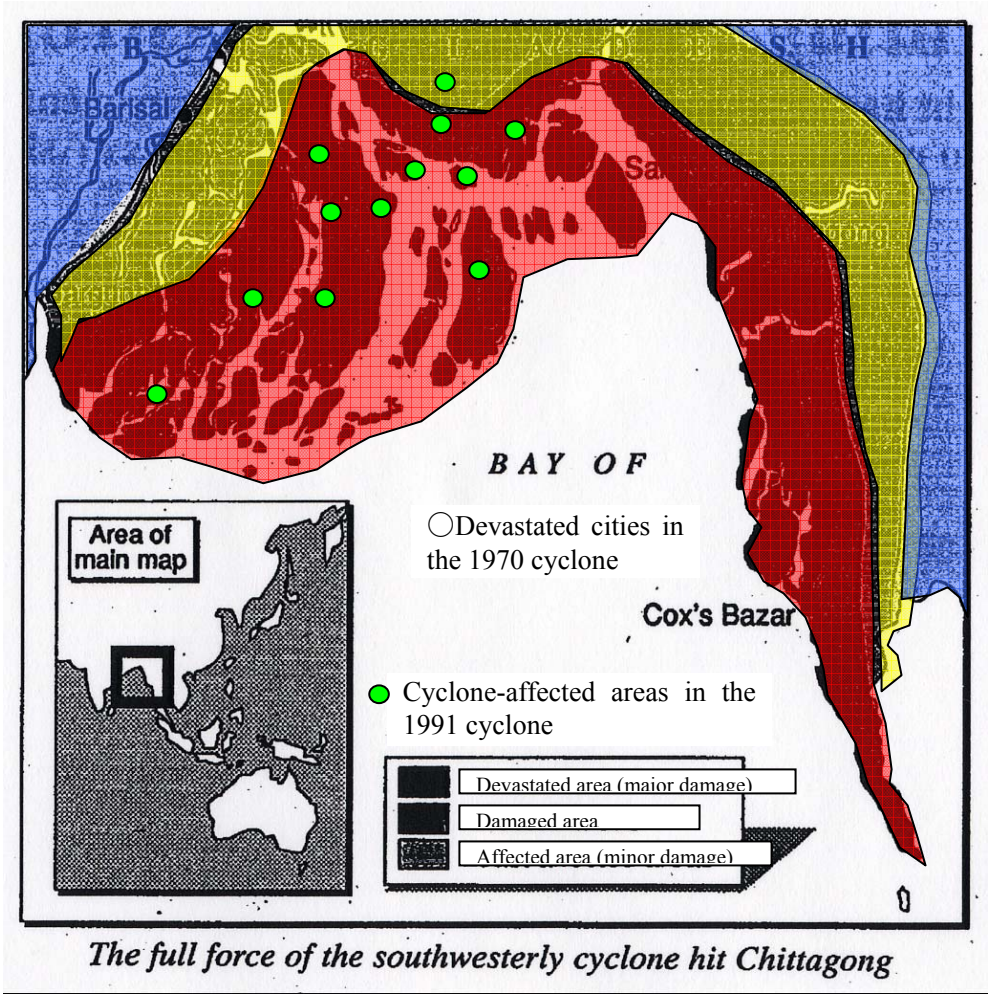


Fig 25: 1991 Cyclone-affected Area

2) Analysis of causes of death

Association figures of disaster factors of the 1991 cyclone are shown in Figure 26. Comments are picked up from disaster factors that are related to the 1991 cyclone, in the same manner as Figure 23.

The number of deaths in the 1991 cyclone was about 140,000, most of which are considered to be attributed to direct causes like drowning in the cyclonic-surge or being killed by debris. The tidal bore of more than 6 meters high lasted from midnight of the 29th to early in the morning on the 30^{th,} with the maximum sea level of 8 meters. Maximum average wind speed was reported to be 260 km/h and intermediate maximum wind speed 315 km/h, which were the most violent in history. Other than debris in the tidal flood, deaths were likely to have been caused by blown-off objects.

At the same time, general infectious diseases, gangrene, diarrhea and respiratory diseases were spread and at least 6,500 people were killed by diarrhea in the middle of May (BA_S_10). There is no specific data in the records, however, a number of deaths due to disease seems not to be included in the number of deaths (140,000) mentioned above, which concludes that not only direct cyclonic force but indirect factors caused the great number of victims.

3) The social structure, evacuation measures to ease the sufferings in cyclone-affected areas

① Why the victims were at high-risk areas

As described in Figure 26, the background of the residents and victims living in highly cyclone-prone areas is almost the same as the 1970 cyclone. As population increased, population density in 1991 is considered to have increased, rather than decreased compared to 1970.

The 1991 the cyclone struck the area on the 29th and 30th of April, in the middle of the cultivating and harvest season of rice (April – May) like the 1970 cyclone, so it is expected that many seasonal workers were living in the affected areas.

② Countermeasures undertaken

Development of 4,000 km of levees started construction in the 1960's and had been completed in 1991. But as in the 1970 cyclone, the design height of 4.5 meters was not changed and so it was not effective to prevent the tidal bores of a maximum 8 meters in the 1991 cyclone. Human factors also regressed the tidal flood prevention measures, for example, 7,500ha of mangrove forest that worked as a natural tidal barrier in the eastern coastal region, between Chittagong to Cox's Bazar, was converted in to a prawn aquaculture pond after 1985, which resulted in causing damage to inland communities that had never been affected by cyclones before.

But since the Cyclone Preparedness Programme including forecasting/warning communication systems was launched into full operation in 1972, it had made good progress and the reception of forecasting/warning amongst the residents was 100% according to a local survey (data collected only from survivors), and also weather radars were installed with the aid of Japan in 1986. In terms of facilities, 770 cyclone shelters had been built in cyclone-prone areas, which were not enough to protect all the residents; however, the progress compared to 1970 had been significant.

③ Hesitation to evacuate among the residents

The residents' hesitation to evacuate was a major factor for causing greater losses in 1970. It had been improved by 1991 and 350,000 people were evacuated to the cyclone shelters, however, fundamental attitudes had not been changed since 1970 as shown below, although they knew the risk of disaster.

- Fear of theft
- Fear of harm to livestock
- Religious beliefs
- Fear of family separation during evacuation due to large numbers in a family
- The shelter usage fee (illegal. Not all shelters require charge)
- Distrust of warning systems

The major difference from the 1970's is that distrust of warning systems which sprung up due to the past when warnings were announced but cyclones didn't strike their regions. Along with the development of the systems, improvement in accuracy is also essential.

④ Expectation from government

The following is what the residents expected the government to provide, according to the reference materials.

- Accurate cyclone forecasting/warning systems
- Development of cyclone shelters with Kira (Hill) for livestock
- Aid for disaster
- Assuring security during and after evacuation

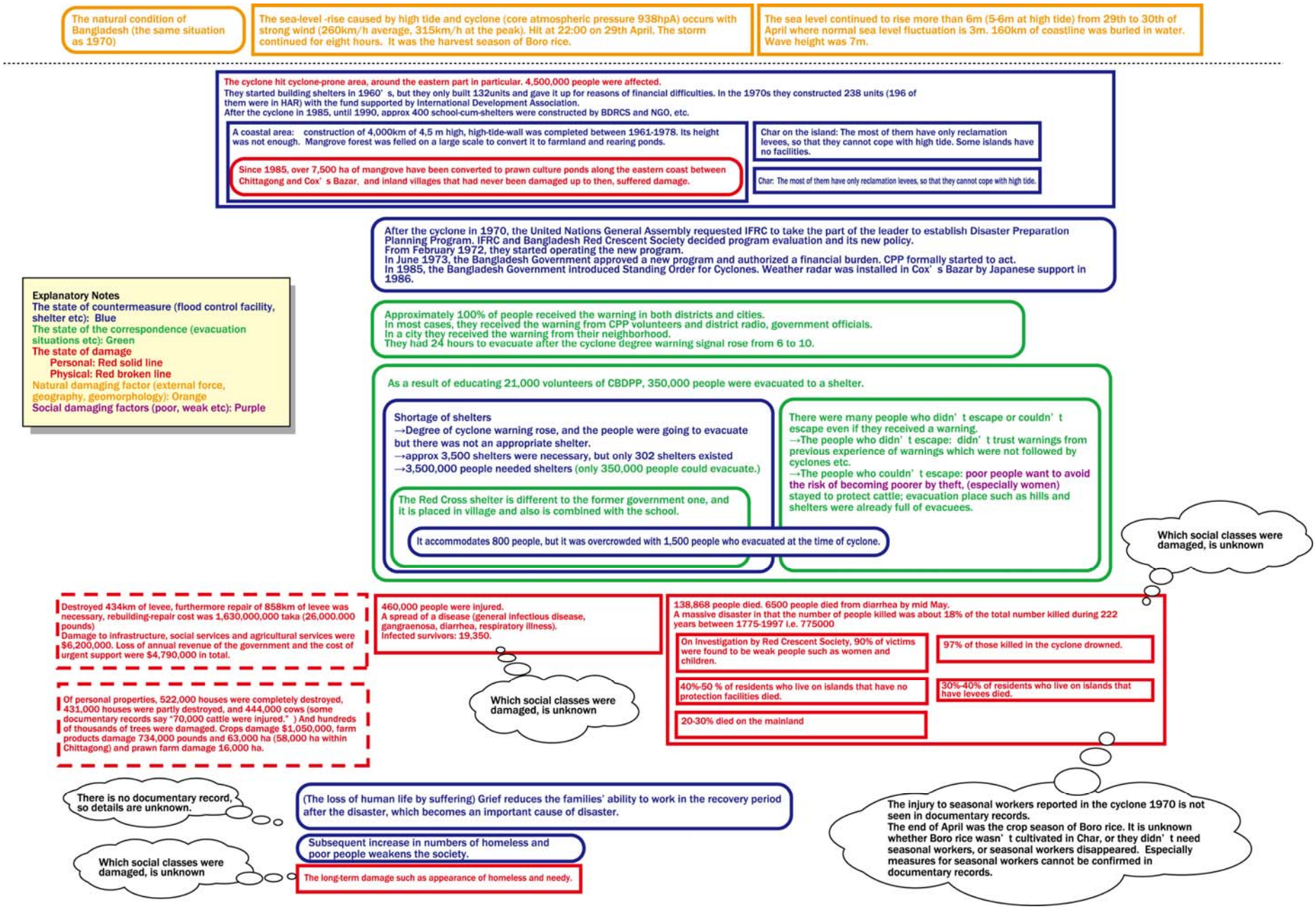


Fig 26: Summary(1991 cyclone)

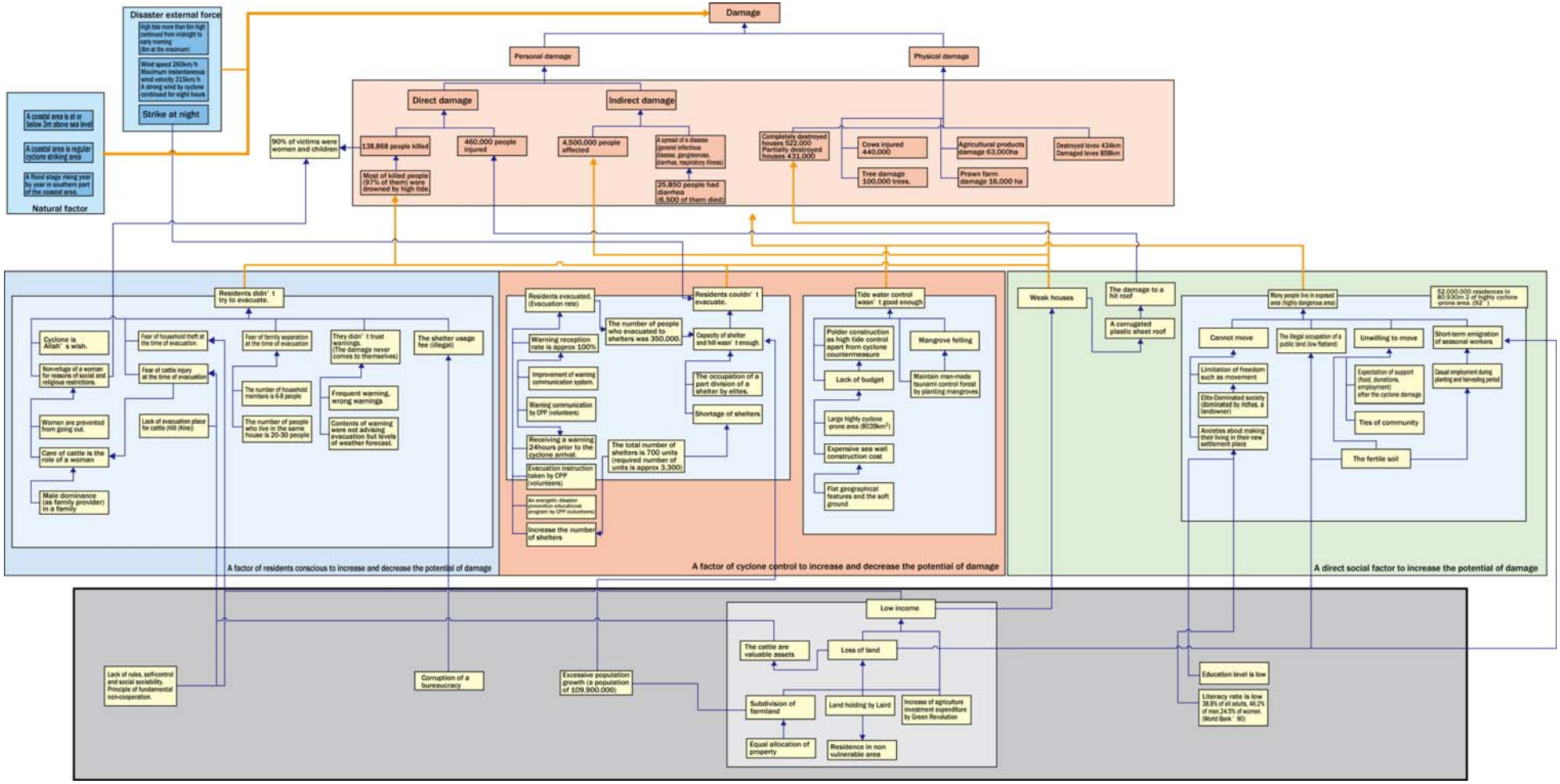


Fig 27: Factor analysis of the 1991 cyclone

(3) Factors of cyclone disasters, history of disaster prevention measures and the effects

As already mentioned, there is not much difference in the factors that caused the disasters of 1970 and 1991. The 1991 cyclone was the largest in history and devastated wider areas, the population in the highly dangerous areas had also increased as shown in figure 25. Despite that fact the number of victims in the 1991 cyclone (140,000) was much smaller than that of 1970 cyclone (300,000).

History of cyclone damages and changes in countermeasures are figured in Figure 28. It shows that in 1991, not only cyclone shelter construction but also non-infrastructure measures such as warning communication systems and education for the residents were more advanced compared to 1970. Relatively large cyclones struck Bangladesh in 1985 and 1997 and both of them were rated as the same size viii (BA_S_15), but the 1985 cyclone killed 10,000 people while the 1997 cyclone killed about 100. These results have been attributed to the following reasons (BA_S_15);

1) Awareness of disaster prevention was established through promotion conducted by the national and local governments, the BDRCS, the NGOs and so on.

2) Enough time for evacuation enabled by disseminated warning announcements through the TV, radio and newspapers.

3) Appropriate actions taken by the local government.

4) Volunteers supported the local government to help residents evacuate.

5) The cyclone made landfall during the day at low tide.

The disaster in the 1991 cyclone may have spurred the cyclone shelter development in the coastal region □, whilst a report says that 1,000,000 people were evacuated to the cyclone shelters before the 1997 cyclone struck the area. So it is conceivable that continuously provided disaster prevention education, as mentioned above, had managed to change the residents' awareness about preparation and evacuation procedures, which contributed to the decreased losses. Planting mangroves by the NGOs started after the 1991 cyclone and is also considered to have worked as a protective barrier.

To reduce disaster effects, it is essential for both infrastructural and non-infrastructural measures to proceed in a continuous coordinated approach, which was carried out in the Bangladesh disaster countermeasures.

Footnote:

(iix) 1985: wind speed 154km/h (Chittagong), height of tidal bore 4.3 meters. 1997: wind speed 225km/h, height of tidal bore 3.05 meters.

(ix) The master plan established in 1993 aimed to build shelters of 1,750 person capacity per unit. Not every shelter can accommodate this number of people, however, if correct, 1,000 shelters can accommodate 1,750,000 people.

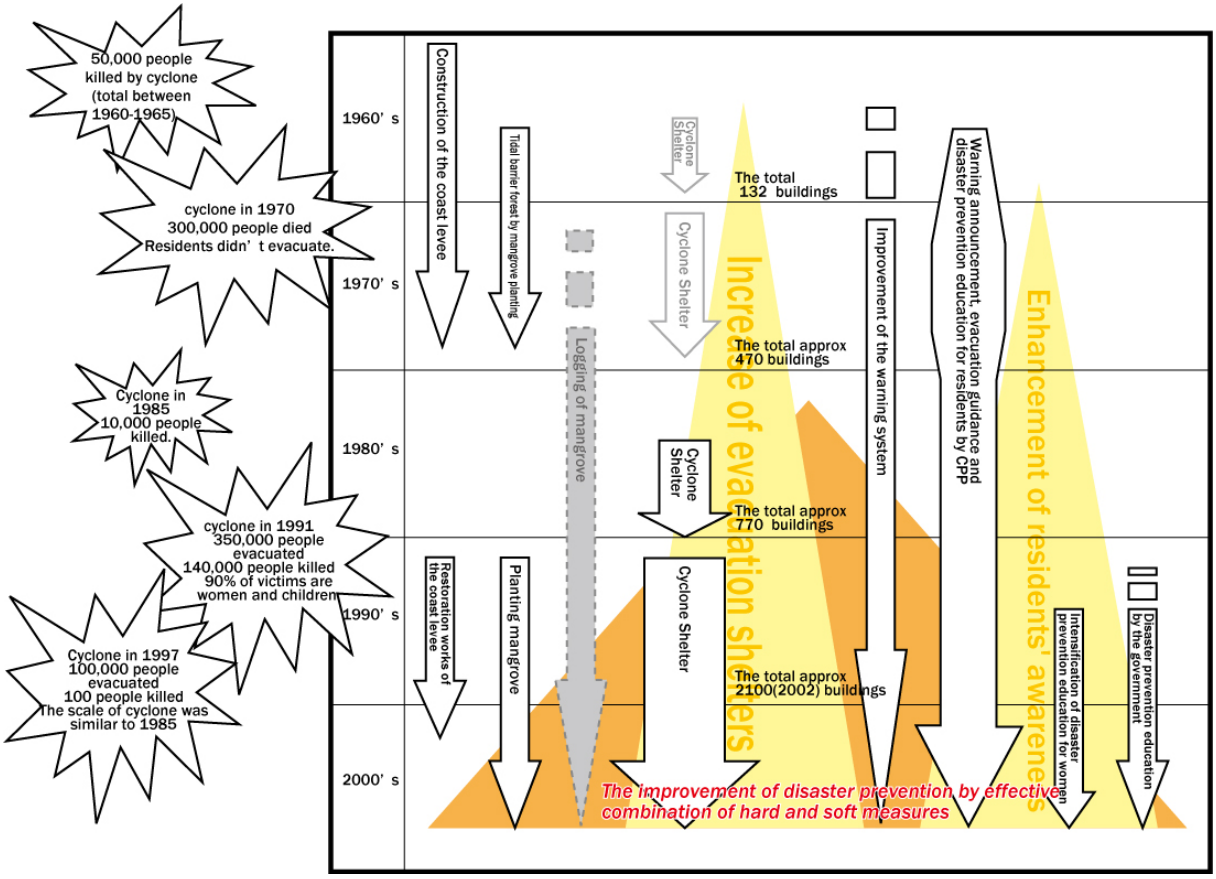


Fig 28: History of cyclonic damage and prevention measures

(4) Policy and challenges for the future

In Bangladesh, both infrastructural and non-infrastructural measures continuously have proceeded in good balance and so it has contributed greatly to reduce the number of deaths, however, it is by no means perfect. To promote more effective cyclone countermeasures, consideration on the following issues are suggested:

1) Disaster prevention measures for the seasonal workers

A report says that the seasonal workers suffered significantly in the 1970 cyclone. The actual number of victims is unknown, while their death rate was expected to be much greater than those of local residents due to their short residential period, living outdoors and non-integration to the local community. Losses of these seasonal workers were not discussed as described in the footnote ii, and seasonal labor is still common in Bangladesh today.

The CPP hasn't explained whether the forecasting/warning communication scheme is also intended for the seasonal workers, but in any case, disaster vulnerability of this group and the residents in the local community are fundamentally the same. Regarding the fact that seasonal labor is an important source of income for a household in Bangladesh, it may become necessary to study their actual situations for countermeasure consideration.

2) Identification of the affected class and details to provide more effective support

The reference sources collected for this study showed general information of each disaster (i.e. number of deaths, damaged houses, effected livestock and so on), however, there was not enough detailed information

on losses to show what social class range in an effected area or how much (i.e. XX percent of victims were in ○○ income range, lost ×× percent of the average number of livestock etc.). Also to show the number of victims among the seasonal workers as mentioned above. This may be due to the fact that the disasters date back many years or decades, or due to insufficient statistics to date.

To make communities more resilient to disaster and to provide more effective support and countermeasures, it is critically important to focus on supporting the most affected social group and their issues. To achieve this, an analysis of detailed losses in the disaster area and narrowing down the target groups is necessary.

3) Measures to reduce property loss (to brake the cycle of poverty followed by disaster)

The principal goal of the CPP activities seems to reduce the number of deaths in a disaster. The effectiveness along with other cyclone prevention measures is obvious and the number of deaths in a disaster has been dramatically reduced. On the other hand, measures to reduce damages by external forces and protection schemes for property loss of the victims are yet to be established. For example, construction of Hills (Kiras) higher than the tidal surge sea level for livestock protection, designated in the master plan of "a multipurpose cyclone shelter project" established in 1993, is incomplete, and also ensuring community security to resolve the fear of theft that makes residents hesitate to evacuate at a time of disaster, and so on. Property loss caused by disasters deprives the area and the residents of capability and interferes with the recovery, which results in difficulties in preparation against a following disaster that increases the vulnerability of the region. So, it is necessary to consider what is required to make people in cyclone-prone areas more resilient to disasters in the viewpoint of issues mentioned above, for providing further support to sever the cycle of poverty followed by disasters.

3. Flood Disaster in Bangladesh

3.1 Outline of the Flood

1) Season and Frequency of the Flood

Bangladesh is located at the mouth of three great rivers, the Ganges, Brahmaputra and Meghna, and 80% of the land is a delta area, which is a flood zone of these rivers. Over 80% of the country's annual precipitation (average 2,200mm) occurs in the rainy season, between May through October. Moreover, at the same time, these three rivers pour the volume of water into the country, which is more than four times larger than that of national rainfall. Because the highest stream flow of each river and such a rain condition lead to the annual disaster, the country is known as an area of frequent flood.

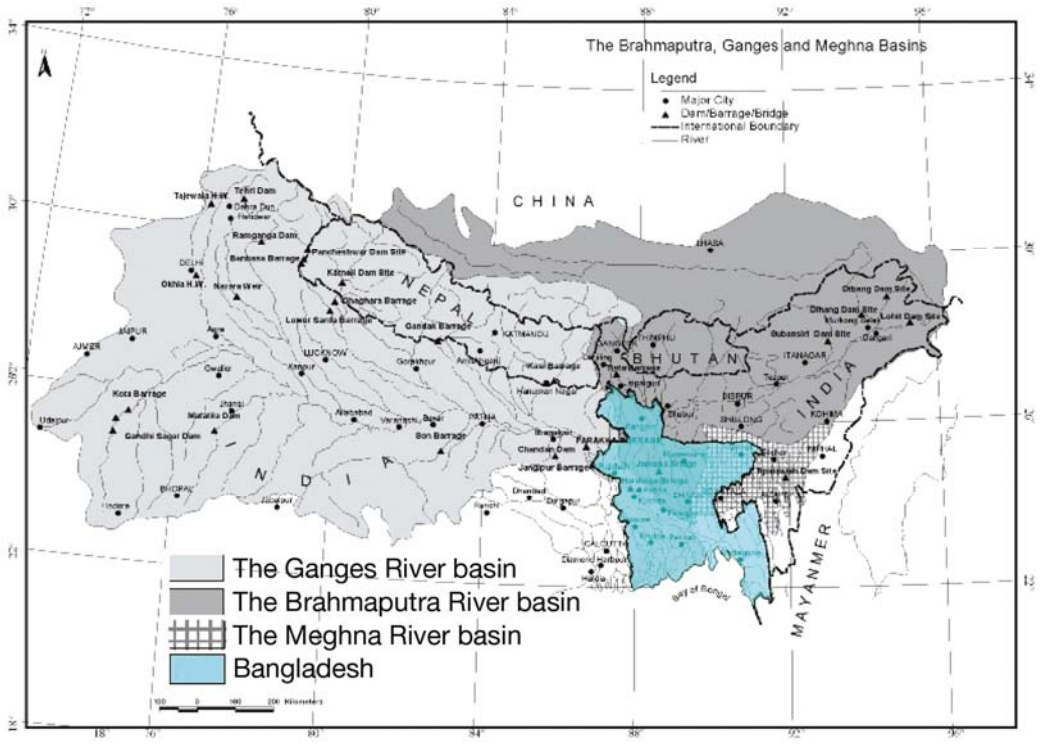


Fig 29: Bangladesh and Related River Basin

The flood usually starts in April or May in a low-lying area in the northeast part of the country (Haor Region), and at the peak of the rainy season, in July or August, approximately 20% of the nation is covered under the water. These floods are called "Barsha" in Bengali and occur almost every year. Barsha does not cause much damage. It actually plays an important role in agriculture and the growth of fishing resources after the rainy season. A tendency is seen that crop yields decline at the dry season in the year of no floods. On the other hand, "Banna", a larger-size flood than usual one, causes the destruction of properties such as agricultural products and the loss of people's life.

The floods in Bangladesh can be divided roughly in four types: 1) By an increase in the amount of water in rivers, 2) By heavy rain and poor drainage systems, 3) Flash flooding types seen in the mountainous areas, 4) By high tide. Among all, the one that is caused by an increase in the amount of water, damages wider areas. With a vast amount of rainwater, the flood covers from a third up to more than a half of the nation in the year of Banna. Bangladesh has had mass-size floods in the years of 1974, 1987, 1988 and 1998; they have occurred in every decade (refer Table 7). The biggest one in 1998 covered 68% of the land with water.

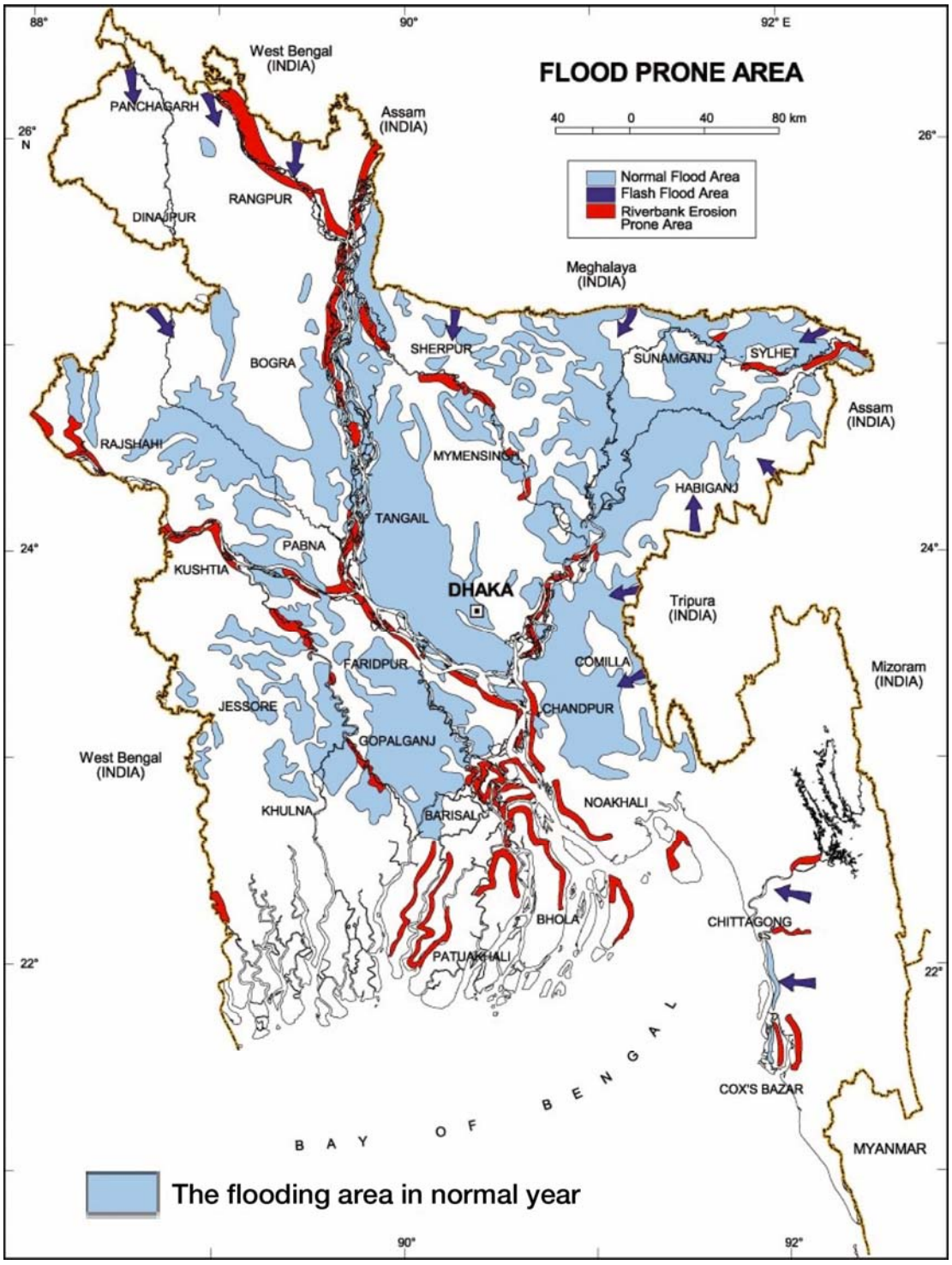


Fig 30: Danger Areas for Floods in Bangladesh

Table 7: Flood List (Bangladesh)

No.	Year	Flood Area (%)[1)]	Month when a flood started[2)]	Sum of Damage (million Takas) [3)]	Death Toll[2), 3)]	Injured People[2)]	Homeless[2)]	Sufferers[2)]
1	1970	42.640 (29.6)	July		0	0	0	10,000,000
2	1971	36,475 (25.3)	-		-	-	-	-
3	1972	20,800 (14.4)	June		50	0	0	0
4	1973	29,900 (20.8)	March, August		427	0	0	0
5	1974	52,720 (36.6)	July	28,490	28,700	0	2,000,000	38,000,000
6	1975	16,590 (11.5)	-		-	-	-	-
7	1976	28,418 (19.7)	June		168	0	0	4,000,000
8	1977	12,548 (8.7)	September, October		13	0	0	213,650
9	1978	10,832 (7.5)	August		17	0	0	400,000
10	1979	-	-		-	-	-	-
11	1980	33,077 (23.0)	August		655	0	0	10,000,000
12	1981	-	-		-	-	-	-
13	1982	3,149 (2.2)	September		0	0	25,000	308,000
14	1983	11,112 (7.7)	April, July, August, September		245	0	100,000	7,160,000
15	1984	28,314 (19.7)	May	4,500	1,200	0	0	30,000,000
16	1985	11,427 (7.9)	June, July		34	0	0	500,000
17	1986	4,589 (3.2)	August		30	0	300,000	400,000
18	1987	57,491 (39.9)	July, August	35,000	2,680	0	0	29,700,000
19	1988	120,973 (84.0)	July, August	100,000	2,440	0	28,000,000	73,000,000
20	1989	9,000 (6.2)	August		180	0	0	200,000
21	1990		March, July		231	1,600	0	2,011,600
22	1991		May, July, September		300	0	200,000	3,990,000
23	1992		April, June, July		15	200	75,000	75,200
24	1993		June, July, August		194	20	75,000	15,751,613
25	1994		April, May, June, August		116	0	70,000	395,100
26	1995		May, June, September		700	0	510,000	21,117,331
27	1996		July		33	0	500,000	6,163,319
28	1997		July		79	30	100,000	900,030
29	1998	100,000（68）	July	100,000	1,000	50	0	15,000,050
30	1999		July, August		48	70	20,000	441,320
31	2000		-		-	-	-	-
32	2001		June, August		9	0	0	700,000
33	2002		July		10	0	0	1,500,000

Source：1)Bangladesh Compendium of Environmental Statistics (BBS, 1999), 2)CRED, 3)Damage by Floods in Bangladesh (Oka, 2004)
Note: Regarding death tolls, a larger number is referred from Reference 2) or 3).
The years with 30% or more flooded area are highlighted with yellow colour.

(2) Features of the Flood's Damage in Bangladesh

Except those where flash flooding occurred in some parts of the border area to India, most of the floods in Bangladesh gradually increase their water level; they do not take the lives of many people instantly. The water level usually starts increasing in July, rise a few meters every month, and water then spreads out over the flood zone. It is seen that the period of the flood is between 15 to 45 days in the distinguished records in the last 50 years (WMO/GWP, 2003), during the period, the people had their lives inhibited by the disaster directly and indirectly.

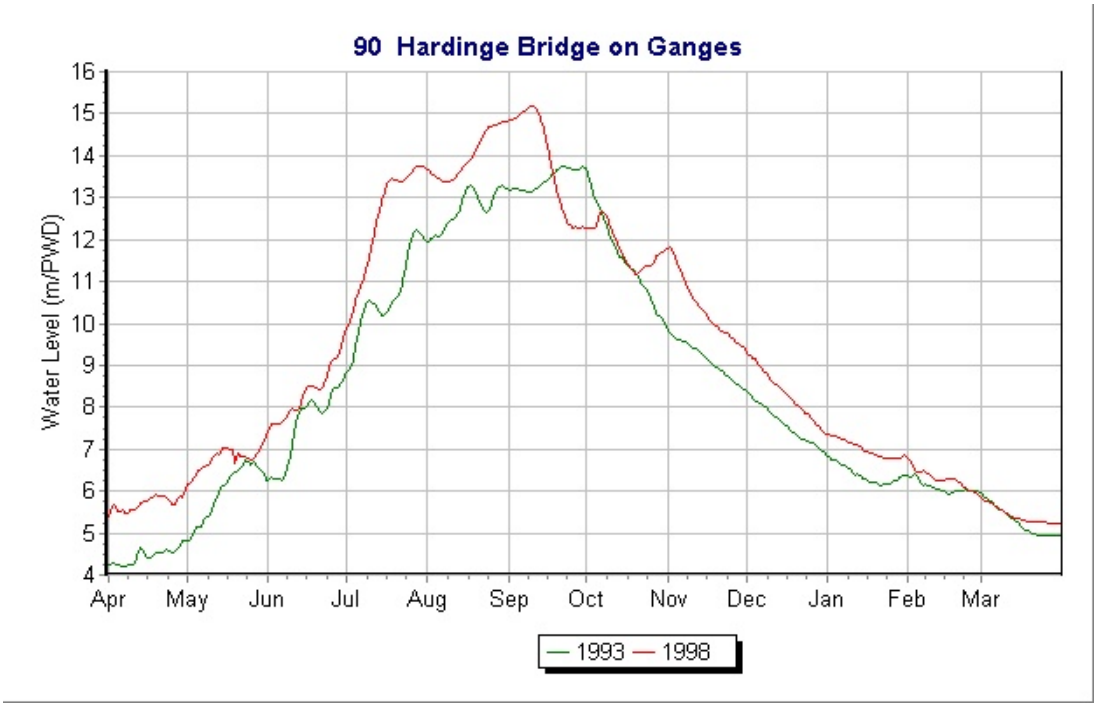


Fig 31: Examples of the Changes in the Water Levels of the Rivers in Bangladesh

1) Loss of Lives

Figure 32 refers to the size of the floods (total area covered with water) between the years of 1970 and 2000 and the death tolls related to them. The one in 1974 claimed a big number of lives (28,490 people), however, most of the deaths were said to be have occurred due to hunger triggered by the flood. The others that killed many people happened in the years of 1987 (2,680 people), 1988 (2,440 people) and 1998 (1,000 people). These floods still cannot be classed as true catastrophes, when compared to cyclones, which kill tens of thousands of people at once in some parts of the country's coastal area, because the death toll is not so big for the size of the floods that covered one to two thirds of the nation with water. On the other hand, when looking at the figure of the people whose lives were affected by the floods (refer Table 7), it is seen that millions of people have suffered from the large-scale floods. By all these facts, the feature of the floods in Bangladesh can be said, rather than to claim people's life directly, they impact on wide range of the people's living environments, such as hygiene issues and properties.

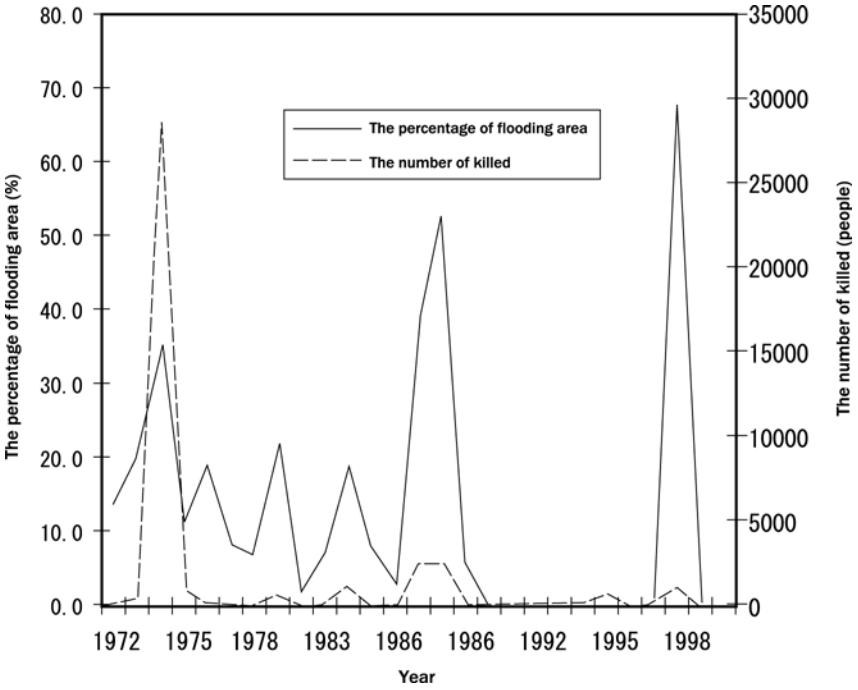


Fig 32: Size of the Floods (total flooded area) and Death Tolls

2) Damage to Agricultural Products

Rice is the staple diet in Bangladesh and is cultivated in triple-cropping. Each of them have different names: Boro rice (dry season: from December through May), Aus rice (before the flood season: from April through July), Aman rice (after the flood season: from July through December). In the country, these rice are cultivated in accordance with the patterns of the occurrence of floods; in usual years, Boro and Aus rice are harvested before floods hit the land, then Aman rice is planted after August when flood waters start receding. But in cases where floods occur earlier or that the drainage of the waters is delayed due to large-scale floods, people cannot implement the planting/cultivation of rice at a certain time, as a result, the production of rice is damaged by the disaster.

On the other hand, it has been reported that the crop yield of Boro rice increases in the years after big floods. It is thought because the amount of ground water has increased and also algae carried by floods, fertilize the lands. It is only the result of the country's overall income and expenditure; we must notice that this increase does not mean the victims of the floods have gotten their usual life back straight away.

Moreover, Bangladesh's Green Revolution occurred in the 1980s and has especially increased the production of Boro rice by introducing HYV rice (high yield variety) and irrigation ground water. But on the other hand, this new production cycle has forced farmers to spend more money on agricultural investments such as fertilizers, pumps and seeds. These were not necessary items before. A survey showed that farmers purchased input materials for Boro rice (fertilizers and pesticide) with the earnings from the selling of Aman rice. They grow Boro rice for self-consumption and spend the sales income of Aman rice to buy materials for other crops (JICA 2005). Therefore, the damage to Aman rice can have a big impact on their agricultural production cycle.

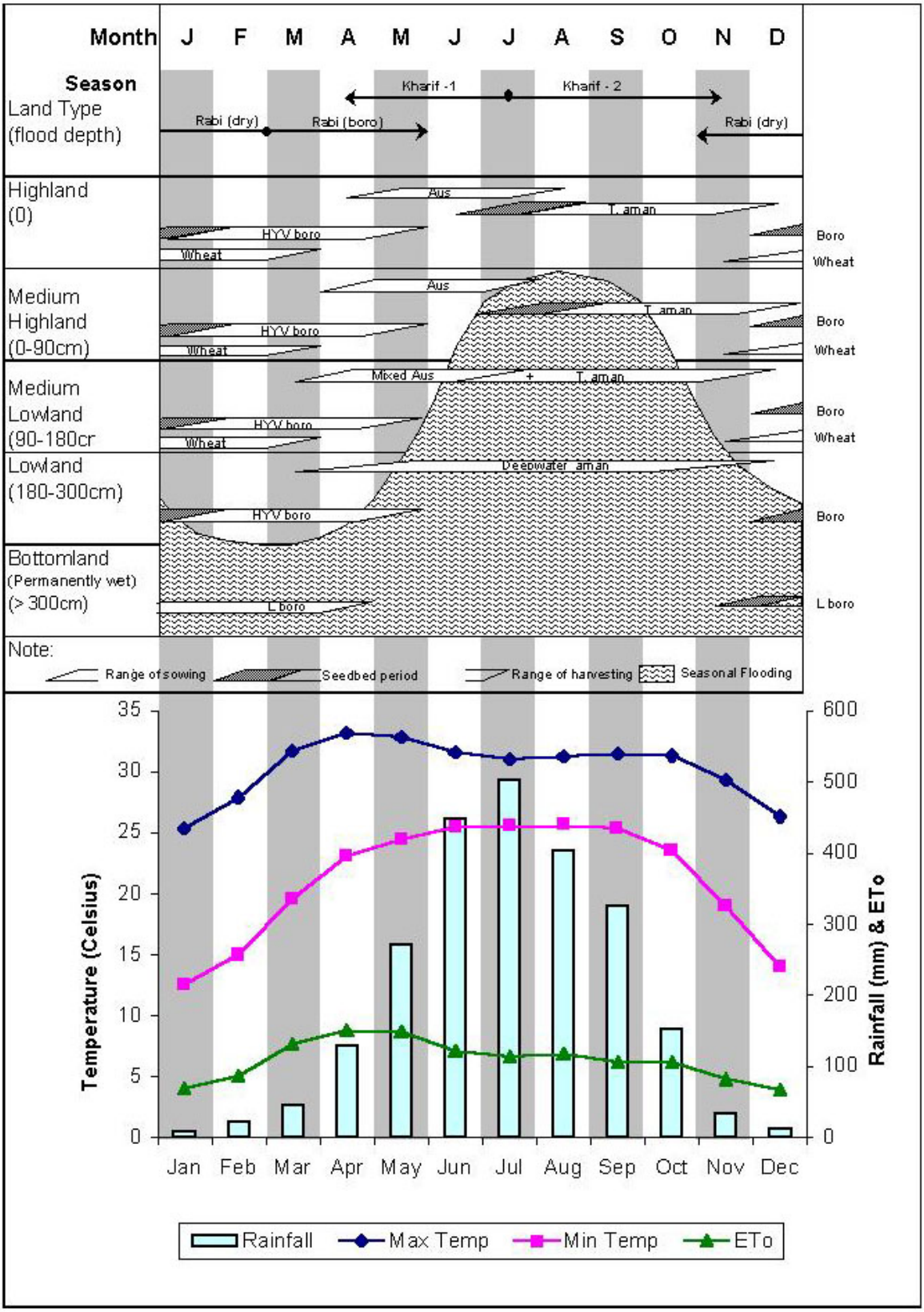


Fig 33: Calendar of Agriculture in Bangladesh

3) Loss of Employment

In Bangladesh, a big ratio of the working population is engaged in agriculture, especially farmers with small land sizes, whose amount of production from their own lands are not enough to feed their families,

and peasants with no land are totally depending on the income from agricultural employment. Floods do not only impact on the agricultural production, but also decrease the labour for planting and harvesting of agricultural products; as a result, the job opportunities for farmers and peasants are declining. A report says that 25 million people lost their employments due to the damage to farming products by the flood in 1984 (Clay 1985). In addition, it is thought that the people, other than those in the agricultural industry, also loose their work because of the damaged transportation and the obstacles in economic activities caused by floods. All these facts are suggesting that the disaster definitely squeezes on locals' life in Bangladesh.

4) Increase in Poverty due to Floods

In addition to the facts mentioned above 2) and 3), victims, whose houses were damaged or swept away by floods, have to make money to repair their assets and for a living. Those in poverty cover these by borrowing money as they don't have enough savings (Ninno et al., 2001). Also, if there is a possibility of lack of livestock feed during floods, farmers take measures such as selling livestock in order to avoid financial risks. But, because they are in a buyers' market, the price would be much lower than usual (Clay, 1985, Sarker, 2003). On the other hand, rich people have buffers, such as their own savings for the damage by floods, so they obtain lands and farm animals at lower prices due to the decline in the market prices, or they can even get income by lending money. Under such circumstances in Bangladesh, floods accelerate unbalanced property distribution, as a result, the gap between the wealthy and the poor becomes wider and those in poverty are getting less resistant against the disaster.

Moreover, in the Char area, frequently flooded places have been developed along rivers, and it is reported that people in power are establishing a feudal exploitation system by supporting poor people victimized by floods (Zamman, 1991).

5) Other Physical Damage

Following are the other physical damages caused by floods: damages to public facilities/private assets, surface soil that has been washed away, decline of the areas of water flow across sections due to accumulated sediment, bank erosion, deterioration of hygiene and living environment due to the flooded water.

(3) Feature of Flooded Areas

Bangladesh is a flood prone country as 80% of the lands are the flood plains of the great three rivers, the Ganges, Brahmaputra and Meghna, and half of the country is seven or less meters above sea level. Figure 34 and Table 8 refer the distribution of Inundation Land Type, a land classification based on the depth of floodwaters in areas, and its ratio. Among five classified lands, except High Land, four areas are flooded even by normal-sized floods. One of the categories in Figure 34, Medium High Land 2, which are normally inundated 30-90cm depth, spreads over the country, except mountainous areas in the eastern part and the northwest part of the country. If larger-than-usual floodwater depths occur, water will cover a wider area than these areas in the figure, of course. Flooding is a nationally common event in Bangladesh.

Table 8: Rate of Inundation Land Type

Source: FAO Websites

Land Class	Usual Flood Water Depth	Rate (%)
Very Low Land	300cm or more	1
Low Land	180 – 300cm	8
Medium Lowland	90 – 180cm	12
Medium High Land（1+2）	0-90cm	35
Highland	No Floods	29

On the other hand, char areas, developed along rivers and downriver, hold a line against other areas in the aspect of the loss of lands due to floods. As of 1993, 630,000 people were living in char area. It has been reported that the ratio of chars at Brahmaputra River, which have been settling there for six years or more, are 60% of overall, and those for 27 years and over are only 2.2%. Although the law was set in 1972 to have the government hold landownership of char areas to re-distribute to poor people, actual land distribution is implemented favorably for people in power, and it is still hard for the poor to access these lands. When loosing their lands to floods, people in chars have no other choice but to move to new chars

which are under the power of the area's authorities. This condition creates a feudal exploitation (Sarker, 2003). According to such backgrounds, char areas can be recognized as a weaker place for the nation's common disaster, floods.

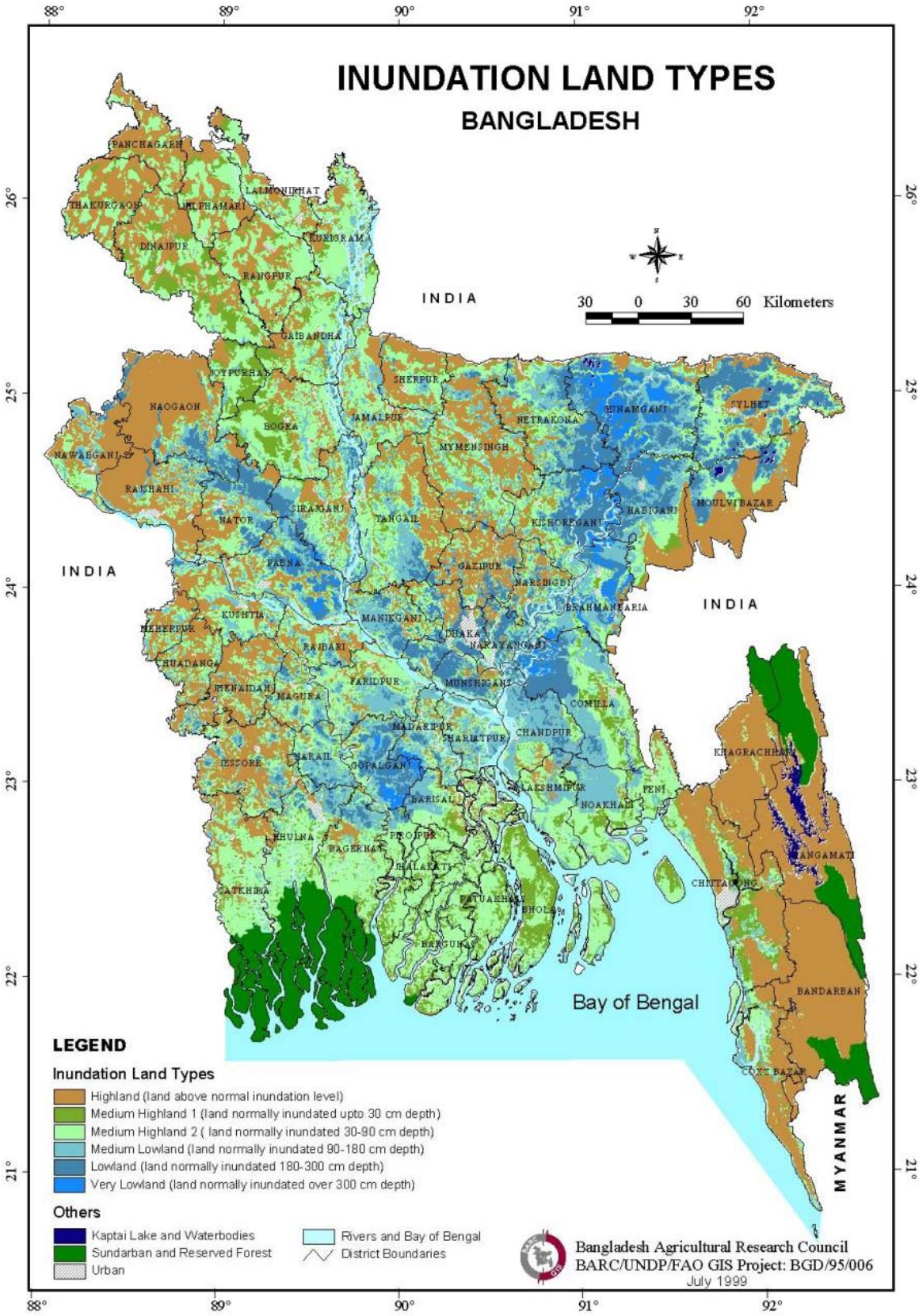


Fig 34: Land Classification Based on Depth of Inundation(Inundation Land Type)

3.2 Change in Countermeasures to Reduce the Damage by Flood

(1) Structural Measures

Since the establishment of the Water Master Plan in 1964, Bangladesh has been conducting measurements for floods, which focus on controlling floodwaters by large-size structures. In the past few decades, many embankment facilities have been built in the country as a part of the activities for flood prevention/drainage improvement. The riverbanks along the major rivers have been always well maintained as Bangladesh Water Development Board (BWDB, used to be called East Pakistan Water and Power. Development Authority) has built approx. 4,000km of banks before 1980s, and they have extended another 2,000km. Total length of the banks maintained currently is 9,143km (Figure 35 and 36).

However, architectural design and maintenance/management of these riverbanks are not always appropriate as they sometimes contribute to extensive damage, such as bad drainage of riverside areas caused by sediment deposition from the change in water channels (Banglapedia) and bursts in the banks (Elahi, 1969, Brammer, 1992 and others). Chowdhury (1992) has pointed out in his written contribution that, when considering the socioeconomical limits in Bangladesh, it is impossible to guarantee the quality of their river embankments. Moreover, he has warned that, under such conditions, carrying on the prevention project from floods that focuses on the expansion of riverbanks can lead to further damage.

Opinions and needs of local people are never included in the construction plans of the banks. Therefore, these embankments, built without listening to local people, are sometimes cut away (public cut) by them (Uchida 2003).

The Flood Action Plan (FAP), established later with the help of UNDP and the World Bank, had been brought along with traditional structure-oriented plans at first. But as the discussion goes, local people's opinions drew more attention for the prevention of floods, and at the end, the guideline was set to regard the locals' participation in the management of flood prevention projects. FAP, which subjects range widely from construction plans of large-sized riverbanks to local's opinion poll, giving the country a good opportunity to have the policies of flood measures shifted from the prevention of floods to the concept of living with floods. However, the plan itself had been targeted with big criticism. The reasons are because among the 26 components of FAP, only two of them were pursuing the way of living with floods, and the rest of them still placed their importance on structural measures. Another reason of the criticism was that the hydrological considerations of the lower reaches of rivers were inadequate for their structural plans; however, in the background of this issue, there was a gap of thoughts between France/ UNDP, focusing on a measure for large buildings, and the U.S., insisting the importance of the concept of living with floods. FAP finalized its plan in 1995, however, except for two of the pilot projects, actual actions have not been taken yet.

Aside from flood measures regarding large-sized constructions, a small range of developmental activities of water resources have currently been proceeding in Bangladesh, including the building of small-size embankments of rivers. Such activities within a small range have been conducted since 1995 by the Local Government Engineering Department (LGED), which is a different association from BWDB, and approx. 300 projects with total 160,000ha have been in operation since 2004. In these activities, local people's participation at the early stage of planning is more important, and its aim is not a perfect prevention of floods.

The Bangladeshi government established the national water policy in 2000, the highest level of water resources developmental plans that includes flood measures, and the structural measures are thought to be in a period of transition from the concept of "living with floods" to actual activation.

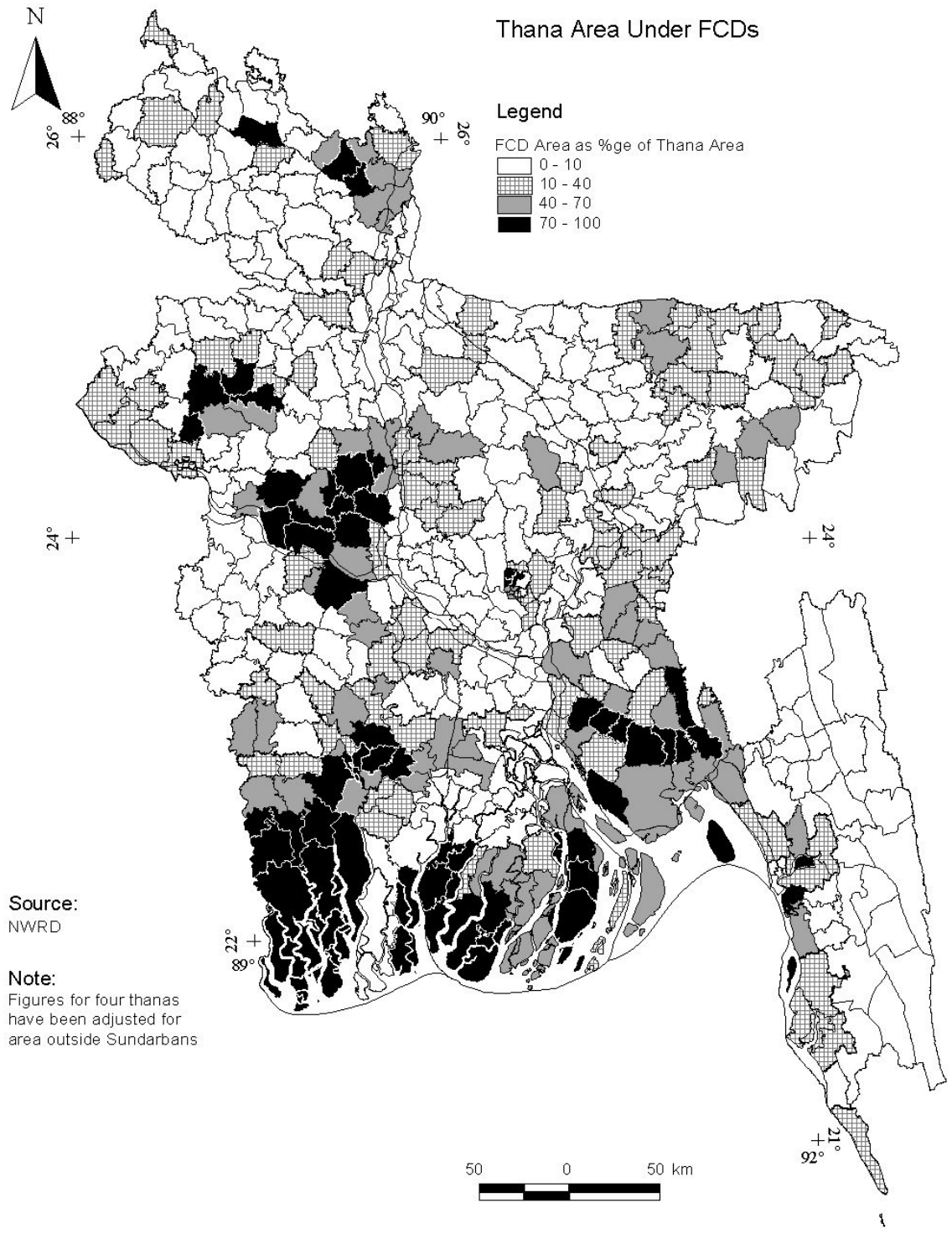


Fig 35: Areas Covered with the Structural Measures in Each District

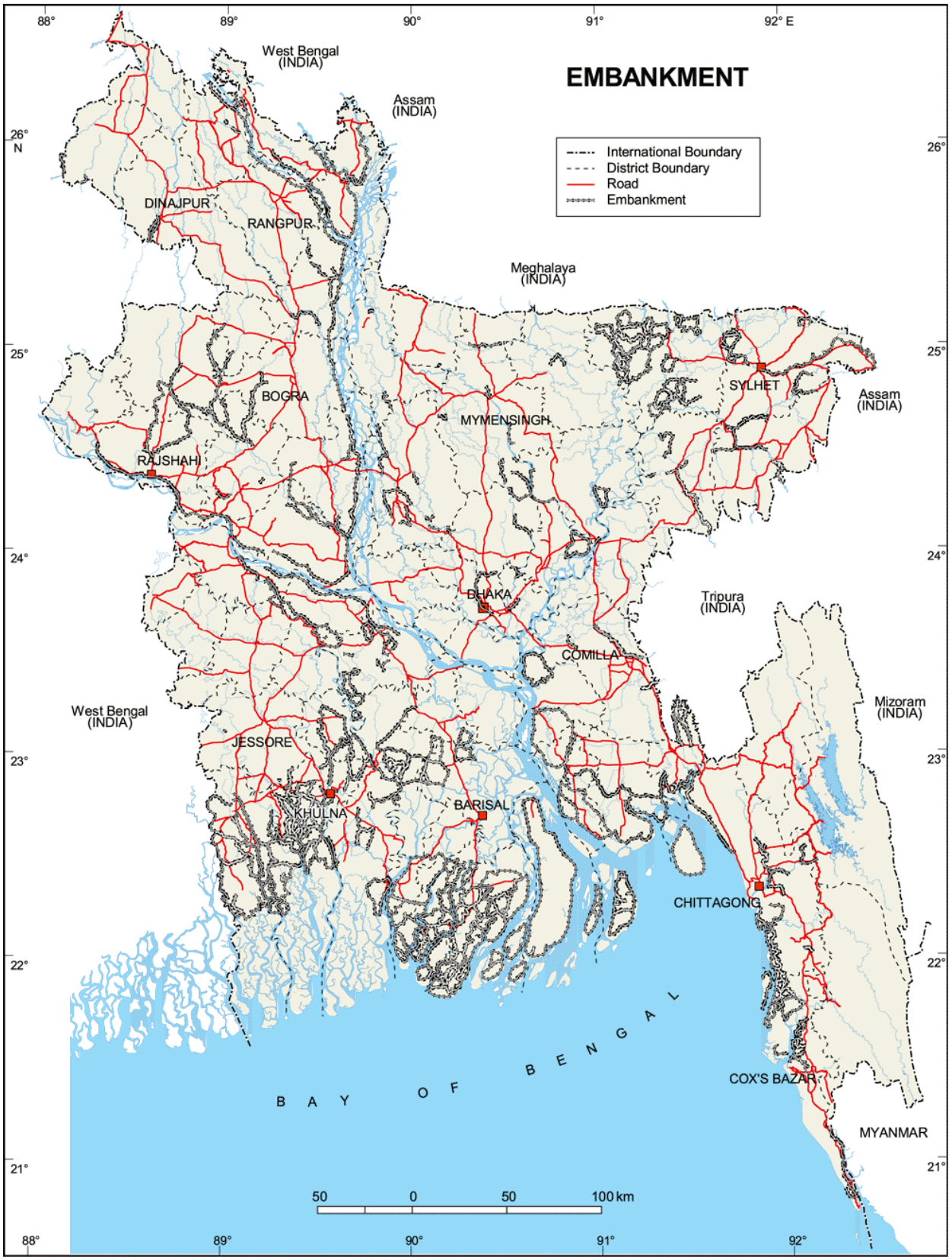


Fig 36: Existing Embankments

(2) Nonstructural Measures

1) Forecasting/Warning for Floods

Flood forecasting/warning has been systemized since the late 1960s. In 1972, the Flood Forecasting and Warning Center (FFWC) was established under the Bangladesh Water Development Board (BWDB). Using ten stations with real-time monitoring systems, the center gives warnings of floods when necessary. But the system of the center did not function adequately for the flood in 1988; this incident has made people perceive the needs for improvement/reinforcement of FFWC, and encouraged its modernization.

The maintenance of the forecasting/warning system in Bangladesh has been supported by Denmark (DANIDA/DHI). The main details supported are as follows:

● With the purposes of the effective control and usage of water resources, the Surface Water Simulation Modeling Programme (SWSMP) has been promoted since 1986 using MIKE11, which is developed by DHI.

● Implementation of Flood Action Plan FAP10（Expansion of Flood Forecasting and Warning Services) from 1991 through 1995

● The nation's rivers have been modeled using MIKE11 since 1992, and the number of the real-time monitoring stations has been increased from 10 to 16.

● MIKE11 GIS has been introduced between 1995 through 1999, and the real time monitoring stations have been expanded to 30.

The flood in 1998 turned out to be a good opportunity for BWDB/FFWC to inspect the forecasting/warning system for floods, flood-monitoring models of FFWC and the daily flood information (Daily Flood Bulletin) was highly evaluated by the central government, organizations in the nation and news media. On the other hand, it revealed that local people did not receive flood information and the current forecasting/warning systems did not meet the needs of the nation. Based on these facts, the system has been improved since 2000 as the Five Year Plan of reinforcement of flood forecasting/warning system has been implemented (2000-04) with the support of DANIDA/DHI and also the help regarding the improvement of the forecasting/warning telecommunication system was offered by Japan.

Since the establishment of the Flood Forecasting and Warning Center in 1972, the technical aspects of the flood forecasting/warning has been steadily improving, though, local people in lower classes are still thought to have poor telecommunication systems to receive flood information. Moreover, the current warning system only provides information regarding the conditions of 72 hours/48hours/24 hours after floods. However, because at least one week is required to prepare for a prospective disaster, the current timings of the forecasting/warning are not quite early enough. Meanwhile, the country must collaborate with other countries because the information from India and other countries are necessary in order to realize the prospect of flood water level for a long period.

2) Education regarding Disaster Preventions

Along with cyclones, the government has been recently placing more importance on the change in awareness of the measures regarding disaster preventions. Following are the parts of measures about the popularization/improvement of knowledge for disasters:

● Implementation of the training of 35,000 local leaders regarding disaster preventions based on a program run from 1997 though 2002.

● Obligation to receive lectures to public officials regarding disaster preventions twice a year

● Installation of the education of disaster preventions into curriculums of elder classes in elementary schools

3.3 Analysis of Flood Damage in 1974 and 1998

In this section, analysis has been conducted regarding the flood in 1974, with the death toll of 30,000, and the latest flood in 1998. Following are the details of these floods.

Table 9: Outline of the Floods in 1974 and 1998

	1974	1998
Flooded Area	52,720 km^2 (37% of the nation)	100,000 km^2 (68% of the nation)
Death Toll	28,700（direct death:1,200）	1,000
Sufferers	36,000,000	15,000,000

Damage	Damaged Houses: 425,000 Total sum of damage: $5million 2million people lost their houses	Damaged houses: 900,000 Sum of damage: $1.67billion Damaged agricultural products: 2.4million tons One million people became homeless

(1) The Flood in 1974

Figure 37 shows damaged areas by the floods in 1974 and Figure 38 refers a factor analysis Table. Special instruction of the reference cited for this analysis is referred to in Appendix 2.

In 1974, a larger number of people were killed by hunger, triggered by the flood, than the death toll caused by the flood directly. The hunger also occurred due to the external environment around the country such as the increase in the market price worldwide and the delay of aid supplies as the side effect of America's international strategies. However, the result of the factor analysis of the disaster roughly indicates following three categories: 1) The government's lack of capability against floods 2) Dysfunction of flood measures 3) No systems exist for the poor against floods.

The following are the details:

1) The Government Did not Have Adequate Capability for Floods

Following are the government's situation related to hunger, which led a big number of deaths as an aftermath of the flood in 1974:

● Lack of rice stock due to bad crop in 1972 and 1973

● Lack of savings in foreign currencies because of the slow economic growth in the country

● The nation's amount of expenses were more than that of income as the time was just after the independence war; so the government failed to buy domestically produced rice.

● The brand-new government could not offer rice to the nation due to its instability.

● Because of the U.S. law prohibiting food supply to a country trading with Cuba, Bangladesh was cut off from food aid from America, which they always received at the time of floods.

While such conditions were surrounding Bangladesh, the nation was hit by further damage to its rice cultivation caused by the flood, and the price of rice had skyrocketed. In addition, people in poverty, whose income were totally depending on agricultural labor, had been double punched by the loss of their jobs due to the flood and their capability of purchasing foods rapidly declined. This is thought to be the major reason of the hunger in the year. On the other hand, the government in those days had attempted to offer emergency food aid, but it was implemented with the focus on comparatively rich people in urban areas and did not reach to the people at the edge of agricultural villages. This happened because the new government, established just after the independence war, put their priority favorably on the people, who could affect the politics. There is also a criticism against the government having been paying less attention to the measures for hunger, even though they were carefully considering the damage by floods in order to collect international support.

This survey does not include the details of the size of the damage caused by diseases triggered by the flood, though, as well as food supply, it is thought that inadequate treatments might have been conducted with limited materials.

Thus one of the clear features of the flood in that year was that the then-government's lack of capability regarding policies, administration and finance had largely impacted on the expansion of the flood damage.

2) Dysfunction of Flood Measures

Although structural measures (building riverbanks) had been implemented in Bangladesh since the 1960s, the details of the maintenance conditions of the measures for long periods could not be found by the report searching at this time. However, there are many indications that most of the embankments for floods are not functioning adequately due to lack of proper maintenance/management, so there would be the same situation at the time of just after the independence war. According to the survey conducted by United Nation Development Programme in 1987, the reasons for the dysfunction of the riverbanks in Bangladesh are: a) inadequate architectural designs, b) incompletion of embankment/water facilities/standards of maintenance/management, c) political issues regarding expropriation of land, d) insufficient numbers of locals joining to design/management of riverbanks. Thus, it is easy to imagine the situations of ten years earlier than that time.

In the meantime, the flood forecasting/warning system had been maintained since 1960s as a part of the planning measures, though, it is thought that, as of 1974, the system had not been functioning properly. In addition, it is known that the information transmission system had not been operating adequately in 1988 to

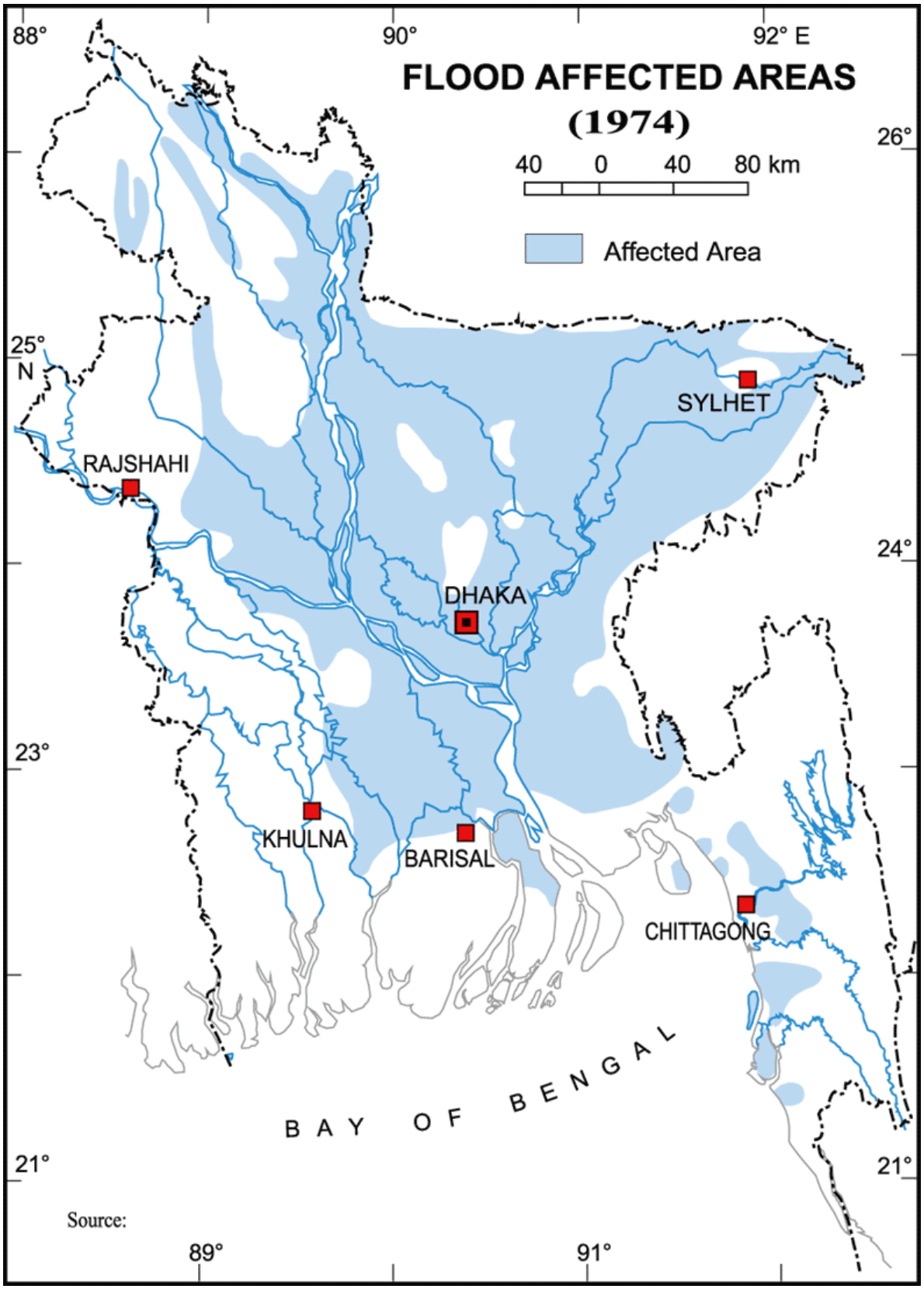
send forecasts/warning to local people, so the same situation was seen in the case in 1974. Even at present in Bangladesh, the system can only forecast the inundation depth of 72 hours prior to floods and it has been indicated that it is not enough to prevent damage from floods. Therefore, it is easy to imagine that the system was not working properly in the year of 1974.

3) Less Resistance against Floods Seen in Poor People

Among disasters in Bangladesh, Banna, one of floods, does not claim many people's life as against the size of damaged population. Floods impact on various aspects of people's life by damaging materials. The worst damage in 1974 was seen in agricultural products. In Bangladesh, rice is possibly grown in triple crop, but when a flood hits, it damages the Aus rice that is harvested before the rainy season, and the Aman rice that is planted at the end of the rainy season. In the meantime, when agricultural products are damaged by floods, side effects are seen not only in farm owners, but also in peasants with no lands and small-land owners, whose income is totally dependant on agricultural labour, who loose their jobs. As a result, farmers, especially in the poor class, have become incapable of purchasing food, and along with the increase in the food market prices, there was big damage to people's life. The ratio of poverty in Bangladesh in the year of 1974 was as high as 70.6%, so this means that many people suffered from lack of food.

Moreover, Banna can cause direct damage to people's properties such as their houses and livestock, and would force those people to sell the rest of their properties by squeezing victims finance (decline in their employments, damage to their products and properties). In such cases, their properties are traded at a cheaper price than usual. For people with enough wealth, these are only a loss to some part of their properties or temporary damage, but other people in poverty have to borrow money to feed their families or have no choice but to sell all of their assets at very low price. Meanwhile, it is a good chance for those in the rich class to expand their properties with low costs. In other words, even if they suffer from the same damage, for the wealthy and the poor, the impact on their life totally differs.

The damage caused by a large scale flood, like the one in 1974, not only claims people's life directly, but it also put them endanger indirectly by establishing a cycle in that weak people become even weaker.



Source:Banglapedia

Fig 37: Affected Areas of the Flood in 1974

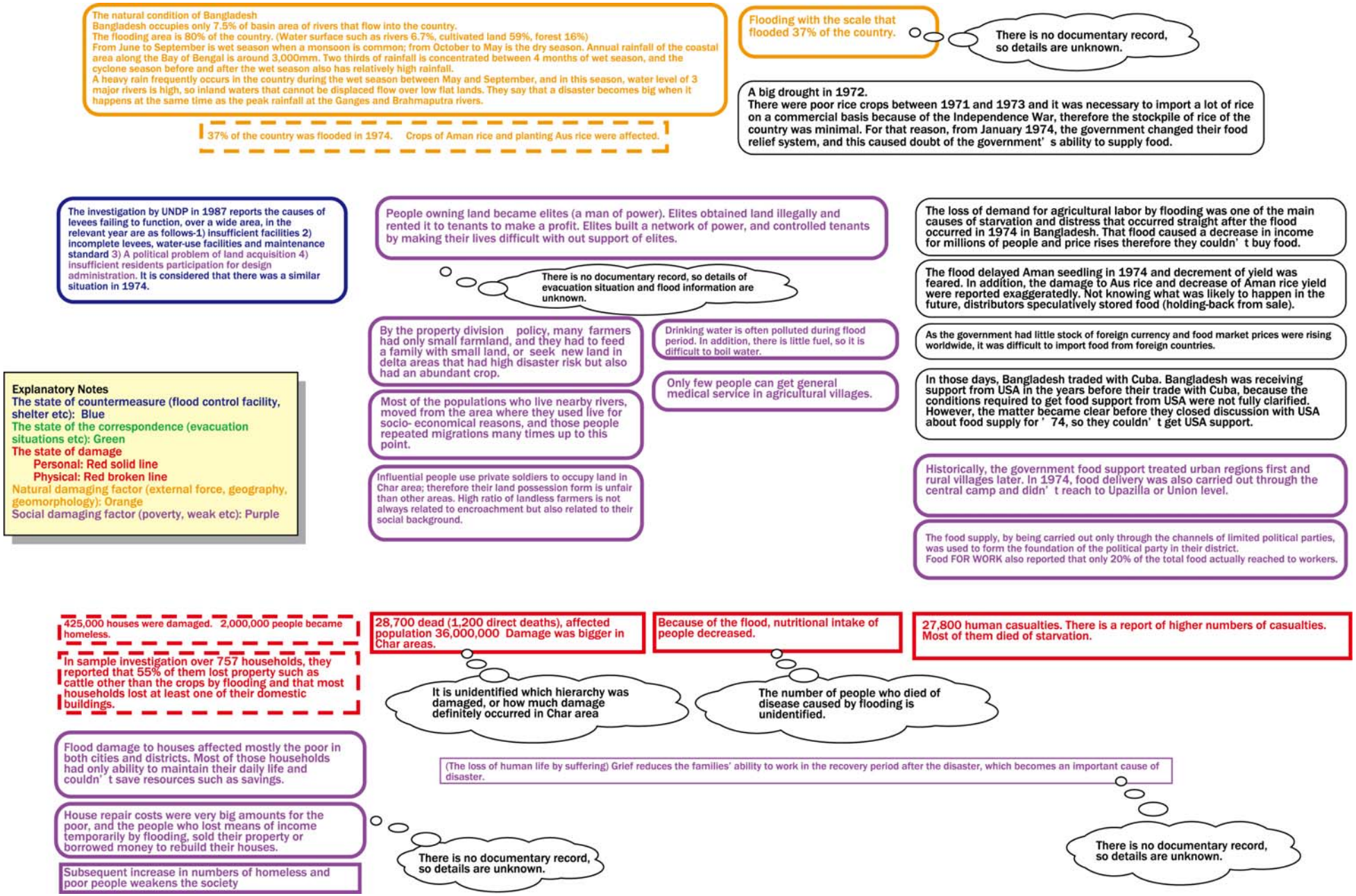


Fig 38: Factor Analysis of the Damage in 1974 (Summary)

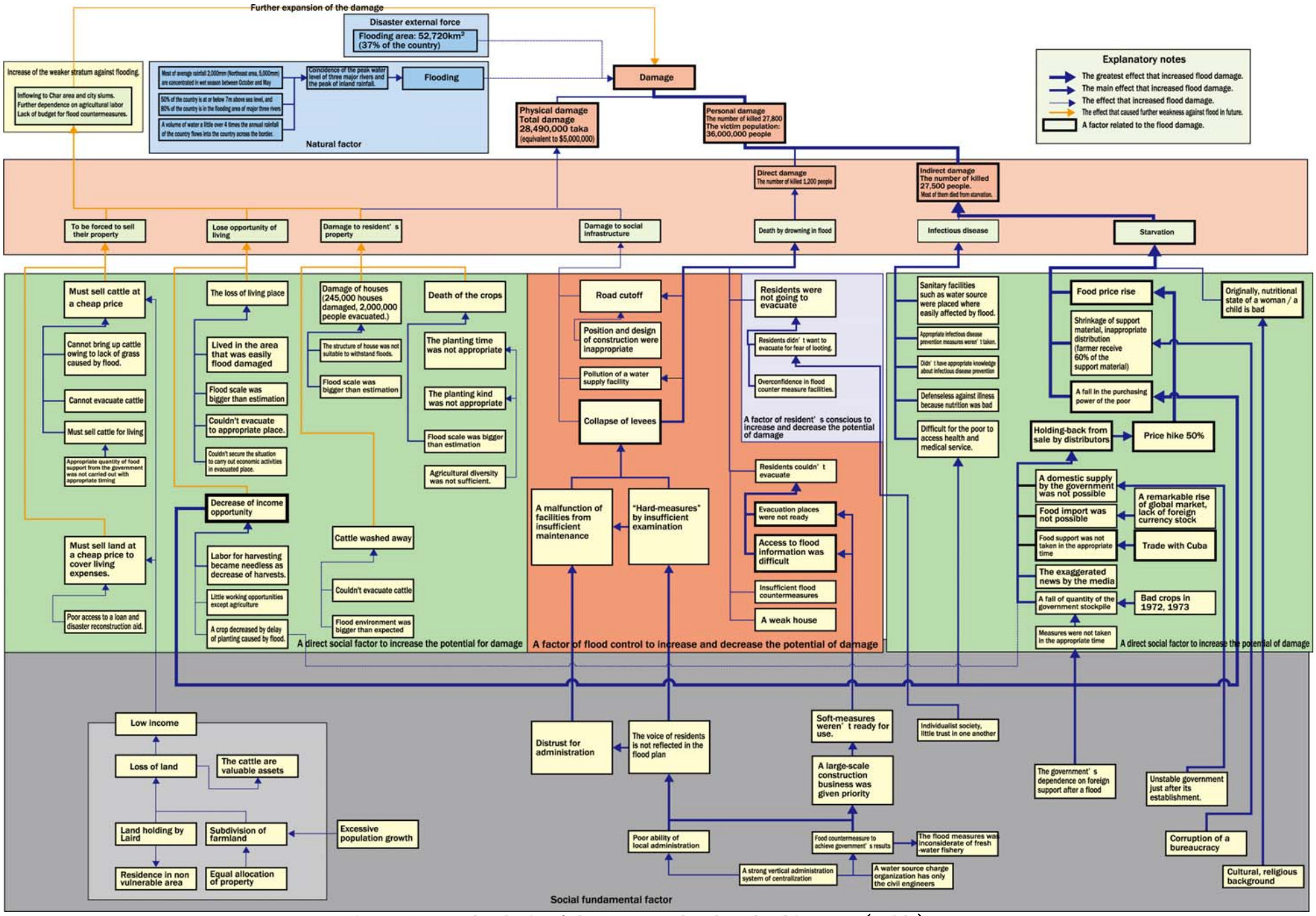


Fig 39: Factor Analysis of the Damage by the Flood in 1974 (Table)

(2) Flood in 1998

Figure 40 shows the flood affected areas in 1998 and Figure 41 refers to a factor analysis Table. As the same matter of the flood in 1970 mentioned previously, the special instruction of the reference cited for this analysis is referred in Appendix 2.

In case of the flood in 1998, two thirds of the nation was flooded and 37% was a non-flooded area. Compared to the one in 1974, its size was much larger. Meanwhile, the death toll of the flood in that year was 1,000, which is still not an ignorable number, but is a little less than that of in 1974. When considering its size, some eternal effects might have reduced the damage at this time. Along with the flood in 1974, the following three categories are roughly pointed as the factors of the basic damage by the flood in 1998:

1) The Government's Capability against Floods' Damage

Compared to 1974, the most outstanding point of the damage in 1998 was, even though the flood size was bigger, no large-scaled hunger was seen in that year after the disaster. The factors which are thought to prevent hunger are as follows:

● Increase in the amount of people's savings as people working overseas send money

● Implementation of importation of rice by private companies along with liberalization policy

● The crop situation was able to be forecasted at some degrees and also the crop yield of Boro rice, which received no damage by the floods, had increased. Therefore, people didn't become anxious about the lack of rice.

● Food aids were operated by international societies at adequate timing.

● Compared to the situation in 1974, the quality and the amount of the food supply were offered efficiently by the government.

Other facts, which didn't lead people to big hunger, were that the external environment around Bangladesh has been changed by the time of the year and the government's capability of supplying food has been improved. In that year, other effective actions taken by the government were: emergency food supplies for the flood sufferers, distribution of the tickets of food aid for families (mainly those with female owners), and operation of Food for Work programs. However, there are still some issues to be considered as a report says that some of the aid materials are misused by politicians and locals' authorities.

2) Flood Measures

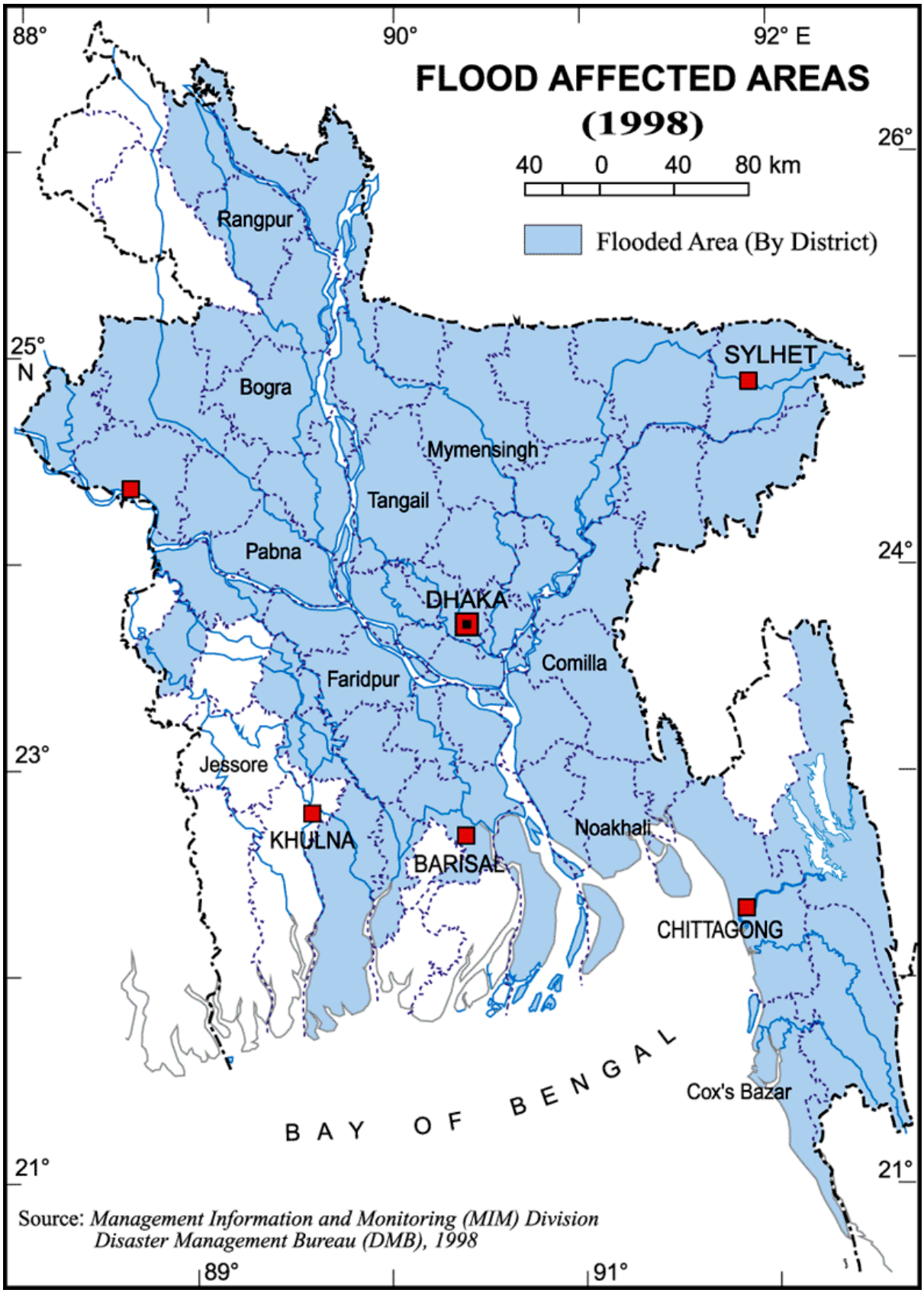
Flood measures in Bangladesh used to focus on the establishment of embankments for floods. By that time, people were paying more attention to the flood forecasting/warning system and there was an increase in the locals' awareness of disasters since the operation of the Flood Action Plan (FAP) in 1990. It was the Bangladesh Water Development Board (BWDB) that had been taking an important role as it had started FAP and has been continuously planning on the building of riverbanks. These measures have been regarded as structural measures. In the meantime, at the last period of FAP (1990-95), the importance of locals' participation has been finally realized for the planning of flood measures, and their participation for development/management of water resources was clearly declared by the nation's water plan in 2000. As of 1998, other plans than pilot projects had not been operated, so there was some damage to the embankments. Regarding the maintenance conditions of riverbanks, it had been reported in the late 1980s that the total of 7,555km of the banks has been built in the whole nation, so they might have been extended further more by that year.

Meanwhile, people have been appreciative about the flood monitoring models and the Daily Flood Bulletin, which both are operated by the Flood Forecasting and Warning Center, though, these are thought to be not effective measures for evacuation as local people still complain that they don't receive flood information. It is also indicated that there is not enough time for operating flood measures because, at the moment, the forecast of inundation depth is provided only 72 hours prior to floods.

3) Resistance of Poor People against Floods

Compared to the time just after the independence war, the poverty of Bangladeshis had largely improved as of the year 1998. However, people's weakness against flooding cannot be said to have improved as the population pressure at the limited land resources have increased and also farmers' expenses have been raised due to the Green Revolution in 1980s. In both urban and rural areas, the wealth gap between the rich and the poor has been becoming wider since early 1990, therefore some classes of people have become more resistant against floods but some have become even weaker.

The basic outline has not been much different since 1974, when the Bonna flood pushed poor people to weaker levels and the rich gained their new assets. But for the flood victims in 1998, various food aids were equally offered by the international societies, so a negative part of the cycle, which is usually seen after the disaster, was not seen much in this year. However, there are still reports saying that, among food aids, only 60% of the people who really need the help have actually received their supply, improvements are still required.



Source:Banglapedia

Fig 40: Affected Areas by the Flood in 1998

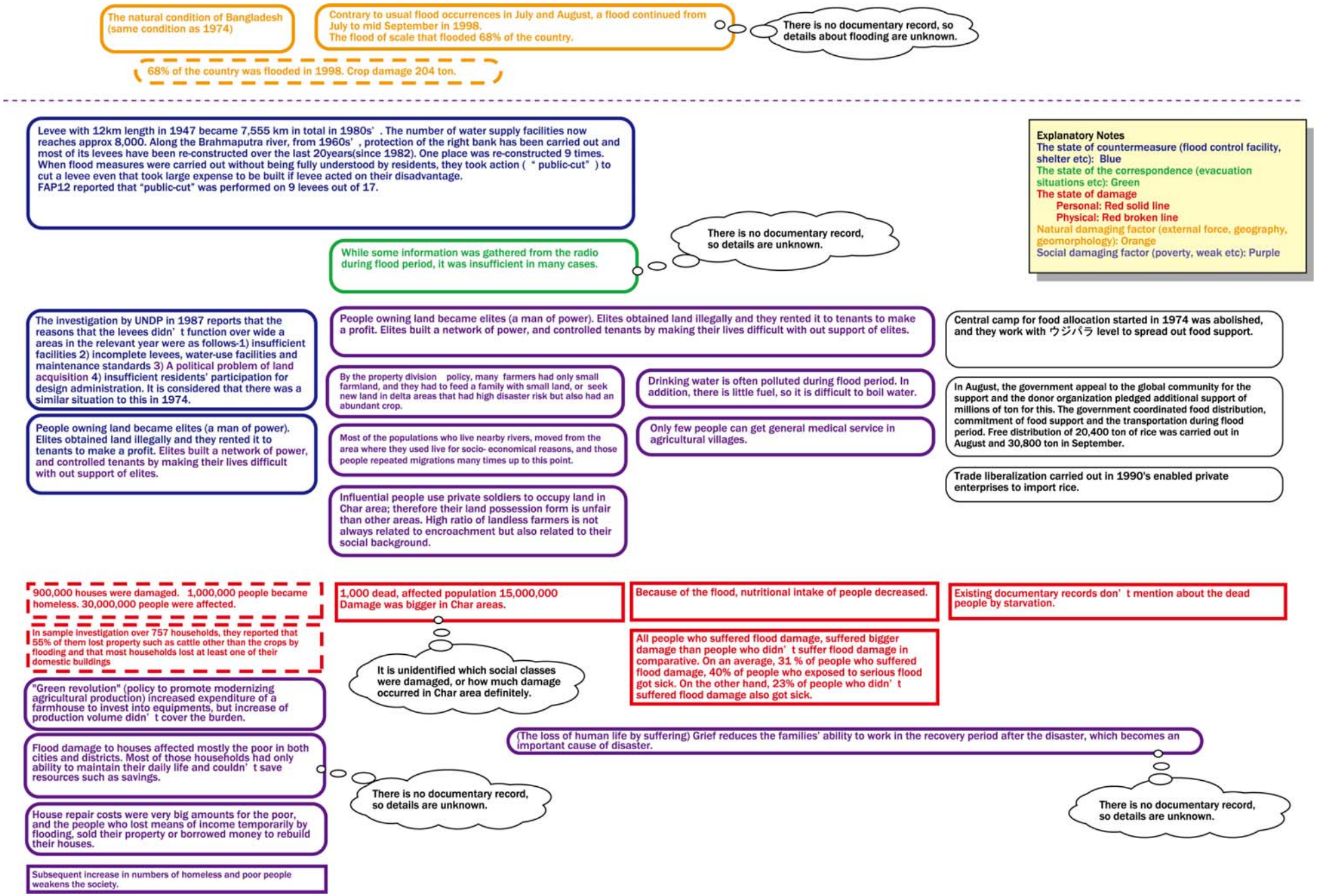


Fig 41: Factors Analysis of Damage by the Flood in 1998 (Summary)

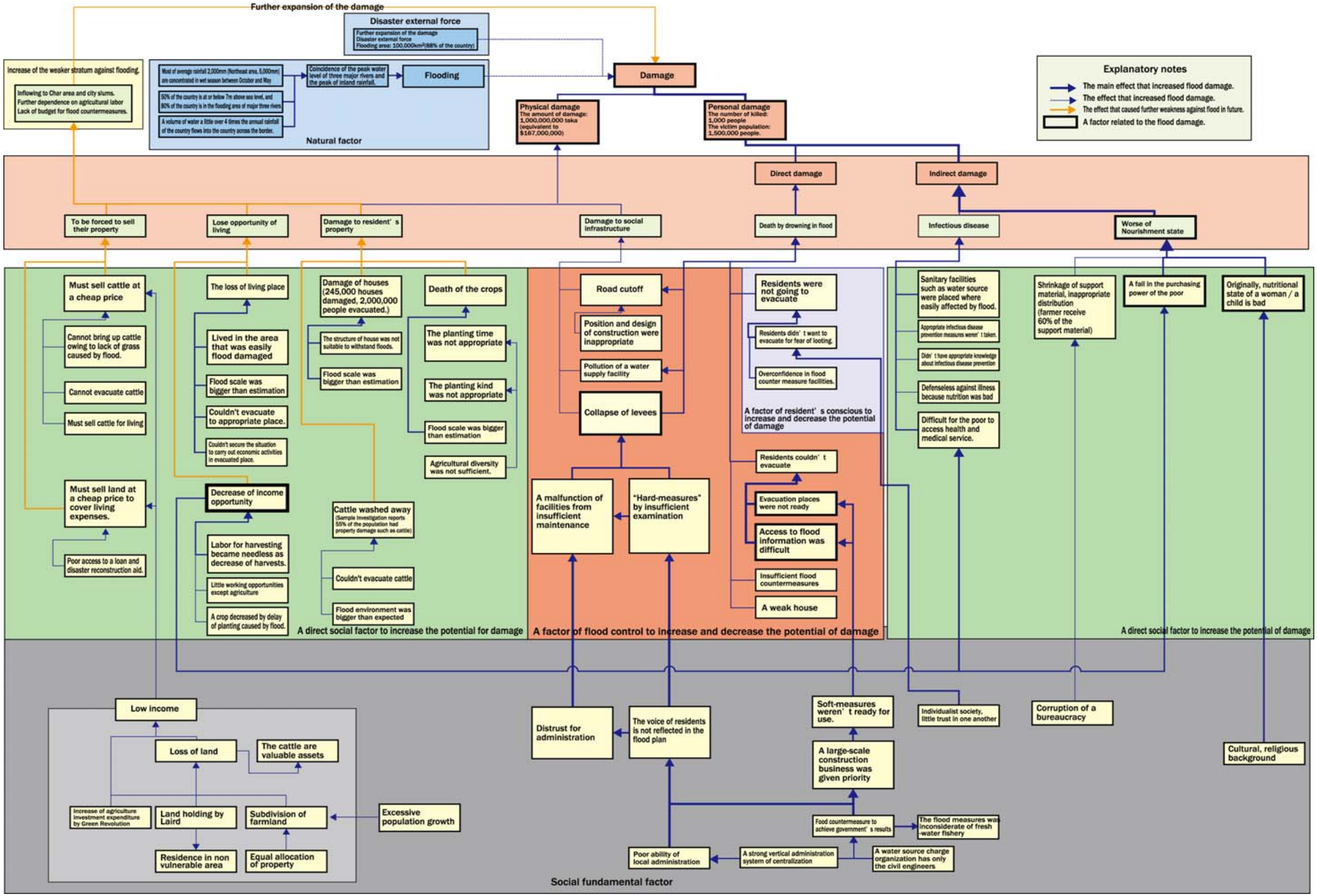


Fig 42: Factors Analysis of Damage by the Flood in 1998 (Table)

Appendix

List of Documents Related to Bangladesh

Ref. No	Document	Date of Publication	Author
BA_S1	The Impact of Local Elites on Disaster Preparedness Planning: The Location of Flood Shelters in Northern Bangladesh	1991	Khan, M. I.
BA_S2	Vulnerability to Tropival Cyclones: Evidence from the April 1991 Cyclone to Coastal Bangladesh	1992	Haque, C. E. and Blair, D.
BA_S3	East Pakistan in the Wake of the Cyclone	1967	Hanson, W. J.
BA_S4	Floodshock: Drowning of Planet Earth	1986	Milne, A.
BA_S5	Tropical Cyclones: Coastal Bangladesh	1974	Islam, M. 1974.
BA_S6	Navies Hunt for Victims of Cyclone	1988	Mahmud, A.
BA_S7	Hazards in a Fickle Environment	1997	Haque, C.
BA_S8	Power of Humanity.	2003	Fazlul, W. n.d. Bangladesh:
BA_S9	Empowering Women in Bangladesh. International Federation of Red Cross and Red Crescent Societies, 25 Feb 2002, via ReliefWeb:	2002	Schmuck-Widmann, H.
BA_S10	Counting the Cost of Catastrophe	1991	Sattaur, O.
BA_S11	In Bangladesh Storms, Poverty More than Weather is the Killer	1991	Kristof, N.
BA_S12	Cyclonic-surge Resistant Housing in Bangladesh: The Case of Urir Char	1988	Ullah, Md. S.
BA_S13	Man's Response to Sea-Level Change	1987	Carter, R.
BA_S14	The Environment as Hazard	1993	Burton, I., Kates, R. and White, G.
BA_S15	Disaster Management and Cyclone Warning System in Bangladesh	2002	Monowar Hossain Akhnad
BA_S18	CPP, At a glance	2002	"Cyclolne Preparedness Programme Bangladesh Red Crescent Society"
BA_S19	Banglapedia	2001	
BA_S20	Basic design study report on the project for the construction of multipurpose cyclone shelters (V) in the People's Republic of Bangladesh (in Japanese)	2003	JICA
BA_S21	Appropriate Criterion for Disaster Preparedness in Asia (in Japanese)	1999	
BA_S22	Current status of disaster problem in Bangladesh and factor analysis in terms of nature and social characteristics (in Japanese)	2003	Hagiwara et al, Disaster Prevention Research Institute of Kyoto Univ.
BA_S23	People in Community Center for Disabled in Mymensingh, Bangladesh (in Japanese)	2002	Mr. Iwamoto
BA_S24	Japan's diplomatic challenges with Bangladesh (in Japanese)	2003	Mr. Horiguchi of Embassy of Japan in Bangladesh
BA_S25	Youth education in Bangladesh (in Japanese)	1998	
BA_S26	Sign of Development and Structural Restriction (in Japanese)	2000	Mr. Fujita of Center for Southeast Asian Studies, Kyoto Univ.
BA_S27	Brief Overview of Bangladesh (in Japanese)	2000	
BA_S28	Activity Report of hunger free world (in Japanese)	2004	
BA_S29	Bangladesh –Approach in terms of Disaster, Anticipation, Countermeasure and illegal activity- (in Japanese)		Mr. Takada of Hiroshima Shudo Univ.

Ref. No	Document	Date of Publication	Author
BA_S30	Problems in Developing Countries such as Bangladesh (in Japanese)	2000	
BA_S31	Bangladesh Report: Social Surroundings (Education) (in Japanese)	2000	Mr. Yamashita of Kyoto Seika Univ.
BA_S32	General Information from Ministry of Foreign Affairs: Current Status of Bangladesh (in Japanese)	2005	Ministry of Foreign Affairs of Japan
BA_S33	Information on Bangladesh from Ministry of Foreign Affairs (in Japanese)	2006	Ministry of Foreign Affairs of Japan
BA_S34	JICA Country Information (in Japanese)	2000	JICA
BA_S35	Project Topics: Project for the construction of multipurpose cyclone shelters (IV) in the People's Republic of Bangladesh (in Japanese)	2001	JICA
BA_S36	Summary of assessment result on the project for the construction of multipurpose cyclone shelters 3 in the Peoples Republic of Bangladesh (in Japanese)	2003	JICA
BA_S37	Wikipedia (in Japanese)	2002	Wikipedia
BA_S38	Death Study – Bangladesh (in Japanese)	1996	Suzuki, Mitsuhashi et al.
BA_S39	Collection and Disclosure of Information for Disaster Reduction (in Japanese)	1999	Asian Disaster Reduction Center
BA_S40	ADRC Annual Report No.5 2002 (in Japanese)	2003	Asian Disaster Reduction Center
BA_S41	Vicious circle of poverty – essentiality of development problem (in Japanese)	1998	Tanaka
BA_S42	Current Status and Problems on religious minorities in Bangladesh (in Japanese)	2004	Togawa
BA_S43	Country Profile: Bangladesh	2003	World Bank
BA_S44	Poverty Profile: Bangladesh (in Japanese)	2001	Japan Bank for International Cooperation
BA_S45	Assessment Report on ODA (FY 2001): Bangladesh (in Japanese)	2002	Ministry of Foreign Affairs of Japan
BA_S46	Country Report in terms of environment and information technology: Bangladesh (in Japanese)	1994	JICA
BA_F1	A Quiet Violence: View from a Bangladesh Village	1983	Hartmann, B. and Boyce, J.
BA_F2	Bangladesh: The Strength to Succeed	1989	Monan, J.
BA_F3	Socio-Economic Impacts of Floods and Flood Protection: A Bangladesh Case Study	1994	Thompson, P. and Penning-Rowsell, E.
BA_F4	Coping with Complexity in Food Crisis Management	1984	Currey, B.
BA_F5	Flood Action Plan: One Sided Approach?	1991	Chowdhury, J.
BA_F6	Living with the Floods: Survival Strategies of Chardwellers in Bangladesh	1996	Schmuck-Widmann, H.
BA_F7	Hoiding back the Flood: Actioned Planned to Help Save Bangladesh	1990	British Overseas Development
BA_F8	Chambers, R. et al. (eds) Seasonal Dimensions to Rural Poverty	1981	
BA_F9	Controversies Sorrounding the Bangladesh Flood Action Plan	2000	Brammer, H.
BA_F10	Facing the Jumuna River: Indigenous and Engineering Knowredge in Bangladesh	2001	Schmuck-Widmann, H.
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Ref. No	Document	Date of Publication	Author
BA_F12	Barth of a Megaproject: The Political Economy of Flood Control in Bangladesh	1990	Boyce, J.
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BA_F14	Environmental Aspects of Bangladesh Flood Action Plan	1990	Dalal-Clayton, B.
BA_F15	Hazards in a Fickle Environment	1997	Haque, C.
BA_F16	Hossain, H., Dodge, C. and Abed, F. (eds) From Crisis to Development: Coping with Disasters in Bangladesh	1992	
BA_F17	Food Security Under Siege? The Emerging Allience between Micro-Credit Lenders and Transnational Corporations. International Development Research Centre, 12 July.	1999	Shore, K.
BA_F18	Perceptation of and Agricultural Adjustments to Floods in Jamuna Floodplain, Bangladesh	1984	Paul, B.
BA_F19	Population Displacement due to Riverbank Erosion of the Jamuna in Bangladesh	1989	Elahi, K.
BA_F20	Local Contrl Versus Technology: The Bangladesh Flood Response Study	1997	Leaf, M.
BA_F21	Social Structure and Process in Char Land Settlement in the Bramaputra-Jamuna Floodplain	1991	Zaman, M.
BA_F22	The Flood Action Plan: A New Initiative Confronted by Basic Questions	1992	Westcoat, J.
BA_F23	The Flood Action Plan: Social Impacts in Bangladesh	1992	Parker, D.
BA_F24	The Rivers That Won't Be Tamed	1991	Pearce, F.
BA_F25	Social and Environmental Aspects of the Flood Action Plan in Bangladesh: A Critical Review	1993	Adnan, S.
BA_F26	Poverty and Famines: An Essay on Entitlement and Deprivation	1981	Sen, A.
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BA_F28	Social and Environmental Aspects of the Flood Action Plan in Bangladesh: A Critical Review. Paper presented at Conference on the Flood Action Plan in Bangladesh	1993	Adnan, S.
BA_F29	Floods in Bangladesh: I. Geographical Background to the 1987 and 1988 Floods	1990	Brammer, H.
BA_F30	Floods in Bangladesh: Ⅱ. Flood Mitigation and Environmental Aspects	1990	Brammer, H.
BA_F31	A Legal Prospective on the FAP	1993	Farooque, M.
BA_F32	Protecting Bangladesh	1993	Brammer, H.
BA_F33	The 1998 Floods in Bangladesh: Disaster Impacts, Household Coping Strategies and Response	2001	del Ninno, C., Dorosh, P., Smith, L. and Roy, D.
BA_F34	Cash and Carry On: Battle Rages over Bangladesh Government's Ban on 'Killer' Plastic Bags Guardian, 27 March.	2002	Mahmud, A.
BA_F35	Flood Control in Bangladesh: A Plan for Action. Asia Region Technical Department. World Bank Technical Paper No. 119	1990	World Bank
BA_F36	The Riverbank Erosion Impact Study Bangladesh	1989	Rogge, J. and Elahi, K.

Ref. No	Document	Date of Publication	Author
BA_F37	Flood Hazard Assessment for the Construction of Flood Hazard Map and Land Development Priority Map Using NOAA/AVHRR Data and GIS - A Case Study in Bangladesh		Md. Monirul Islam and Kimiteru Sado
BA_F38	Dynamic flood warning system: An integrated approach to disaster mitigation in Bangladesh		Farah Aziz, Dr.Nitin Kumar Tripathi, Dr. Ole Mark, Dr. Michiro Kusanagi
BA_F39	Flood study in the Meghna - Dhonagoda Polder, Bangladesh	1994	J. A. M. de Brouder
BA_F40	Rivers, chars and char dwellers of Bangladesh	2003	Maminul Haque Sarker, Iffat Huque and Mustafa Alam
BA_F41	Flood Disaster in Bangladesh (in Japanese)	2003	Taro Oka
BA_F42	Analysis on current status in terms of disaster problem and social characteristics (in Japanese)	2003	Mr. Hagiwara, Ms. Hagiwara and Bilqis Amin Hoque
BA_F43	Water Resource Management in Bangladesh - A policy review -, Livelihood-Policy Relationships in South Asia, Working Paper 1		DFID Working Paper
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BA_F45	Food aid in Bangladesh, A Gradual Shift from Relief to Reform	1997	USAID
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