Enhancing end-to-end Flood Forecasting and Warning Capacity

Short Range Regional Early Warning System

SDMC, Gandhinagar, India

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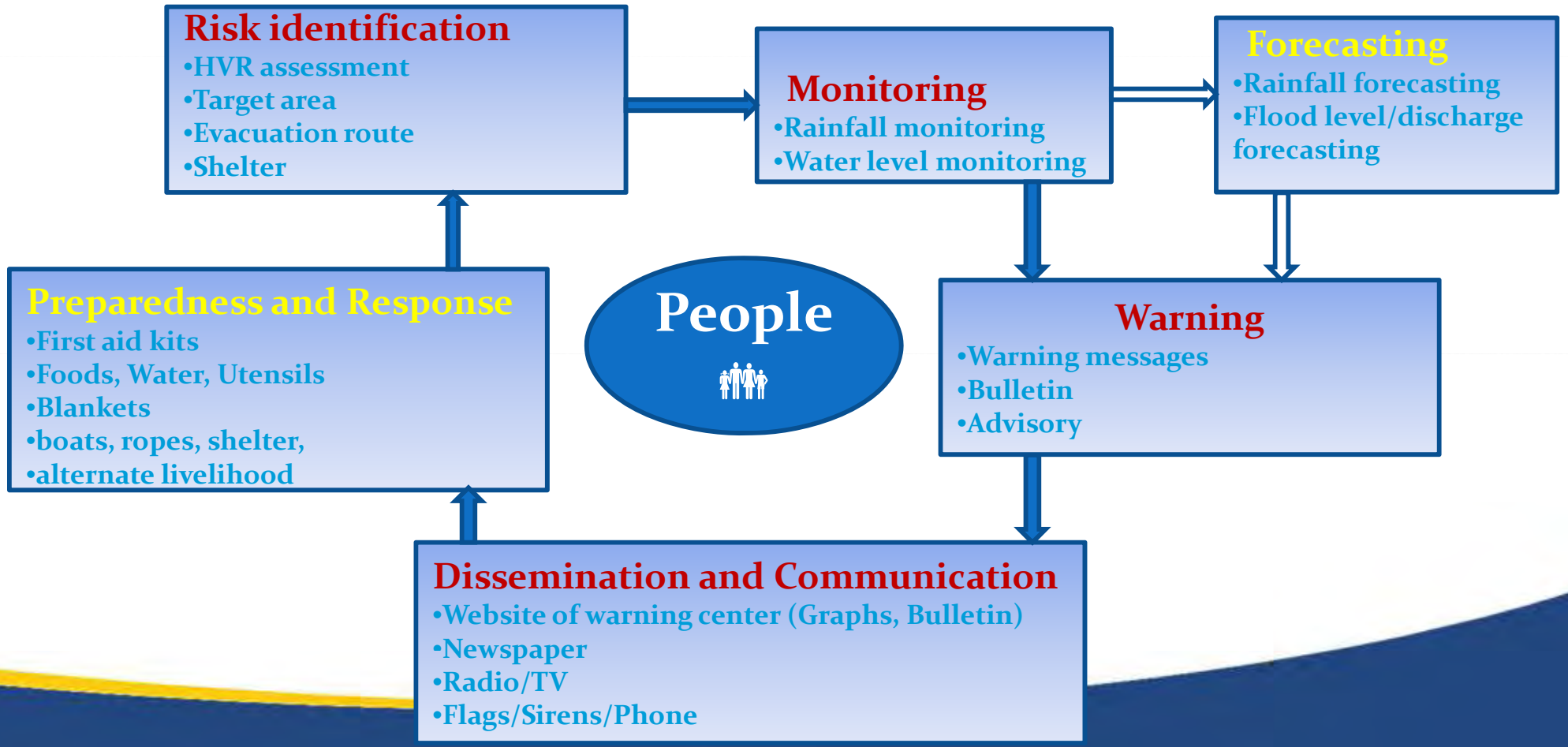
Outline

- Elements of FEWS
- Risk Identification
- Observation network
- Forecasting system
- Training and capacity building
- Case Study

Components

- Enhancing meteorological and hydrological monitoring capacities
- Development of flood forecasting systems
- Development of Decision Support System (DSS) to communicate relevant, long-lead, location-specific flood risk information
- Training and Capacity Building

Elements of FFEWS



RISK IDENTIFICATION

Risk Identification

- Participatory approach
- Historical flood depth, extent, duration assessed from community consultation
- HVR map developed on the basis of historical data analysis and field survey
- Local threshold values for warning assessed
- Evacuation route and shelter identified

Project Initiation

Involving various stakeholders to identify the target areas and locations for forecasting

Progress meetings involving various beneficiaries

To discuss the model setup and verifying the inclusion of all important locations

Risk Identification

Participating Agencies: (Myanmar flood project)

- Department of Meteorology and Hydrology (DMH)
- Department of Water Resources (DoWR)
- Irrigation Department (ID)
- Ministry of Energy and Power (MoEP)
- Ministry of Construction (MoC)

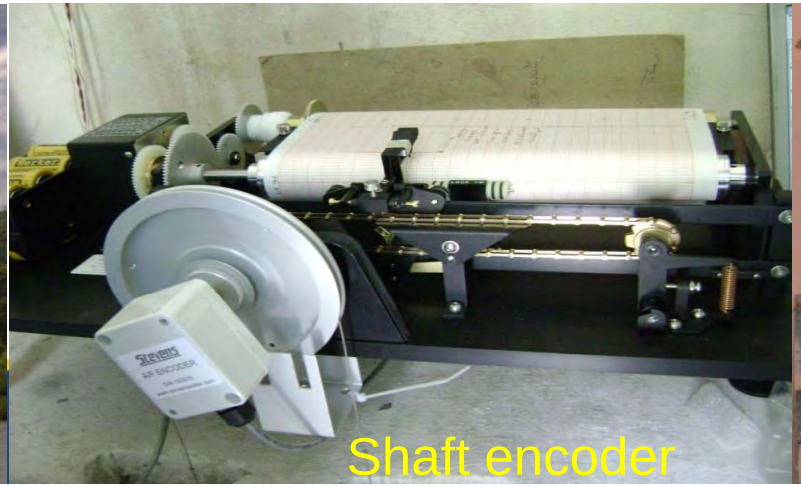
ENHANCING THE OBSERVATION NETWORK

Real Time Monitoring System


Staff gauges


Tipping bucket


Radar

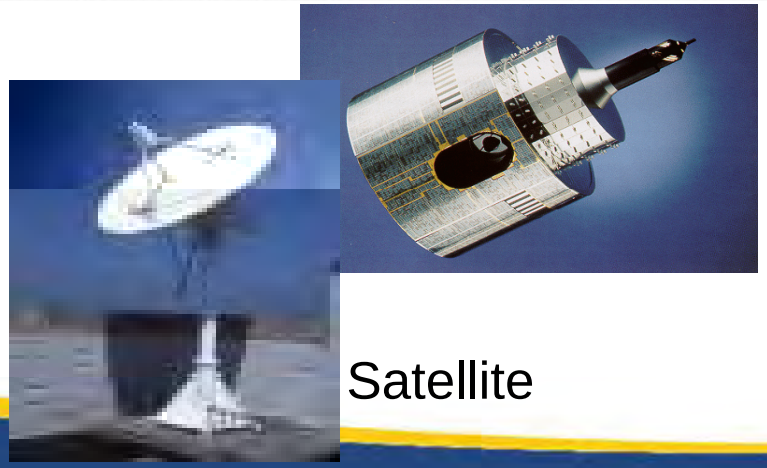

Shaft encoder


Bubbler

Real Time Data Transmission System


VHF Radio at Station


VHF Radio at Forecasting Center


Satellite


Mobile

Real Time Monitoring System

Government of Nepal
Ministry of Science, Technology and Environment
Department of Hydrology and Meteorology
Flood Forecasting Project

Home | Real Time Data | Manually Observed Data | Current Forecast | Community Outreach | Projects | Publications | River Watch | Rainfall Watch

- Mahakali
- Karnali
- Babai
- West Rapti
- Narayani
- Bagmati
- Koshi
- Kankai

Flood Alerts

Water Level of **Karnali at Chisapani** at **2014-08-15 02:00:00** is **rising** [**10.09 m**] and Higher Than Warning Level

Water Level of **Babai River** at **Chepang** at **2014-08-15 04:15:00** is **steady** [**5.15 m**] and Below Warning Level

Water Level of **Rapti River** at **Kusum** at **2014-08-15 09:00:00** is **falling** [**8.28 m**] and **Higher Than Danger Level**

Water Level of **Narayani River** at **Devghat** at **2014-08-15 09:00:00** is **rising** [**7.90 m**] and Higher Than Warning Level

Water Level of **East Rapti** at **Rajaiya** at **2014-08-15 09:00:00** is **falling** [**1.85 m**] and Below Warning Level

Water Level of **Bagmati River** at **Karmaiya** at **2014-08-15 09:10:00** is **N/A** [**N/A m**] and N/A

Water Level of **Koshi River** at **Chatara** at **2014-08-15 08:55:00** is **rising** [**5.92 m**] and Higher Than Warning Level

Water Level of **Kankai River** at **Mainachuli** at **2013-01-04 14:56:46** is **N/A** [**N/A m**] and N/A

West Rapti At Kusum (375) : Waterlevel

Real Time Data

The current reading is **8.28 m** on date **2014-08-15 09:00:00**

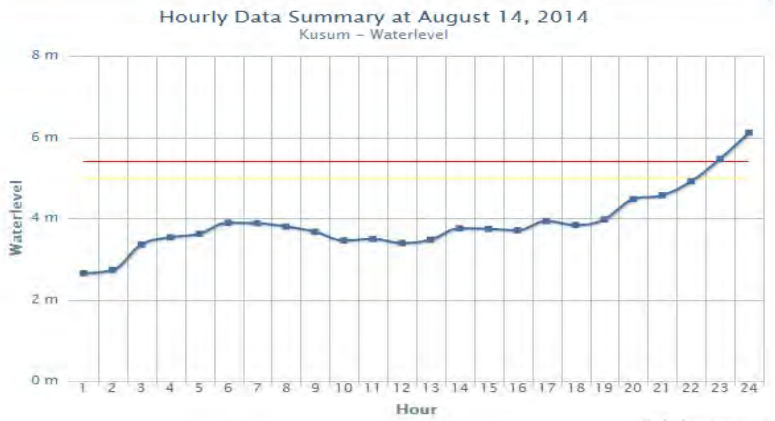
Water Level is falling and Higher Than Danger Level

Danger Level is 5.40 m And Warning Level is 5.00 m

Choose Your Option

Select Date 2014-08-14 View Type Hourly View

Hour	Value (m)	Flow (m^3/s)
1	2.65	135.50
2	2.73	154.80
3	3.35	364.50
4	3.53	445.70
5	3.62	490.40
6	3.89	640.20
7	3.87	628.60
8	3.79	582.40
9	3.66	511.20
10	3.45	408.50
11	3.49	426.50
12	3.39	381.70
13	3.47	417.50
14	3.75	560.00
15	3.74	554.40
16	3.70	532.00
17	3.93	664.60



Hourly Data Summary at August 14, 2014
West Rapti at Kusum – Flow

FORECAST SYSTEM

Elements of Forecasting System

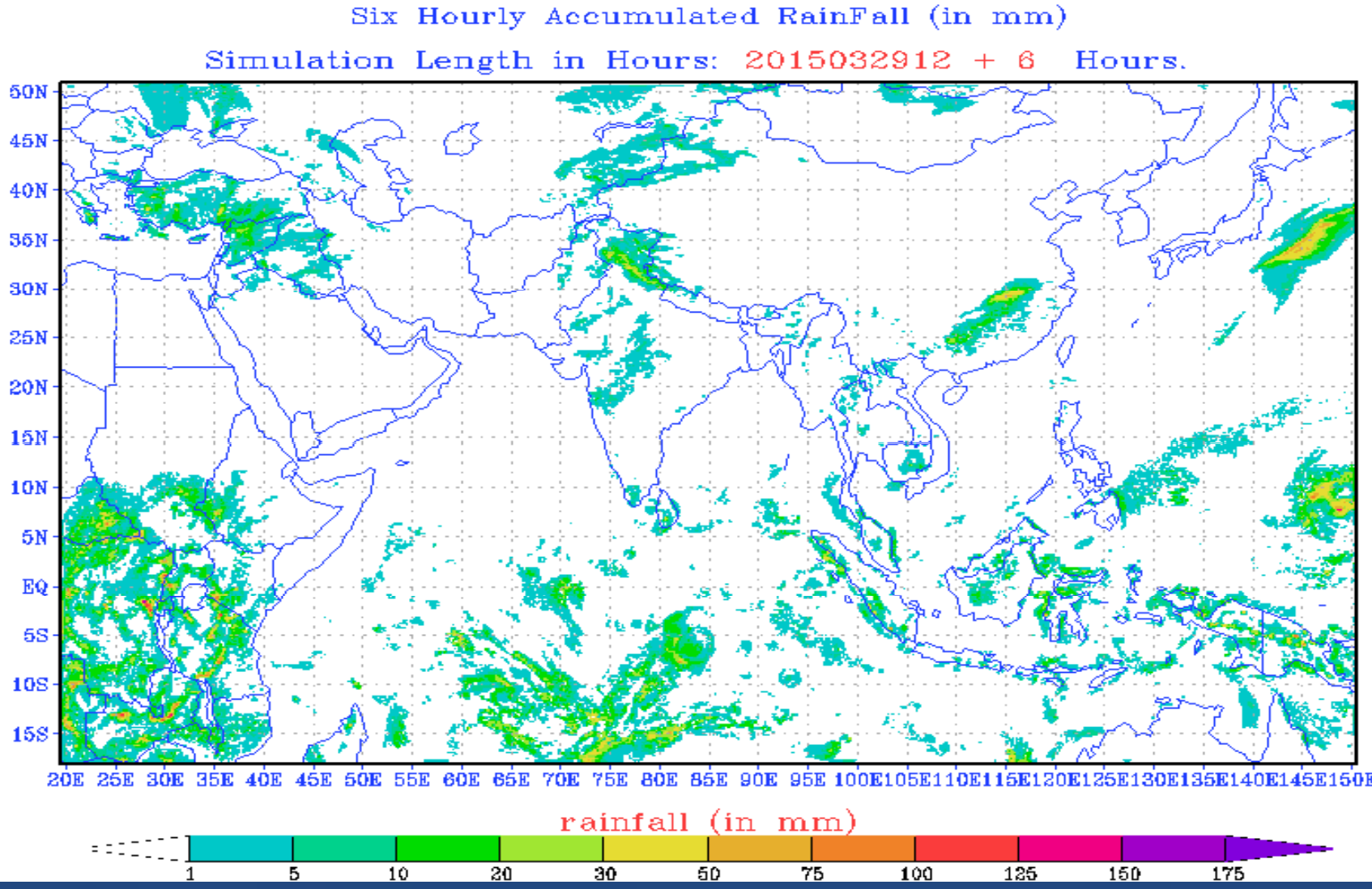
- Numerical Weather Prediction (NWP) system
- Data preprocessing system
- Hydrological modeling system
- Hydraulic modeling system
- Error correction system

Numerical Weather Prediction

- Processed and basin specific WRF 3 days/ECMWF 15-days rainfall forecast is employed to generate flood/flow forecast

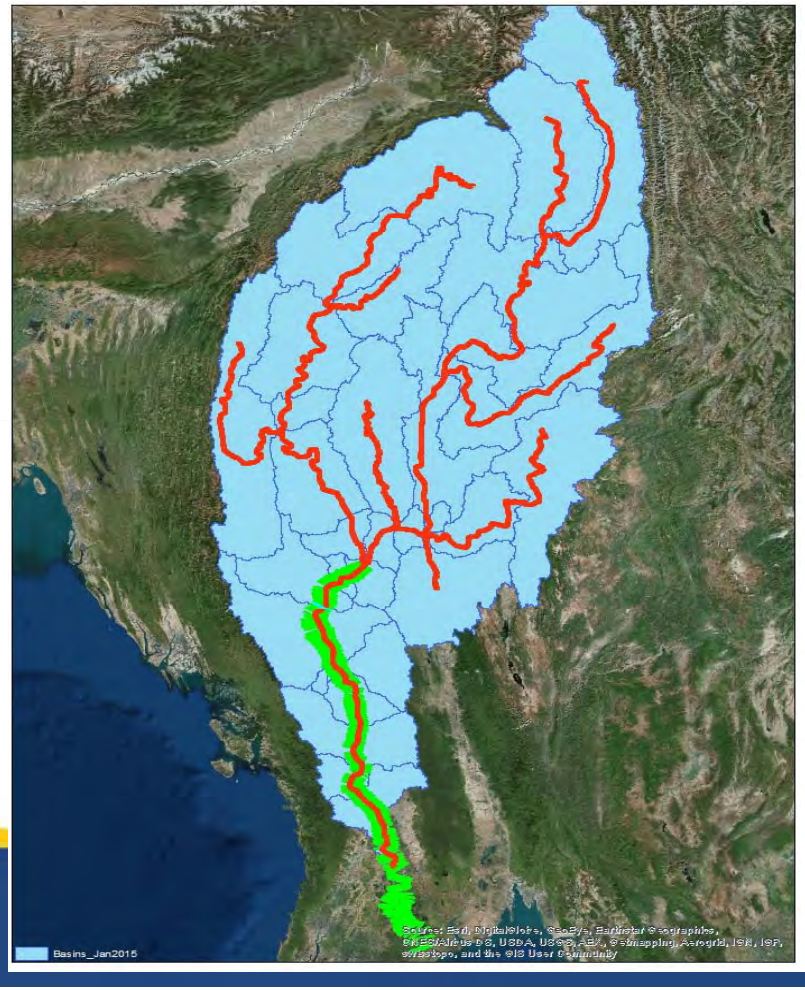
- Various steps involved in forecast processing are:
  - Filling gaps in observation data
  - Generating basin average observations
  - Generating basin average forecast for baseline period
  - Forecast verification against the observations
  - Applying bias correction scheme in forecast used in hydrological models

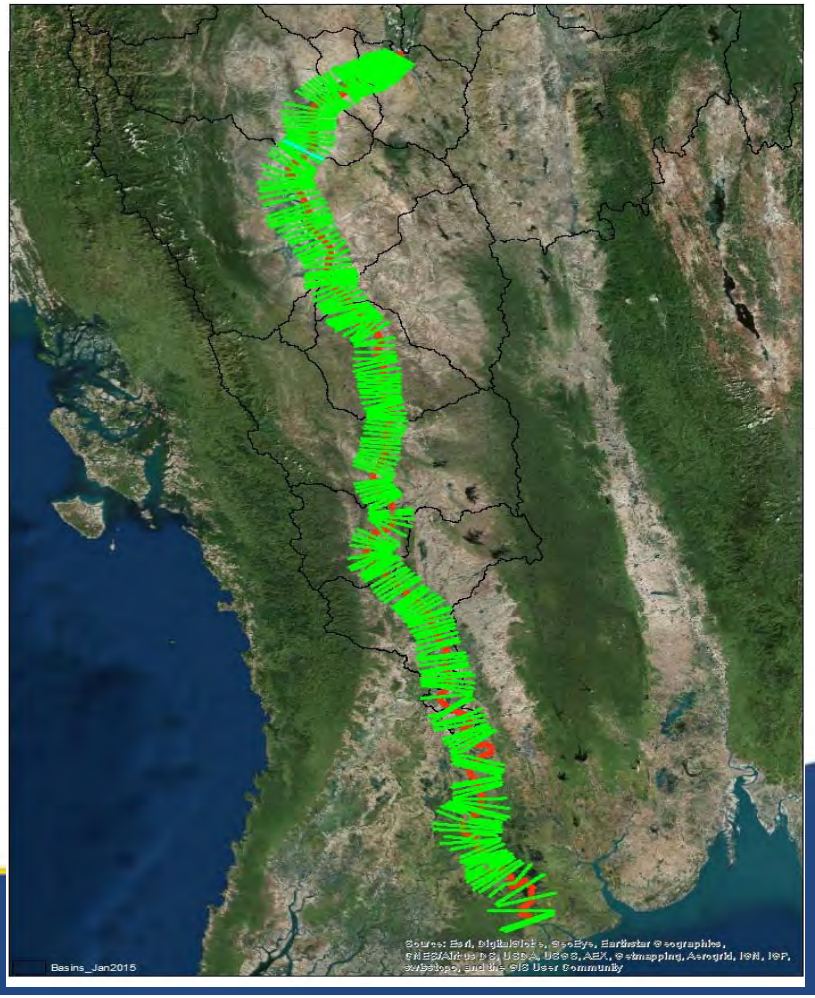
Numerical Weather Prediction



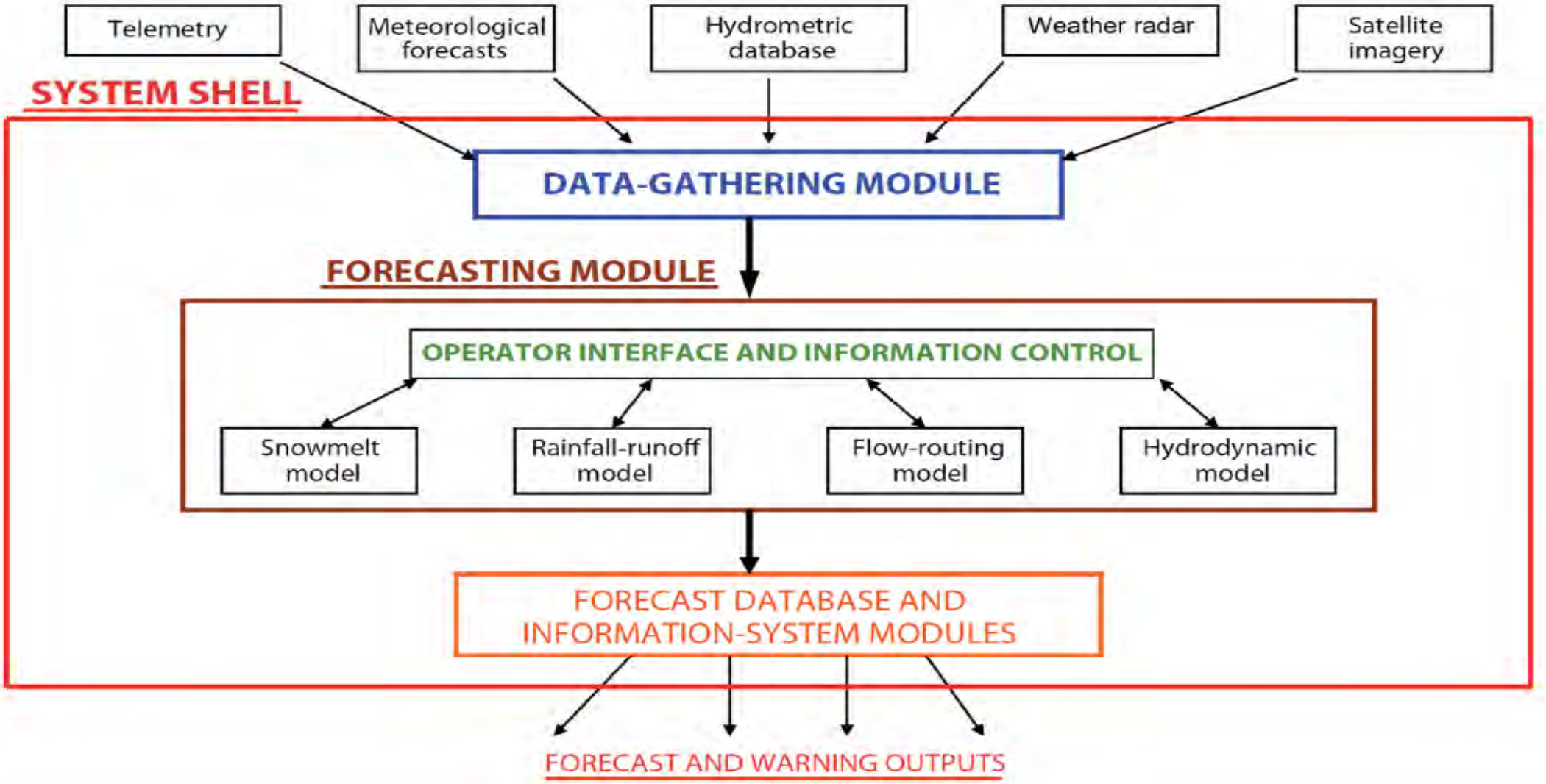
Model Development

Hydrological and Hydraulic model integrated with Decision Support System





Data and Model Integration System



TRAINING AND CAPACITY BUILDING

Training and Capacity Building

Training and capacity building at local and national level on

- Capacity to generate flood forecasts
- interpretation of flood forecasts and associated uncertainties
- local dissemination
- preparedness and immediate response

Training and Capacity Building

- Training on telemetry system installation, operation and maintenance for local NMHSs staff
- Secondment training on WRF/ECMWF model validation to meteorologist for a designated period
- Secondment training on hydrological modeling and DSS to hydrologists
- Training at NMHSs office premises during the transfer of systems
- Continuous backup support

Community Preparedness and Response

- Build the capacity of a community to respond to the consequences of floods by having plans in place in advance so that people know what to do and where to go if a warning is issued.
- Community based organizations are strengthened to take immediate response
- Provision of multi-purpose shelters
- Periodic drills/simulation
- Improving coping capacity

Local Preparedness

- prepare evacuation and response plans by identifying high grounds with adequate sanitation and communication
- plan to store dry food and safe drinking water
- plan to mobilise resources for relief and recovery activities
- prepare work plan for relief and rehabilitation activities
- plan for alternative livelihood options (e.g. small scale fishing, boat making)

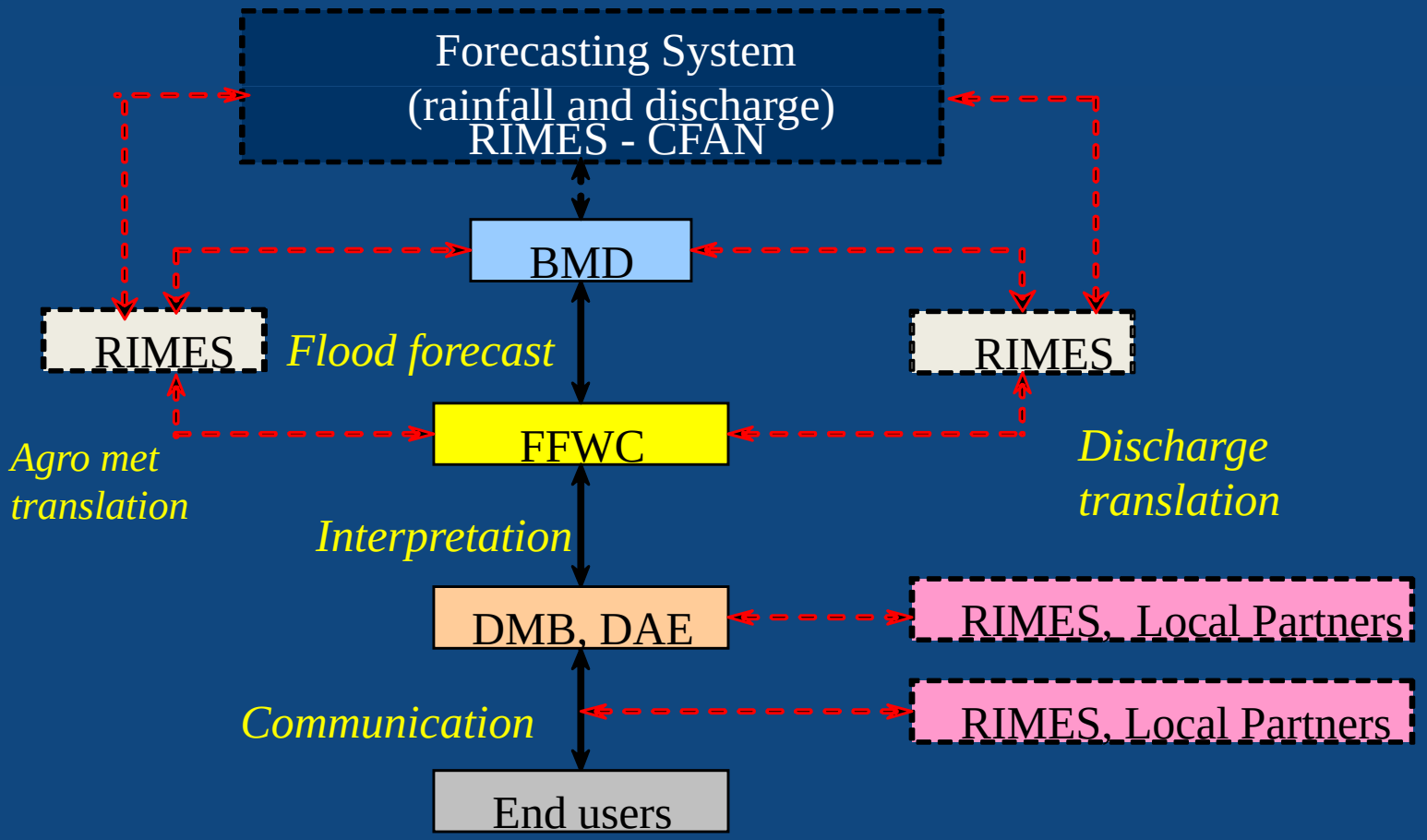
Community Response

- evacuate people and livestock from the flood prone areas during flooding
- secure cattle, poultry birds, homestead vegetables, protect fishery by putting nets in advance
- secure cooking stove, small vessels, firewood and animal dry fodder

System sustainability

- Continues support to NMHSs for making the forecast operational
- Community level workshops to develop the understanding of end users
- Back up system working at RIMES until country system become self dependent

Institutional Collaboration For Sustainable End-to-End Flood Forecasts System



CASE STUDY: Bangladesh

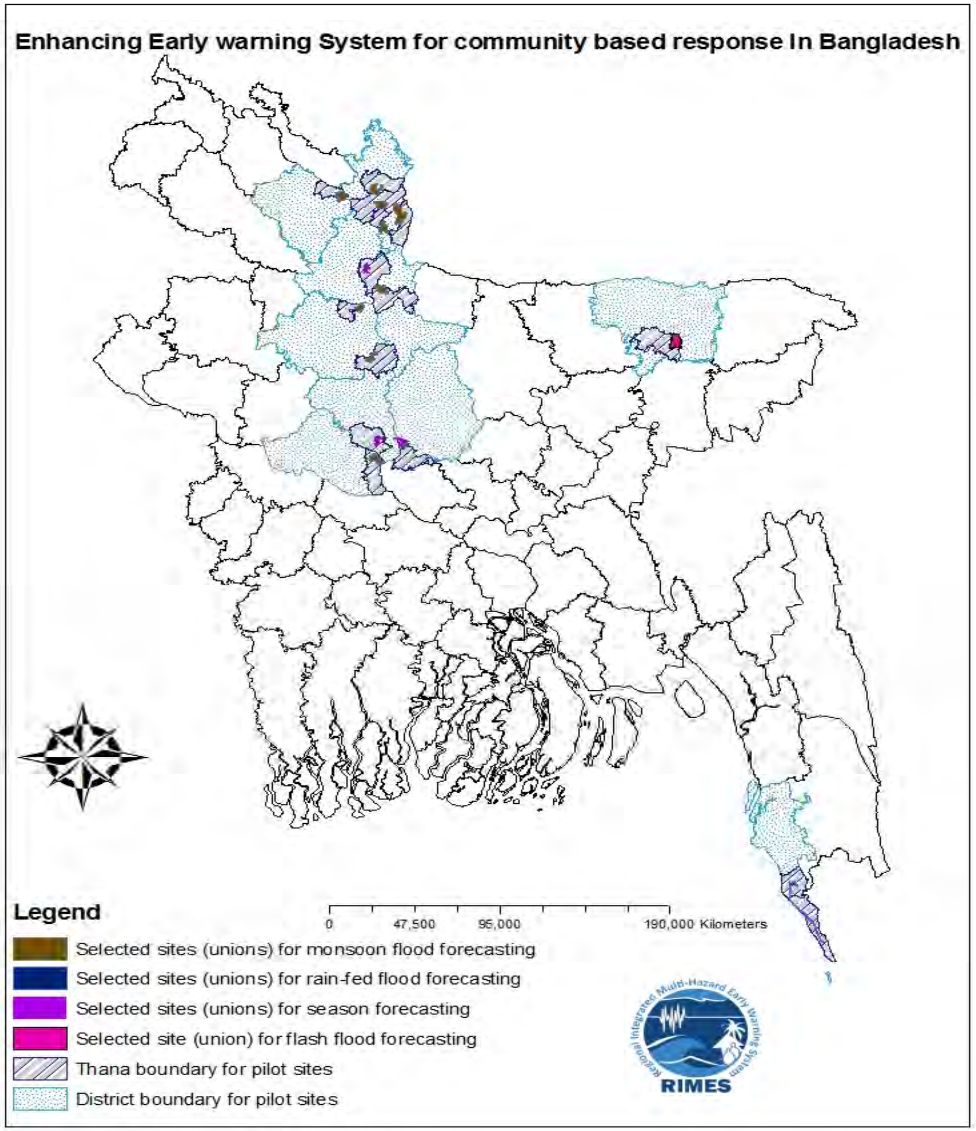
Objectives

1. **Expand medium range (1-10 days) flood forecast**

2. **Piloting flash flood early warning system at Sunamgang & Cox's Bazar area;**

3. **Operationalize long range (1-3 month) forecasts.**

Pilot Areas

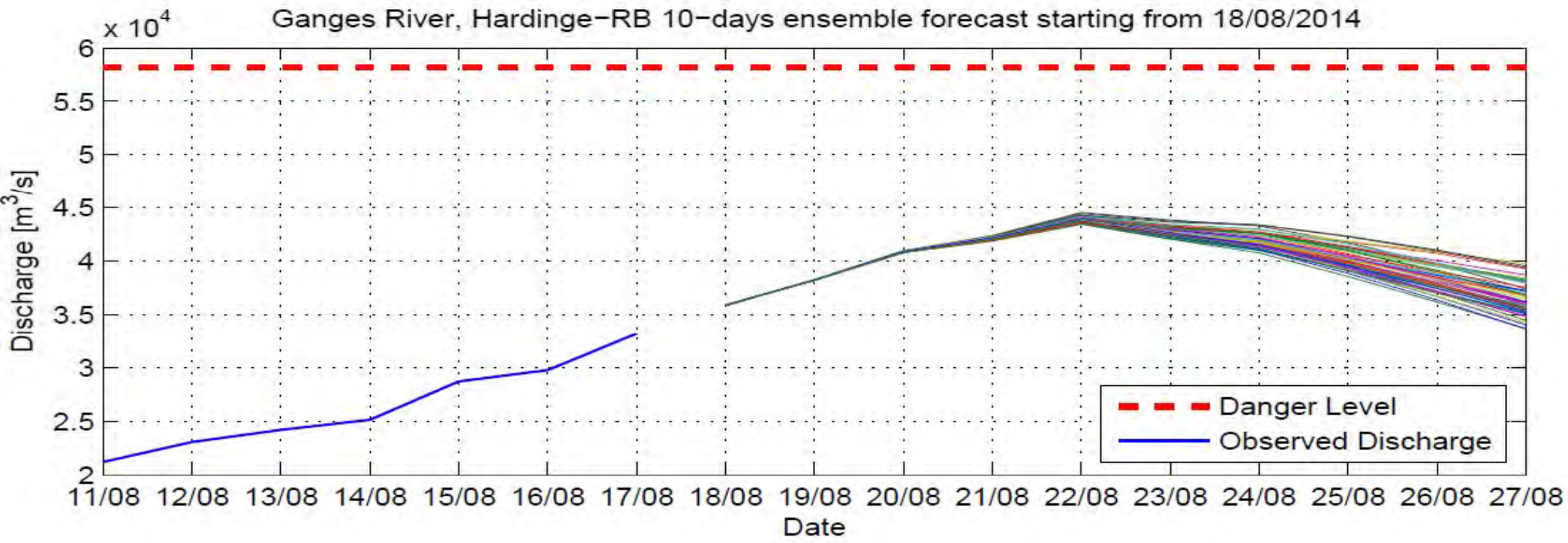

Enhancing Early warning System for community based response In Bangladesh
Legend
0
47,500
95,000
190,000 Kilometers
Selected sites (unions) for monsoon flood forecasting
Selected sites (unions) for rain-fed flood forecasting
Selected sites (unions) for season forecasting
Selected site (union) for flash flood forecasting
Thana boundary for pilot sites
District boundary for pilot sites
RIMES

Forecasting

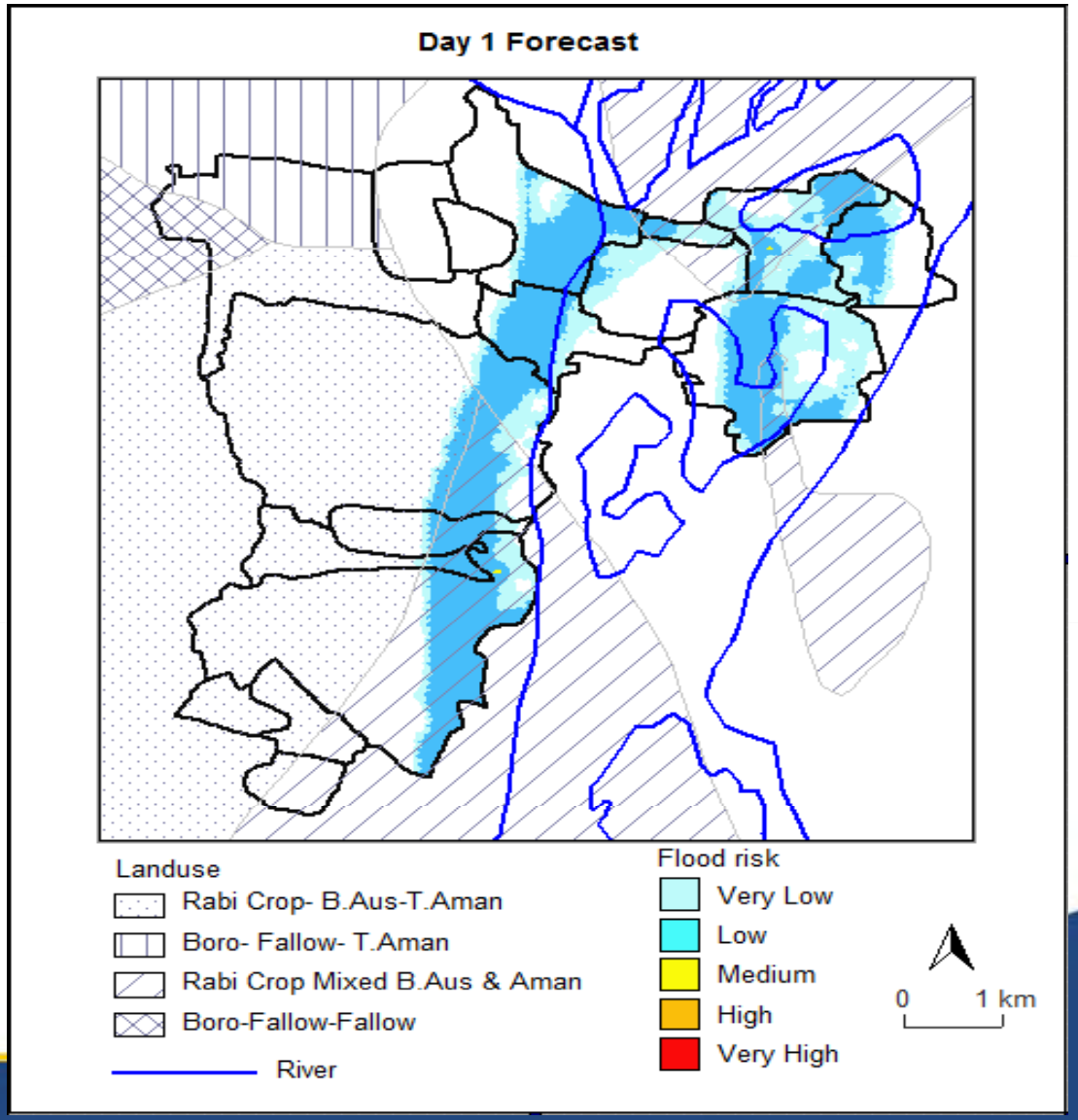
- 3-days deterministic forecast, now extended to 5-days
  - based on water level data as boundary condition at Pankha on Ganges River and Noonkhawa on Brahmaputra River

- 10-days probabilistic forecast with RIMES support
  - based on discharge forecast boundary condition at Hardinge Bridge on Ganges River and Bahadurabad on Brahmaputra River
  - uses ECMWF EPS rainfall forecast, CFAB-FFS model and MIKE11 model

10-days Forecasting



Flood Forecast



Flash Flood Warning Methodology

- Assessment of rainfall intensity-duration thresholds
- Analysis of flash flood potential using observed and forecasted rainfall and thresholds
- Development of web-based system for flash-flood advisory by integrating thresholds with rainfall forecast

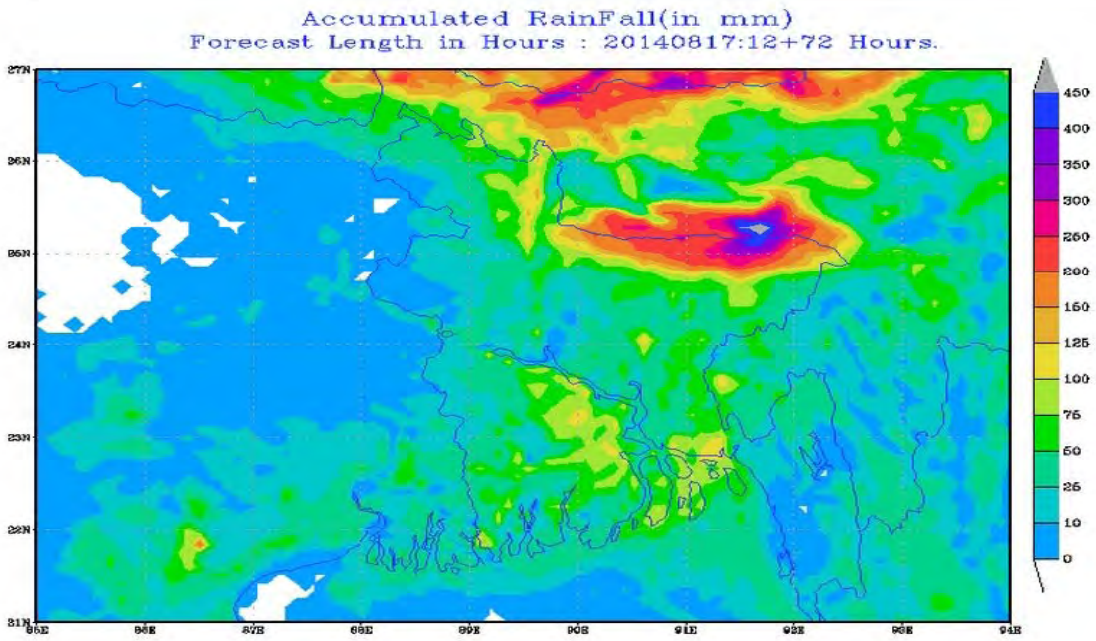
Flash Flood Analysis

Bangladesh Flash Flood Advisory

Station Details | Rainfall Data Analysis | Flash Flood Analysis | User Details | Advisory Composition | Logout

Select Rainfall Type: WRF 3 Days Forecast Select Stations: Sylhet Date of Forecast: 18 August 2014 SUBMIT

RAINFALL | ACC RAINFALL



FORECAST LEAD TIME (HRS) >> 6 | 12 | 18 | 24 | 30 | 36 | 42 | 48 | 54 | 60 | 66 | 72 | 78 | 84

Flash Flood Analysis

Accumulated Rainfall of Sylhet (mm)			
Duration (hrs)	18-08-2014	19-08-2014	20-08-2014
24	28	87.91	56.78
48	56	115.91	144.69
72	56	143.91	172.69
120	56	143.91	200.69
168	56	143.91	200.69
240	56	143.91	200.69
Advisory	NFF	FFW	FFW

Flash Flood Advisory	
FFW: Flash Flood Warning	Flash Flood Warning on 19-08-2014 to 20-08-2014
FFA: Flash Flood Alert	-
NFF: No Flash Flood	No Flash Flood on 18-08-2014

Create Advisory

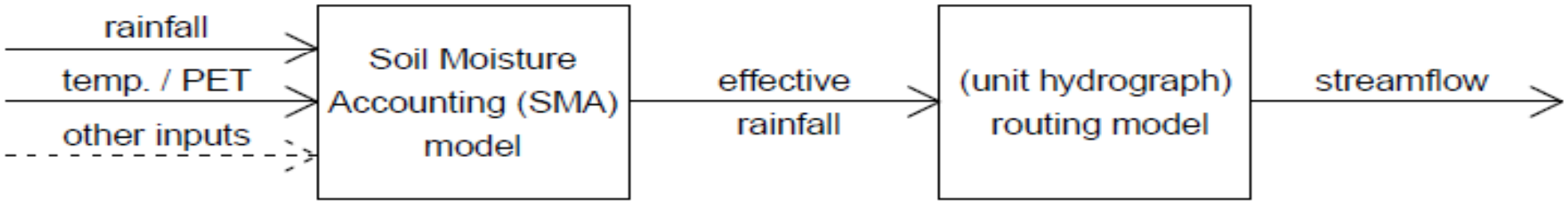
Web-based Dissemination System

Seasonal Flow Outlook

1) Extract ECMWF historical seasonal ensemble (41) forecast of rainfall and temperature for the Ganges and Brahmaputra basins
2) Compute ensemble mean for each grid
3) Compute Mean Areal Precipitation (MAP) and Mean Areal Temperature (MAT) over the catchment
4) Set up rainfall-runoff model with MAP and MAT as input
5) Calibrate and validate the model

Seasonal Flow Outlook

Approach & Methodology



Rainfall-runoff modeling in R-Hydromad package

For Ganges,

SMA: Catchment Wetness Index (cwi),

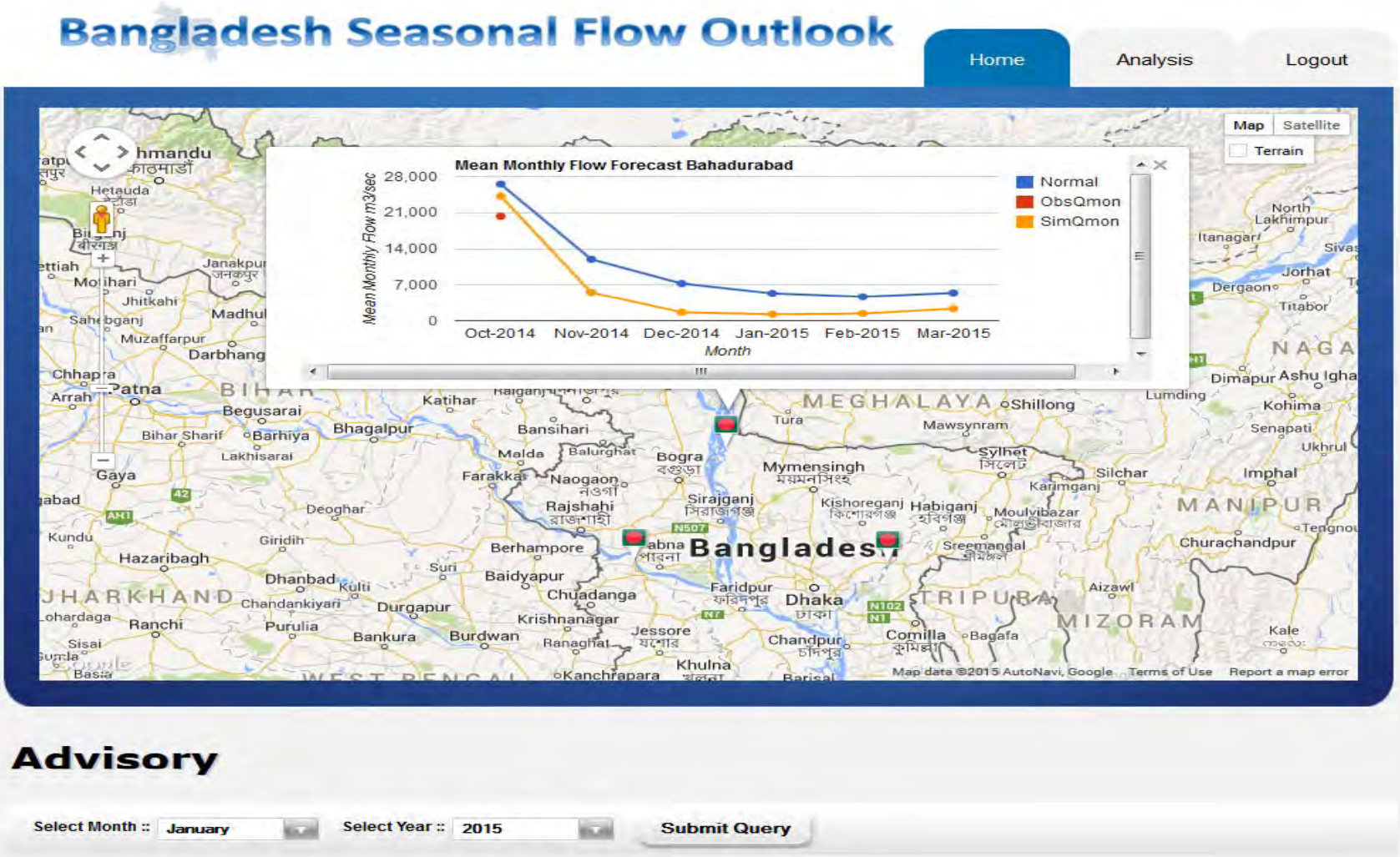
Routing: Exponential Unit Hydrograph (expuh)

For Brahmaputra,

SMA: Catchment Wetness Index (cwi),

Routing: AutoRegressive Moving Average with eXogenous inputs (armax)

Seasonal Flow Outlook System

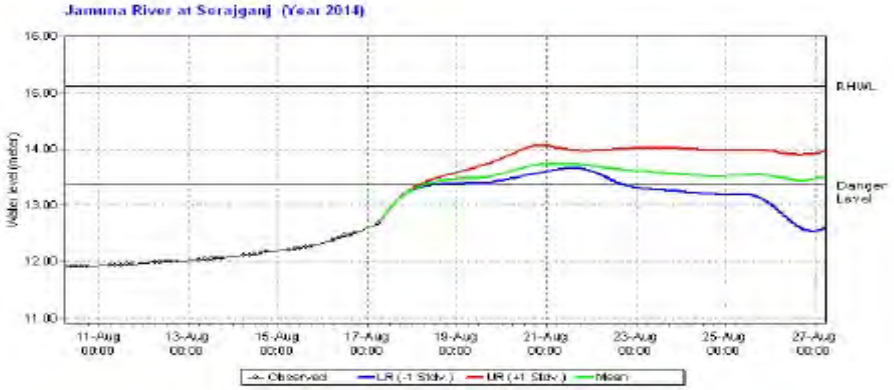


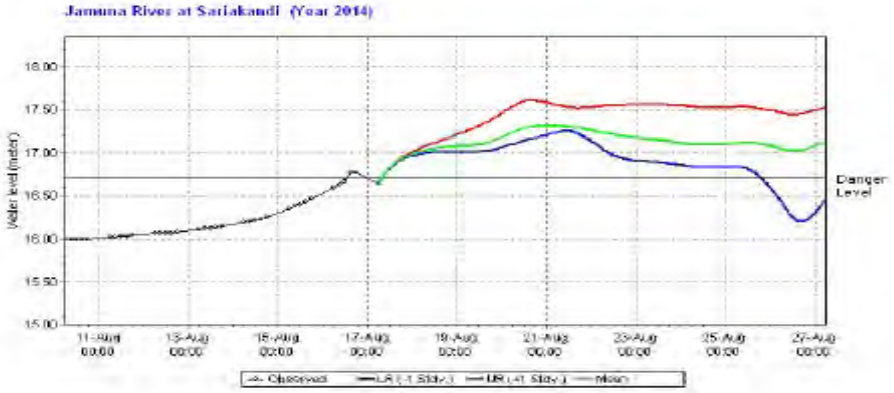
Web-based Dissemination System

Monthly and Seasonal Flow Outlook [Jan 2015 - Mar 2015]

Station	Latitude	Longitude	Mean Monthly Flow (m^3/s)						Mean Seasonal Flow (m^3/s)	
			Jan 2015		Feb 2015		Mar 2015			
			Normal	Forecast	Normal	Forecast	Normal	Forecast	Normal	Forecast
Bahadurabad	25.1655	89.7330	5,351	1,257	4,679	1,394	5,445	2,342	5,158	1,664
Hardinge Bridge	24.0658	89.0264	2,144	695	1,148	941	773	1,245	1,355	960

Integration into FFWC System





ilistic forecasts (51 ensemble series) on
Hardinge Bridge point)and ECMWF rainfall

tandard Deviation from the Mean and -1

rge and the mean rainfall forecast of all

t Board (BWDB) is acting as a background
rought out in FFWC model for this 10-day

with extreme care.

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arning Center
lopment Board
com; ffwcbwdb@gmail.com

Conclusions

- RIMES is developing capacity of member states to generate different ranges of hydrological forecasts (flash flood, 10-days, seasonal).
- Training and capacity building is core component
  - National Professional level
  - Community level
  - Secondment scientists
- Overall flood risk management has been enhanced in member states through different range of early warning systems.

Thank You !

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