IMPROVEMENT OF THE FLOOD FORECASTING AND WARNING SYSTEM OF BANGLADESH BY ADVANCED TECHNOLOGICAL DEVELOPMENT

Mohammad Khaled Akhtar

&

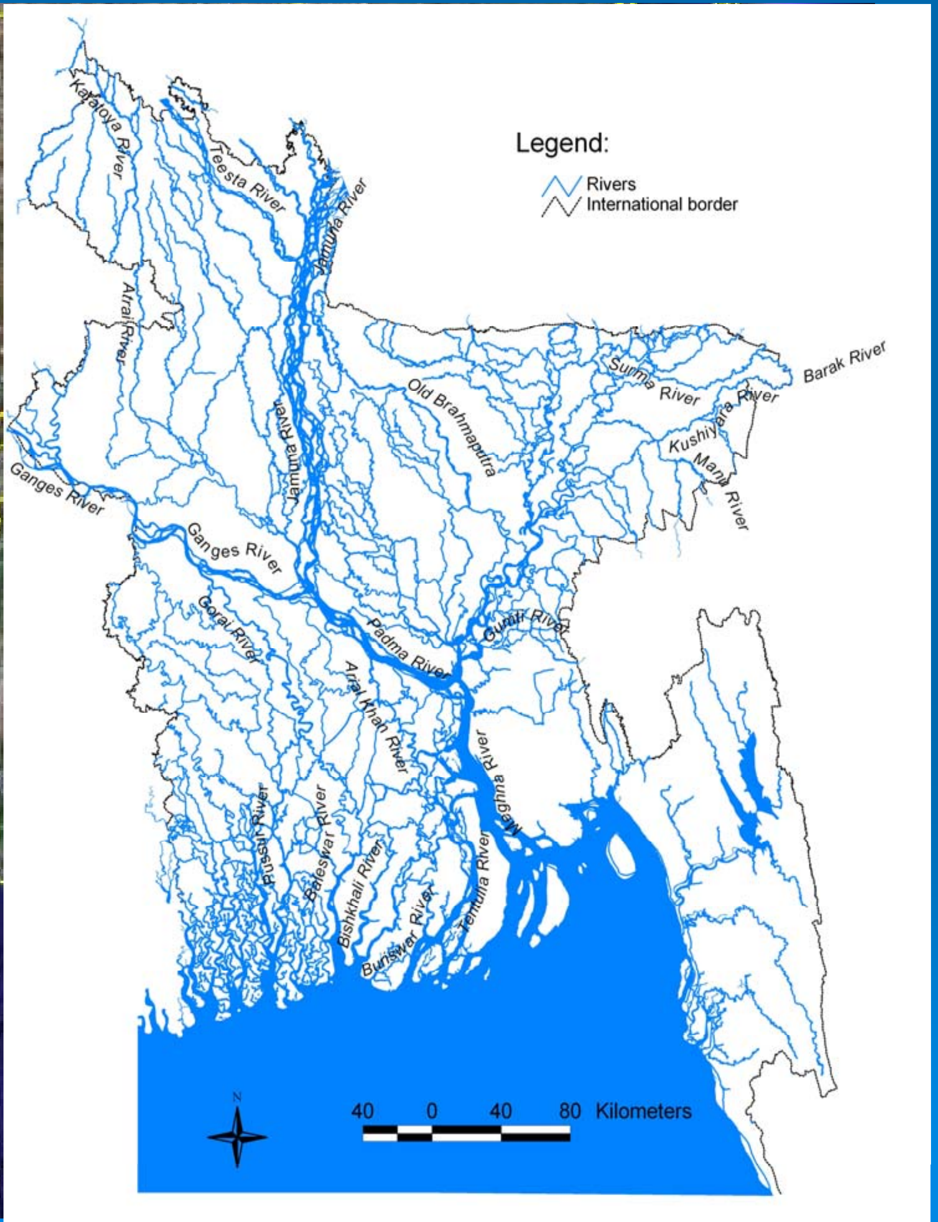
Slobodan P. Simonovic

University of Western Ontario, Canada

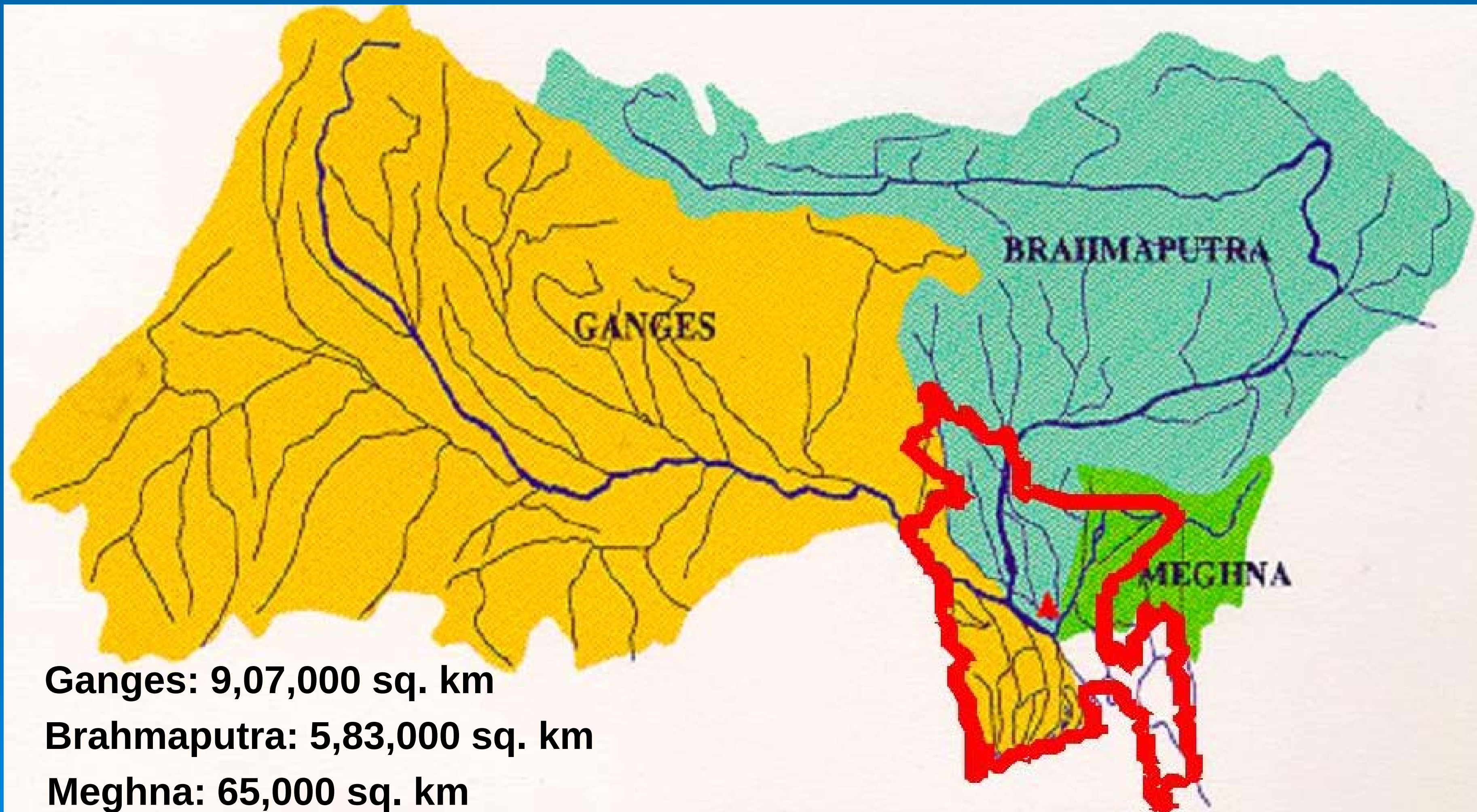
Outline

- ✓Introduction
- ✓Background
- ✓Objective
- ✓FFWC and it’s activity
- ✓Future application & improvement
- ✓Conclusion/Big picture

Introduction



Introduction



Ganges: 9,07,000 sq. km

Brahmaputra: 5,83,000 sq. km

Meghna: 65,000 sq. km

Introduction

Sub-tropical monsoon climate

winter (November–February)

summer (March–June)

monsoon (July– October)

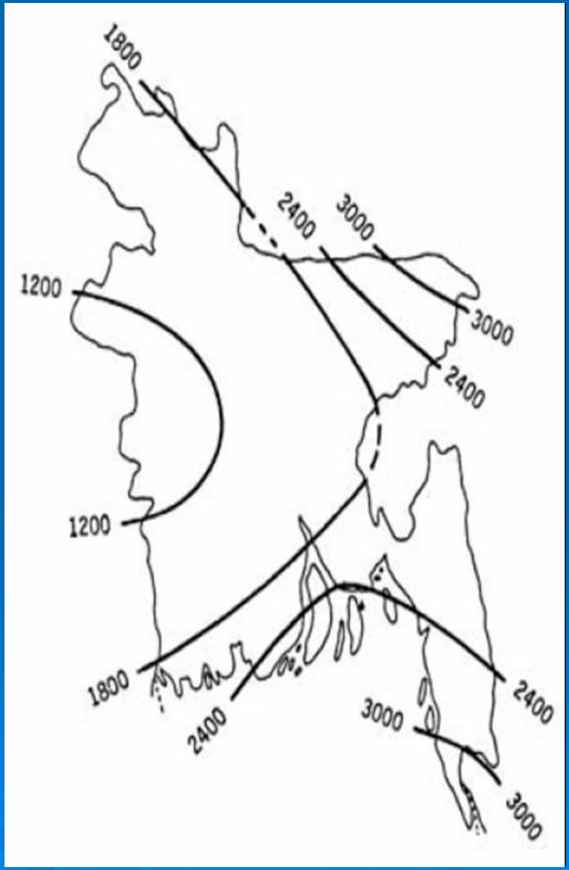
Rainfall averages 2160 mm per annum

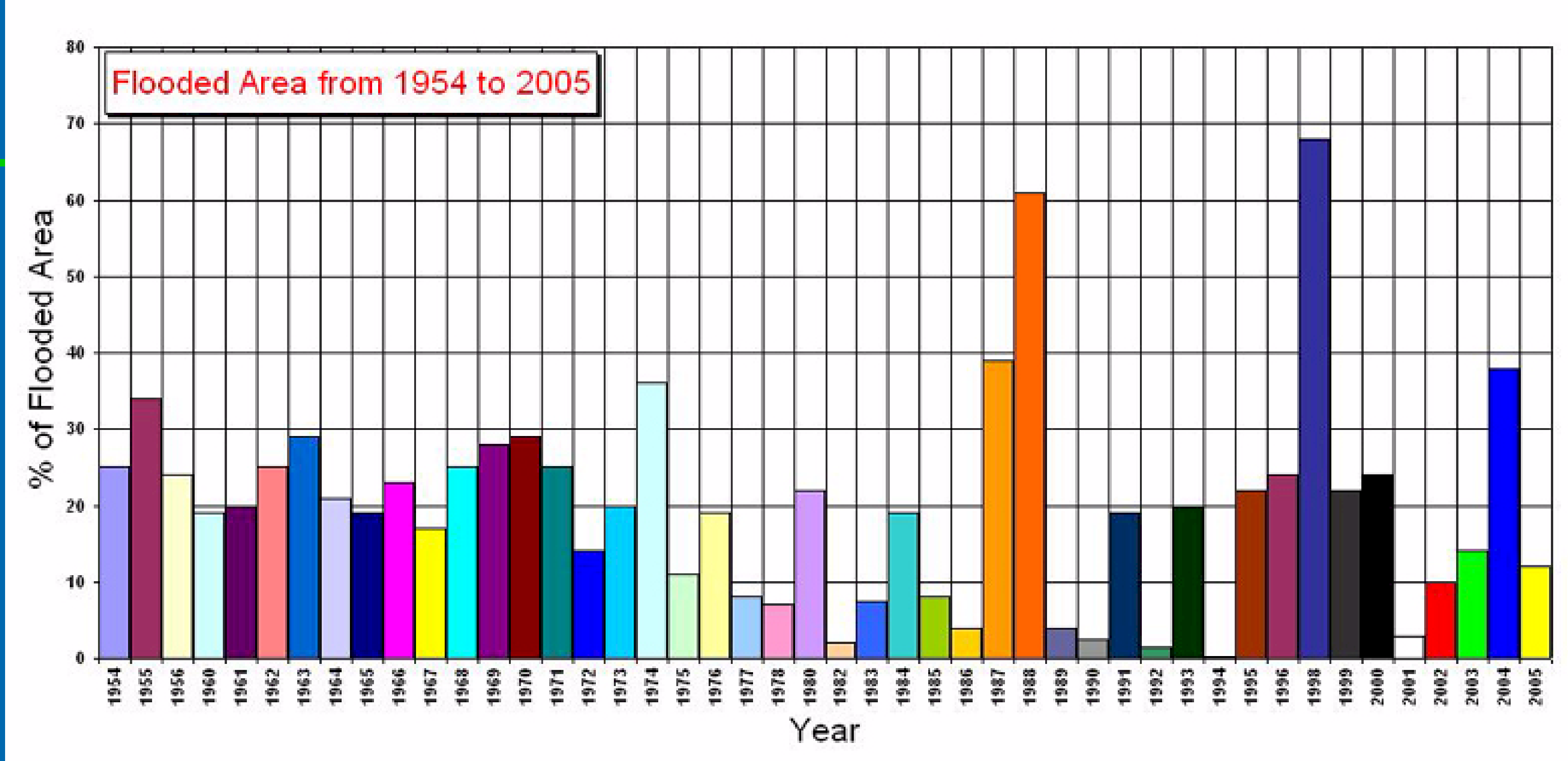
1728-mm fall during the monsoon

Temperature

highest temperature in April (34ºC)

lowest in January (12ºC)




Flooded Area from 1954 to 2005
% of Flooded Area
80
70
60
50
40
30
20
10
0
1954 1955 1956 1960 1961 1962 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1980 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1998 1999 2000 2001 2002 2003 2004 2005
Year

Background

Flood Damage:

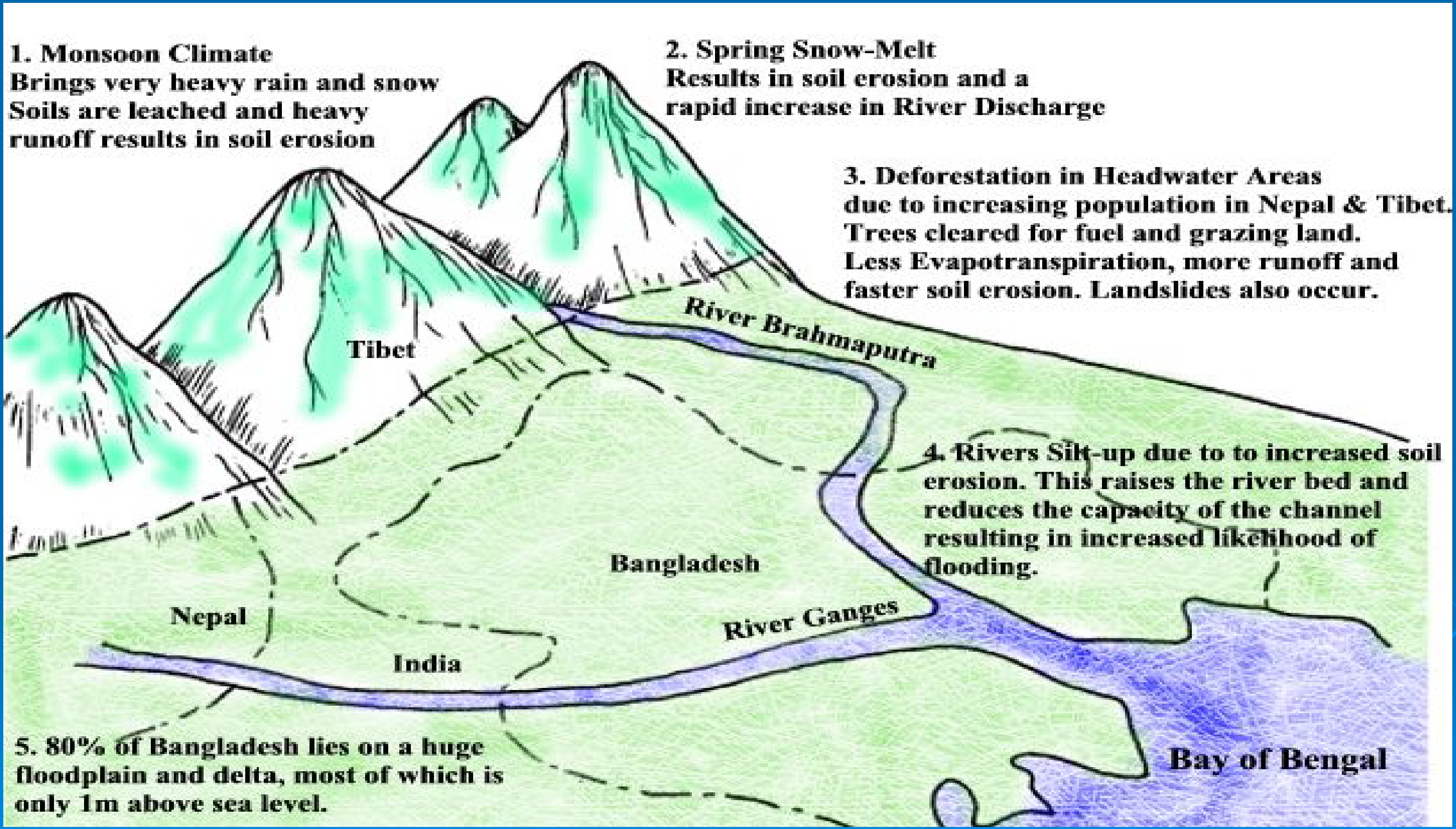
- Area affected by flood – 38 districts
- Crop Damage:

  fully-793,140 hectares

  partly- 656,187 hectares
- Affected People –10 million
- People taking refuge – 373,939 in 1601 shelters
- Housing units destroyed – 89,048
- Deaths – 192

(As of 8th August 2007, GoB)

Causes of Flooding



Objectives

This paper aims to discuss:

- current flood forecasting activities
- techniques to improve the lead time & accuracy

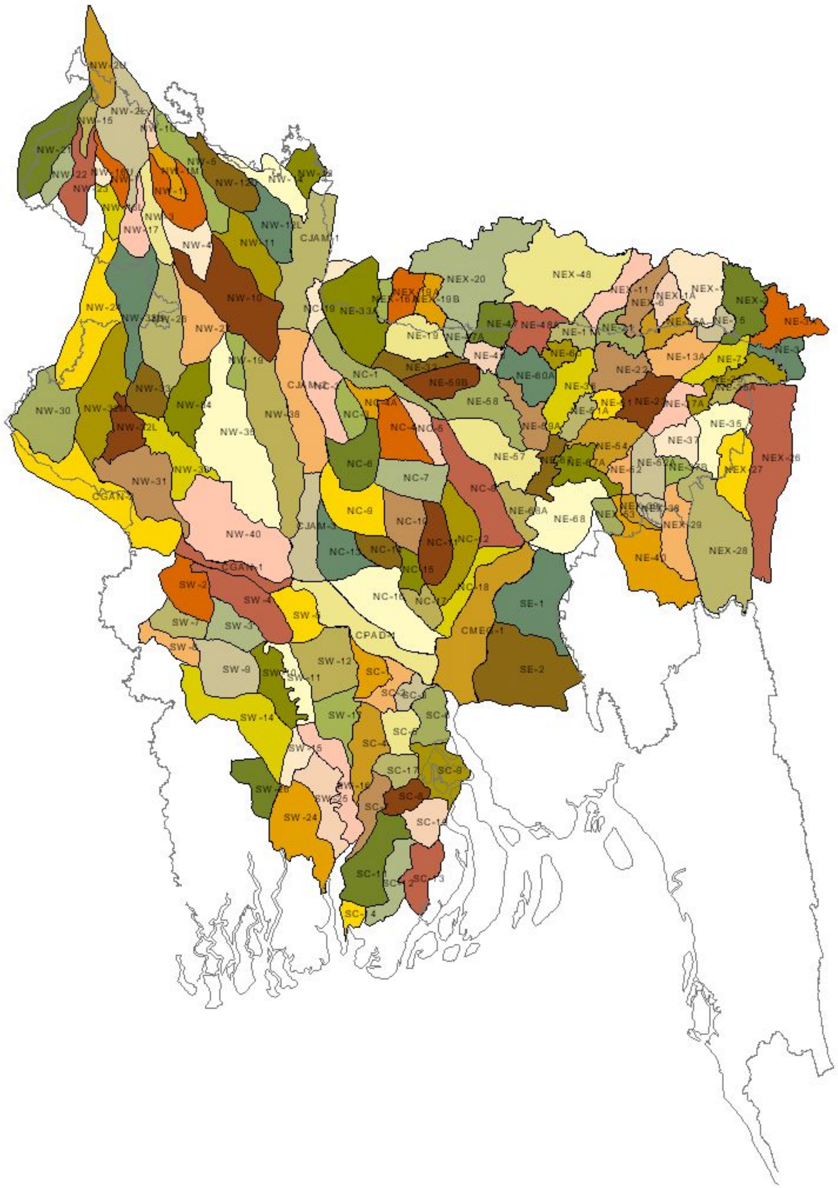
FFWC and it's activity

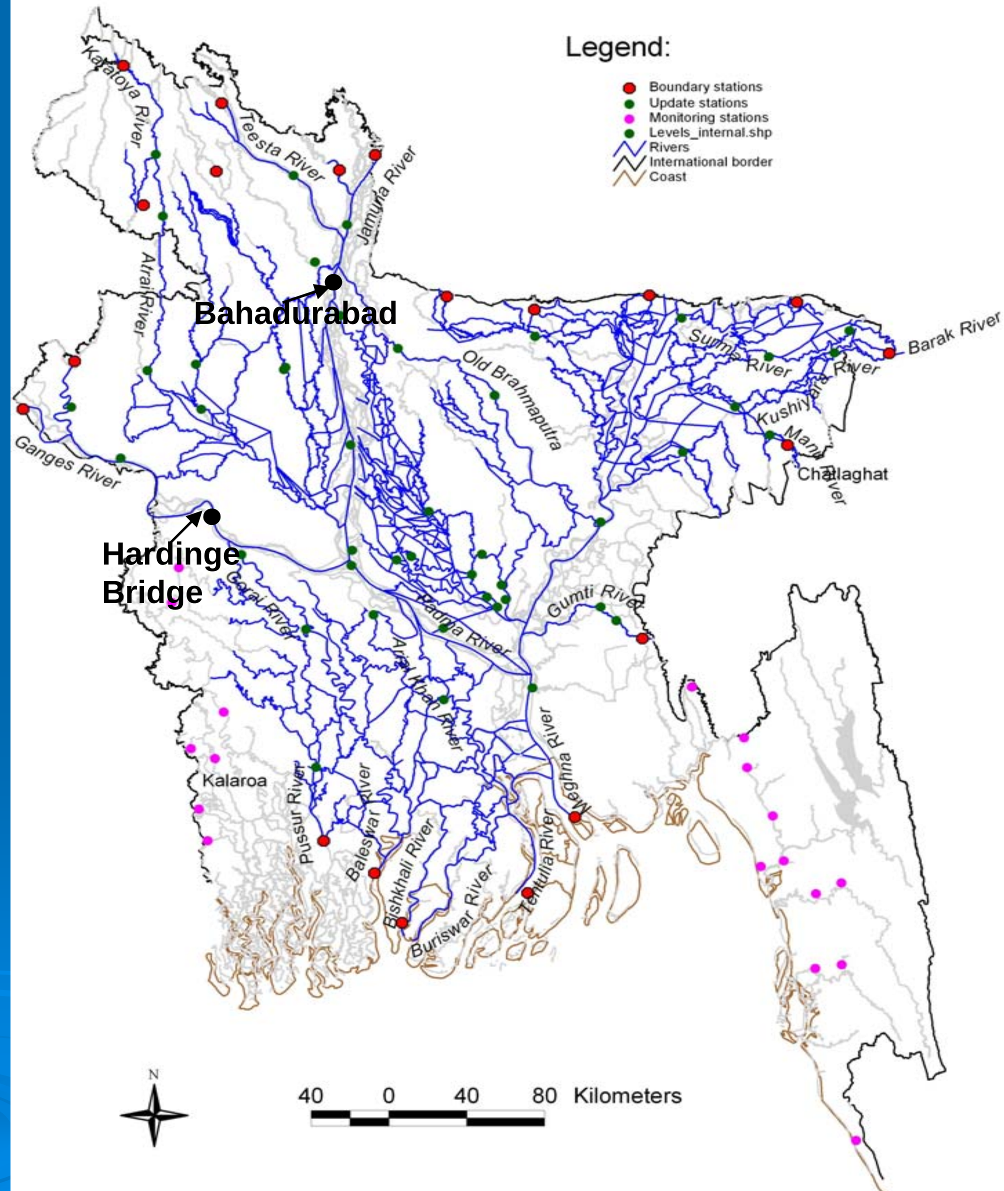
FFWC operates model for the estimation of water levels at some selected stations

The model consists of two separate but closely integrated components:

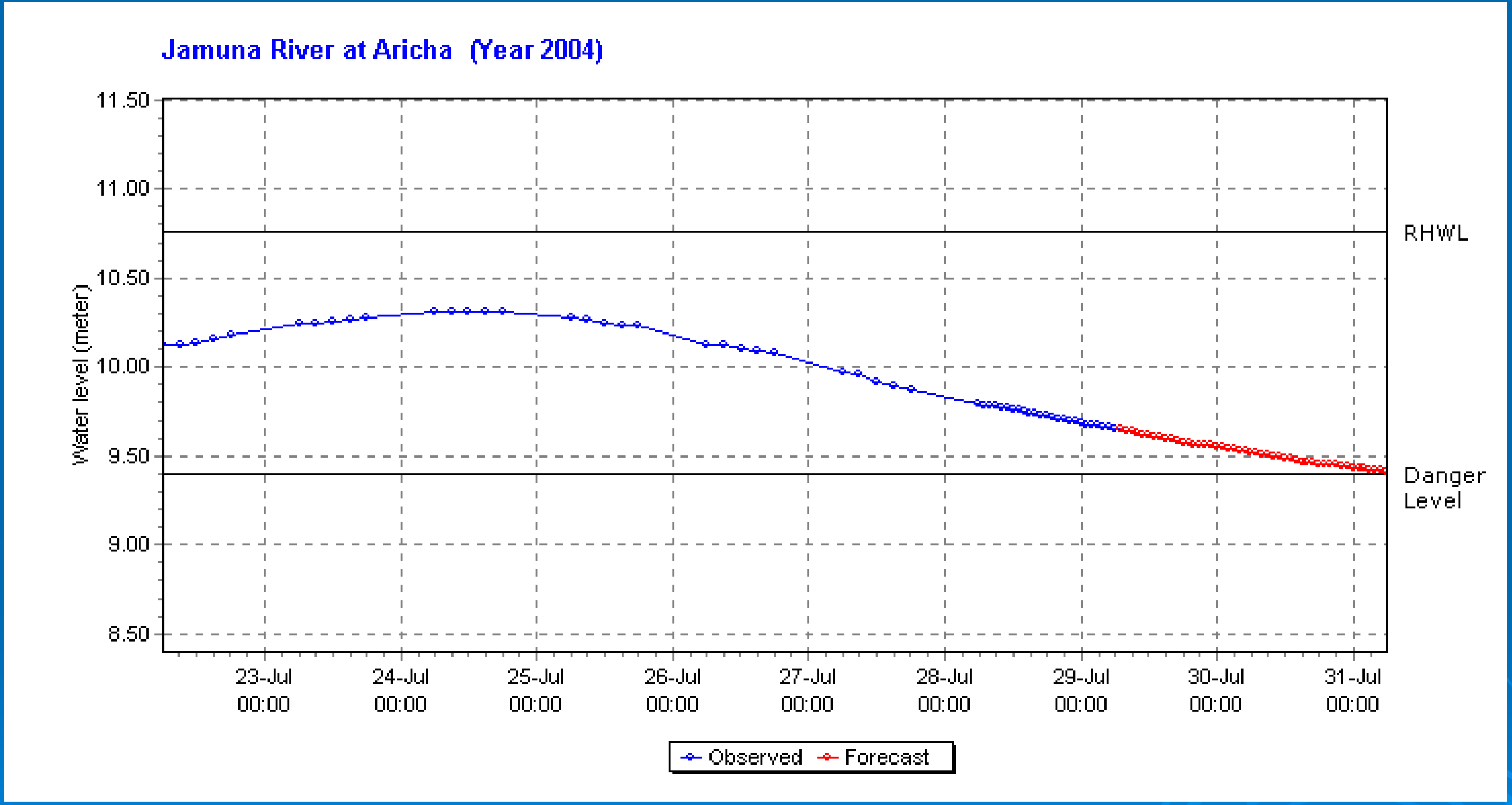
- rainfall-runoff model
- hydrodynamic model

Model and Boundary Data

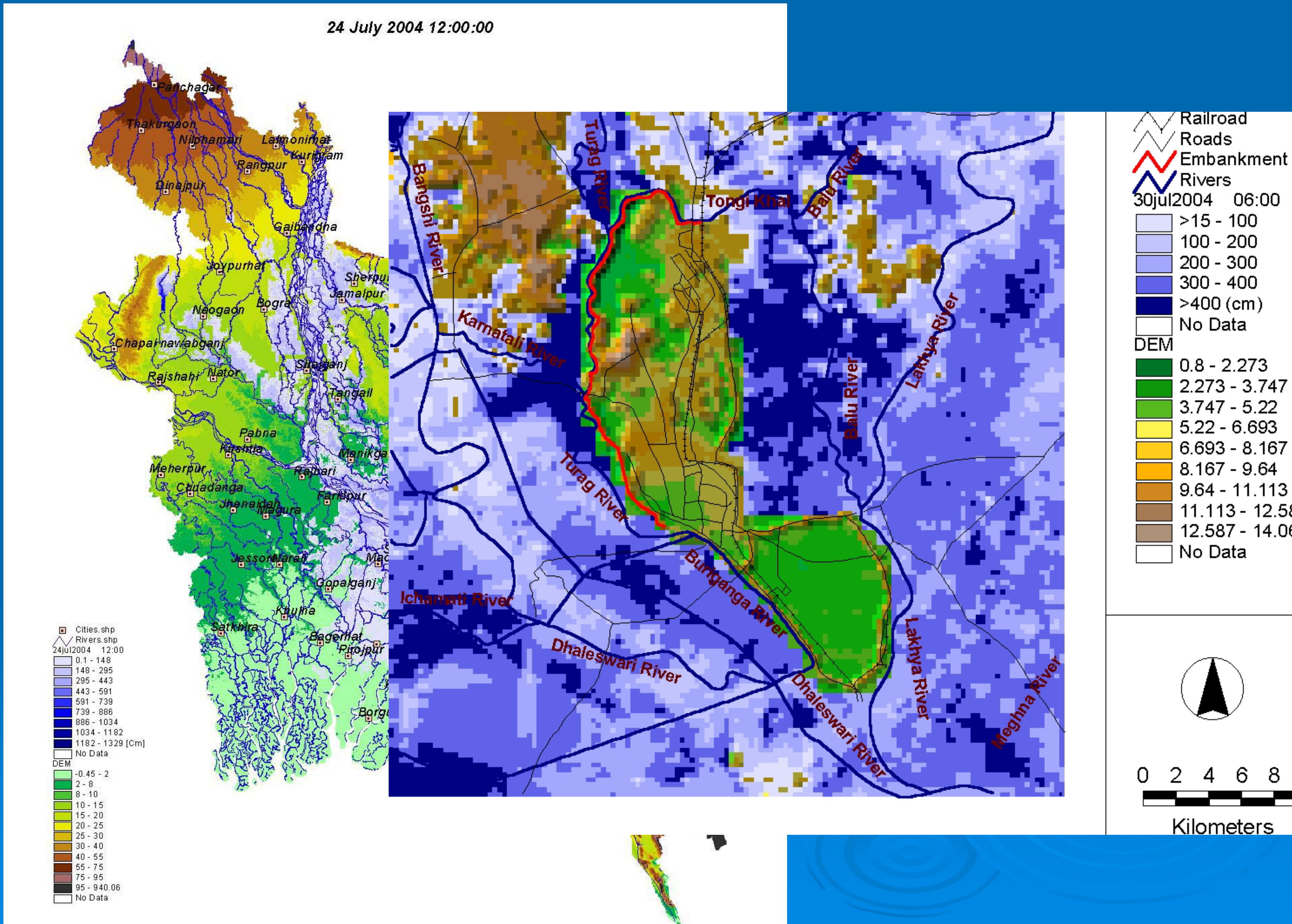




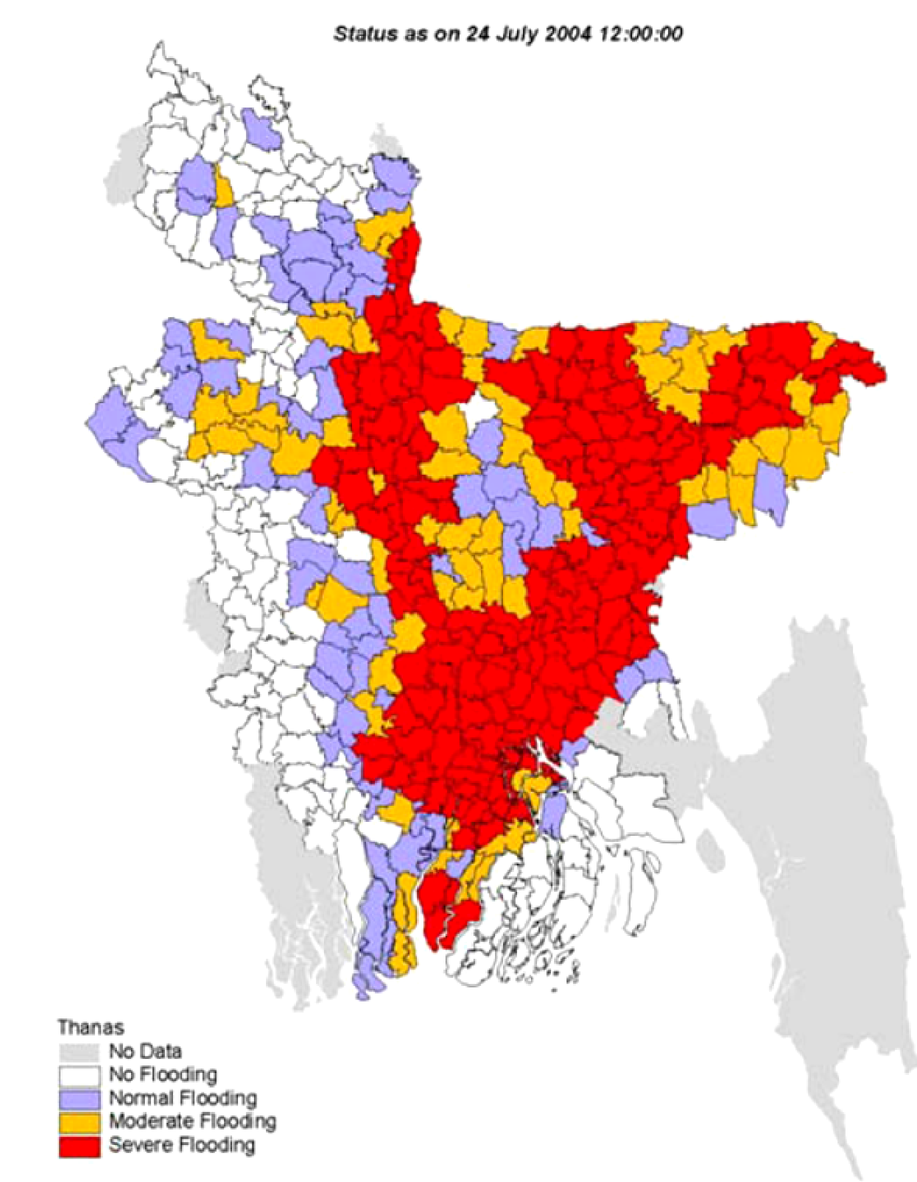
Result


Jamuna River at Aricha (Year 2004)
Water level (meter)
11.50
11.00
10.50
10.00
9.50
9.00
8.50
RHWL
Danger Level
23-Jul 00:00
24-Jul 00:00
25-Jul 00:00
26-Jul 00:00
27-Jul 00:00
28-Jul 00:00
29-Jul 00:00
30-Jul 00:00
31-Jul 00:00
Observed
Forecast

Flood Depth Map



Thana Status Map



Problems

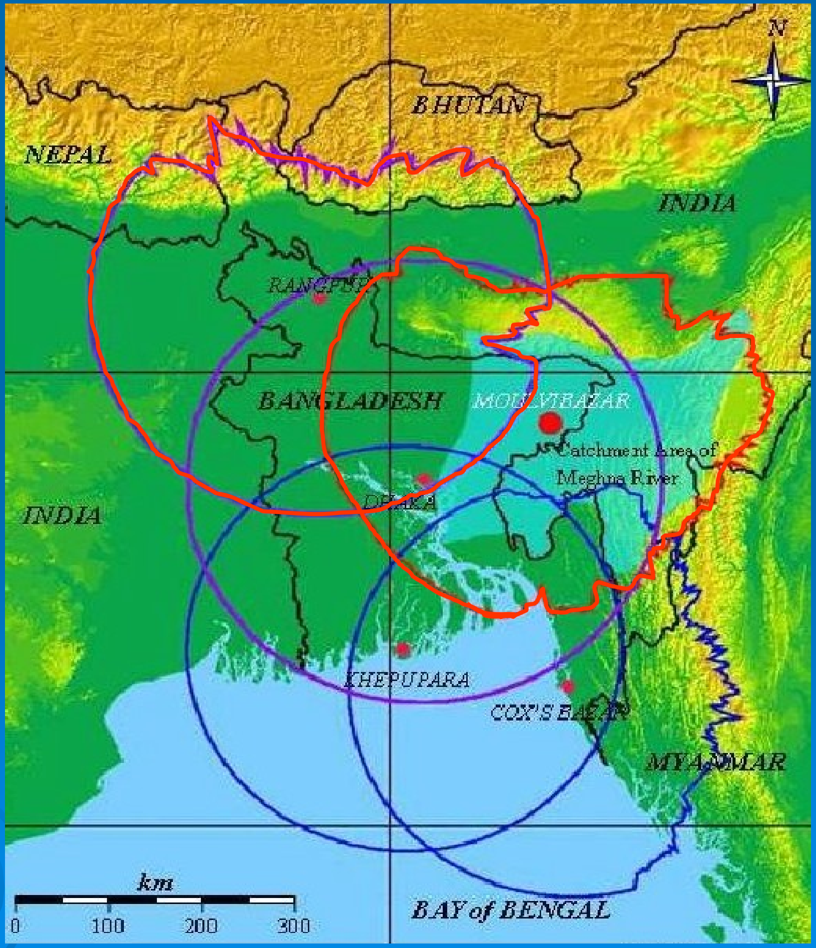
- ✓ Presently FFWC is disseminating 3 day forecast with some weaknesses
- ✓ It's not possible to extend the model boundary
- ✓ Data collection system is not automated
- ✓ Qualitative rainfall forecast is not enough for the model input
- ✓ 3 day lead time is not sufficient

Future Application / Operation

- Doppler Radar
- Satellite Based RF and Q estimation
- Application of Numerical Weather Prediction Model Result

Doppler Radar

The spatial and temporal resolution of an event like flash flood can only be captured by Doppler radar



Satellite-based RF and Q Estimation

Satellite derived 3 hourly rainfall data of TRMM is promising

The reliability of the remotely sensed data ?

TRMM is producing error within acceptable range

practicable to generate boundary discharge with ANN

So, the combination of satellite rainfall and ANN is capable to improve boundary estimation and thereby extending FF lead time

Application of Numerical Weather Prediction Model Result

3-individual time horizon are used to predict river Q at the U/S and regional precipitation

1-10day: issued daily

20-30 day: issued 5 day interval

1-6 months: issued at 1 month interval

However,1-10 day forecasted data has been used for FF, on experimental basis

Application of Numerical Weather Prediction Model Result

<u>CFAN Data:</u>

Rainfall

Discharge

Application of Numerical Weather Prediction Model Result

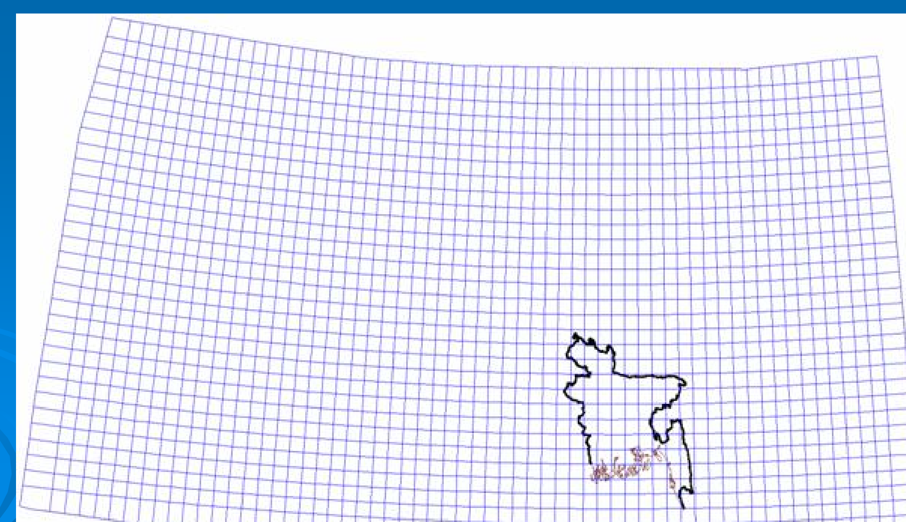
Data (Rainfall):

- ✓Satellite observed Rainfall
- ✓ECMWF forecasted Rainfall

24hr precip[m];	longitude [deg];	latitude [deg]
0.00115002	70.0000	20.0000
0.00122683	70.5000	20.0000
0.00130364	71.0000	20.0000
0.00163024	71.5000	20.0000
0.00195685	72.0000	20.0000
0.00735991	72.5000	20.0000
0.0127630	73.0000	20.0000
0.00936465	73.5000	20.0000
0.00596634	74.0000	20.0000
0.00384683	74.5000	20.0000

48hr precip[m];	longitude [deg];	latitude [deg]
0.00195182	77.0000	20.5000
0.00130633	77.5000	20.5000
0.000660840	78.0000	20.5000
0.000563079	78.5000	20.5000
0.000465318	79.0000	20.5000
0.00190174	79.5000	20.5000
0.00333817	80.0000	20.5000
0.00578501	80.5000	20.5000
0.00823185	81.0000	20.5000
0.00860233	81.5000	20.5000
0.00897282	82.0000	20.5000
0.0107720	82.5000	20.5000

The resolution is 0.5°



Application of Numerical Weather Prediction Model Result

The flood forecasting is based on ECMWF model result

Real time rainfall over the catchment is provided by satellite estimation

ECMWF has 51 Ensemble Prediction data set

The 51 scenarios then combined into an average or small number of alternative forecasts

Only 3 sets of data are used in real time forecasting

Application of Numerical Weather Prediction Model Result

Forecast Initialization Start Time: 15 7 2006

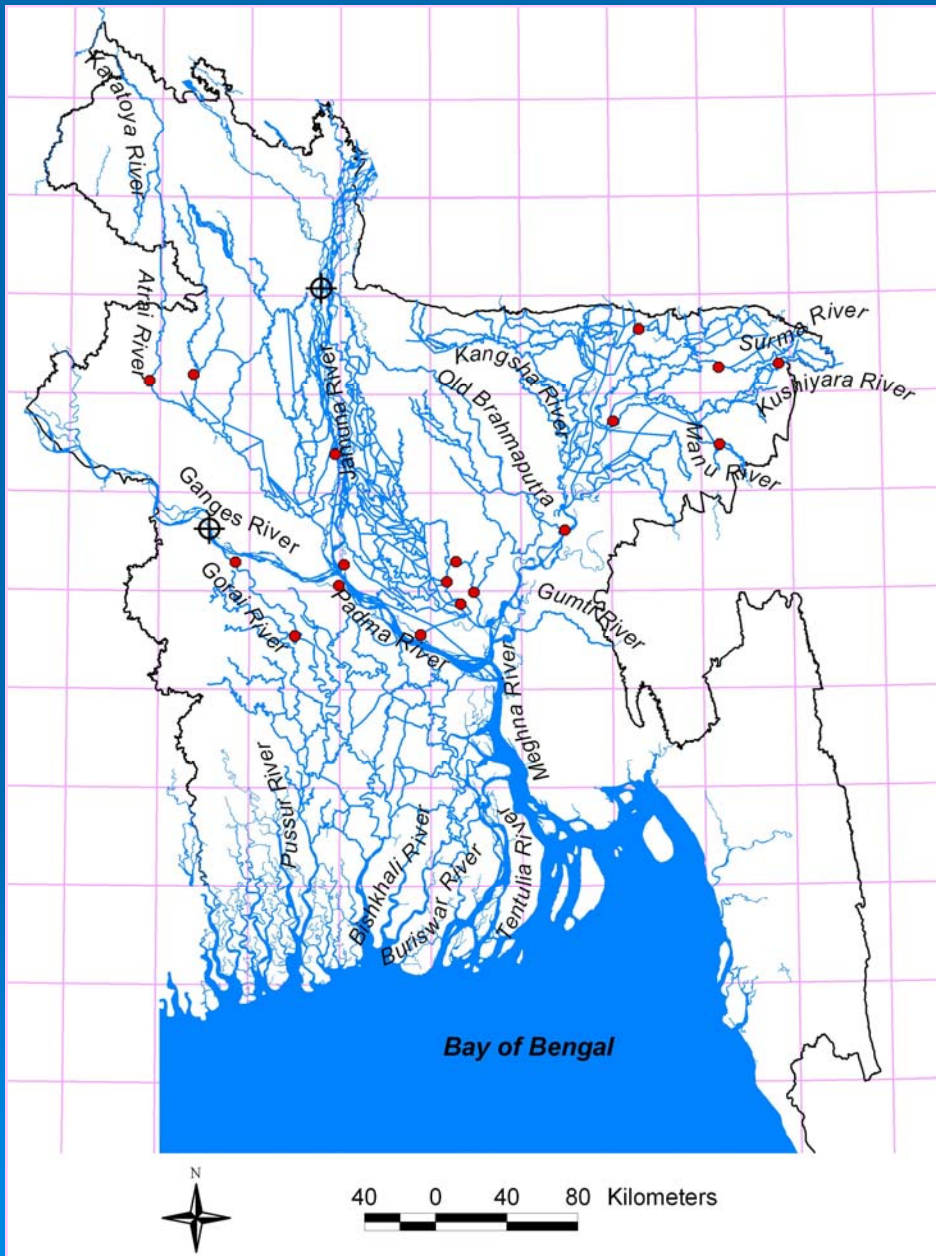
1 day forecast: (Q observed value = -9999.00)

2.5% Quantile:	34434.1
16% Quantile:	35656.5
25% Quantile:	36810.8
Ensemble mean:	37863.0
75% Quantile:	38756.7
84% Quantile:	39312.6
97.5% Quantile:	42607.8

2 day forecast: (Q observed value = -9999.00)

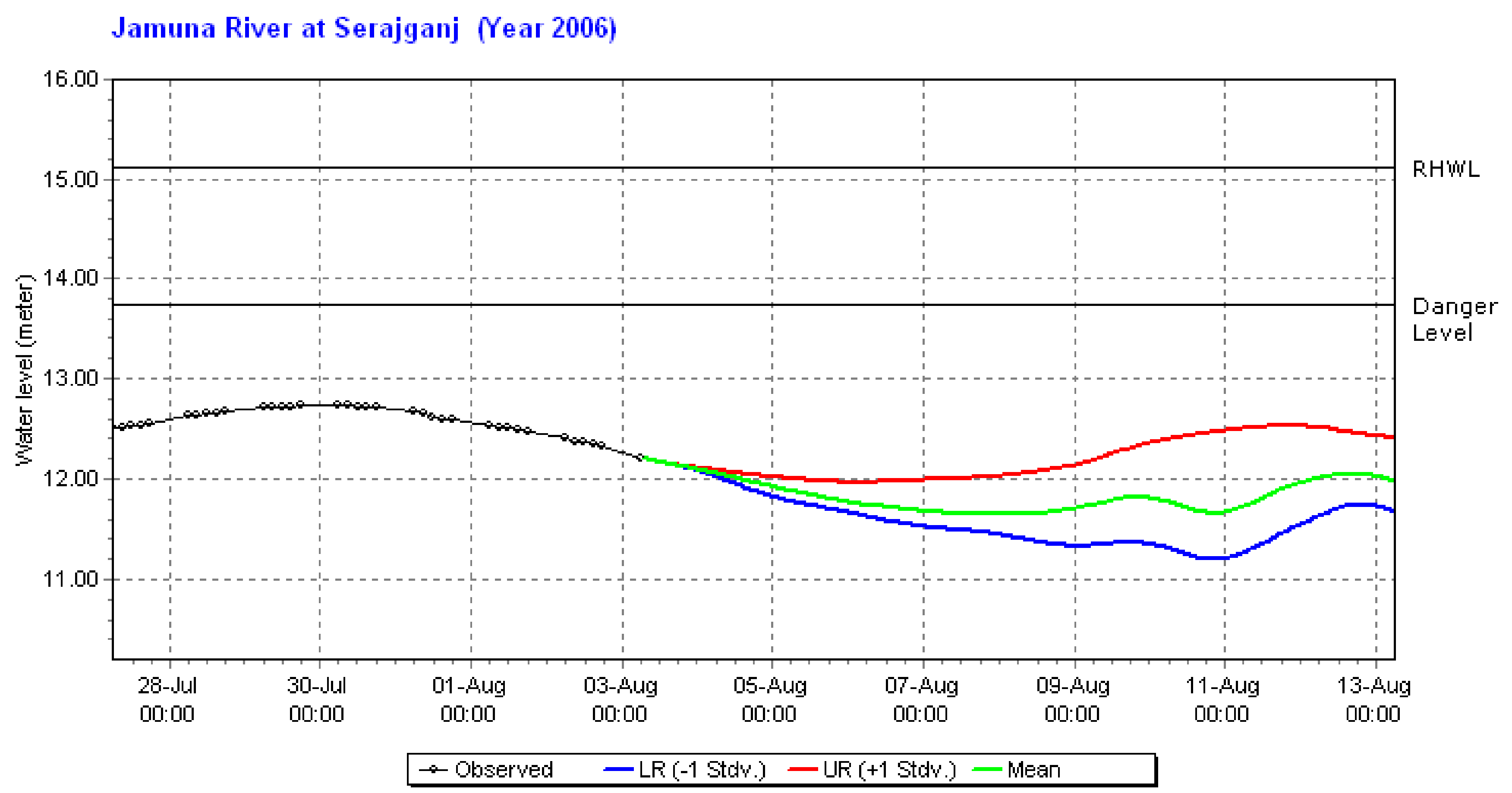
2.5% Quantile:	36834.2
16% Quantile:	38126.2
25% Quantile:	38178.5
Ensemble mean:	38866.2
75% Quantile:	39751.0
84% Quantile:	40815.6
97.5% Quantile:	51643.2

Comparison Station



Station name	River name
Serajganj	Jamuna
Aricha	Jamuna
Tongi	Tongi Khal
Mirpur	Turag
Dhaka	Buriganga
Demra	Balu
Goalondo	Padma
Bhagyakul	Padma
Gorai Railway Bridge	Gorai
Kamarkhali	Gorai
Sheola	Khusiyara
Sherpur	Khusiyara
Moulvi Bazar	Manu
Sylhet	Surma
Sunamganj	Surma
Bhairab Bazar	Upper Meghna
Naogaon	L-Jamuna
Mohadevpur	Atrai

Forecasted Result

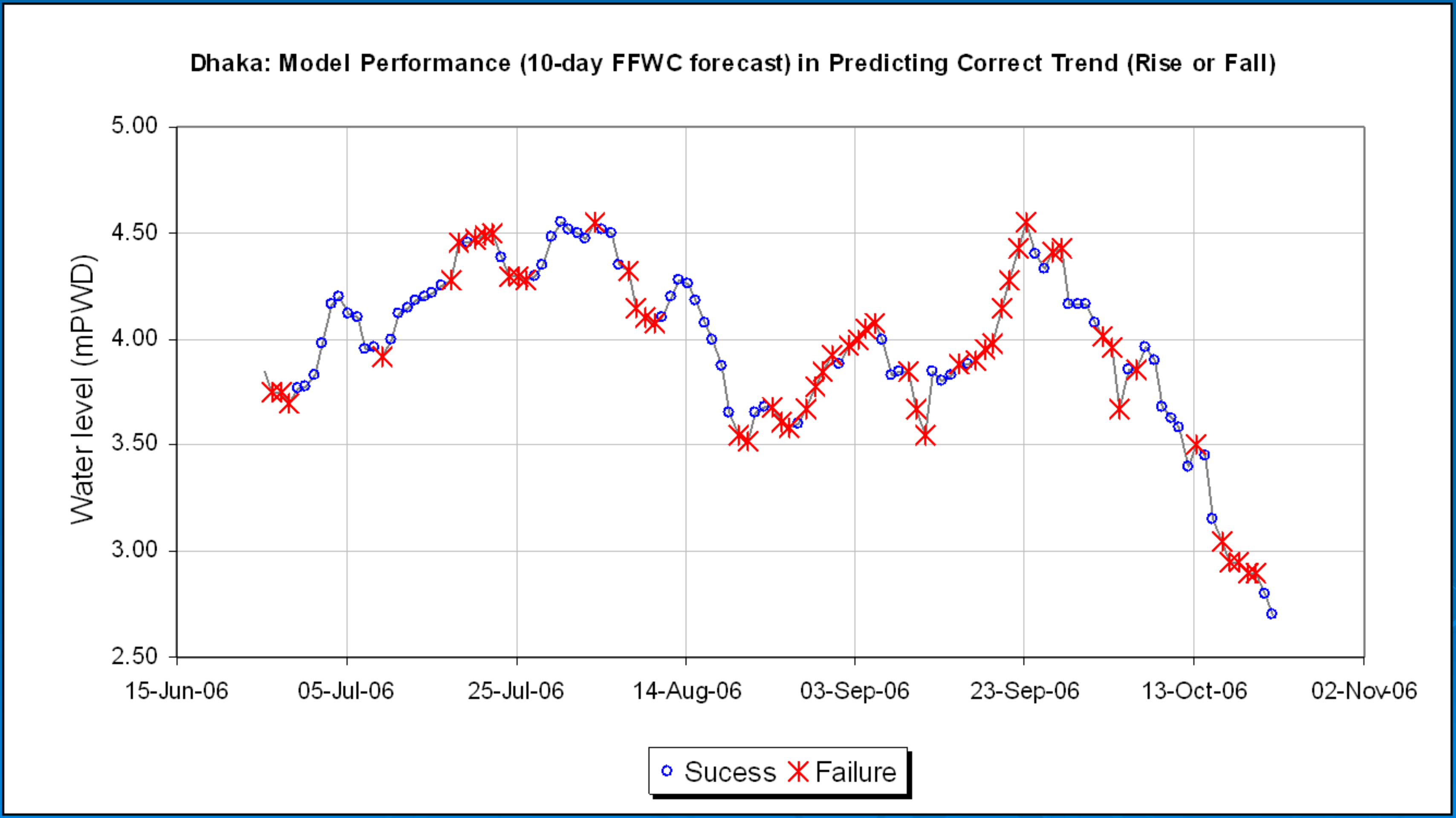


Forecasted Result

Forecast made on: 03-08-2006

Water Level in [m]			today	1-day forecast	2-day forecast	3-day forecast	4-day forecast	5-day forecast	6-day forecast	7-day forecast	8-day forecast	9-day forecast	10-day forecast	
			03-08	04-08	05-08	06-08	07-08	08-08	09-08	10-08	11-08	12-08	13-08	Forecast type
River	Station	D.L	0600	0600	0600	0600	0600	0600	0600	0600	0600	0600	0600	
Jamuna	Serajganj	13.75	12.21	12.08	12.00	11.96	11.99	12.04	12.19	12.40	12.50	12.51	12.41	Upper Range
				12.02	11.78	11.62	11.50	11.41	11.33	11.30	11.26	11.63	11.66	Lower Range
				12.05	11.88	11.74	11.66	11.64	11.74	11.77	11.72	12.01	11.97	Mean
Jamuna	Aricha	9.40	8.77	8.73	8.72	8.80	8.86	8.85	8.93	9.11	9.20	9.15	9.07	Upper Range
				8.70	8.59	8.51	8.46	8.38	8.31	8.31	8.20	8.18	8.21	Lower Range
				8.72	8.67	8.62	8.58	8.55	8.59	8.72	8.65	8.63	8.62	Mean
Tongi Khal	Tongi	6.08	4.87	4.85	4.84	4.82	4.81	4.80	4.80	4.80	4.81	4.82	4.82	Upper Range
				4.86	4.84	4.81	4.78	4.76	4.73	4.70	4.68	4.65	4.62	Lower Range
				4.86	4.84	4.81	4.79	4.77	4.75	4.74	4.74	4.73	4.70	Mean
Turag	Mirpur	5.94	5.27	5.25	5.22	5.21	5.21	5.20	5.20	5.21	5.23	5.23	5.23	Upper Range
				5.25	5.22	5.18	5.15	5.12	5.09	5.06	5.04	5.00	4.96	Lower Range
				5.25	5.22	5.20	5.17	5.15	5.13	5.12	5.13	5.10	5.09	Mean
Buriganga	Dhaka	6.00	4.55	4.52	4.50	4.48	4.49	4.48	4.48	4.49	4.51	4.52	4.51	Upper Range
				4.52	4.49	4.45	4.42	4.39	4.36	4.33	4.31	4.27	4.23	Lower Range
				4.52	4.50	4.47	4.45	4.42	4.40	4.40	4.41	4.38	4.36	Mean

Performance of Trend Prediction



Conclusions

Further extension of existing (3day)forecasting lead time is required

Newly introduced technology shows its capability of extending lead-time for more than 3 days

However, the forecasting performance starts to deteriorate after 5 day

Conclusions

The model succeeded 58% of the time in predicting correct trend (10-day)

The actual drawback remains on the course grided weather prediction model and satellite RF

Therefore, the overall forecasting performance can be improved by reducing the uncertainty of satellite and ECMWF data over the catchment area

Way Forward

Discharge prediction of the 2 boundary stations are required to be improved for 10-day lead time

Calibration of the weather prediction model along with satellite measured rainfall estimation is vital

Downscaling of the ECMWF forecast can be helpful

THANK YOU !