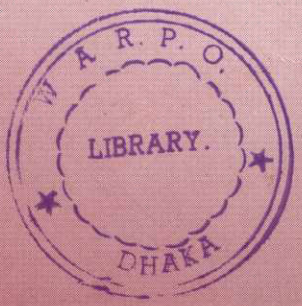
BANGLADESH FLOOD ACTION PLAN

Ministry of Irrigation Water Development and Flood Control

Flood Plan Coordination Organization (FPCO)



GIS MAPPING OF BWDB FLOOD FORECASTING DATA

Draft-April 1994

Prepared by

Geographic Information System (GIS)

IRRIGATION SUPPORT PROJECT FOR ASIA AND NEAR EAST

Sponsored by the U.S. Agency for International Development

2

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FAP 19

ISPAN

IRRIGATION SUPPORT PROJECT FOR ASIA AND THE NEAR EAST

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ISPAN

IRRIGATION SUPPORT PROJECT FOR ASIA
AND THE NEAR EAST

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1. Introduction

The Ganges, Brahmaputra, and Meghna rivers, which flow through Bangladesh enroute to the Bay of Bengal, represent one of the most complex and flood-prone river delta systems in the world. The system carries a huge volume of Himalayan snowmelt, and drains the high rainfall areas of the northeastern portion of the Indian sub-continent. These factors, combined with high levels of local precipitation during the monsoon season, create a situation that often causes extensive flooding. These floods inevitably damage rural and urban properties, and often cause epidemics of diseases, and bring about inestimable human misery.

In an attempt to better prepare Bangladesh with flood forecasting information the Bangladesh Water Development Board (BWDB) operates a Flood Information Centre. The Flood Forecasting & Warning Division (FFWD) of the center monitors water levels at 38 stations along the three major river basins. During monsoon season, the FFWD also forecasts flood levels at 10 of those stations. The FFWD daily distributes the observed water level data for three consecutive days in tabular form (Appendix 1). Its flood level forecasts, also issued daily, are for 24 and 48 hour periods.

While the FFWD data and forecasts are reasonably accurate, extracting and visualizing information from the tables can be time-consuming for the planners, policy makers, and disaster managers who need to make use of the data.

The objective of this study, therefore, is to enhance understanding of the existing flood forecasting system by reproducing it in a more easily interpreted map form. This type of mapping will:

- Help planners to immediately assess daily flood scenarios;
- Provide support information necessary for the improvement of flood management policy; and
- Help disaster managers to better anticipate and plan for floods.

2. Methodology

2.1 Creating a River Reach Schematic and Database

The first step was to create a schematic representation of each of the major rivers showing the reaches covered by the 38 FFWD gauging stations. The reaches were depicted according to the length of river associated with each gauging station based on interpretations of hydrologic and geomorphic features. The boundaries of the 38 reaches were digitized manually as an overlay on a map of Bangladesh (Figure 1). Each reach polygon in the digital map was then assigned a unique identification number which would allow it to be linked to relational database tables containing reformatted FFWD flood report data.

2.2 Assessing the Danger Level

Danger level is defined as the level above which it is likely that flooding will damage crops and homesteads. Using this definition, FFWD has established a river level and danger level for each of its gauging stations. The difference between the two is the flood level (F).

$$F = (W - D)$$

where, W = daily water level (m)
D = danger level (m)

The flood level is a useful means of categorizing FFWD flood report data for mapping purposes. Two types of maps were produced. One is a flood level map and the other is based on the daily change in the water level (rising vs. falling). The data for each map was categorized respectively:

Flood Level Categories

- Below danger level (greater than 10 cm below the BWDB danger level)
- At danger level (within 10 cm of the BWDB danger level)
- 11-30 cm above BWDB danger level
- 31-50 cm above BWDB danger level
- >50 cm above BWDB danger level

Rise/Fall Categories

- Below danger level
- At/above danger level and rising more than 5 cm from the previous day
- At/above danger level and falling more than 5 cm from the previous day
- At/above danger level and no change (rising or falling less than 5 cm from the previous day)

Spreadsheet analysis was used to calculate the flood level and the daily change in water level from the tabular FFWD flood report data. These data were then entered into a relational database table and linked to the digital river reach map. A database table containing typical results of these calculations is shown in Table 1.

3. Results and Discussion

A series of maps were generated for the time period 23 to 26 July 1993 to test the results of the calculations. Figures 2-5 show river levels with respect to BWDB danger level and Figures 6-8 show river rise/fall during the same period.

The flood forecasting maps clearly illustrate specific trends in water level occurring in several reaches. For example, the water level map for 23 July 1993 (Figure 2) shows that the danger level has been exceeded in the Sylhet basin and along the upper Jamuna River. During the next three days, subsequent water level maps (Figures 3-5) indicate that the water levels are receding in both of these regions. Similarly, flux in water level along the lower Ganges River can easily be noted on these maps for the four consecutive days. In all three cases the rise/fall maps for the same time period display corresponding trends. The ease with which these trends can be observed demonstrates the enhanced data visualization afforded by GIS map products. Extracting the same information from the tabular data provided by FFWD is more difficult and time-consuming. The benefits of these maps are even more fully realized when water levels are rising, in which case they provide advanced warning of flood occurrences in a readily interpreted graphic format.

The flood forecasting maps also indicate possible inconsistencies in the results shown between adjacent reaches or data anomalies. For example, the reaches in the Sylhet basin are shown with flood indices far above the danger level, while the Upper Meghna River reaches to the south are below the danger level (Figures 2-5). This discrepancy may be due to erroneous water level data. However, it is more likely due to variations in the definition of danger level among gauging stations. For instance, on unembanked reaches the danger level is approximately the average annual flood level, while for embanked reaches it is slightly below the level of the embankment. Regardless of the actual cause, this possible discrepancy may not have been noticed without these maps. This situation illustrates another benefit of mapping flood levels with GIS: it can aid in the refinement of flood monitoring techniques by uncovering potential problems in the current system.

4. Recommendations

This exercise demonstrates that a GIS can produce useful flood forecasting maps from FFWD flood reports. These data visualization tools could have wide applications for those involved in flood mitigation and response planning, and would be a useful compliment to the daily flood forecast report now produced by the FFWD.

The current definition of flood danger level—the level above which it is likely that flooding may damage crops and homesteads—could benefit from refinement. In practice, specific danger levels have been established for each measuring station and its immediate vicinity. These are numeric values reported in meters. A single water level is difficult to define for the complex hydrology of the Bangladesh rivers. Furthermore, most rivers are constantly changing in planform, alignment, and bed level. In consideration of these dynamics, the established danger levels should be regularly reviewed and revised, if necessary, based on contemporaneous field surveys.

FFWD currently uses the flood forecasting module of MIKE 11 to predict river levels for only 10 of

its 38 water level observation stations in the main river system. They could similarly forecast flood levels for all 38 observation locations, which would ultimately make it possible to produce more accurate flood forecasting maps using GIS technology.

Implementation of the techniques outlined in this document could provide the BWDB and the FFWD with a simple method for enhancing the interpretation of their daily flood level reports. This could be accomplished with a small investment of time and human resources. In order to expedite the installation of an automated system for GIS mapping of flood forecasting data, guidance and oversight from FAP 19 could be provided. Once established, it would produce daily flood forecasting maps in soft copy or hard copy format and would require minimal maintenance.

Table 1 Attributes in the Flood Report Database File

Station Name	River Reach No.	Danger Level (m)	Water Level (m)				Flood Level (cm)				Water Level Rise/Fall Code		
			23 July	24 July	25 July	26 July	23 July	24 July	25 July	26 July	24 July	25 July	26 July
Panchagarh	6	70.75	69.27	68.85	68.65	68.45	-148	-190	-210	-230	1	1	1
Dalia	5	52.25	51.27	51.38	51.53	51.5	-98	-87	-72	-75	1	1	1
Kurigram	1	26.5	26.94	26.31	25.93	25.67	+44	-19	-57	-83	1	1	1
Noonkhawa	2	27.89	26.81	26.41	26.16	26.04	-108	-148	-173	-185	1	1	1
Kaunia	4	30	29.58	29.14	29.07	29.06	-42	-86	-93	-94	1	1	1
Dinajpur	7	33.5	32.67	31.84	30.85	30.39	-83	-166	-265	-311	1	1	1
Chilmari	3	24	24.11	23.81	23.62	23.52	+11	-19	-38	-48	1	1	1
Bahadurabad	8	19.5	19.89	19.7	19.48	19.35	+39	+20	-2	-15	3	3	1
Durgapur	30	13	12.67	12.25	12.05	11.88	-33	-75	-95	-112	1	1	1
Jamalpur	27	17	16.38	16.67	16.7	16.62	-62	-33	-30	-38	1	1	1
Naogaon	11	15.25	13.61	13.88	14	14.07	-164	-137	-125	-118	1	1	1
Sunamgonj	38	8.25	8.62	8.56	8.5	8.42	+37	+31	+25	+17	3	3	3
Sylhet	37	11.25	11.35	11.33	11.32	11.26	+10	+8	+7	+1	4	4	3
Kanairghat	36	13.2	14.48	14.44	14.45	14.46	+128	+124	+125	+126	4	4	4
Nawabganj	12	21	16.98	17.25	17.6	17.78	-402	-375	-340	-322	1	1	1
Serajganj	9	13.75	13.73	13.75	13.61	13.5	-2	0	-14	-25	4	1	1
Sheola	34	13.5	14.06	14.1	14.11	14.08	+56	+60	+61	+58	4	4	4
Amalashid	35	15.85	17.59	17.7	17.65	17.56	+174	+185	+180	+171	2	3	3
Pankha	13	21.5	17.14	17.45	17.86	18	-436	-405	-364	-350	1	1	1
Bhairab Baz	29	6.25	6.76	6.85	6.91	6.93	+51	+60	+66	+68	2	2	4
Moulvi Baz	32	11.75	12.74	12.5	12.2	11.74	+99	+75	+45	-1	3	3	3
Aricha	10	9.14	8.65	8.84	8.87	8.84	-49	-30	-27	-30	1	1	1
Rajshahi	14	18.5	14.92	15.16	15.46	15.63	-358	-334	-304	-287	1	1	1
Monu R. B.	33	17.07	18.35	17.92	17.25	16.6	+128	+85	+18	-47	3	3	1
Habiganj	31	9.5	10.8	9.74	8.9	8.59	+130	+24	-60	-91	3	1	1
Hardinge BD.	15	14.25	11.32	11.6	11.95	12.16	-293	-265	-230	-209	1	1	1
Dhaka	25	6	5	5.18	5.27	5.32	-100	-82	-73	-68	1	1	1
Tongi	24	6.08	5.32	5.47	5.55	5.57	-76	-61	-53	-51	1	1	1
Tara Ghat	22	8.38	7.64	7.86	8.02	8.1	-74	-52	-36	-28	1	1	1
Goalonda	17	8.5	8.26	8.45	8.48	8.44	-24	-5	-2	-6	2	4	4
Mirpur	23	5.94	5.31	5.48	5.56	5.63	-63	-46	-38	-31	1	1	1
Gorai R. B.	16	12.75	9.55	9.87	10.24	10.46	-320	-288	-251	-229	1	1	1
Narayanganj	21	5.5	4.95	5.11	5.28	5.3	-55	-39	-22	-20	1	1	1
Bhagyakul	19	6	5.78	5.95	6	5.97	-22	-5	0	-3	2	4	4
Chandpur	20	4	3.43	3.51	3.53	3.52	-57	-49	-47	-48	1	1	1
Comilla	28	11.75	13.56	13.54	13.42	13	+181	+179	+167	+125	4	3	3
Faridpur	18	7.5	4.11	4.24	4.33	4.37	-339	-326	-317	-313	1	1	1

Note: Flood Level (F) = (W-D)*100

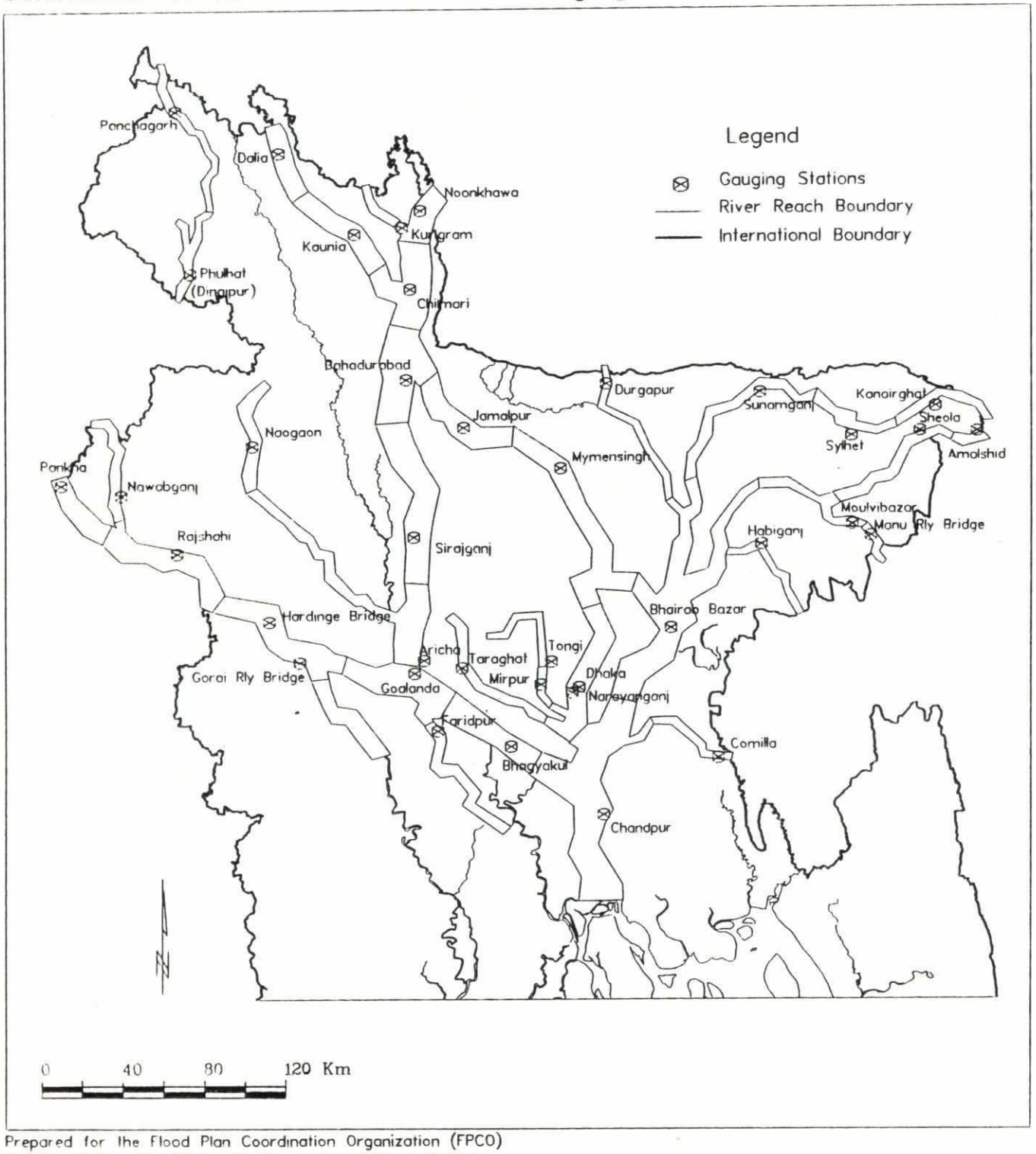
where, W = water level
D = danger level

Flood Level Categories
Below danger level (>10 cm below)
At danger level (within 10 cm)
11-30 cm above BWDB danger level
31-50 cm above BWDB danger level
>50 cm above BWDB danger level

Rise/Fall Code Categories
1 - Below danger level
2 - At/above danger level and rising >5 cm
3 - At/above danger level and falling >5 cm
4 - At/above danger level and no change

Schematic of River Reaches with Gauging Stations

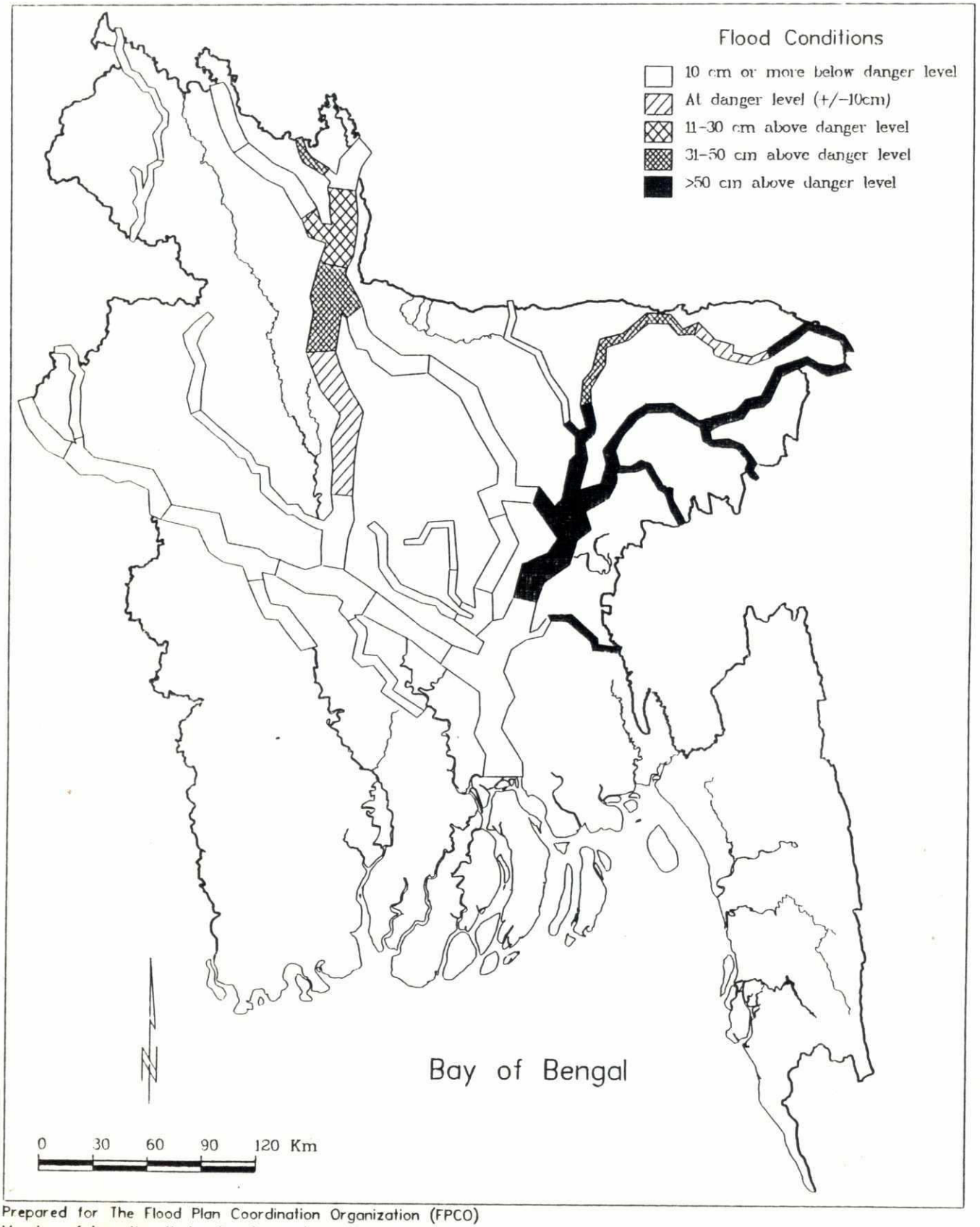
Figure 1



Prepared for the Flood Plan Coordination Organization (FPCO)
Ministry of Irrigation Water Development and Flood Control
Produced by ISPAN FAP19

Flood Warning Schematic of 23 July 1993

Figure 2



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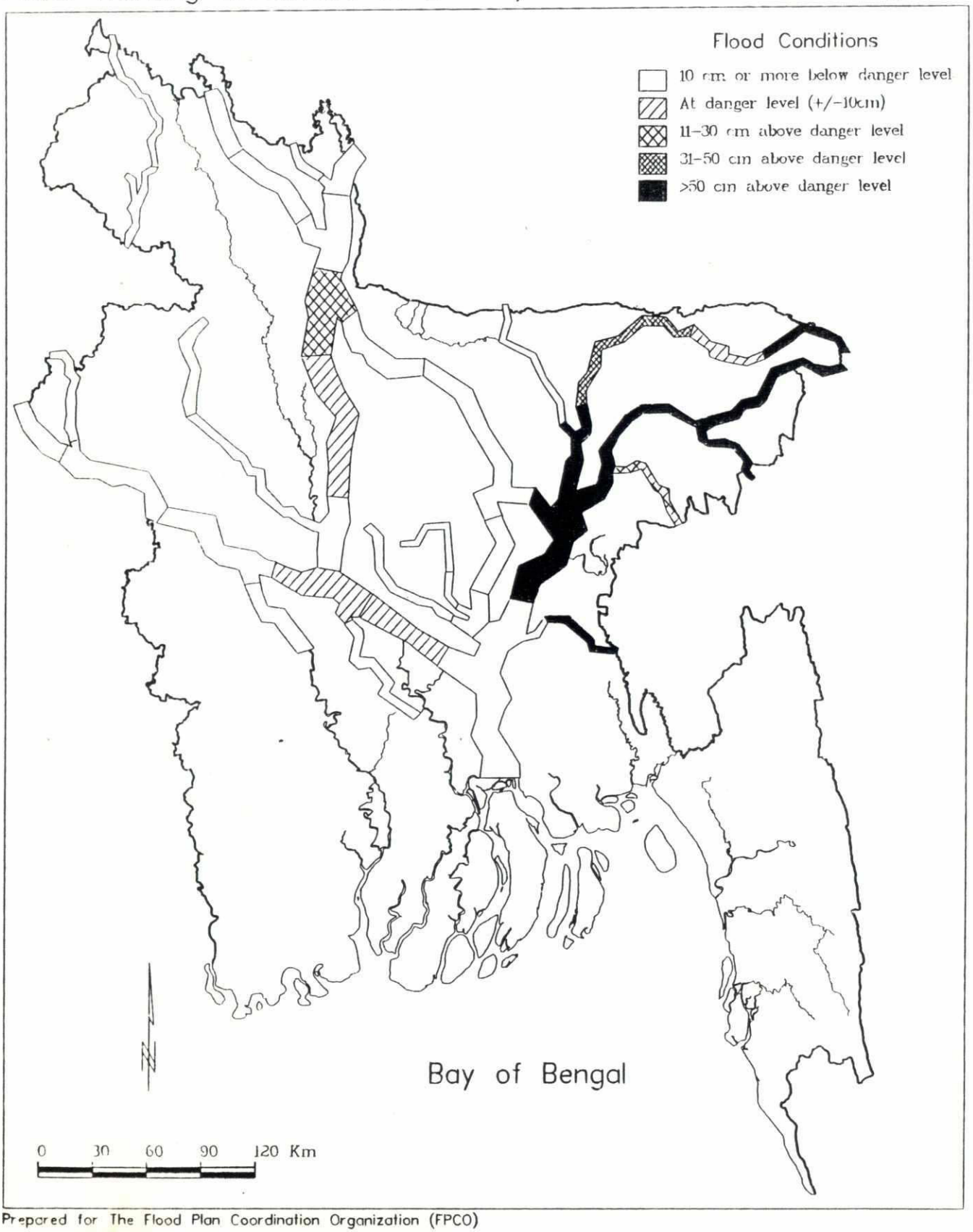
Flood Warning Schematic of 24 July 1993

Figure 3



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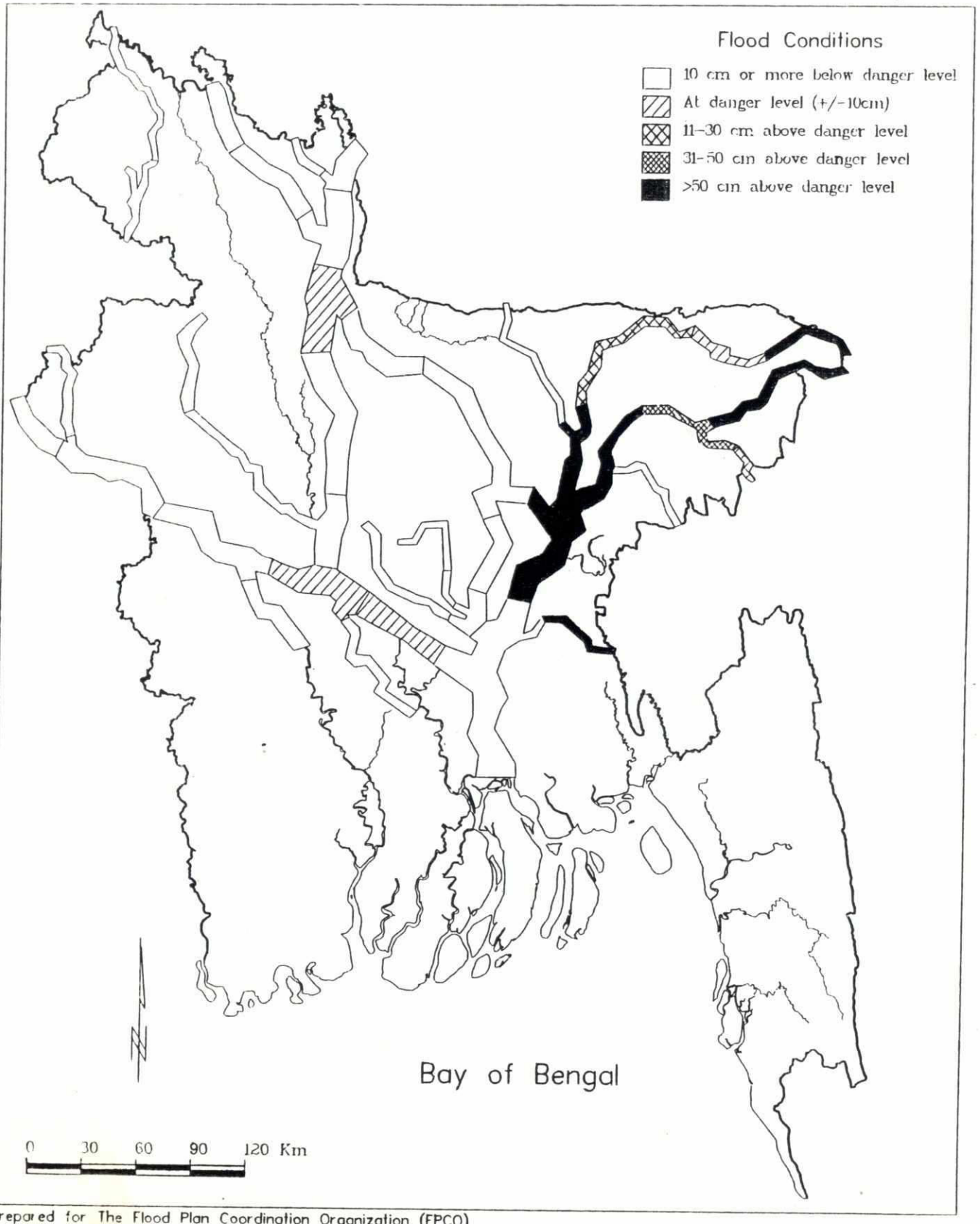
Flood Warning Schematic of 25 July 1993

Figure 4



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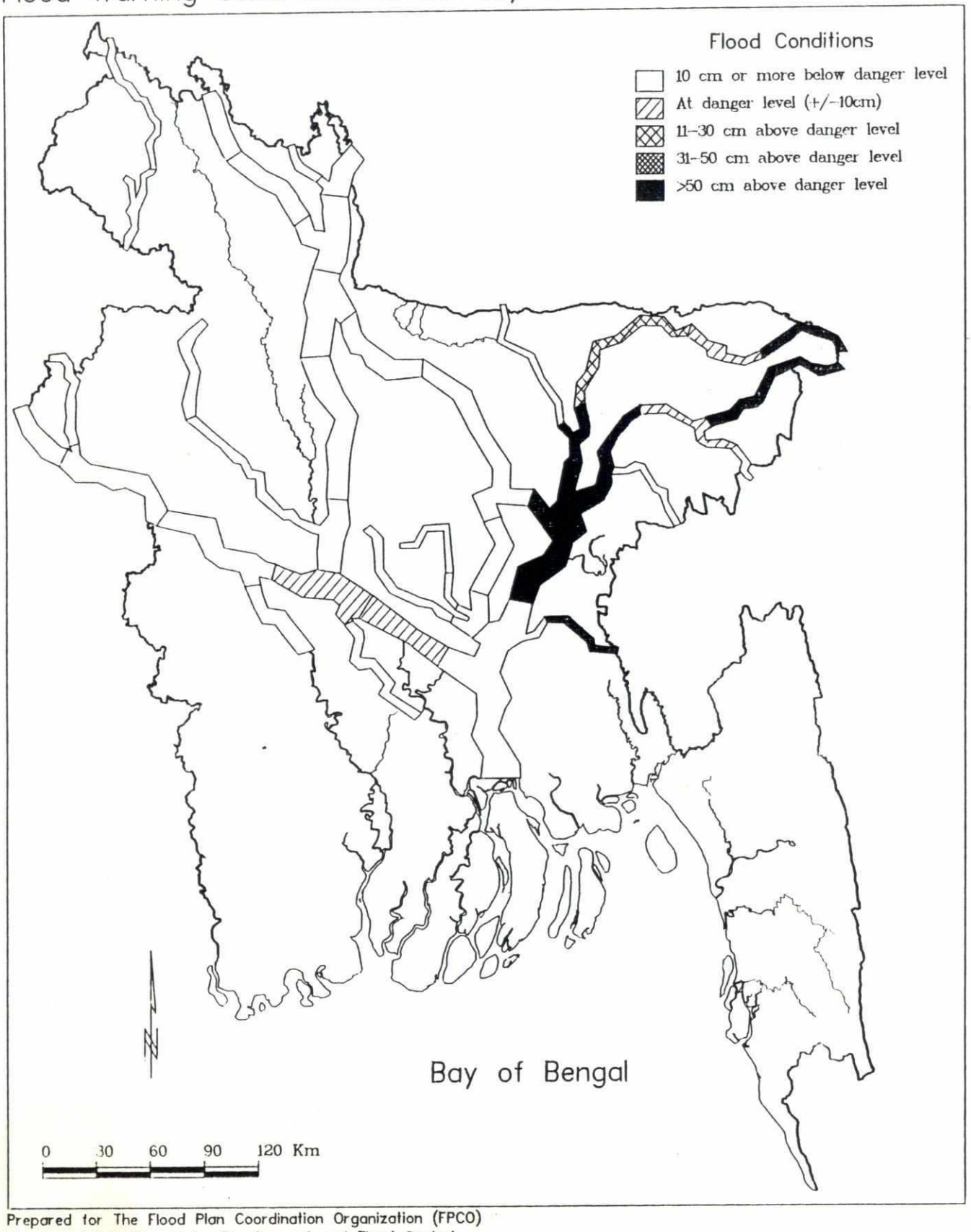
Flood Warning Schematic of 26 July 1993

Figure 5



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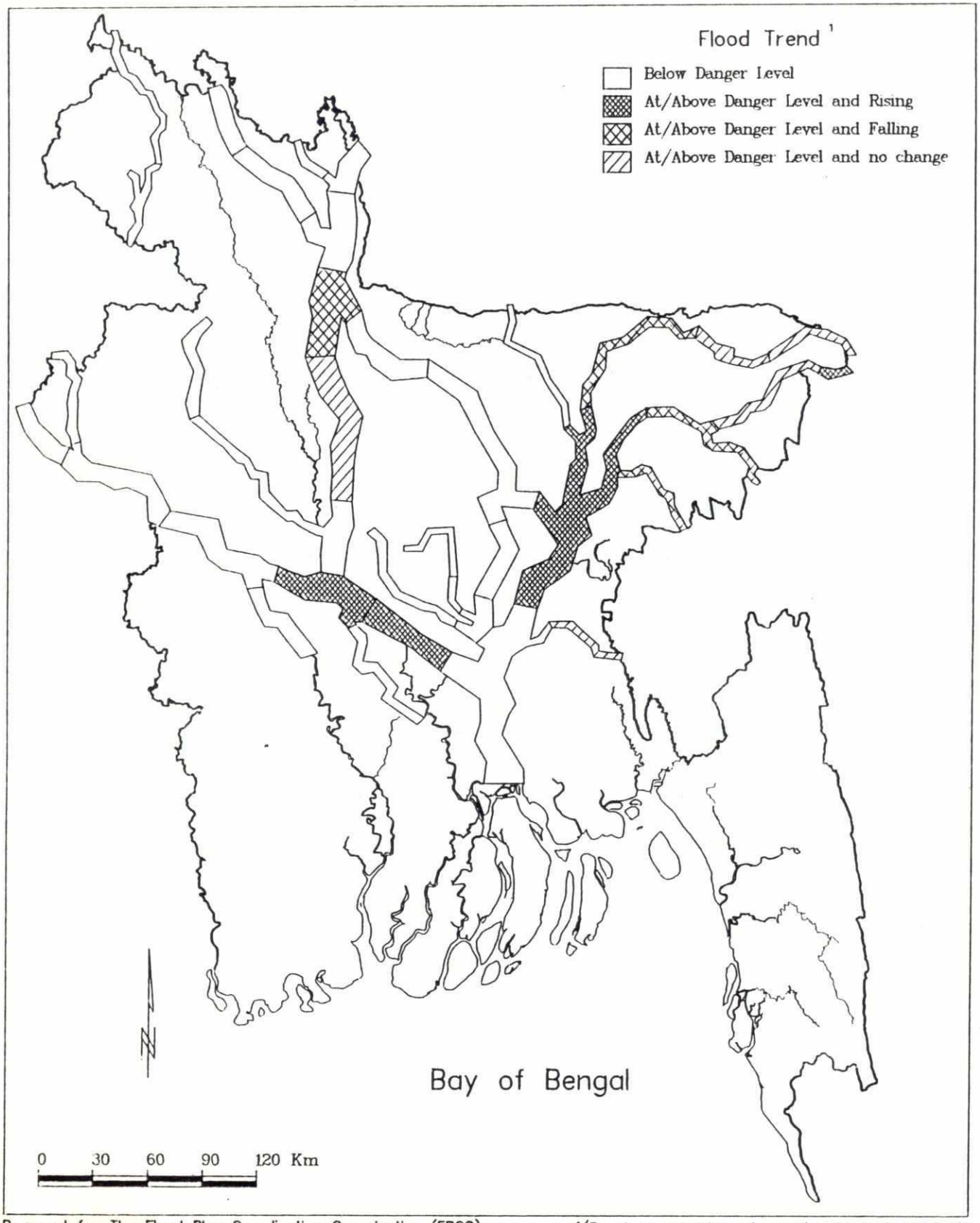
Schematic of River Rise/Fall on 24 July 1993

Figure 6



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Ministry of Irrigation Water Development and Flood Control
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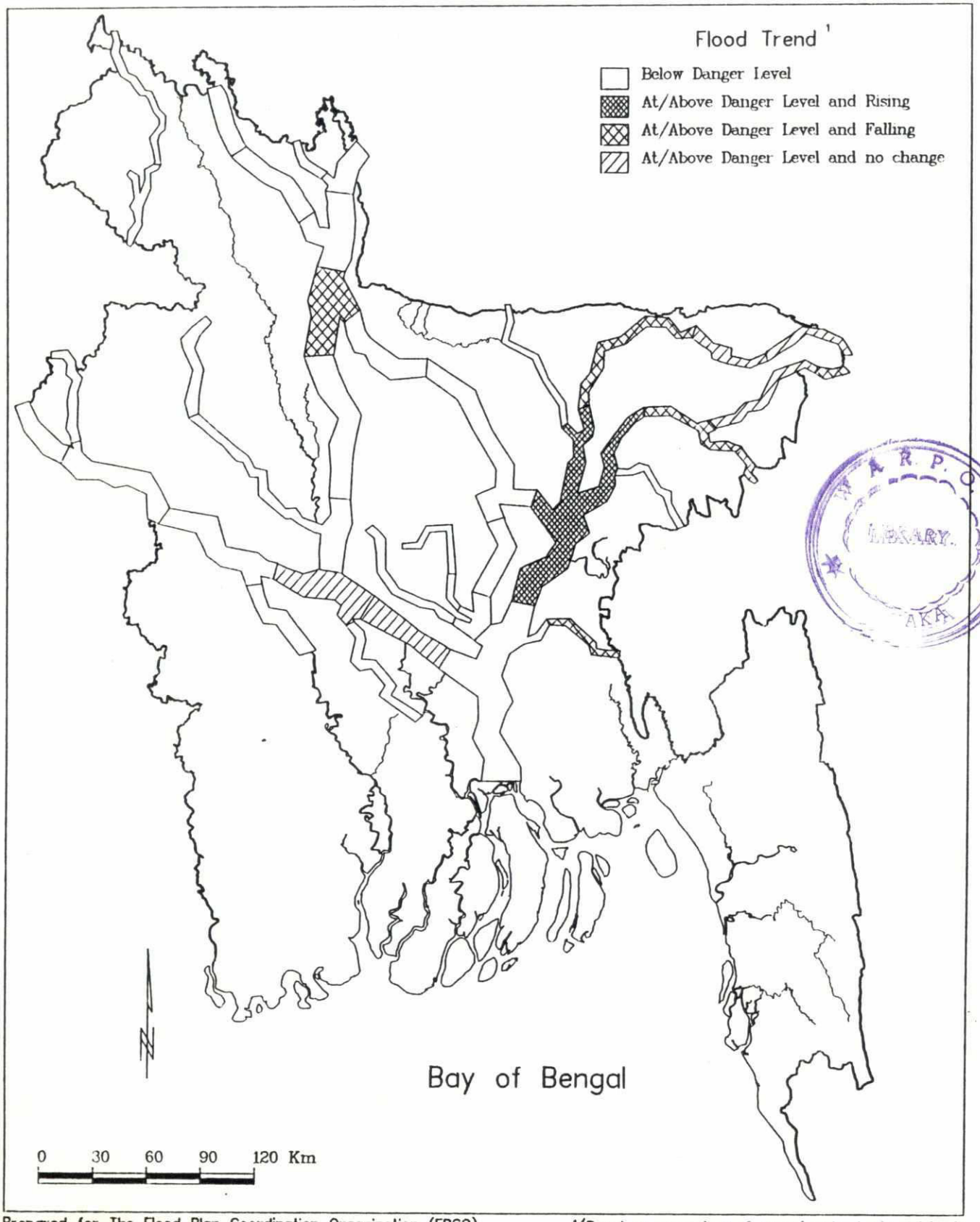
1/Based on comparison of current water levels and levels from the previous day. Rise or fall less than 5 cm is considered "no change".

Schematic of River Rise/Fall on 25 July 1993

Figure 7



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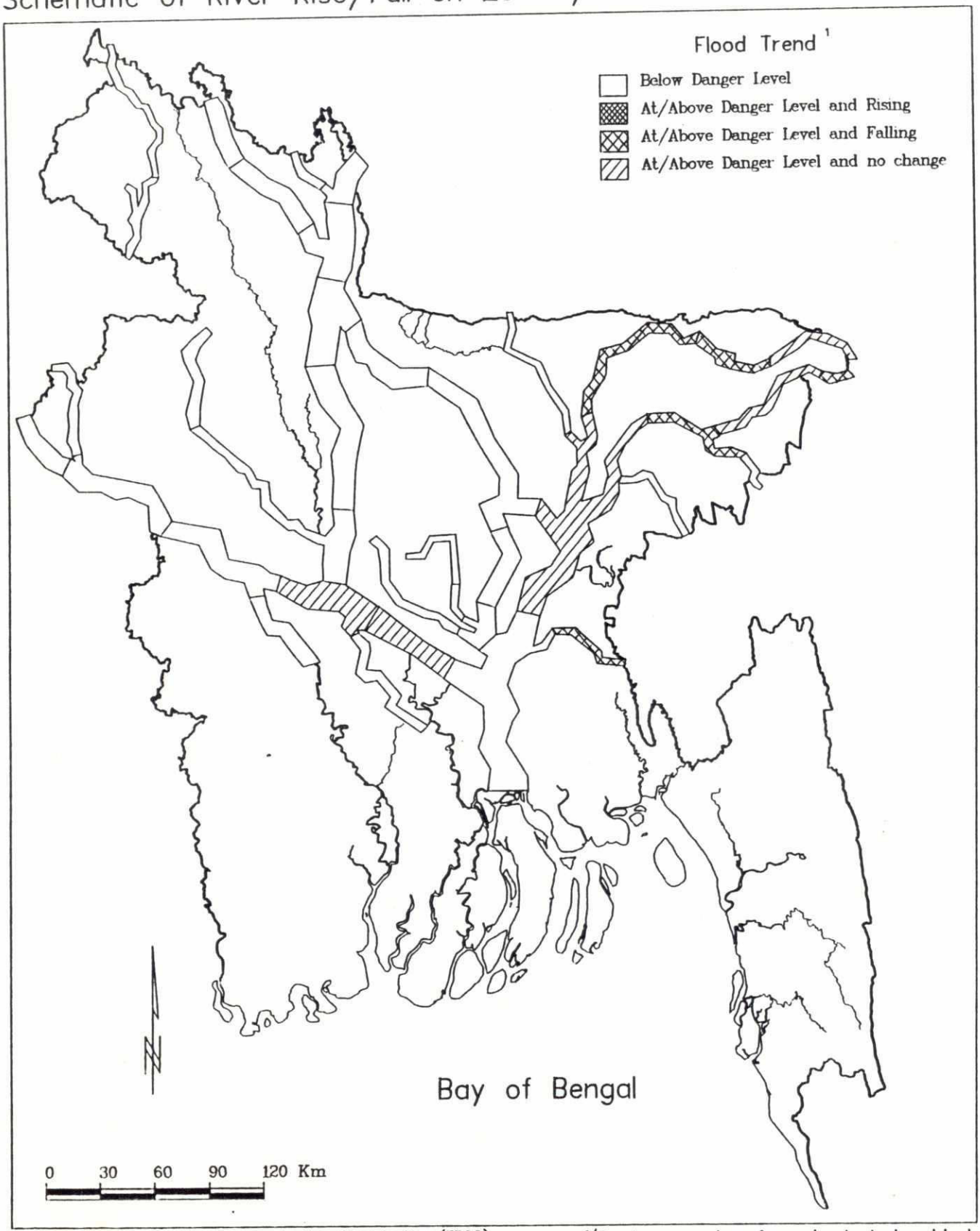
1/Based on comparison of current water levels and levels from the previous day. Rise or fall less than 5 cm is considered "no change".

Schematic of River Rise/Fall on 26 July 1993

Figure 8



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Ministry of Irrigation Water Development and Flood Control
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1/Based on comparison of current water levels and levels from the previous day. Rise or fall less than 5 cm. is considered "no change".

APPENDIX 1

FLOOD FORECASTING AND WARNING DIVISION
SURFACE WATER HYDROLOGY - 2
FLOOD INFORMATION CENTRE
BWDB, DHAKA.
Tel: 233118
231680

26

RAINFALL AND RIVER SITUATION SUMMARY AS ON 26th JULY 1993

RAINFALL:

Monsoon is less active all over the country. No significant rainfall has been recorded except 25.0 mm (0.98 inches) at Dewanganj during the last 24 hours ending 9 A. M. today.

GENERAL RIVER CONDITION:

The Brahmaputra continued to fall at all points. The Ganges continued to rise at upstream points. All the rivers in the Meghna Basin marked fall except the Surma at Kanairghat & the Meghna at Bhairab Bazar. Rivers in the S.E. Hill Basin also recorded fall. The Surma at Kanairghat, Sylhet & Sunamganj, the Kushiyara at Amalshid & Sheola, the Meghna at Bhairab Bazar and the Gumti at Comilla are flowing above danger level. The details of the basin reports are as follows :

BRAHMAPUTRA BASIN:

The Brahmaputra marked fall at all points. It recorded further fall by 12 cm (4.72 inches) at Noonkhawa, 10 cm (3.94 inches) at Chilmari, 13 cm (5.12 inches) at Bahadurabad, 11 cm (4.33 inches) at Serajganj and by 3 cm (1.18 inches) at Aricha. The Dharla at Kurigram registered further fall by 26 cm (10.24 inches). The Teesta recorded further rise by 5 cm (5.91 inches) at Dalia but marked slight fall at Kaunia. The Old Brahmaputra recorded further rise by 18 cm (8.66 inches) at Mymensingh but it receded by 8 cm (3.15 inches) at Jamalpur. The Buriganga at Dhaka registered rise by 5 cm (1.97 inches) and the Lakhya at Narayanganj by 2 cm (0.79 inches). The Turag marked rise by 3 cm (1.18 inches) at Mirpur and slight rise at Tongi. All the rivers in this basin are flowing below danger level.

GANGES BASIN:

The Ganges registered further rise by 14 cm (5.51 inches) at Pankha, 17 cm (6.69 inches) at Rajshahi, 21 cm (8.27 inches) at Hardinge Bridge while it receded by 4 cm (1.57 inches) at Goalundo and by 3 cm (1.18 inches) at Bhagyakul. The Gorai at Gorai Rly Bridge recorded further rise by 22 cm (8.66 inches) and the Kumar at Faridpur by 4 cm (1.57 inches). The Punarbhaba at Dinajpur further sharp fall by 46 cm (1.51 ft) and the Karatoa at Panchagarh by 20 cm (7.87 inches). All the rivers in this basin are flowing below danger level.

MEGHNA BASIN:

The Surma registered slight rise at Kanairghat but it receded by 6 cm (2.36 inches) at Sylhet & by 8 cm (3.15 inches) at Sunamganj but the river is still flowing 1.26 m (4.13 ft), 1 cm (0.39 inches) & 17 cm (6.69 inches) above their respective danger level. The Kushiyara recorded further fall by 9 cm (3.54 inches) at Amalshid and by 3 cm (1.18 inches) at Sheola. The river is still flowing 1.71 m (5.61 ft) & 58 cm (1.90 ft) above their respective danger level. The Manu recorded further fall by 65 cm (2.13 ft) at Manu Rly. Bridge & by 46 cm (1.51 ft) at Moulvi Bazar and it is flowing below danger level by 47 cm (1.54 ft) at Manu Rly. Bridge & by 1 cm (0.39 inches) at Moulvi Bazar. The Khowai at Habiganj also marked further fall by 31 cm (1.02 ft). The Someswari at Durgapur recorded further fall by 17 cm (6.69 inches). The Gumti marked further fall by 42 cm (1.38 ft) but the river is still flowing 1.25 m (4.10 ft) above danger level. The Meghna at Bhairab Bazar recorded slight rise and is flowing 68 cm (2.23 ft) above danger level. All the rivers in this basin are flowing above danger level except the Manu at Manu Rly. Bridge & Moulvi Bazar, The Khowai at Habiganj and the Someswari at Durgapur.

P.T.O

SOUTH EASTERN HILL BASIN:

All the rivers in this basin registered sharp fall. The Muhuri at Parshuram marked further fall by 43 cm (1.41 ft). The Halda recorded further sharp fall by 65 cm (2.13 ft) at Narayanhat and by 73 cm (2.39 ft) at Panchpukuria and the river is flowing 57 cm (1.87 ft) below danger level at Narayanhat. The Sangu at Fasiakhali also recorded sharp fall by 87 cm (2.85 ft). The Matamuhuri at Lama also registered further fall by 62 cm (2.03 ft). All the rivers in this basin are flowing below danger level.

FORECAST FOR THE NEXT 24 HOURS. (For 27th July at 0600 hours)

The flood situation in the districts of Sylhet, Sunamganj, Moulvi Bazar, Habiganj & Comilla is likely to start improving.

The Brahmaputra at :

a) Chilmari is likely to fall by 6 cm (2.36 inches) and may flow 54 cm (1.77 ft) below danger level.
b) Bahadurabad is likely to fall by 5 cm (1.97 inches) and may flow 20 cm (7.87 inches) below danger level.
c) Serajganj is likely to fall by 9 cm (3.54 inches) and may flow 34 cm (1.12 ft) below danger level.
d) Aricha is likely to fall by 6 cm (2.36 inches) and may flow 36 cm (1.18 ft) below danger level.

The Old Brahmaputra at :

a) Jamalpur is likely to fall by 6 cm (2.36 inches) and may flow 44 cm (1.44 ft) below danger level.
b) Mymensingh is likely to remain steady and flow 55 cm (1.80 ft) below danger level.

The Meghna at :

a) Bhairab Bazar is likely to remain steady & may flow 68 cm (2.23 ft) above danger level.

FORECAST FOR THE NEXT 48 HOURS. (For 28th July at 0600 hours)

The Brahmaputra at :

a) Chilmari is likely to further fall by 4 cm (1.58 inches) and may flow 58 cm (1.90 ft) below danger level.
b) Bahadurabad is likely to fall further by 2 cm (0.79 inch) and may flow 22 cm (8.66 inches) below danger level.
c) Serajganj is likely to fall further by 3 cm (1.18 inches) & may flow 37 cm (1.21 ft) below danger level.
d) Aricha is likely to fall by 5 cm (1.97 inches) and may flow 41 cm (1.35 ft) below danger level.

The Old Brahmaputra at :

a) Jamalpur is likely to fall further by 4 cm (1.58 inches) & may flow 48 cm (1.58 ft) below danger level.
b) Mymensingh is likely to fall by 5 cm (1.97 inches) and may flow 60 cm (1.97 ft) below danger level.

The Meghna at :

a) Bhairab Bazar is likely to fall by 1 cm (0.39 inch) and may flow 67 cm (2.20 ft) above danger level.

(Mazizul Islam Bhuiya)
Deputy Director
Flood Forecasting

APPENDIX 2

FLOOD FORECASTING AND WARNING DIVISION
SURFACE WATER HYDROLOGY-2
FLOOD INFORMATION CENTRE, BWDB
WAPDA BUILDING, 8TH FLOOR, DHAKA

TIME OF ISSUE : 10:31 Hrs. ON 26 July1993

PHONE: 233118 (ROUND THE CLOCK
231680 ON ALL DAYS)

STATISTICAL STATEMENT OF WATER LEVEL & RAINFALL

6 A.M. WATERLEVEL IN METER/FEET (PWD DATUM)

SL NO	RIVER	STATION	RECORDED HIGHEST LEVEL	DANGER LEVEL	DATE 24- 7 1993	DATE 25- 7 1993	DATE 26- 7 1993	DATE 26- 7 1992
	BRAHMAPUTRA BASIN: RANGPUR, BOGRA, PABNA, MYMENSINGH, JAMALPUR, TANGAIL, DHAKA							
1	Dharla	Kurigram	27.50	26.50	26.31	25.93	25.67	24.86
			90.22	86.94	86.32	85.07	84.22	81.56
2	Teesta	Dalia	52.97	52.25	51.38	51.53	51.58	51.55
			173.78	171.42	168.57	169.06	169.22	169.13
3	Teesta	Kaunia	30.52	30.00	29.14	29.07	29.06	29.12
			100.13	98.42	95.60	95.37	95.34	95.54
4	Brahmaputra	Noonkhawa	28.10	27.89	26.41	26.16	26.04	25.01
			92.19	91.50	86.65	85.83	85.43	82.05
5	Brahmaputra	Chilmari	25.06	24.00	23.81	23.62	23.52	22.78
			82.22	78.74	78.12	77.49	77.16	74.74
6	Brahmaputra	Bahadurabad	20.62	19.50	19.70	19.48	19.35	18.35
			67.65	63.98	64.63	63.91	63.48	60.20
7	Brahmaputra	Serajganj	15.12	13.75	13.75	13.61	13.50	12.36
			49.61	45.11	45.11	44.65	44.29	40.55
8	Brahmaputra	Aricha	10.58	9.14	8.84	8.87	8.84	7.30
			34.71	29.99	29.00	29.10	29.00	23.95
9	Old B.putra	Jamalpur	18.00	17.00	16.67	16.70	16.62	15.01
			59.05	55.77	54.69	54.79	54.53	49.24
10	Old B.putra	Mymensingh	14.02	12.50	11.55	11.77	11.95	10.56
			46.00	41.01	37.89	38.62	39.21	34.65
11	Buriganga	Dhaka	7.58	6.00	5.18	5.27	5.32	3.93
			24.87	19.68	16.99	17.29	17.45	12.89
12	Lakhya	Narayanganj	6.71	5.50	5.11	5.28	5.30	4.12
			22.01	18.04	16.76	17.32	17.39	13.52
13	Turag	Mirpur	8.35	5.94	5.48	5.56	5.63	4.37
			27.39	19.49	17.98	18.24	18.47	14.34
14	Turag	Tongi	7.84	6.08	5.47	5.55	5.57	4.41
			25.72	19.95	17.95	18.21	18.27	14.47
[illegible]	[illegible]	Saraghat	10.39	8.39	7.86	8.03	8.10	6.36
			34.09	27.49	25.79	26.34	26.57	20.86

9 A.M. RAINFALL IN MILLIMETER/INCH (FOR LAST 24 HOURS)

SL NO	STATION	MONTHLY MAXIMUM	MONTHLY NORMAL	DATE 24- 7 1993	DATE 25- 7 1993	DATE 26- 7 1993	CUMULATIVE July 1993	CUMULATIVE July 1992
1	Kurigram	969.3	519	6.0	0.0	0.0	529.2	313.5
		38.16	20.43	0.24	0.00	0.00	20.83	12.34
2	Dalia	1137.5	751	9.0	3.0	0.0	636.5	582.0
		44.78	29.57	0.35	0.12	0.00	25.06	22.91
3	Kaunia	1554.5	594	0.0	1.0	0.0	495.1	290.8
		61.20	23.39	0.00	0.04	0.00	19.49	11.45
4	Rangpur	1378.4	490	0.0	1.5	0.0	513.5	292.0
		54.27	19.29	0.00	0.06	0.00	20.22	11.50
5	Chilmari	1265.8	496	0.0	0.0	0.0	422.0	236.8
		49.83	19.53	0.00	0.00	0.00	16.61	9.32
6	Dewanganj	1158.2	503	2.5	20.0	25.0	488.4	320.7
		45.60	19.80	0.10	0.79	0.98	19.23	12.63
7	Gaibandha	680.0	387	0.0	0.0	7.3	292.3	431.2
		26.77	15.24	0.00	0.00	0.29	11.51	16.98
8	Bogra	680.0	420	32.9	7.2	5.3	553.3	342.7
		26.77	16.54	1.30	0.28	0.21	21.78	13.49
9	Jamalpur	864.5	489	5.6	3.4	8.3	674.4	447.4
		34.04	19.25	0.22	0.13	0.33	26.55	17.61
10	Mymensingh	891.0	531	0.3	1.5	5.0	673.7	647.2
		35.08	20.91	0.01	0.06	0.20	26.52	25.48
11	Dhaka	677.0	360	24.0	14.0	0.0	411.2	351.9
		26.66	14.17	0.94	0.55	0.00	16.19	13.85
12	Tangail	681.5	311	46.0	3.0	0.0	484.0	304.0
		26.83	12.24	1.89	0.12	0.00	19.06	11.97

CONVERSION FACTOR: 1 FT =0.3048 M; 1 M = 3.2808 FT 1 INCH = 25.4 MM; 1 MM = .03937 INCH * NOT AVAILABLE

6 A.M. WATERLEVEL IN METER/FEET (PWD DATUM)

SL NO	RIVER	STATION	RECORDED HIGHEST LEVEL	DANGER LEVEL	DATE 24- 7 1993	DATE 25- 7 1993	DATE 26- 7 1993	DATE 26- 7 1992
	GANGES BASIN: DINAJPUR, RAJSHAHI, PABNA, KUSHTIA, JESSORE, KHULNA, DHAKA, FARIDPUR, BARISAL							
1	Karatoa	Panchgarh	72.65	70.75	68.85	68.65	68.45	68.43
			238.35	232.12	225.88	225.23	224.57	224.51
2	Punarbhaba	Dinajpur	34.40	33.50	31.84	30.85	30.39	29.80
			112.86	109.91	104.46	101.21	99.70	97.77
3	Mahananda	ChapaiNawabgan	22.25	21.00	17.25	17.60	17.78	16.64
			73.00	68.90	56.59	57.74	58.33	54.59
4	Jamuna	Naogaon	15.63	15.24	13.88	14.00	14.07	13.39
			51.28	50.00	45.54	45.93	46.16	43.93
5	Ganges	Pankha	22.97	21.50	17.45	17.86	18.00	16.58
			75.36	70.54	57.25	58.60	59.05	54.40
6	Ganges	Rajshahi	20.00	18.50	15.16	15.46	15.63	14.18
			65.62	60.69	49.74	50.72	51.28	46.52
7	Ganges	Hardinge Br	15.04	14.25	11.60	11.95	12.16	10.37
			49.34	46.75	38.06	39.21	39.89	34.02
8	Ganges	Goalundo	9.83	8.50	8.45	8.48	8.44	6.77
			32.25	27.89	27.72	27.82	27.69	22.21
9	Ganges	Bhagyakul	7.58	6.00	5.95	6.00	5.97	4.95
			24.87	19.68	19.52	19.68	19.59	16.24
10	Gorai	Gorai Rly Br	13.65	12.75	9.87	10.24	10.46	8.26
			44.78	41.83	32.38	33.60	34.32	27.10
11	Kumar	Faridpur	8.76	7.50	4.24	4.33	4.37	4.07
			28.74	24.61	13.91	14.21	14.34	13.35

9 A.M. RAINFALL IN MILLIMETER/INCH (FOR LAST 24 HOURS)

SL NO	STATION	MONTHLY MAXIMUM	MONTHLY NORMAL	DATE 24- 7 1993	DATE 25- 7 1993	DATE 26- 7 1993	CUMULATIVE July 1993	CUMULATIVE July 1992
1	Panchagarh	1440.2	891	8.7	7.0	8.2	730.7	335.6
		56.70	35.08	0.34	0.28	0.32	28.77	13.21
2	Dinajpur	990.3	495	0.0	4.6	0.0	173.8	372.0
		38.99	19.49	0.00	0.18	0.00	6.84	14.65
3	Pabna	577.3	290	63.0	1.9	0.8	261.7	268.8
		22.73	11.42	2.48	0.07	0.03	10.30	10.58
4	Naogaon	690.7	354	94.0	1.5	4.0	418.2	269.6
		27.19	13.94	3.70	0.06	0.16	16.46	10.61
5	Kushtia	439.4	297	34.3	13.4	0.0	294.3	431.5
		17.30	11.69	1.35	0.53	0.00	11.59	16.99
6	Rajshahi	893.6	345	21.5	0.0	*	210.7	241.1
		35.18	13.58	0.85	0.00		8.30	9.49
7	Jessore	702.1	353	62.0	21.5	1.6	405.1	231.8
		27.64	13.90	2.44	0.85	0.06	15.95	9.13
8	Khulna	638.3	346	30.0	10.0	9.0	313.3	176.0
		25.13	13.62	1.18	0.39	0.35	12.33	6.93
9	Satkhira	679.7	399	15.0	3.6	6.0	237.6	289.8
		26.76	15.71	0.59	0.14	0.24	9.35	11.41
10	Faridpur	660.9	335	15.0	2.0	7.0	231.0	342.0
		26.02	13.19	0.59	0.08	0.28	9.09	13.46
11	Barisal	1110.8	4[illegible]	24.4	0.0	0.0	452.8	261.1
		43.97	16.[illegible]	0.96	0.00	0.00	17.83	10.28
12	Patuakhali	1260.2	[illegible]	30.7	4.0	0.0	564.5	553.7
		49.97	24.[illegible]	1.21	0.16	0.00	22.22	21.80

CONVERSION FACTOR: 1 FT = 0.3048 M. 1 M = 3.2808 FT 1 INCH = 25.4 MM; 1 MM = .03937 INCH NOT AVAILABLE

6 A.M. WATERLEVEL IN METER/FEET (PWD DATUM)

SL NO	RIVER	STATION	RECORDED HIGHEST LEVEL	DANGER LEVEL	DATE 24- 7 1993	DATE 25- 7 1993	DATE 26- 7 1993	DATE 26- 7 1992
	MEGHNA BASIN: SYLHET, MYMENSINGH, COMILLA, DHAKA							
1	Surma	Kanairghat	15.26	13.20	14.44	14.45	14.46	11.48
			50.07	43.31	47.37	47.41	47.44	37.66
2	Surma	Sylhet	11.95	11.25	11.33	11.32	11.26	9.72
			39.21	36.91	37.17	37.14	36.94	31.89
3	Surma	Sunamganj	9.46	8.25	8.56	8.50	8.42	7.69
			31.04	27.07	28.08	27.89	27.62	25.23
4	Kushiyara	Amalashid	18.28	15.85	17.70	17.65	17.56	13.60
			59.97	52.00	58.07	57.91	57.61	44.62
5	Kushiyara	Sheola	14.33	13.50	14.10	14.11	14.08	11.98
			47.01	44.29	46.26	46.29	46.19	39.30
6	Manu	Manu Rly Bridg	19.39	17.07	17.92	17.25	16.60	13.71
			63.61	56.00	58.79	56.59	54.46	44.98
7	Manu	Moulvi Bazar	13.14	11.75	12.50	12.20	11.74	8.55
			43.11	38.55	41.01	40.03	38.52	28.05
8	Khowai	Habiganj	11.00	9.50	9.74	8.90	8.59	7.17
			36.09	31.17	31.95	29.20	28.18	23.52
9	Someswari	Durgapur	15.15	13.00	12.25	12.05	11.88	11.64
			49.70	42.65	40.19	39.53	38.98	38.19
10	Upper Meghna	BhairabBazar	7.66	6.25	6.85	6.91	6.93	5.45
			25.13	20.51	22.47	22.67	22.74	17.88
11	Gumti	Comilla	13.32	11.75	13.54	13.42	13.00	8.42
			43.70	38.55	44.42	44.03	42.65	27.62
12	Meghna	Chandpur H.W.L	5.35		4.36	4.33	*	3.98
			17.55		14.30	14.21		13.06
13	Meghna	Chandpur L.W.L	4.86	4.00	3.51	3.53	*	3.19
			15.94	13.12	11.52	11.58		10.47

9 A.M. RAINFALL IN MILLIMETER/INCH (FOR LAST 24 HOURS)

SL NO	STATION	MONTHLY MAXIMUM	MONTHLY NORMAL	DATE 24- 7 1993	DATE 25- 7 1993	DATE 26- 7 1993	CUMULATIVE July 1993	CUMULATIVE July 1992
1	Kanair Ghat	1072.0	755	15.0	0.0	2.0	1167.0	721.0
		42.20	29.72	0.59	0.00	0.08	45.94	28.39
2	Sylhet	1820.2	824	9.0	0.0	2.0	1202.0	868.0
		71.66	32.44	0.35	0.00	0.08	47.32	34.17
3	Sunamganj	2097.3	1402	8.0	10.0	0.0	1524.0	1482.5
		82.57	55.20	0.31	0.39	0.00	60.00	58.37
4	Sheola	1220.5	748	9.0	5.0	0.0	1014.0	651.0
		48.05	29.45	0.35	0.20	0.00	39.92	25.63
5	Moulvi Bazar	724.4	441	4.0	0.0	3.5	768.3	255.2
		28.52	17.36	0.16	0.00	0.14	30.25	10.05
6	Manu Rly Br	643.1	413	6.0	0.0	16.0	712.0	198.0
		25.32	16.26	0.24	0.00	0.63	28.03	7.80
7	Habiganj	816.1	417	18.0	5.0	17.0	749.5	295.5
		32.13	16.42	0.71	0.20	0.67	29.51	11.63
8	Durgapur	1862.3	807	1.8	0.0	0.0	957.1	707.2
		73.32	31.77	0.07	0.00	0.00	37.68	27.84
9	BhairabBazar	638.0	404	0.0	5.0	0.0	759.0	423.0
		25.12	15.91	0.00	0.20	0.00	29.88	16.65
10	Comilla	1144.0	470	10.5	42.0	1.5	470.1	300.4
		45.04	18.50	0.41	1.65	0.06	18.51	11.83
11	Chandpur	840.7	373	51.0	0.0	0.0	400.3	300.5
		33.10	14.69	2.01	0.00	0.00	15.76	11.83

CONVERSION FACTOR. 1 FT =0.3048 M; 1 M = 3.2808 FT 1 INCH = 25.4 MM; 1 MM = .03937 INCH * NOT AVAILABLE

SL NO	STATION		7 A.M. WATERLEVEL IN METER/FEET (PWD DATUM) RECORDED HIGHEST LEVEL	DANGER LEVEL	DATE 24- 7 1993	DATE 25- 7 1993	DATE 26- 7 1993	DATE 26- 7 1992	SL NO	STATION	7 A.M. RAINFALL IN MILLIMETER/INCH (FOR LAST 24 HOURS) MONTHLY MAXIMUM	MONTHLY NORMAL	DATE 24- 7 1993	DATE 25- 7 1993	DATE 26- 7 1993	CUMULATIVE July 1993	CUMULATIVE July 1992
SOUTH EASTERN HILL BASIN: NOAKHALI, CHITTAGONG, BANDARBAN, CHITTAGONG HILL TRACTS																	
1	Muhuri	Parshuram	14.48	13.00	12.55	12.10	11.67	10.40	1	Parshuram	1133.6	576	27.0	12.5	1.8	543.1	233.7
			47.51	42.65	41.17	39.70	38.29	34.12			44.63	22.68	1.06	0.49	0.07	21.38	9.20
2	Karnafully	Kaptai	34.32	33.25	32.28	32.17	32.17	23.78	2	Noakhali	1285.6	703	45.0	18.0	0.0	615.8	525.1
			112.60	109.09	105.90	105.54	105.54	78.02			50.61	27.68	1.77	0.71	0.00	24.24	20.67
3	Halda	Narayan Hat	18.25	14.63	15.66	14.71	14.06	12.32	3	Narayan Hat	1446.0	747	35.5	8.0	5.8	536.2	332.1
			59.87	48.00	51.38	48.26	46.13	40.42			56.93	29.41	1.40	0.31	0.23	21.11	13.07
4	Halda	Panchpukuria	10.52	9.50	9.67	8.97	8.24	5.30	4	Panchpukuria	1201.9	702	48.7	0.2	0.0	720.8	298.2
			34.51	31.17	31.73	29.43	27.03	17.39			47.32	27.64	1.92	0.01	0.00	28.38	11.74
5	Sangu	Bandarban	20.38	15.25	12.45	10.62	9.75	7.47	5	Bandarban	1345.4	703	23.8	1.0	0.0	554.7	331.2
			66.86	50.03	40.85	34.84	31.99	24.51			52.97	27.68	0.94	0.04	0.00	21.84	13.04
6	Sangu	Dohazari	9.05	7.00	5.70	4.62	4.00	2.45	6	Rangamati	1491.7	642	5.7	1.5	1.9	872.5	21.5
			29.69	22.97	18.70	15.16	13.12	8.04			58.73	25.28	0.22	0.06	0.07	34.35	0.85
7	Matamuhuri	Lama	15.45	12.25	9.13	8.43	7.81	6.86	7	Lama	1809.5	800	30.0	0.0	0.0	694.3	447.3
			50.69	40.19	29.95	27.66	25.62	22.51			71.24	31.50	1.18	0.00	0.00	27.33	17.61
8	Matamuhuri	Chiringa	6.83	5.75	4.84	4.38	4.12	3.30	8	Chittagong	1527.0	816	26.0	0.0	0.0	586.0	438.0
			22.41	18.86	15.88	14.37	13.52	10.83			60.12	32.13	1.02	0.00	0.00	23.07	17.24
9	Feni	Ramgarh	21.41	17.37	*	*	*	12.41	9	Ramgarh	1539.0	626	*	*	*	549.0	199.1
			70.24	56.99				40.71			60.59	24.65				21.61	7.84
									10	Sandwip	2199.0	828	55.2	4.0	3.0	674.3	0.0
											86.57	32.60	2.17	0.16	0.12	26.55	0.00
									11	Cox's Bazar	1866.1	1057	19.0	13.0	0.0	674.5	739.0
											73.47	41.61	0.75	0.51	0.00	26.56	29.09

CONVERSION FACTOR: 1 FT =0.3048 M; 1 M = 3.2808 FT 1 INCH = 25.4 MM; 1 MM = .03937 INCH * NOT AVAILABLE

REMARKS : a) FOR EVERY STATION, LOWER FIGS. INDICATE VALUES IN FPS SYSTEM
b) C COMPUTED HIGHEST LEVEL FOR 1954 FLOOD AT BHAGYAKUL
c) RIVER ABOVE DANGER LEVEL UNDERLINED
d) HIGHEST WATERLEVEL EXCEEDED DURING CURRENT SEASON UNDERLINED

DANGER LEVEL: Danger level of a river is a level above which it is likely that the flood may cause damages to crops and homesteads. [In a river having no embankment, danger level is about annual average flood level. In an embanked river, danger level is fixed slightly below the design flood level of the embankment. Danger level is defined for a particular measuring station for the reach to its immediate vicinity.]

NO. FDN/F-4/FIC/ 85(75) DATED ... July 1993

FOR INFORMATION AND FAVOUR OF NECESSARY ACTION PLEASE.

SIGNED BY. 27/7/93

DUTY OFFICER,
FLOOD INFORMATION CENTRE,
BWDB, DHAKA.