

Tools for Flood Management

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Integrated Flood Management



Land-use Planning & control

Structural Measures

Flood Preparedness

Emergency Management

Tools for

Knowledgebase
(data systems)

Analysis &
Modelling

Decision making &
Communication



Overall Goal:
Reduced Risk to society

Making Information travel
faster than flood waters

Learning from past

- A judicious combination of structural flood mitigation and preparedness programs supported by information technology reduces flood disaster risks and minimizes people's suffering

flood management decision making

Questions asked?

- What are the effects of predicted
- What will be the water levels the
- Where are critical locations?
- How to operate the reservoirs?
- Controlled embankment failures

Planning

- Repair and reinforcement of embankments: where?
- How to plan for controlled flooding?

Pak diverts rivers to save cities from floods

Islamabad: Military specialists blew up dikes in central Pakistan to divert swollen rivers and save cities from raging floods that have killed hundreds of people, authorities said Saturday, as officials stepped up efforts to prevent the spread of waterborne diseases.

In Pakistan, at the overflow of the River well on Saturday night as floodwaters hit Multan, a city of Sufi saints. The channels showed floodwaters gushing

the blown-up dikes. Civil and military officials have been using helicopters and boats to evacuate marooned people since Sept. 3, when floods triggered by monsoon rains hit Kashmir, which is part of Pakistan.

Military specialists blew up dikes to divert swollen cities & save cities from raging floods

Integrated Flood Management

Flood Management investigations involve:

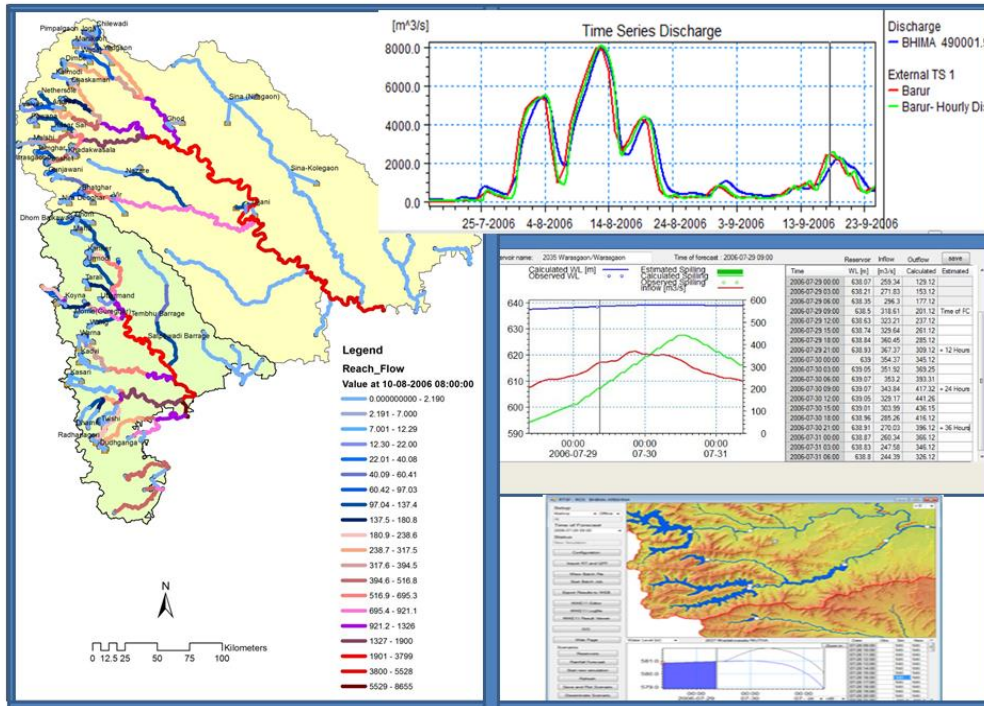
- Comprehensive amounts of data
- Unlimited number of solutions
- Need tools for analysing and decision making

Mathematical Models

Examples

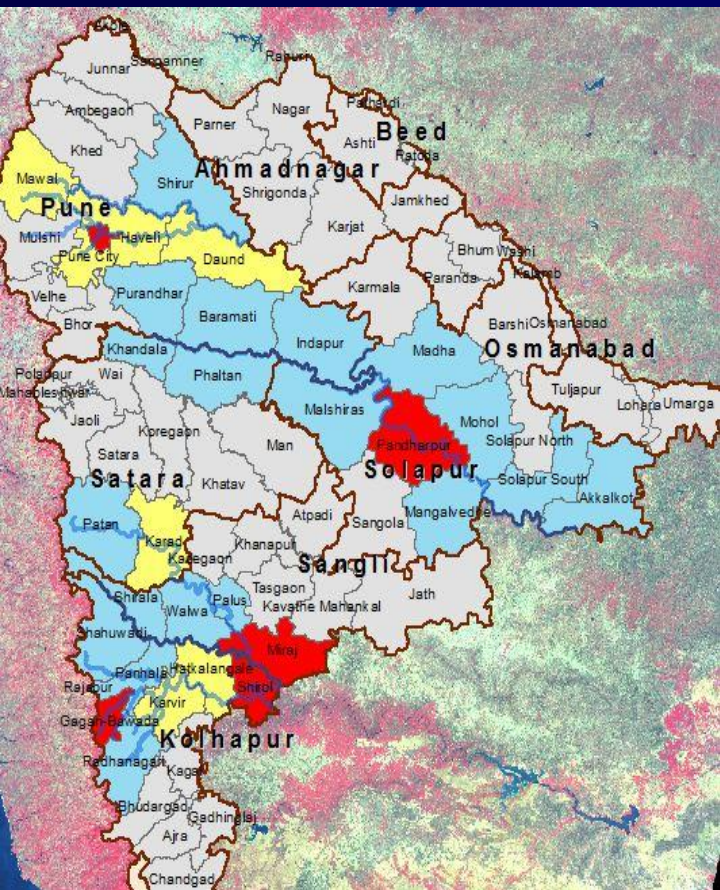
Tools

Example: Krishna-Bhima basins Maharashtra: RTDSS



Inflow forecast
Reservoir operation
Optimization
Food forecasting
Warning dissemination
Benefits

Flood disasters in Maharashtra

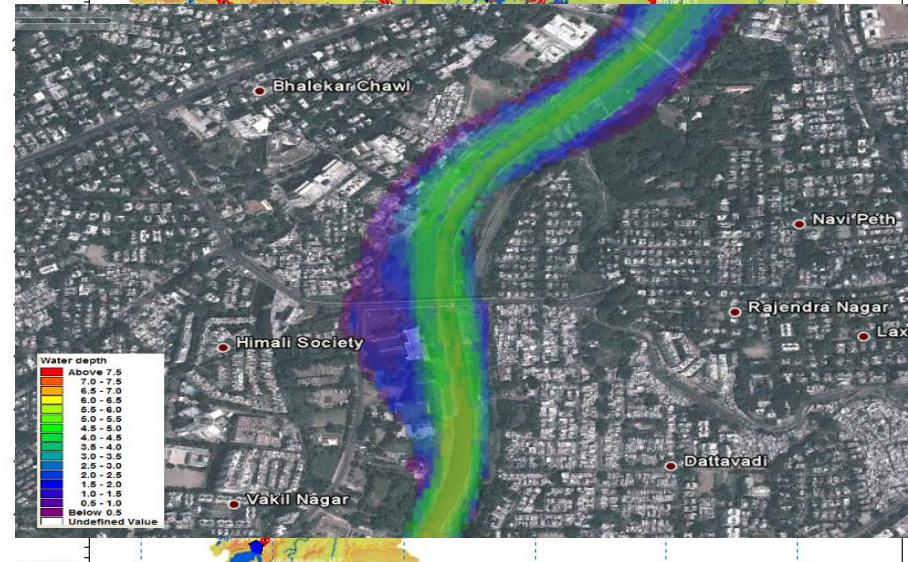


Widespread Floods In Maharashtra, 30 Cars Submerged In Pune



Maharashtra: Krishna-Bhima basins floods of 2005-2006

District	Human Losses		Cattle Losses	
	2005	2006	2005	2006
Satara	11	23	156	239
Sangli	13	19	224	23
Kolhapur	26	26	236	80



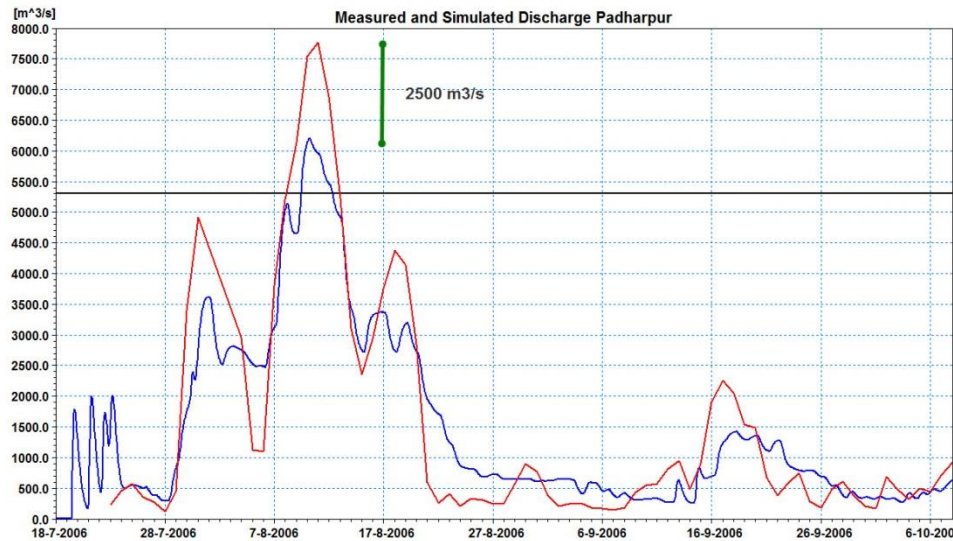
46 major and medium reservoirs
Operated with rigid operational rule
curves: keep the reservoirs full
towards the end of rainy season.

But when heavy rain occurs in
catchments, then the reservoirs
are operated releasing sudden
floods downstream causing
damaging floods.

High Level Government commission:

Floods of 2005 and 2006 were devastating, strong needs of specific forecasts and early warning were felt. Reservoir operations should consider downstream flooding more explicitly.

Optimized reservoir operation during flood emergencies



**These losses
could have been
avoided**

1.3

2386.3

238 crore / yr.

District

2005

2006

2005

2006

Satara

11

23

156

239

Sangli

13

19

224

23

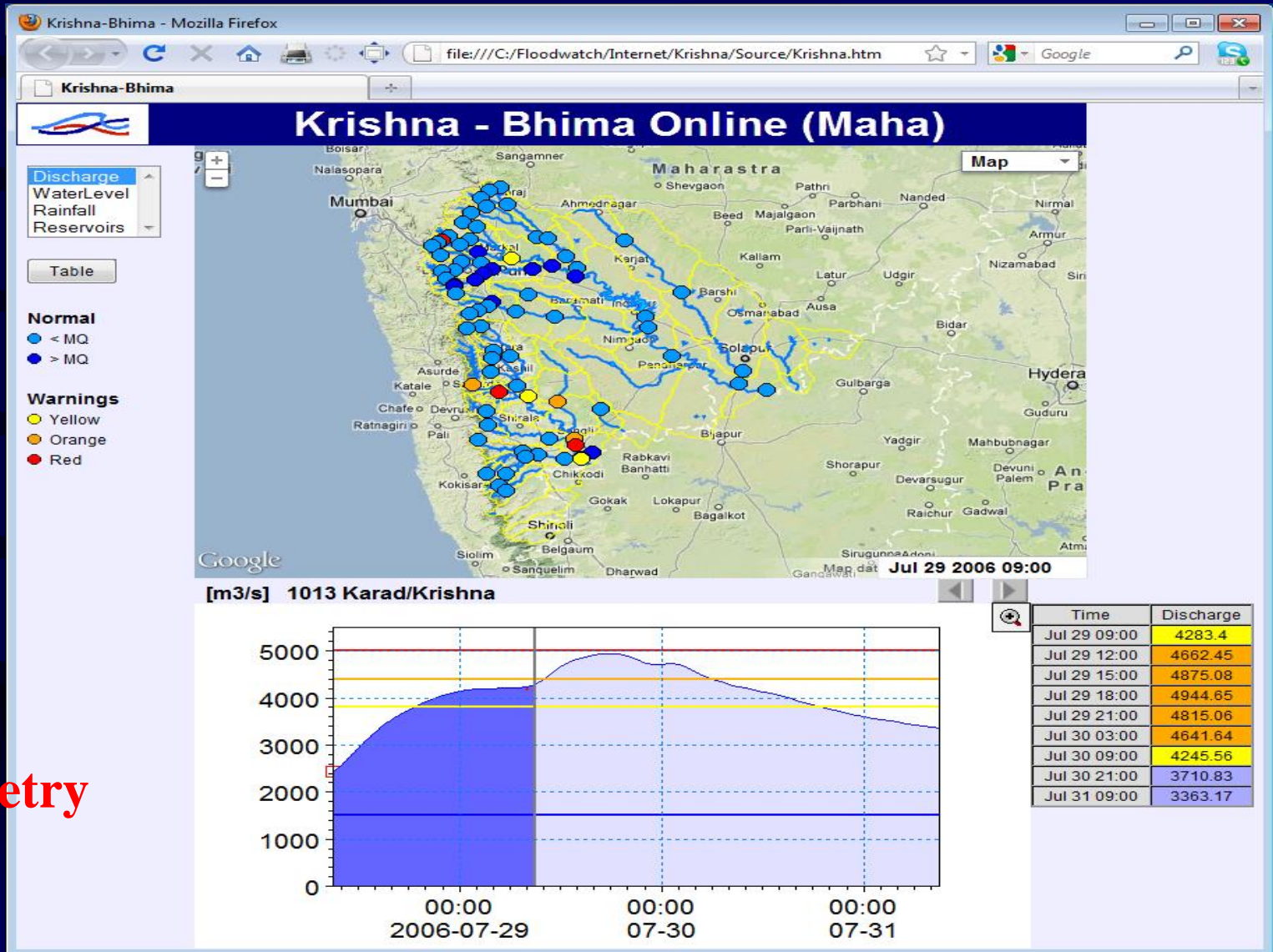
Total Project cost = 31.85 Crores

Cost of setting up RTDAS (telemetry 300 stations) = 23 crores

**Cost of forecasting system incl., software, datatbase, capacity bldg.,
(completed in 18 months + 2 years support = 8.15 cr**

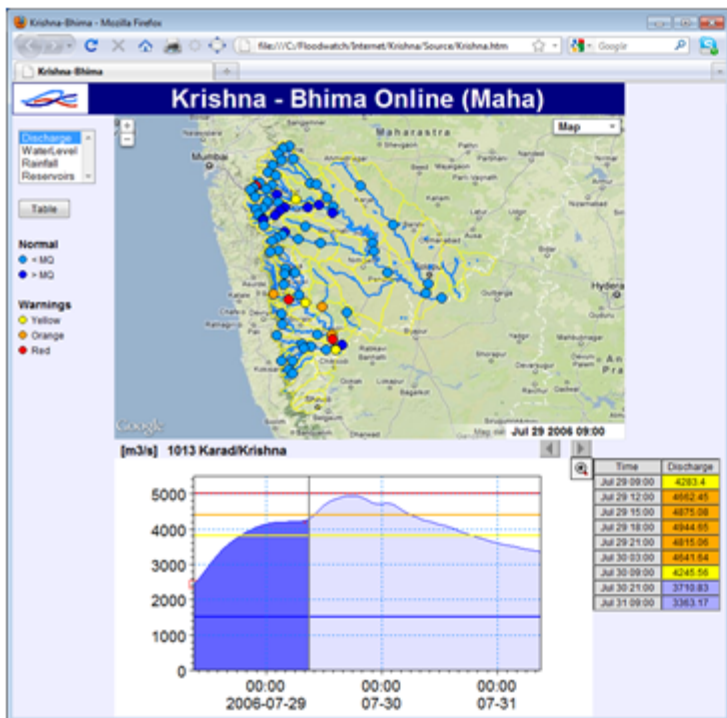
**Cost of software (1 set of MIKE11 RT= Rs. 16 lakhs only (less than
0.50 %)**

Krishna River Forecasting (Maharashtra)



300 telemetry stations

Overall RT Flood forecasting System



DATA BASE
Historical
Data
Real Time

RTDAS

Met
Forecasts

Calibrated
Models (RR-
HD)

Forecasting,
Operation
System

COMMUNICATION
Warning
Dissemination

WEB
PC

WEB
Mobile



Comprehensive Knowledge base system (linked to RTDAS)

Krishna-Bhima Knowledge Base System - workspace1

Connection View Settings

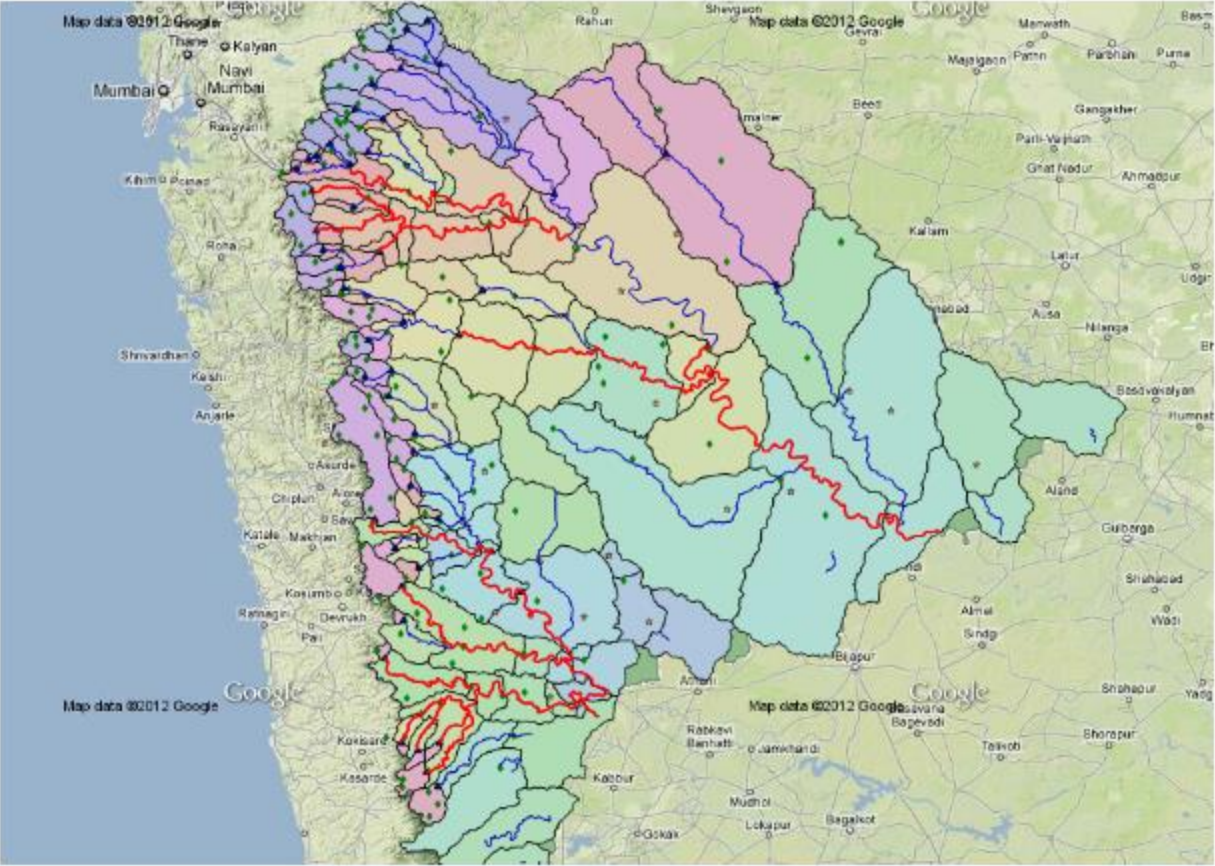
Time series

Database

- KrishnaBhima
 - Forecasting
 - GroundWater
 - Hydrology_Historical
 - Hydrology_RT
 - Irrigation_Daily
 - Irrigation_Historical
 - Meteorology_Historical
 - Meteorology_RT
 - New group1
 - Realtime
 - FCS
 - AirPressure
 - Evaporation
 - Humidity
 - Rainfall
 - SolarRadiation
 - Temperature
 - WindDirection
 - WindSpeed
 - RAIN
 - RESERVOIR
 - Gate Level
 - Water Level
 - RIVER stations
 - Discharge
 - Water Level

Start Page

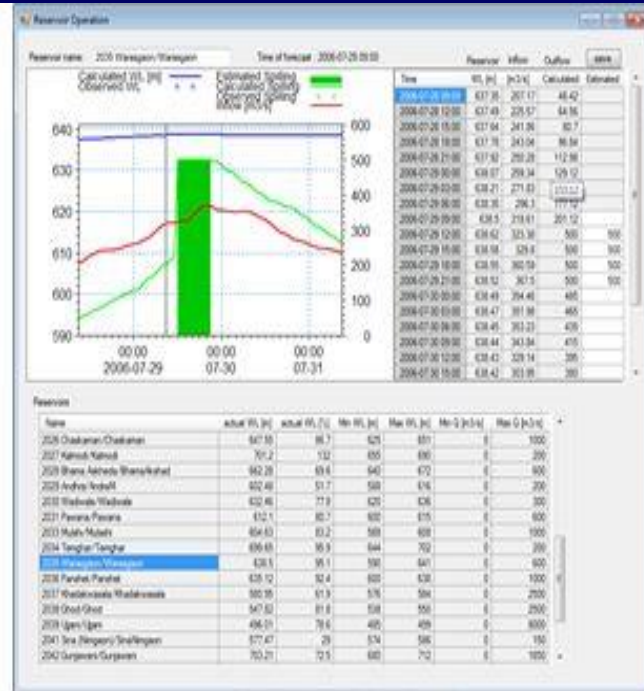
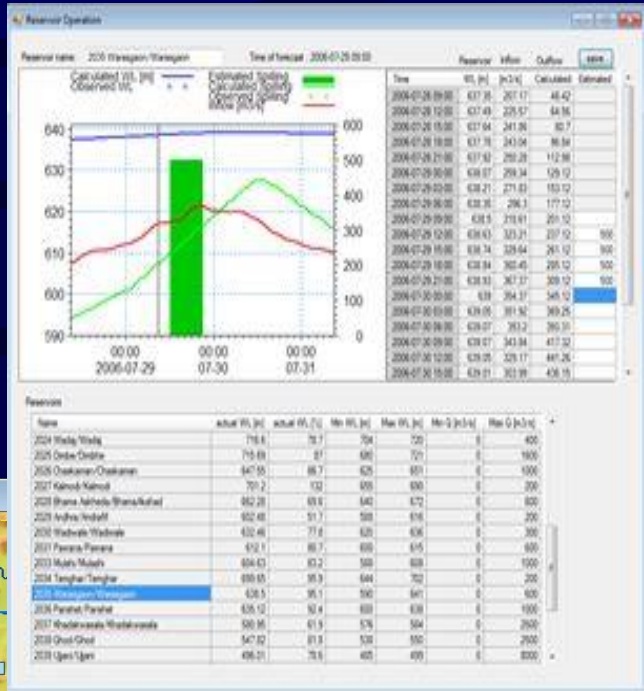
RTSF & ROS for Krishna & Bhima Basins in Maharashtra (Knowledge Base System)



Map data ©2012 Google

admin | Connected to: KrishnaBhima | Status: Ready

SOLUTION

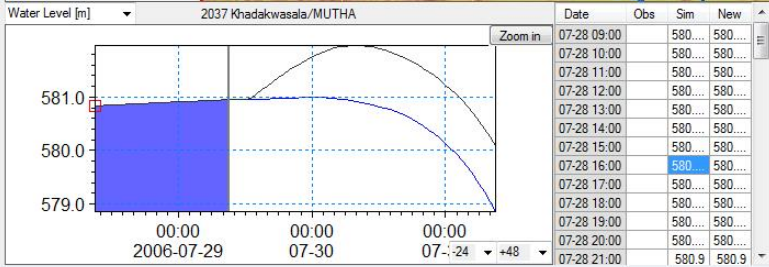
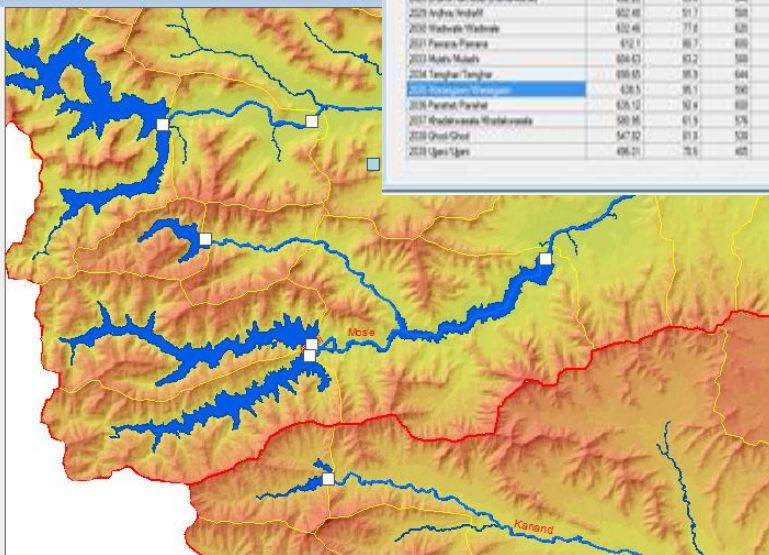


RTSF - ROS BHIMA-KRISHNA

Setup
 Krishna Offline
 All
 Time of Forecast
 2006-07-29 09:00
 Status
 New Simulation

Configuration
 Import RT and QPF
 View Batch File
 Start Batch Job
 Export Results to WEB
 MIKE11 Editor
 MIKE11 Logfile
 MIKE11 Result Viewer
 GIS
 Web Page

Scenarios
 Reservoirs
 Rainfall Forecast
 Start new simulation
 Refresh
 Save and Plot Scenario
 Disseminate Scenario



Reservoir operation decision making - interactive

Dissemination system

Flood Bulletin

Krishna-Bhima - Mozilla Firefox

file:///C:/Floodwatch/Internet/Krishna/Source/Krishna.htm

Krishna-Bhima

Krishna - Bhima Online (Maha)

Discharge
WaterLevel
Rainfall
Reservoirs

Table

Normal
 • < MQ
 • > MQ

Warnings
 • Yellow
 • Orange
 • Red

Map

Nanded, Nirmal, Amrur, Nizamabad, Bidar, Hyderabad, Gudur, Devarasugur, Devuni, Anaparthi, Pra

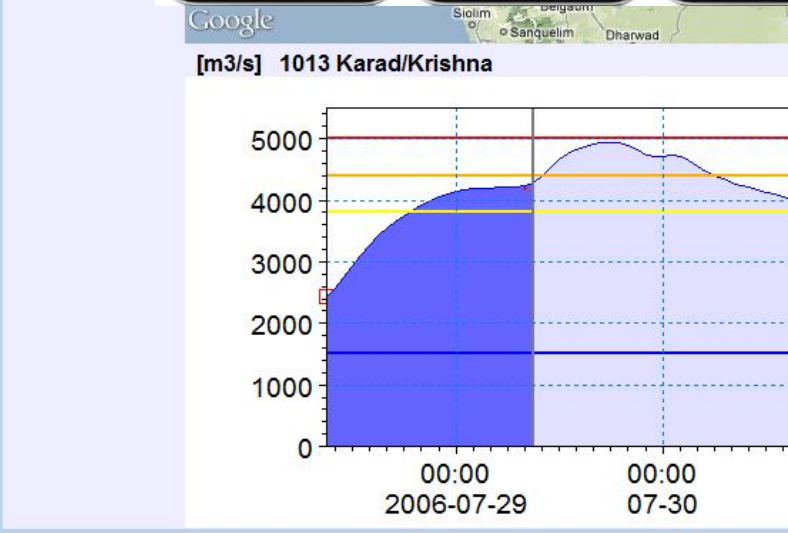
Flood Warnings

ig Message

Krishna-Bhima Discharge Bulletin

Time of Forecast : 2006/07/29 09:00

Station / River	MG	Valley	Orange	Red	0	3	6	9	12	18	24	36	48	Time	Maximum	Max
1001 Krishna Bridge (Sangam Mahuli/Krishna)	1800	2000	3000	376	404	427	403	317	241	160	102	2006-07-29 15:00	427			
1002 Navarata (Sangavadi Bridge)/Koyna	1200	2000	2800	3243	3834	3610	3500	3225	3009	3034	2846	2804	2006-07-29 12:00	3834		
1003 Shingam/Warana	1800	1800	1788	2000	2111	206	712	729	746	769	802	742	587	2006-07-30 09:00	802	
1004 Nizamabad/Kaam	800	1000	1500	256	267	289	334	360	384	460	236	359	2006-07-30 09:00	868		
1005 Balinga/Phangavati	800	1000	1268	1500	422	435	479	588	705	915	700	401	844	2006-07-30 03:00	913	
1006 Watalgaon/Paranganga	1800	2000	2800	160	162	169	177	187	1412	1136	849	1023	2006-07-30 09:00	1440		
1007 Lohakranji/Phanganga	1800	2000	2250	2800	572	547	547	551	706	1059	1195	588	1110	2006-07-30 05:00	1195	
1008 Shivdada/Krishna	1200	2000	2250	2800	949	909	1023	1000	1005	977	933	563	431	2006-07-29 19:00	1073	
1009 Sangli/Bhuteswar/Krishna	1800	2000	3000	3900	4168	4508	4808	4808	4808	4808	4808	4808	4808	2006-07-30 07:00	4808	
1010 Ankal Bridge/Krishna	1500	2000	3000	4000	4322	4674	4793	5021	5001	5054	5008	5078	2006-07-30 11:00	5089		
1011 Miraj/Krishna	800	8000	8000	8139	8420	8656	8887	8123	8047	8032	8743	8790	2006-07-30 14:00	8887		
1012 Sheshajai (Aphal) Aqueduct/Venata	800	100	169	200	176	227	274	294	298	278	202	178	98	2006-07-29 19:00	298	
1013 Karad/Krishna	1800	2000	4400	4283	4688	4848	4833	4848	4248	4371	3983	2006-07-29 18:00	4848			
1014 Kumbhaji/Krishna	2000	4000	8000	4144	4374	4628	4883	5166	5667	6000	6000	6000	2006-07-30 18:00	6000		
1015 Shirur/Ghod	400	800	1150	1500	44	47	54	57	54	71	84	93	2006-07-31 09:00	93		
1016 Andajadi/Ghod	400	800	1150	1800	48	48	52	56	58	84	71	82	89	2006-07-31 09:00	89	
1017 Korangal/Bhima-Bhima	400	800	1000	1200	883	886	884	889	889	889	889	889	2006-07-30 18:00	889		
1018 Nighoje/Indrayani	500	1000	1500	2000	812	815	815	794	764	671	618	498	394	2006-07-29 13:00	819	
1019 Phimale/Ghatra/Pavana	800	800	1000	1200	101	99	96	94	110	97	82	66	2006-07-30 09:00	112		
1020 Pavali/Mula	200	300	400	500	95	96	98	101	102	90	88	78	69	2006-07-29 22:00	102	
1021 Dattawadi/Multha	800	2000	2800	3000	1448	1448	1450	1451	1452	1456	1452	1448	2006-07-30 08:00	1456		
1022 Kalyani Nagar Bridge/Multha	1800	2000	3000	1821	1952	1976	1990	2007	2024	2054	1948	1680	2006-07-30 04:00	2028		
1023 Khajangal/Multha	1800	3000	4000	1570	1917	1943	1983	2000	2024	2039	1938	1923	2006-07-30 08:00	2040		
1024 Pargan/Bhima	2000	1900	8000	2819	2716	2787	2841	2882	2810	2885	2728	2848	2006-07-30 04:00	2810		
1025 Gavati/Ghod	800	0	0	0	0	0	0	0	0	0	0	0	0	2006-07-31 01:00	0	
1026 Panthapur/Bhima	3000	4000	8000	189	191	189	180	148	112	81	421	2006-07-31 01:00	281			
1027 Tali/Banur/Bhima	800	8000	7000	15	13	12	12	12	11	183	186	2006-07-31 02:00	186			
1028 Siddharwad/Nagari	1500	500	769	1000	0	0	0	0	0	1	1	1	2006-07-30 04:00	1		
1029 Dausdi/Bhima	1800	3000	4000	2354	2524	2649	2740	2809	2888	2933	2913	2006-07-30 09:00	2903			
1030 Kumbhaji/Bhima	1800	1800	1800	11	12	13	14	15	17	16	18	2006-07-30 09:00	17			
1031 Nira Naranjipurna	1500	3000	7000	1000	10	10	9	9	17	35	30	2006-07-30 17:00	40			
1032 Umbara Kasurdi/Karnad	300	800	1000	1200	398	407	414	445	443	443	311	220	2006-07-29 21:00	471		
1033 Lake/Nira	800	3200	1500	1	1	1	1	1	1	1	1	24	2006-07-31 09:00	34		
1034 Ambajhari/Nira	400	800	800	1800	88	81	77	74	72	70	67	89	89	2006-07-29 05:00	89	
1035 Bulani/Krishna	2000	4000	8000	4122	4345	4545	4707	5181	5468	5836	5806	5999	2006-07-30 18:00	5999		
1036 Devuni/Krishna	800	800	8000	23	23	23	23	23	23	23	23	113	2006-07-31 09:00	113		
2001 Dhom/DHOM RESERVOIR	800	1000	1280	0	0	0	0	0	0	0	0	0	2006-07-29 09:00	0		
2002 Dhoni/Balkavadi/DHOM BALKAVADI RESERVOIR	100	200	280	300	0	0	0	0	0	0	0	0	2006-07-29 09:00	0		



2012-08-31 08:00
Flood Warning Message for Bhima and Krishna rivers.
Rivers are flowing above WARNING LEVEL at one or more locations within the next 24 hours.
Please check [www.tifros.com/Krishna/Source/Krishna.htm](http://www.tifros.com/Krishna/Source/KrishnaMobile.htm) for more information.

Send SMS

SMS & E-mail alerts

Email Warning Message

Subject Warning Message from Flood Control Center in Pune

2012-08-31 08:00
Flood Warning Message for Bhima and Krishna rivers.
Rivers are flowing above WARNING LEVEL at one or more locations within the next 24 hours.
Please check www.tifros.com/Krishna/Source/Krishna.htm for more information.

Following locations are forecasted to be above WARNING LEVEL:
Water Level at 2002 Navarata (Sangavadi Bridge)/Koyna
Release from 4034 Temghar/TEMGHAR RESERVOIR

Send Email

SMS Receivers

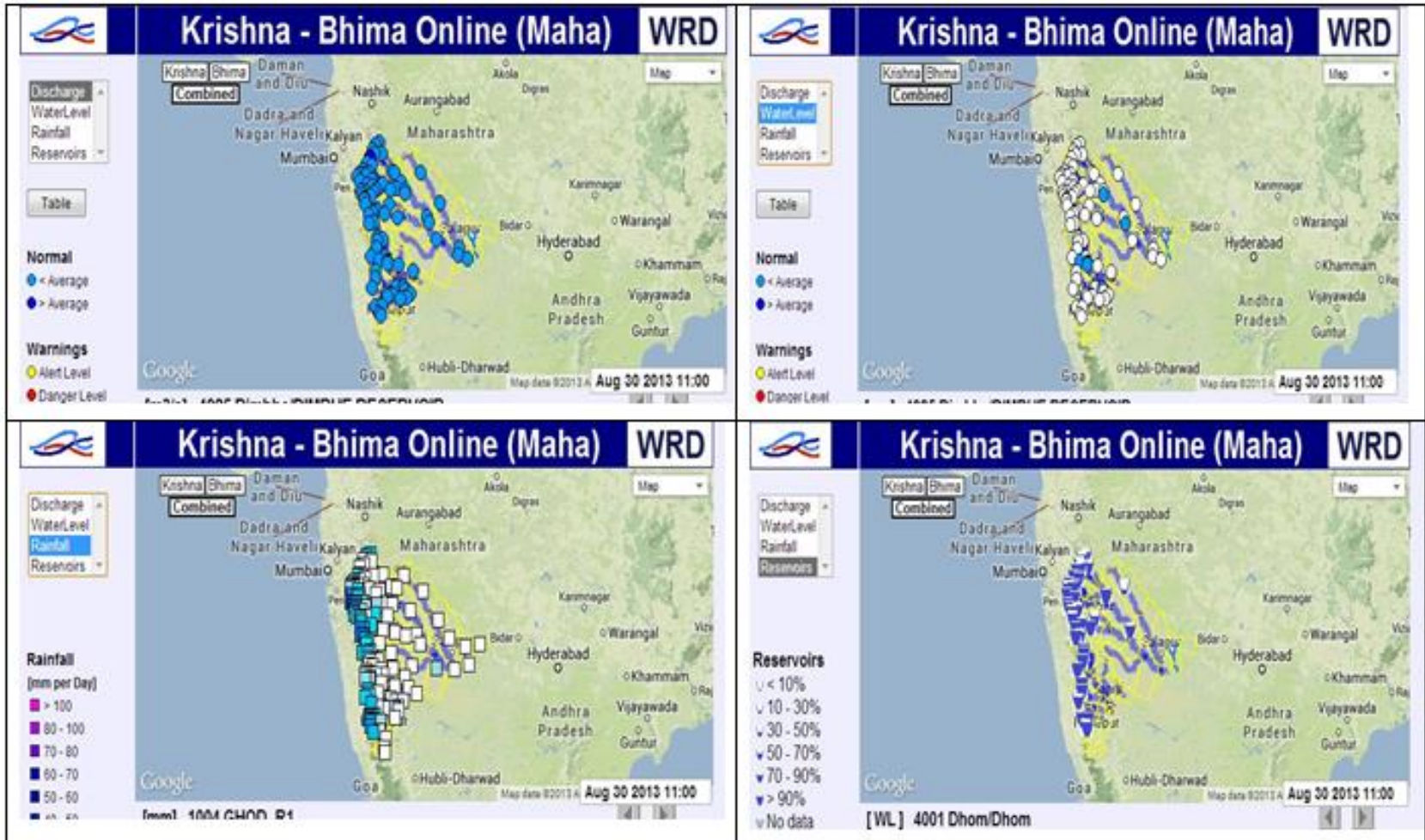
Name	Number
Chief Engineer	9599999999
Executive Engineer	8888888888
Director	7777777777
Receiver n	6666666666

Email Receivers

Name	Email
Receiver 1	email1@gmail.com
Receiver 2	email2@gmail.com
Receiver n	emailn@gmail.com

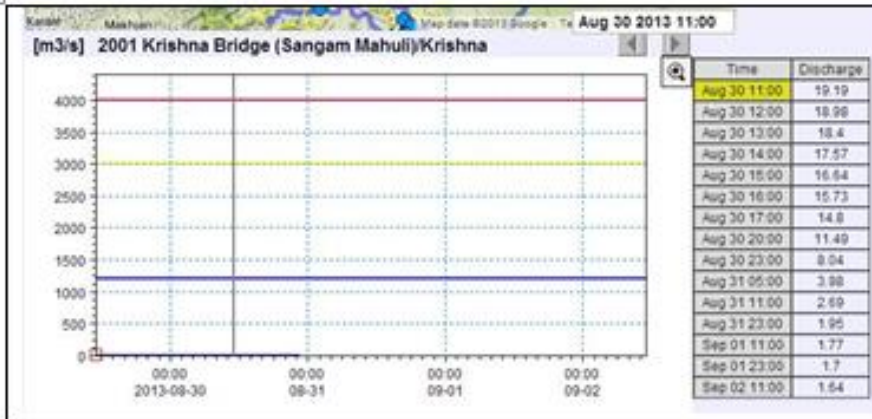
System tetsing: 2013, 2014 monsoons

30th August 2013



Day-to-day operation results

Krishna Bridge



Sangali Bypass



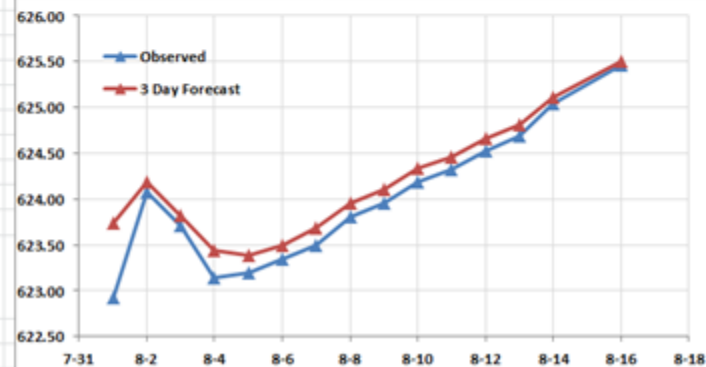
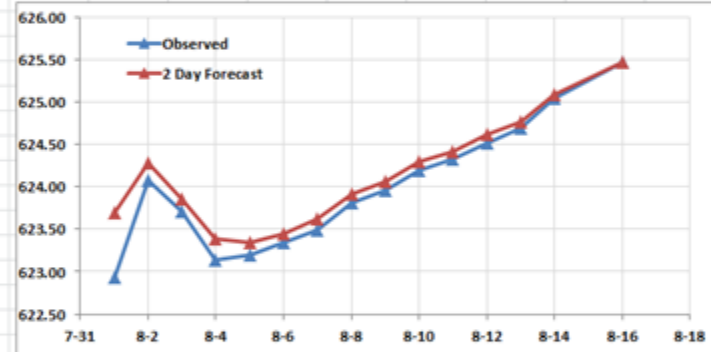
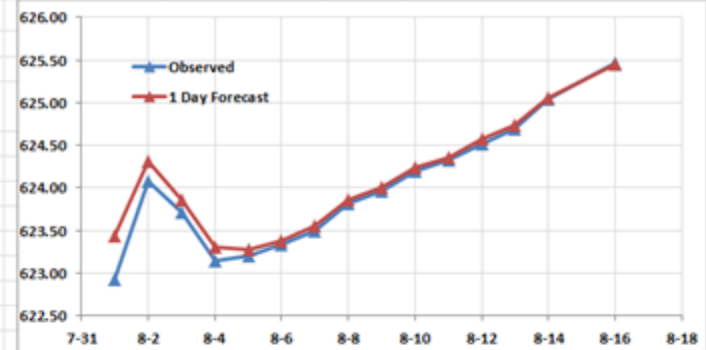
System performance

warana

Date	Observed	1 Day Forecast		2 Day Forecast		3 Day Forecast	
		Forecasted	Difference	Forecasted	Difference	Forecasted	Difference
01-08-2013	622.93	623.44	-0.51	623.70	-0.77	623.74	-0.81
02-08-2013	624.08	624.31	-0.23	624.28	-0.20	624.18	-0.10
03-08-2013	623.71	623.86	-0.15	623.86	-0.15	623.82	-0.11
04-08-2013	623.14	623.31	-0.17	623.39	-0.25	623.44	-0.30
05-08-2013	623.20	623.28	-0.08	623.34	-0.14	623.39	-0.19
06-08-2013	623.34	623.38	-0.04	623.44	-0.10	623.50	-0.16
07-08-2013	623.49	623.55	-0.06	623.62	-0.13	623.69	-0.20
08-08-2013	623.81	623.86	-0.05	623.91	-0.10	623.96	-0.15
09-08-2013	623.96	624.00	-0.04	624.06	-0.10	624.11	-0.15
10-08-2013	624.19	624.24	-0.05	624.29	-0.10	624.34	-0.15
11-08-2013	624.32	624.36	-0.04	624.41	-0.09	624.46	-0.14
12-08-2013	624.52	624.57	-0.05	624.61	-0.09	624.66	-0.14
13-08-2013	624.69	624.73	-0.04	624.77	-0.08	624.81	-0.12
14-08-2013	625.04	625.05	-0.01	625.08	-0.04	625.11	-0.07
16-08-2013	625.46	625.45	0.01	625.46	0.00	625.50	-0.04

Count		15		15		15
Mean	623.59	624.09		624.15		624.18
bias		-0.101		-0.156		-0.189
RMS		0.161		0.234		0.258
BI		-0.0002		-0.0003		0.000
SI		0.000		0.000		0.000
r (Correlation Coefficient)		0.85		0.84		0.84

Note: Correlation coefficient varies between -1 to +1 depending upon rising or falling nature of water level. +1 and -1 signifies perfect match mean accurate result. Zero mean poor match.



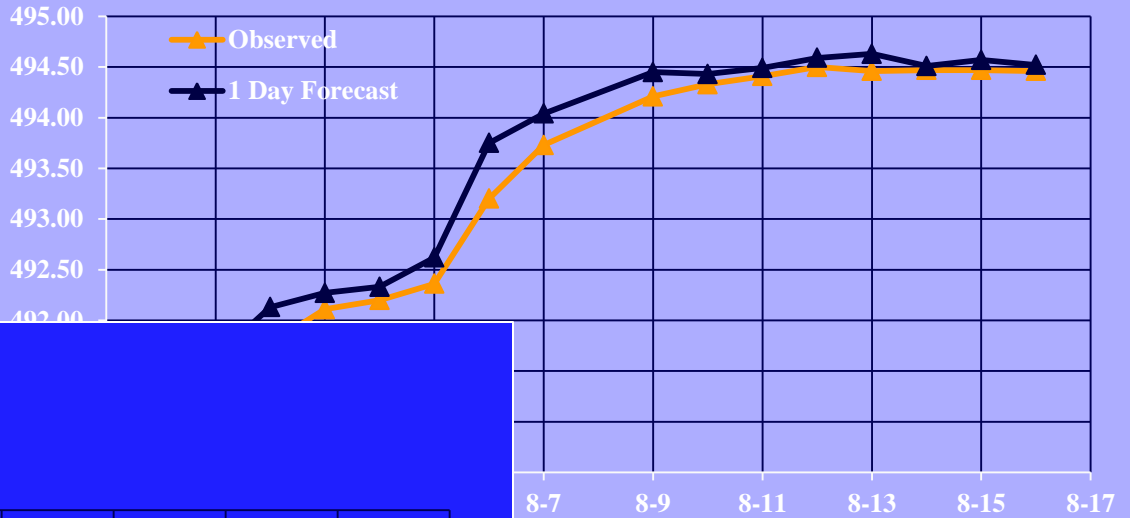
System performance 2014

Ujjani Res

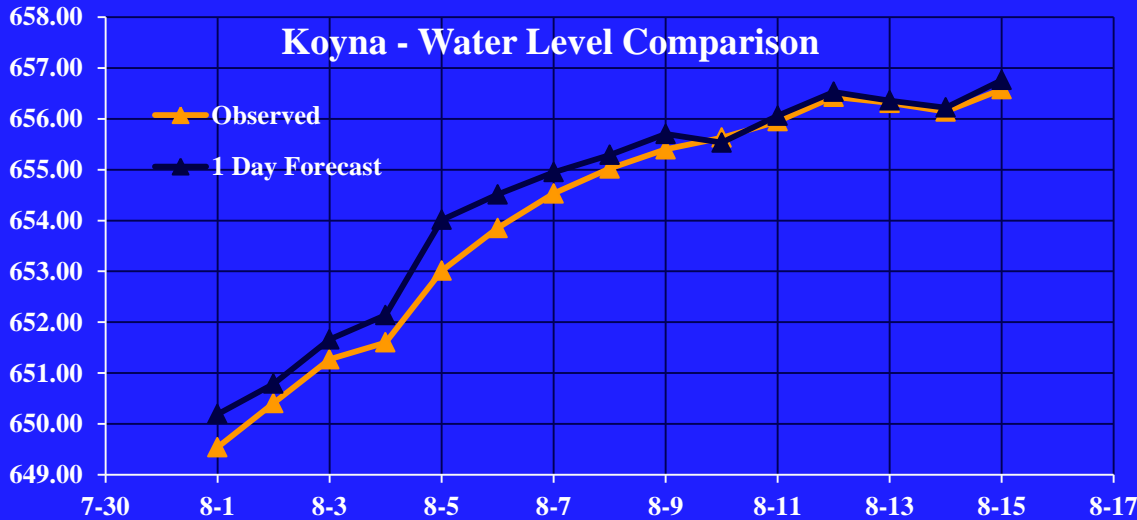
1 Day Forecast
Forecasts Differ

Date Observed

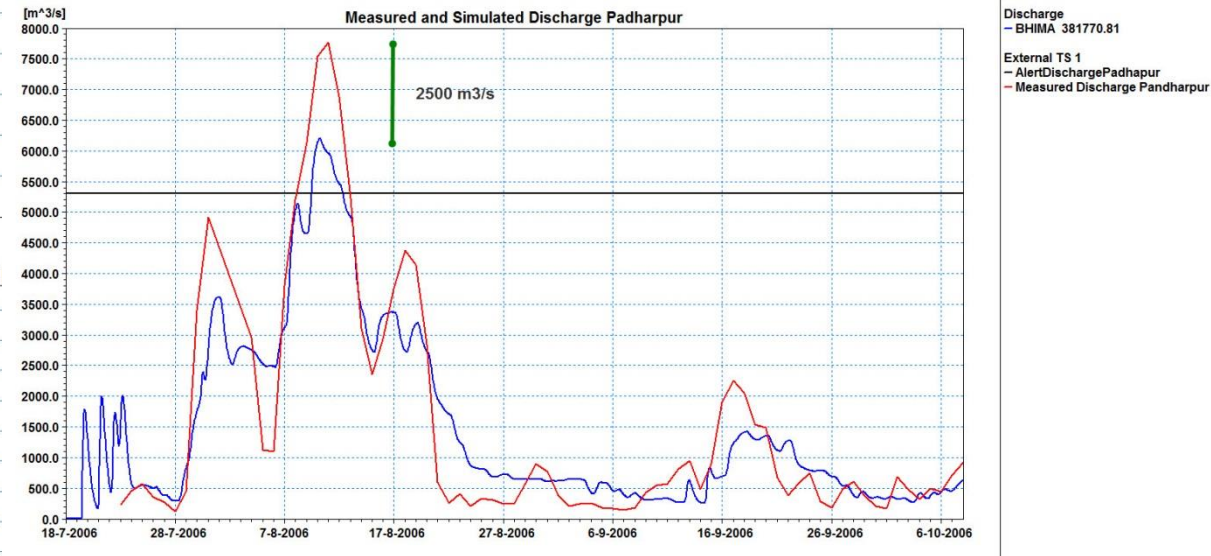
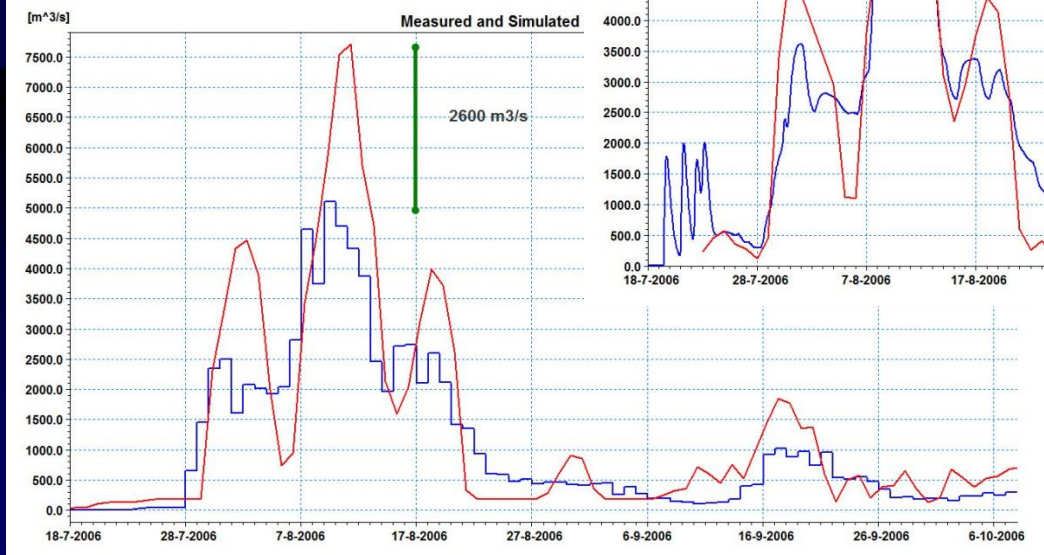
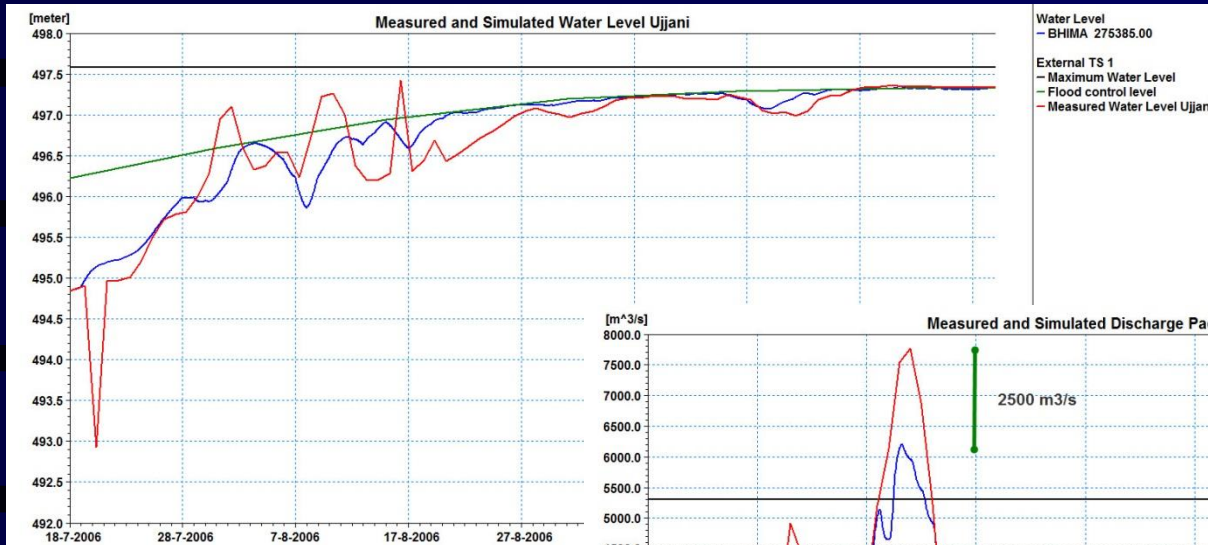
Ujjani- Water Level Comparison



Koyna - Water Level Comparison

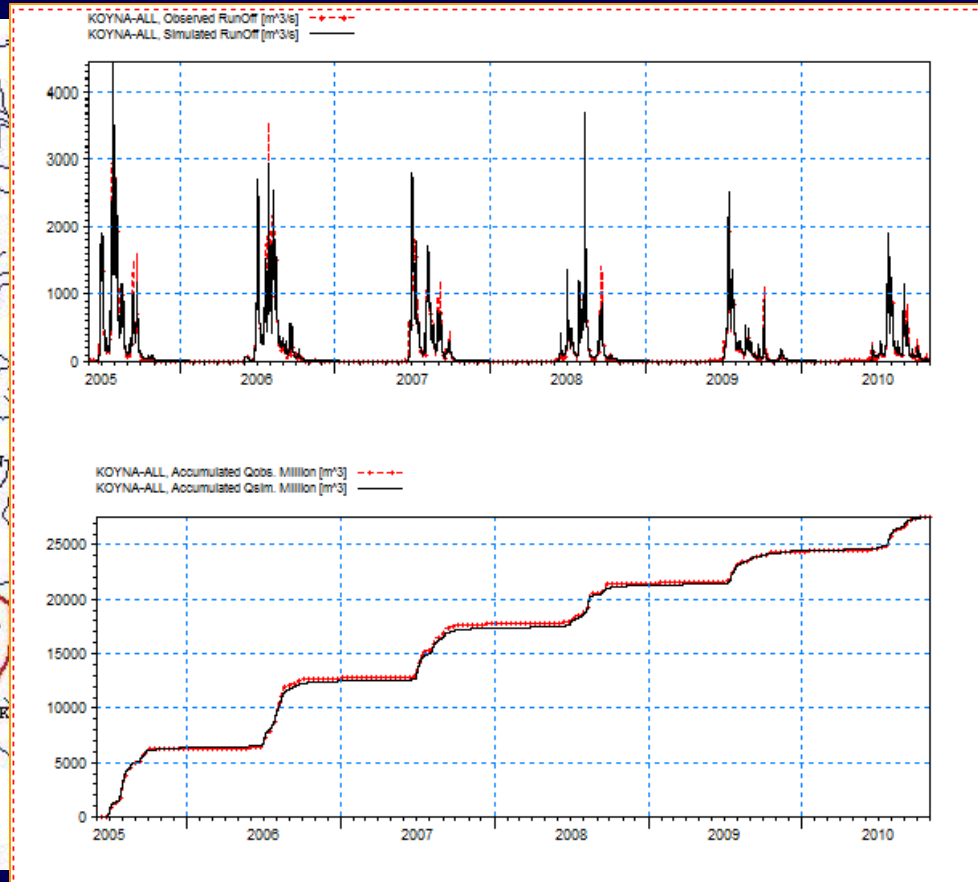


Optimization of Reservoir Operational short term during flood emergencies



Koyna Dam model

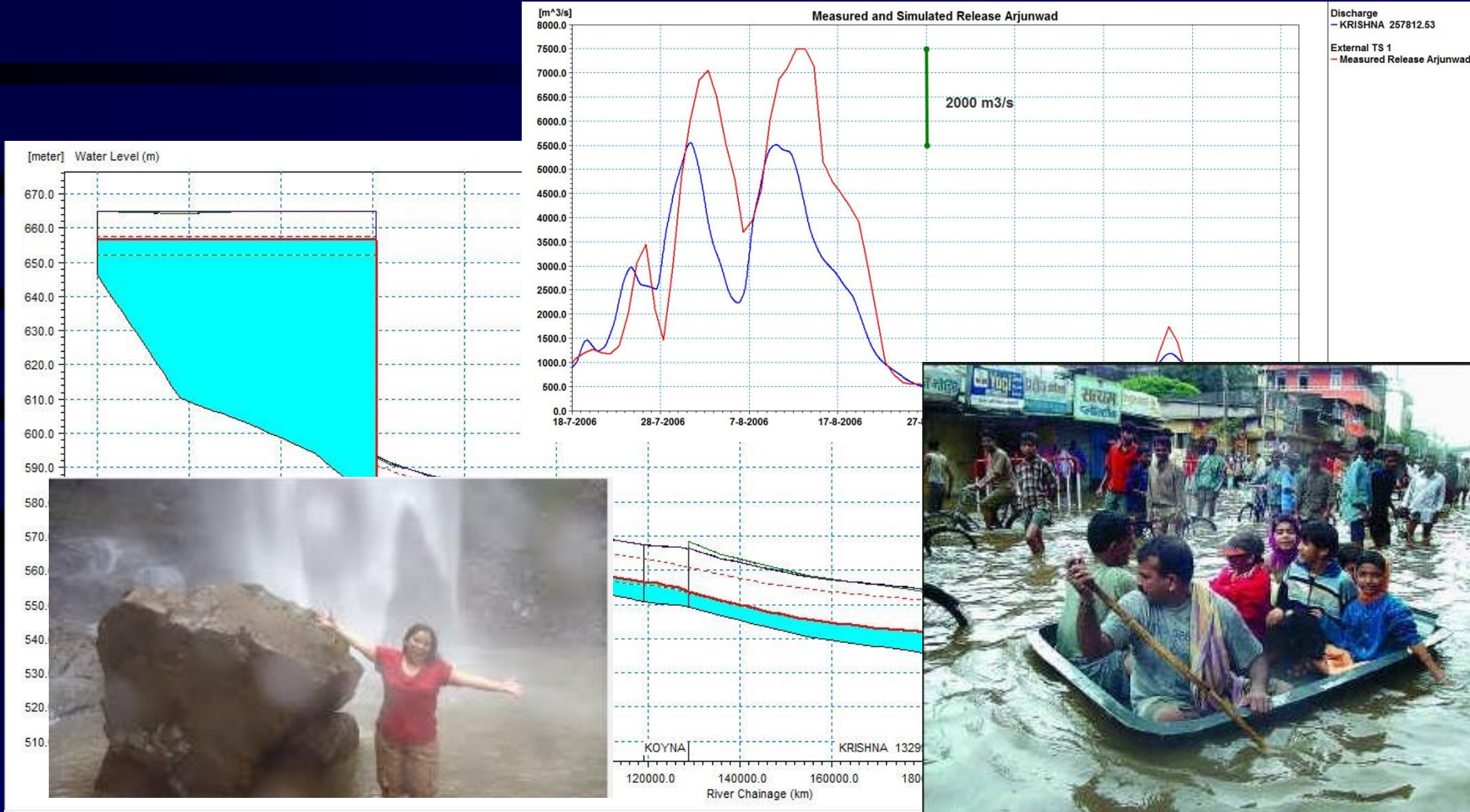
6 hrs lead time)



Comparison of Simulated and Observed Discharges for Koyna Catchment ($R^2=0.95$, $Wb1=0.00\%$ (Obs=5660mm/y, Sim=5660mm/y)) – near perfect calibration with good rainfall data

Reservoir Operational Guidance System

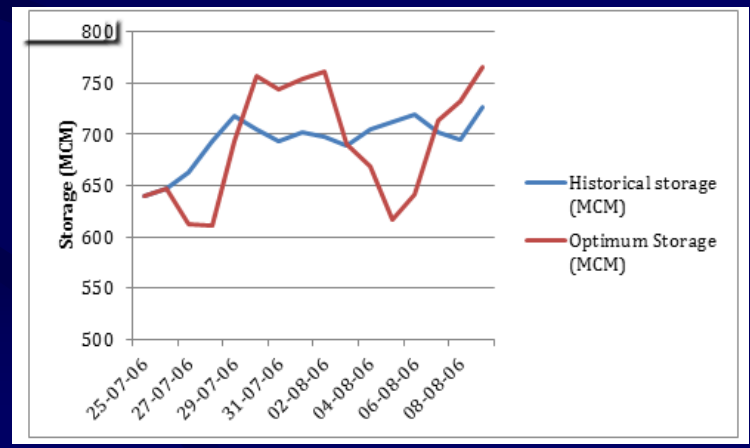
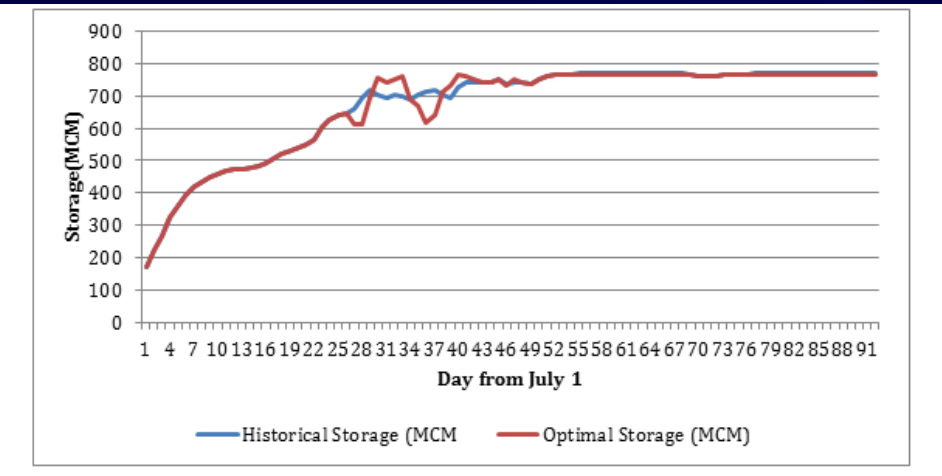
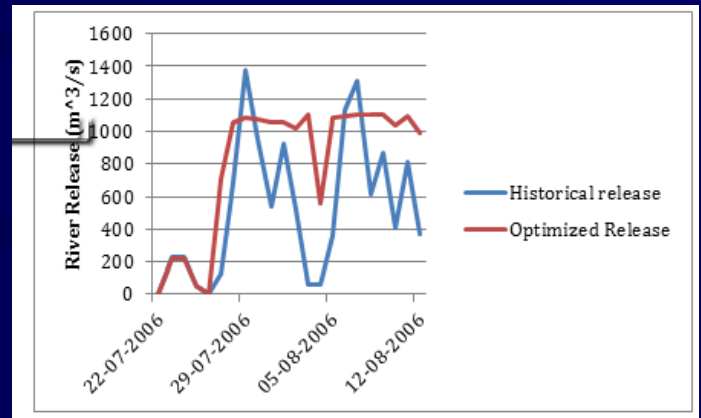
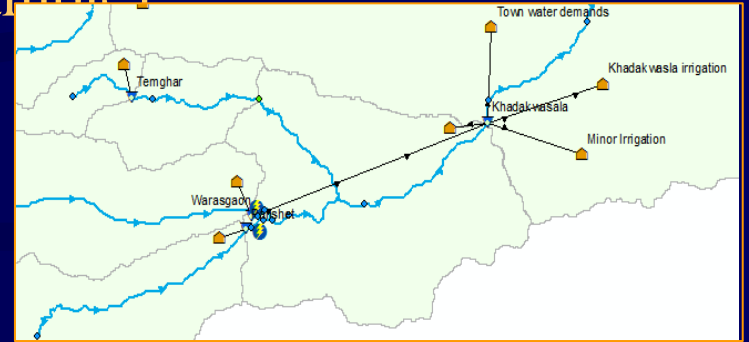
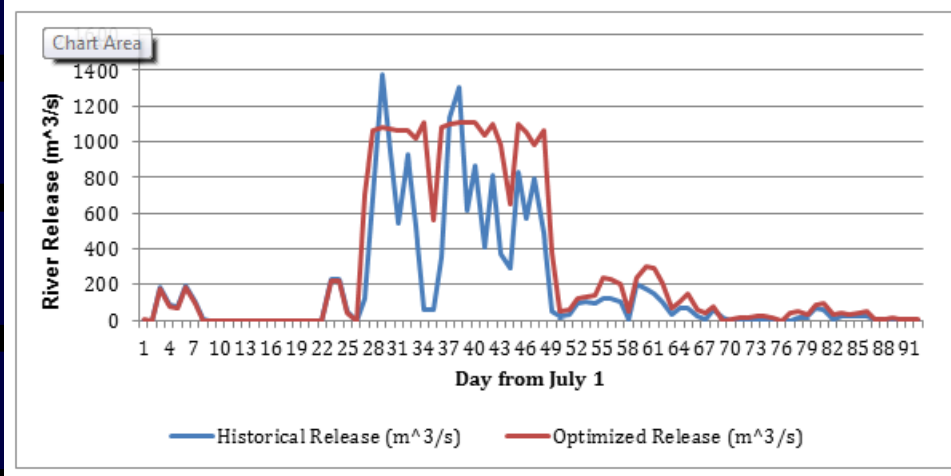
Results at Arjunwad (Koyna Complex)



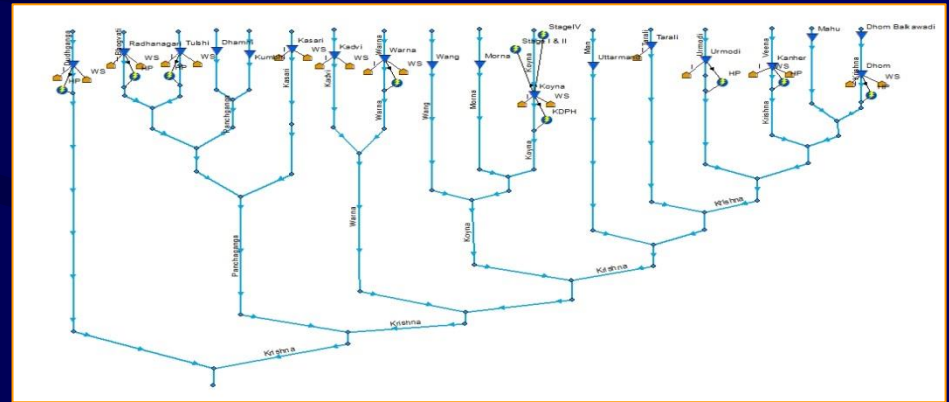
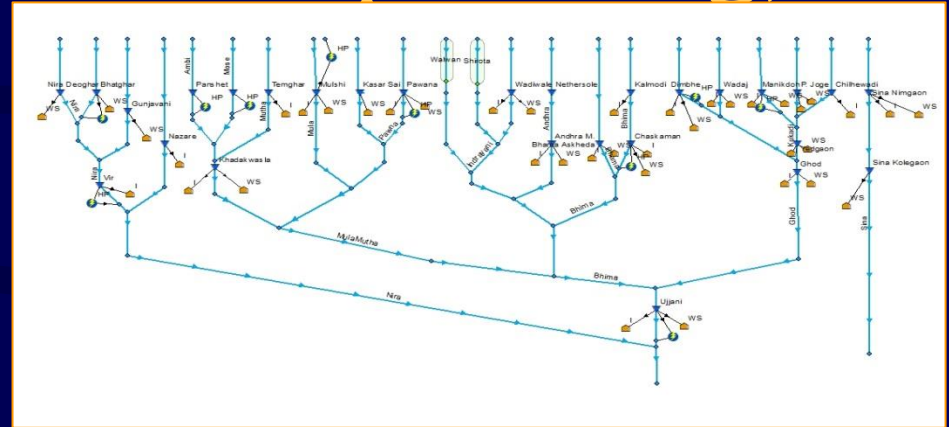
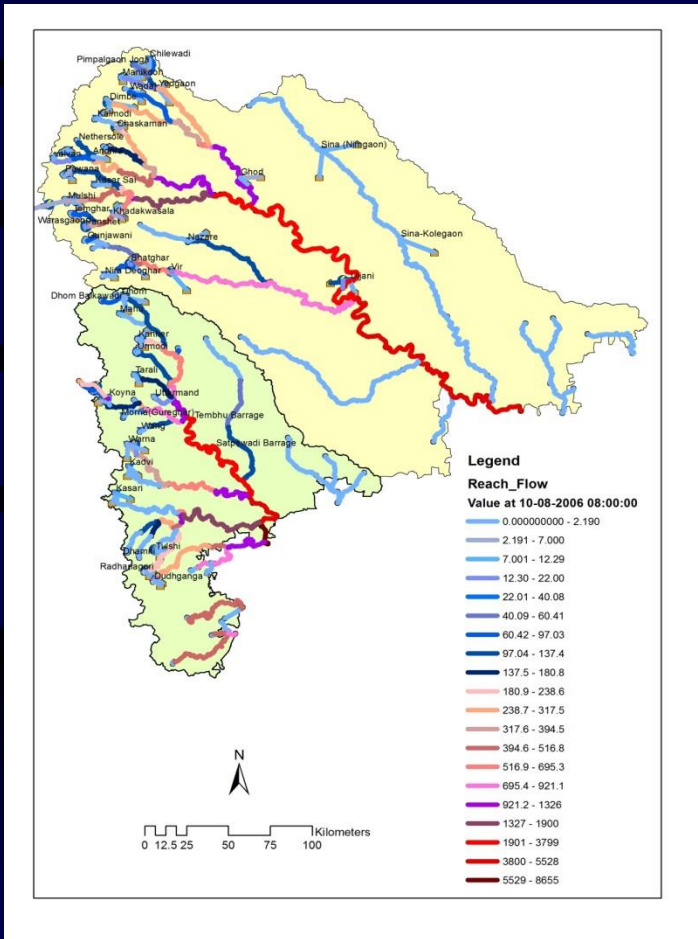
Joy for some

Flood trouble for others

Optimum operation during the whole flood season (Khadakwasala example)



Optimization of Reservoir Operation (long term operation – planning)



Over 20,000 evacuated in flood-hit Vadodara

Reservoir Water Raises River Level

TIMES NEWS NETWORK

Vadodara: The menacing Vishwamitri brimmed over in Vadodara, leaving several areas of the city in waist-deep water. Over 20,000 people were evacuated to safer locations across the district due to the flash floods.

While the city and district hardly received any rainfall since Tuesday night, the water released from Ajwa reservoir till early on Wednesday morning lead to the flooding of Vishwamitri. The river reached a level of 34 feet in Vadodara on Wednesday morning.

While the 62 gates of Ajwa reservoir were closed at



People shift from a flooded locality after heavy rains in Vadodara

5.30am, waters in Vishwamitri refused to recede. Till 8pm, the water level was stagnant at 34 feet and was expected to recede only in the night.

VMC commissioner Manish Bhardwaj said that the water level did not go down through the day as the Dhadhar river, into which the Vish-

wamitri flows into, was also in spate. "Dhadhar was at a level of 35.6feet and it was unable to accommodate the flow from Vishwamitri," said Bhardwaj. Ajwa reservoir was 213.8 feet on Wednesday night, down from Tuesday's 215.5 feet. Bhardwaj said that 15 to 20 per cent of the city

Crocodiles flow into city with Vishwamitri water

When firemen reached Siddharth Bungalows on Sama-Savli Road to rescue stranded residents on Tuesday night, the last thing they expected was crocodiles. It was one of the scariest rescue operations carried out by the fire brigade personnel in Vadodara. When water from the Vishwamitri gushed into the residential colony on Tuesday, about five crocodiles too flowed in.

The reptiles also caused delays in the evacuation process that was on at around 2am on Wednesday. "When we were rescuing people from the colony, I spotted a crocodile swimming near our boat. It was risky as we had to ensure that people don't step into the water. Also, we couldn't tell people about the crocodiles as they would have panicked and put lives of others in the lifeboat at risk," said Om Jadeja, a fire brigade officer.

"The crocodiles were following our rescue boats all the time. About six came in the colony after the wall of EME got washed away on Tuesday. The crocodiles didn't have any exit route from the colony so they kept moving around inside. However, they did not interfere with our operations," Jadeja told TOI. Pinal Parikh, a resident of Siddharth Bungalows, too spotted crocodiles. "I saw some crocodiles and two snakes swimming near my house. We were too scared to come out."

There are close to 204 crocodiles in the Vishwamitri and the incident has refreshed memories of 2005 floods when the reptiles had entered several homes. TNN

was waterlogged due to the floods when Vishwamitri reached 34 feet.

In Vadodara city, 12,761 were moved to safer areas while 9,528 from villages were relocated. National Disaster Response Force and EME Corps of the Indian Army also joined the rescue efforts.

The city was divided into two parts with the western parts cut off from the rest of the city. Waters from the Vishwamitri river that runs through the city had inundated approaches to major bridge crossing it. A heavy traffic jam was witnessed on the newly constructed Ako-

ta-Dandia Bazaar link in the morning. But the approach of the link on the Akota side got inundated later in the day and it had to be closed.

The flash flood here comes at a time when the nation has put all efforts for rescue and relief of victims of the worst-ever floods in J&K.

The Krishna model could be replicated to optimize the operation of Ajwa Reservoir

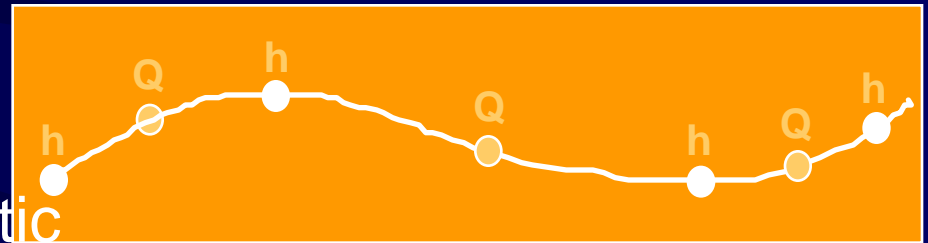
Computational tools are well developed.

Hydrodynamic Module, Core of MIKE 11

- Saint Venant Equations

$$\frac{\delta Q}{\delta x} + b \frac{\delta h}{\delta t} = 0, \quad \frac{\delta Q}{\delta t} + \frac{\delta \left(\alpha \frac{Q^2}{A} \right)}{\delta x} + gA \frac{\delta h}{\delta x} = 0$$

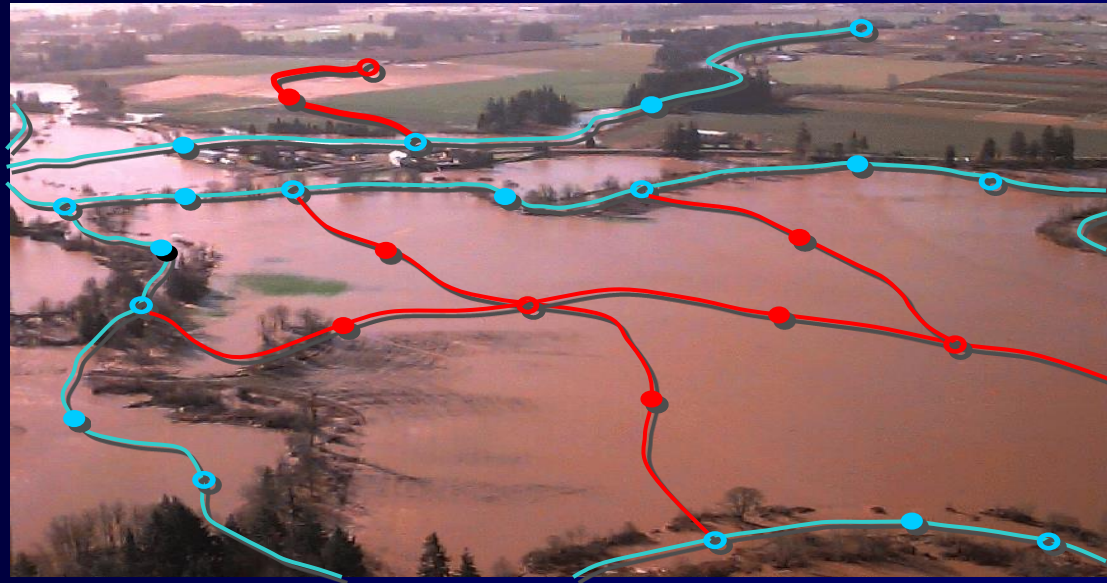
- 6 Point Abbott-Ionescu
Finite Difference Scheme
dynamic/diffusive/kinematic



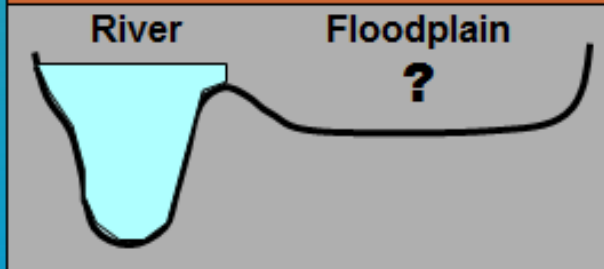
- Looped Network



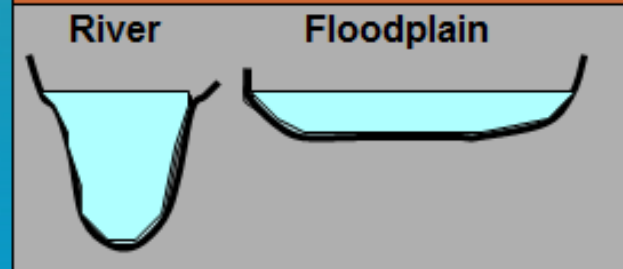
Knowledge of hydrology and Hydraulics is a basic requirement to a successful modelling



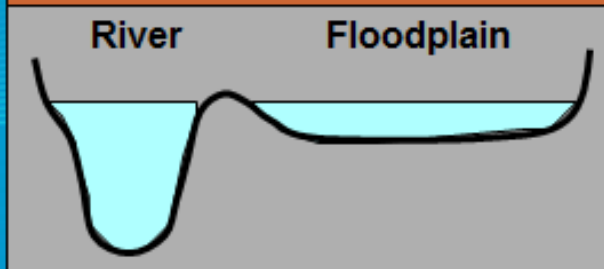
FP1: Ignored



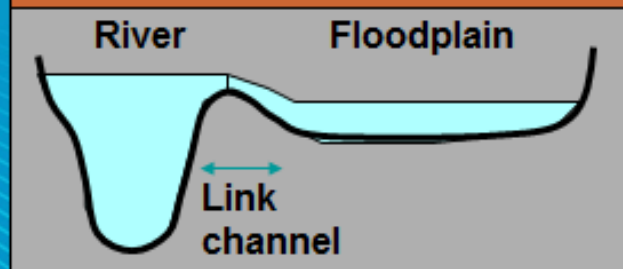
FP2: Added Storage



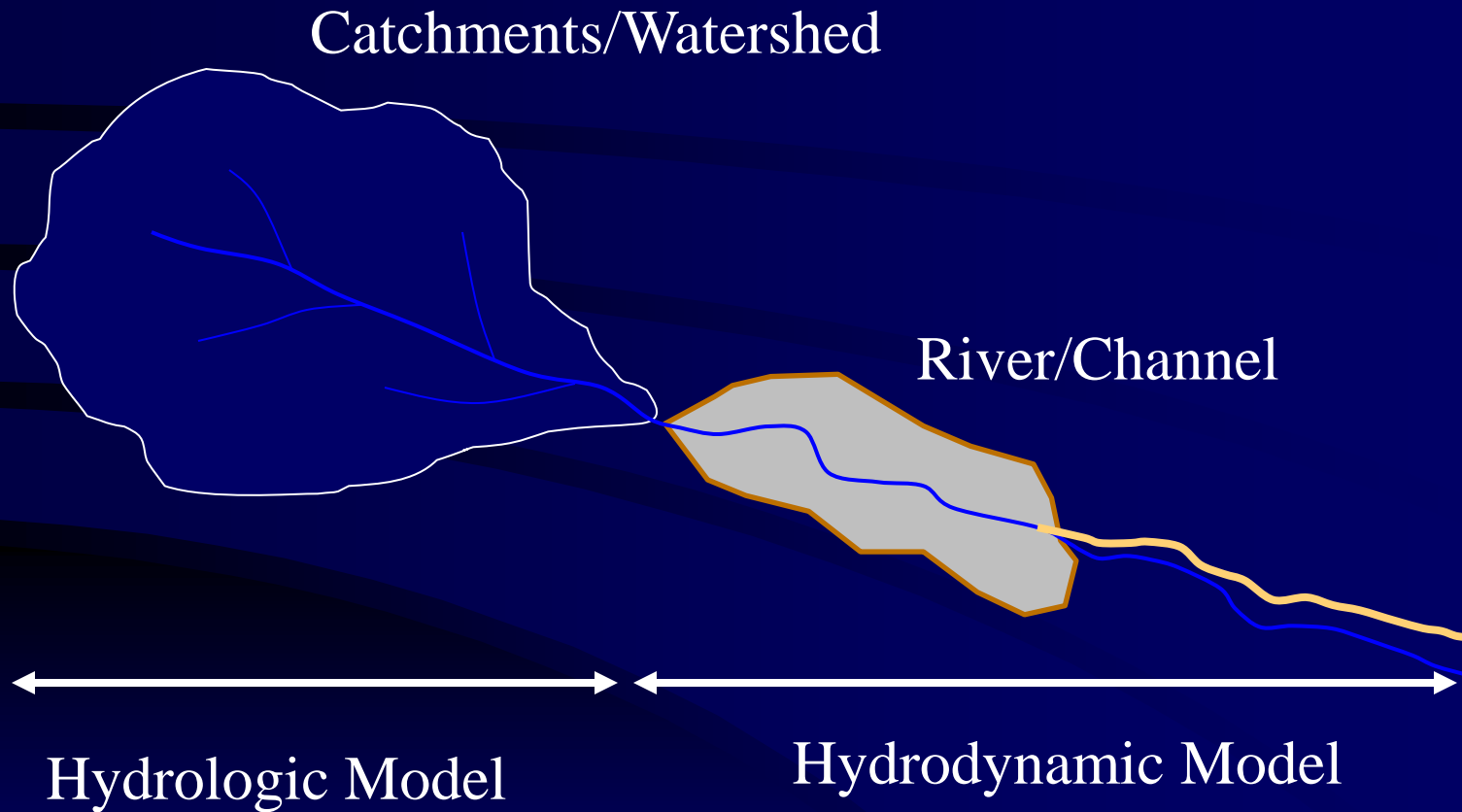
FP3: Part of the Cross-Section



FP4: Separated from the River



Modelling of water resources



Example of Bagmati River Flood forecasting in Bihar

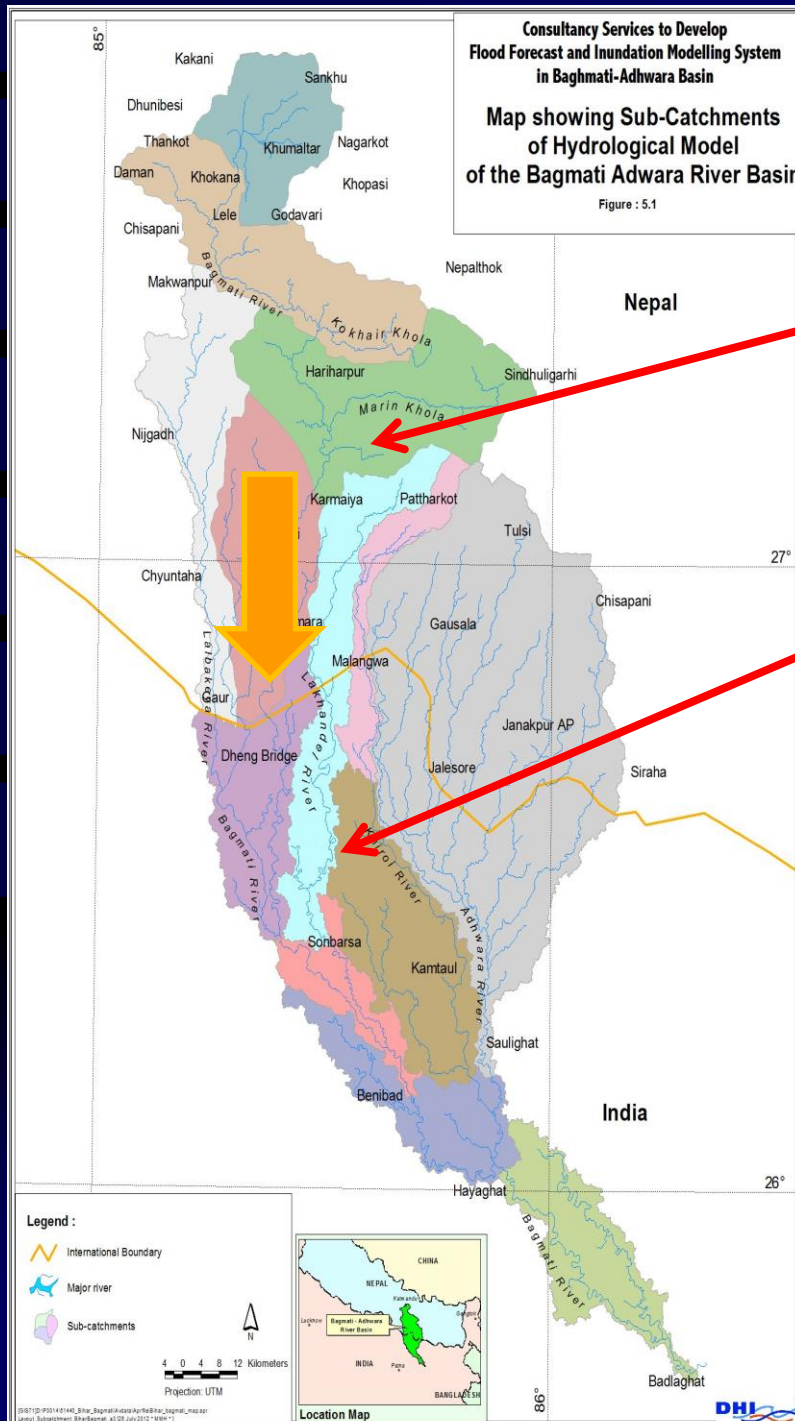
Consultancy Services to Develop
Flood Forecast and Inundation Modelling System
in Bagmati-Adhwara Basin
Map showing Sub-Catchments
of Hydrological Model
of the Bagmati Adhwara River Basin
Figure : 5.1

Floods are generated from
Nepal (flashy catchments)

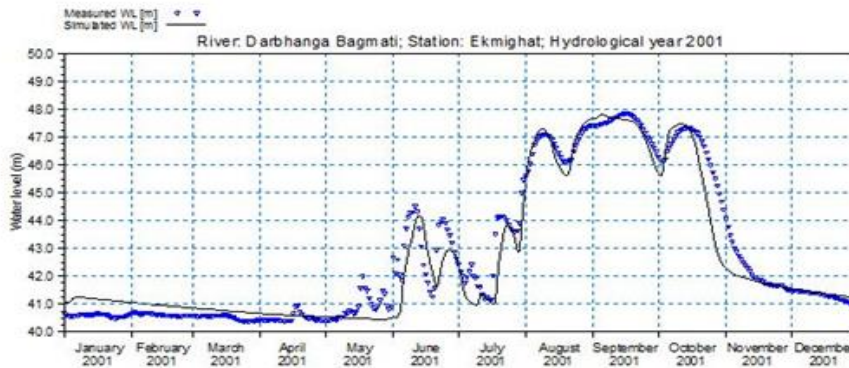
Floods are also generated
form Catchments in Bihar

For effective flood management

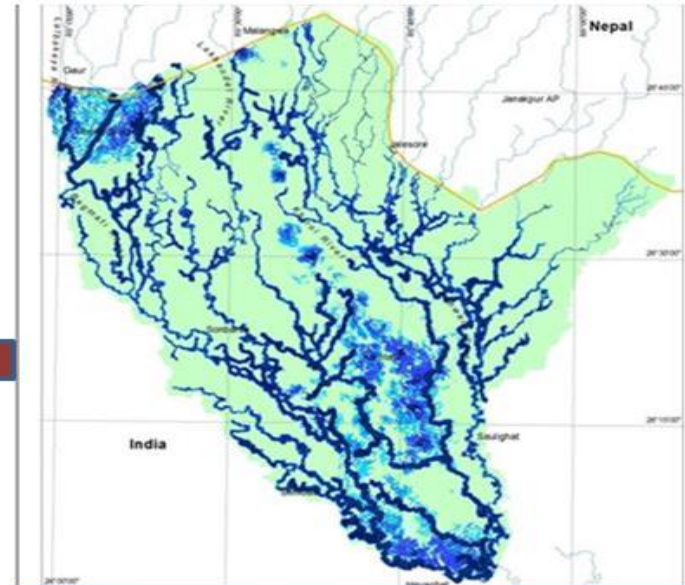
- Need to increase lead time of forecast
- Need to increase locations
- Need to know area inundation
- Need to analyse embankment breaches
- Early warning system
- Real time implementation



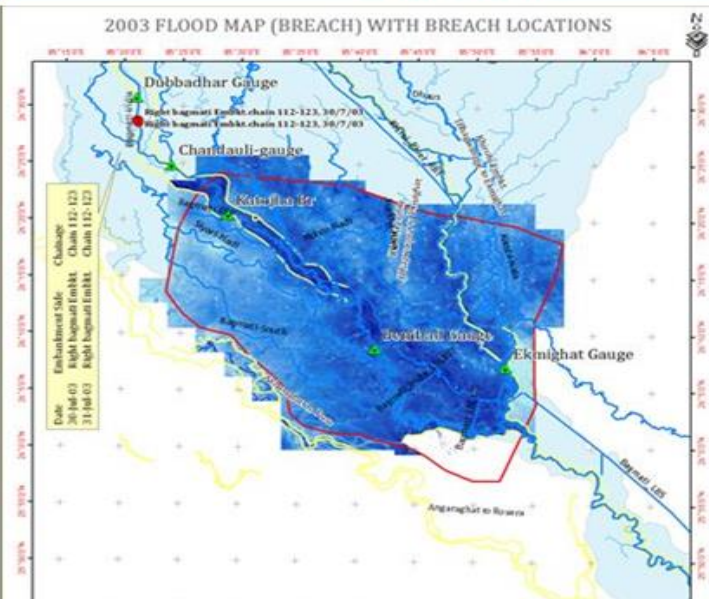
Flood Forecast products



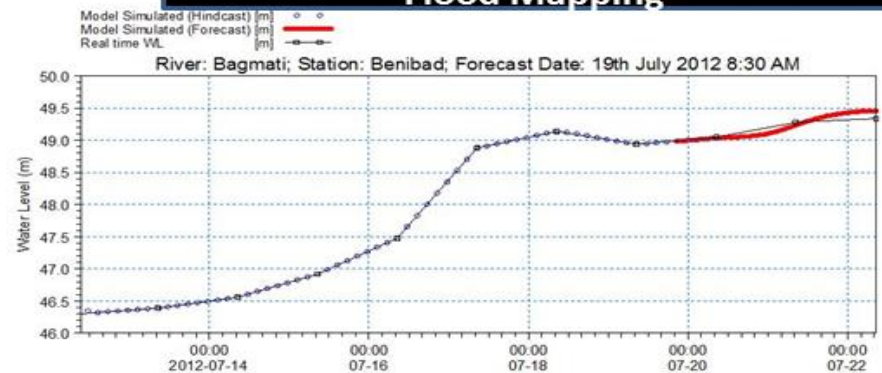
Calibration



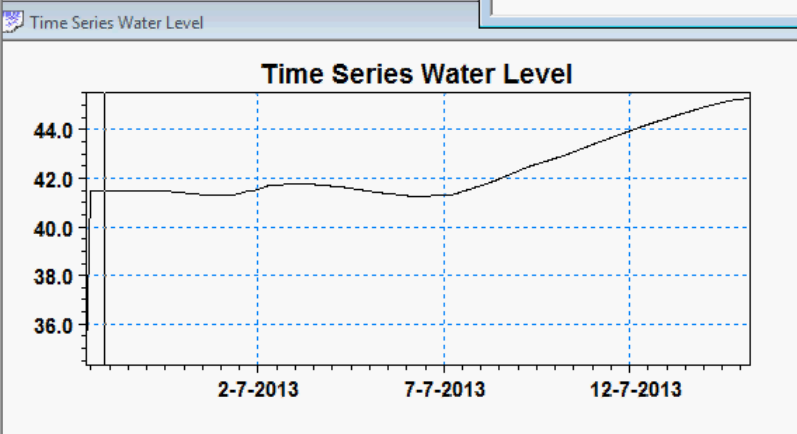
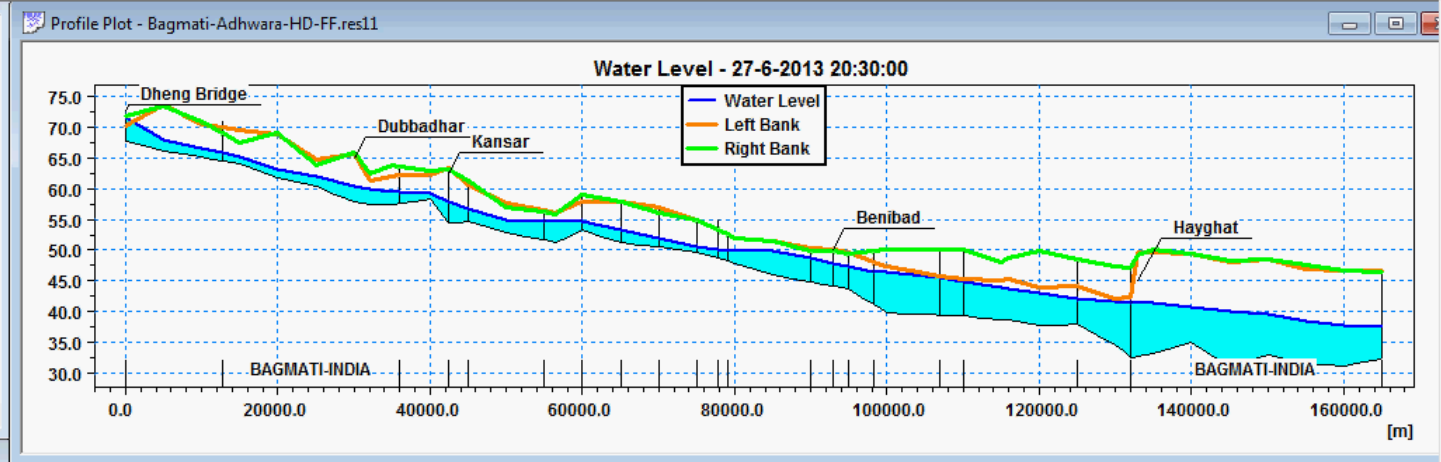
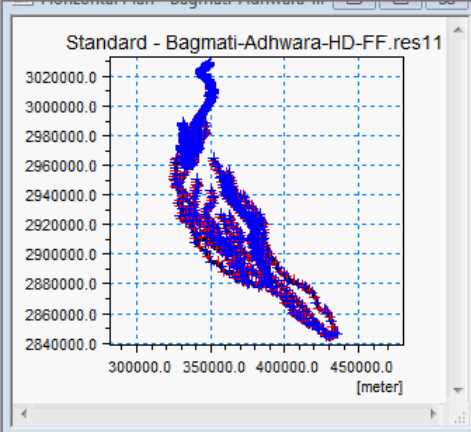
Flood Mapping



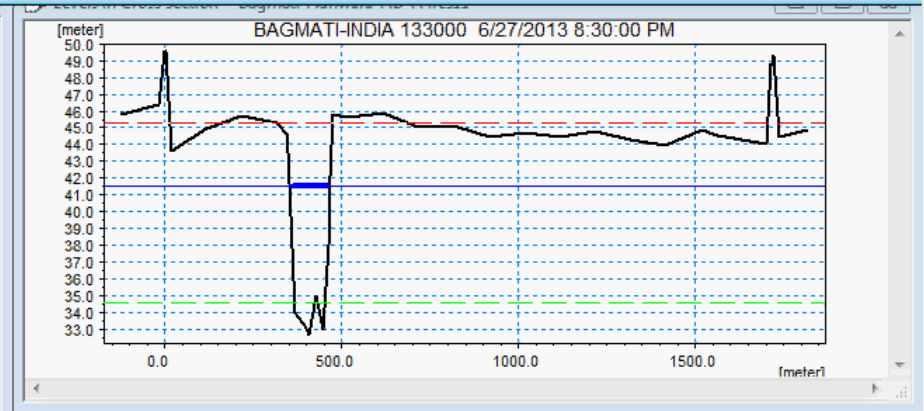
Embankment Breach Simulation



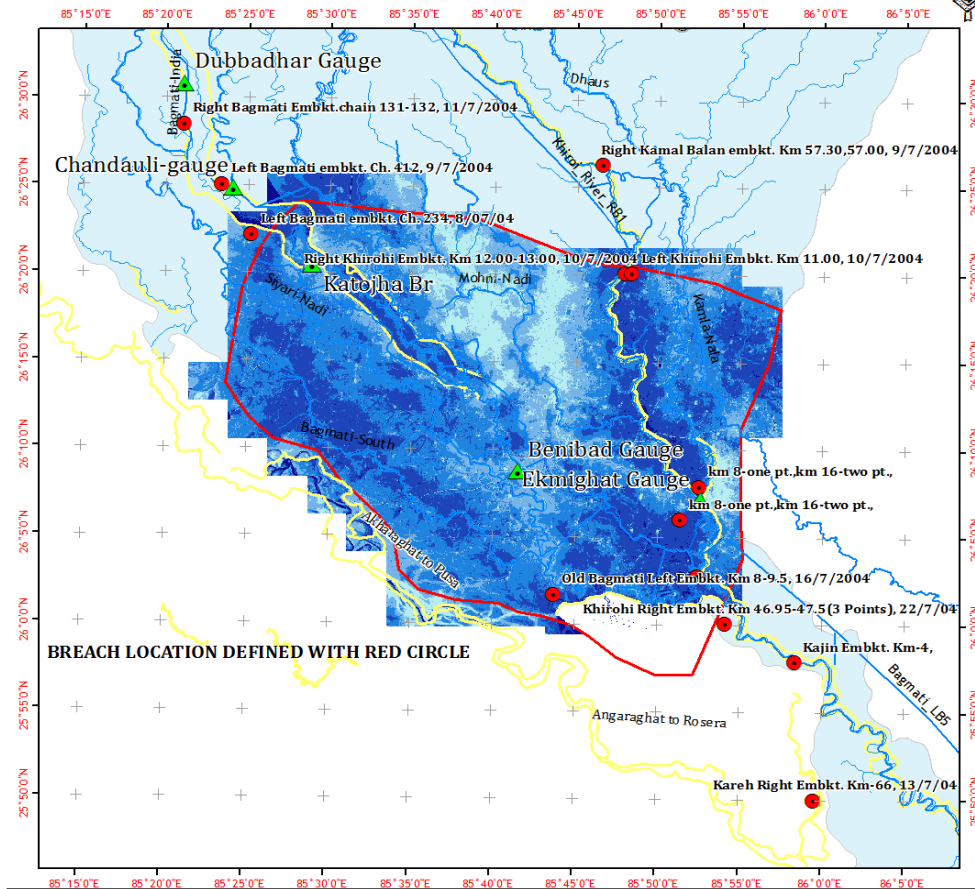
Flood Forecasting



Water Level
- Hayghat



2004 FLOOD MAP (BREACH) WITH BREACH LOCATIONS



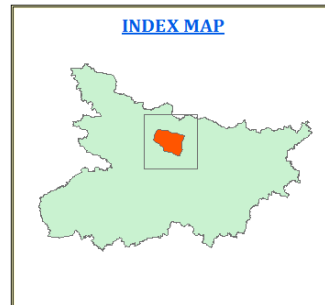
Accurate Flood
Maps Using
LiDAR DEM

Consulting Services
To Develop Flood Forecast and Inundation
Modeling System in Bagmati- Adhwara Basin.

LEGEND

- ▲ Gauge Sites
- Emb Breach Pre 2007
- Drainage_Clip_Bagmati_Adhwara1
- Bihar_UTM_45N
- RIVER
- EMB
- AOI LIDAR

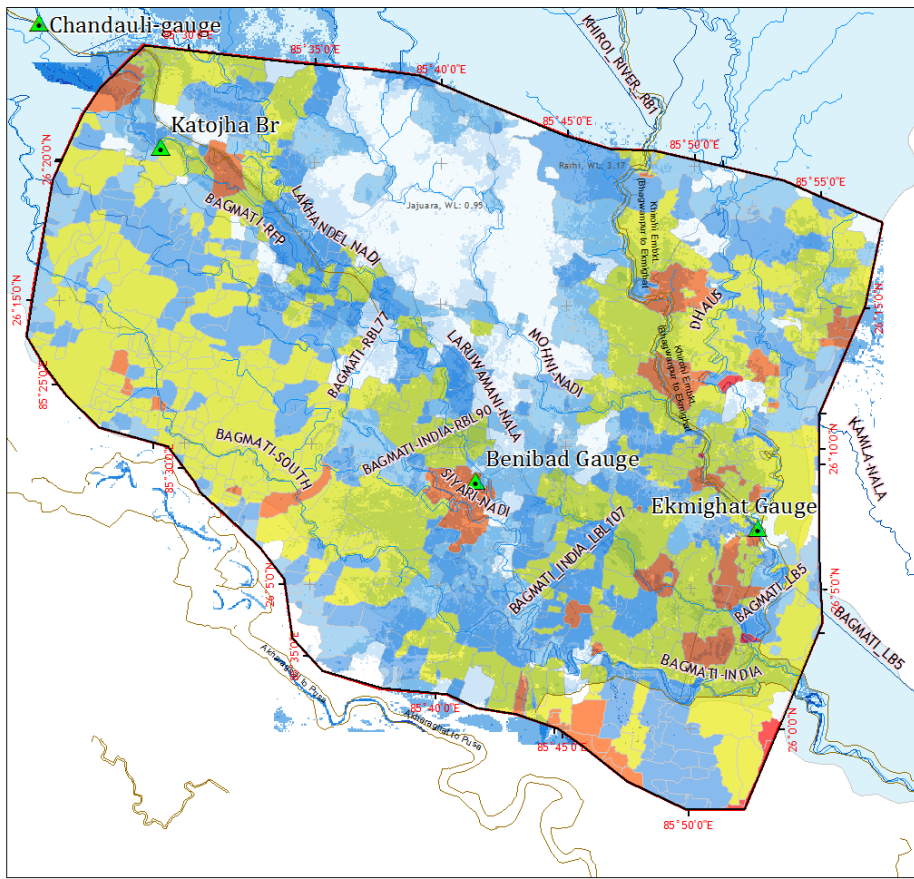
INDEX MAP



1:350,000



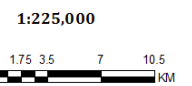
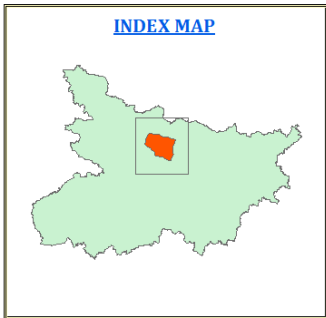
INUNDATION MAP OF YEAR 2003 SHOWING EXTENT OF WATER LEVEL



Village wise inundation map

Consulting Services
To Develop Flood Forecast and Inundation
Modeling System in Bagmati- Adhwara Basin.

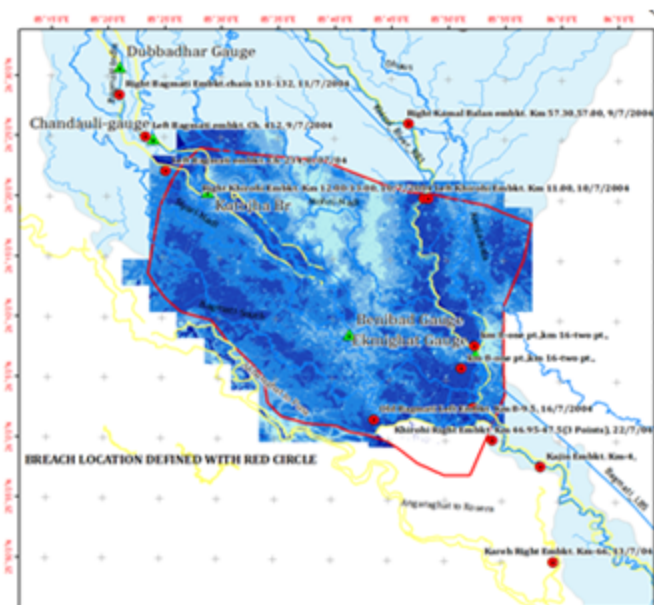
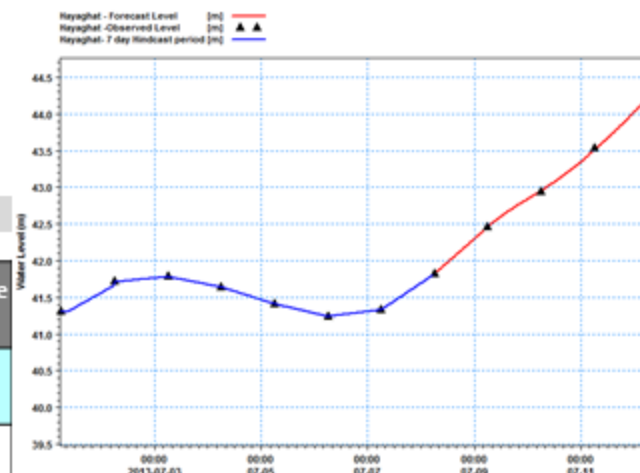
LEGEND	
Embankment by PCH	
DRAINAGE_CLIP_BAGMATI_ADHWARA1	
GAUGE SITES	
BIHAR	
RIVER	
AOI LIDAR	
fm 2003breach	
<VALUE>	
-9.175136566 - 0.040783856	
0.040783856 - 2	
2.000000001 - 4	
4.000000001 - 8	
8.000000001 - 11.53	
RASTERVALU	
0.001720 - 1.889122	
1.899036 - 2.674107	
2.676270 - 3.306324	
3.312073 - 4.562439	
4.571640 - 6.654839	
7.068002 - 8.707951	



FLOOD MONITORING
CELL
WATER RESOURCES DEPARTMENT
GOVT. OF
BIHAR

Daily Flood Information Buletin 4 PM 12-July-2013

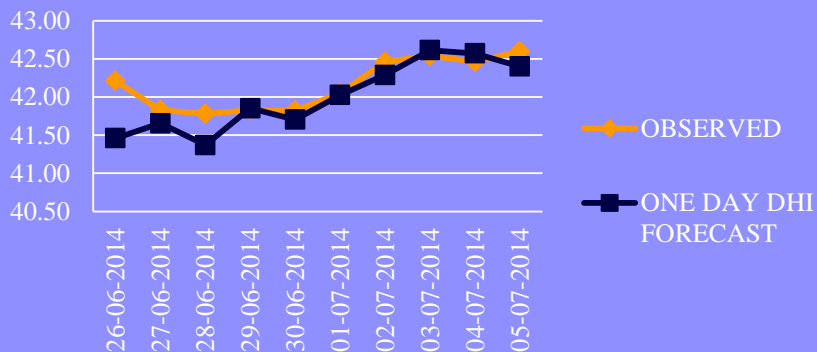
	Todays Water Level (m) at 6:AM					Water Level (m) Forecast in Bagmati-Adhwara Stations			Obsvrd Water Level	Differen ce	
	Basin Name	District	Gauge Site	High Flood Level	Danger Level	Observed Water Level	13-Jul 6:00 AM	14-Jul 6:00 AM			15-Jul 6:00 AM
Bagmati-Adhwara Basin Flood Forecast report	BAG MATI-ADHWARA	Sitamarhi	Dheng Bridge		70.100	70.50	70.28	69.99	69.81	70.00	0.28
		Sitamarhi	Sonakh an	70.770	68.800	68.40	68.28	68.07	67.92	68.10	0.18
		Sheohar	Dubb dar	63.750	61.280	62.40	61.37	60.67	60.20	61.40	-0.03
		Sitamarhi	Kansar	60.860	59.060	59.50	58.72	58.03	57.48	58.60	0.12
		Muzaffarp ur	Runisai dpur		53.730	57.15	56.84	56.47	56.31	57.58	-0.74
		Muzaffarp ur	Benibad	50.010	48.680	49.28	49.35	48.43	47.58	49.34	0.01
		Darbhanga	Hayagh at	45.720	45.720	44.08	44.57	45.03	45.29	44.44	0.13
		Darbhanga	Ekmigh at	49.520	46.940	45.19	45.62	45.88	45.92	45.62	0.00
		Darbhanga	kamtaul	52.990	50.000	49.40	49.35	48.91	47.66	49.35	0.00
		Madhubani	Sauligh at		52.370	48.55	48.76	48.90	49.01	48.54	0.22
CWC Forecasts	BAG MATI-ADHWARA	Muzaffarp ur	Benibad	50.010	48.680	49.28	49.35	NA	NA		
		Darbhanga	Hayagh at	45.720	45.720	44.08	NA	NA	NA		
		Darbhanga	Ekmigh at	49.520	46.940	45.19	NA	NA	NA		
		Darbhanga	kamtaul	52.990	50.000	49.40	49.46	NA	NA		





Examples of 2014 forecasts for Bagmati

EKMIGHAT FORECAST COMPARISON



HAYAGHAT FORECAST COMPARISON



➤ The state-of-the-art for flood modeling

1-d river
modellign



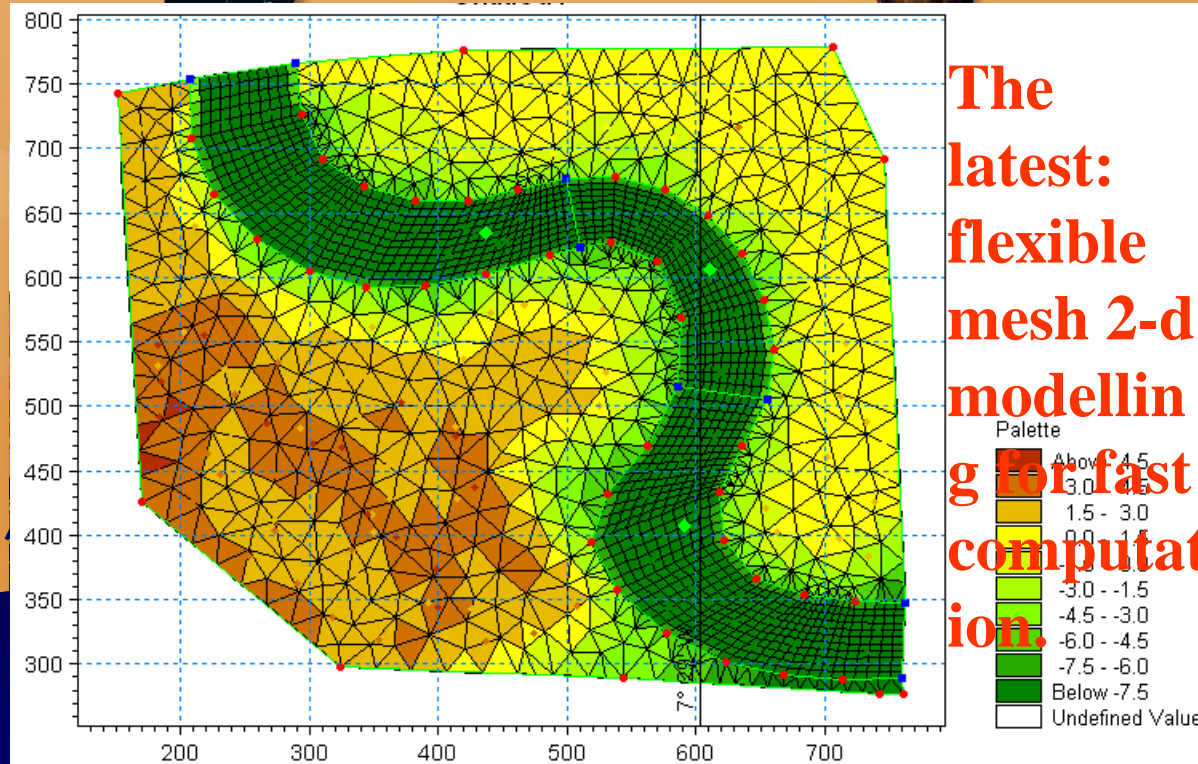
2-d flood
modellign

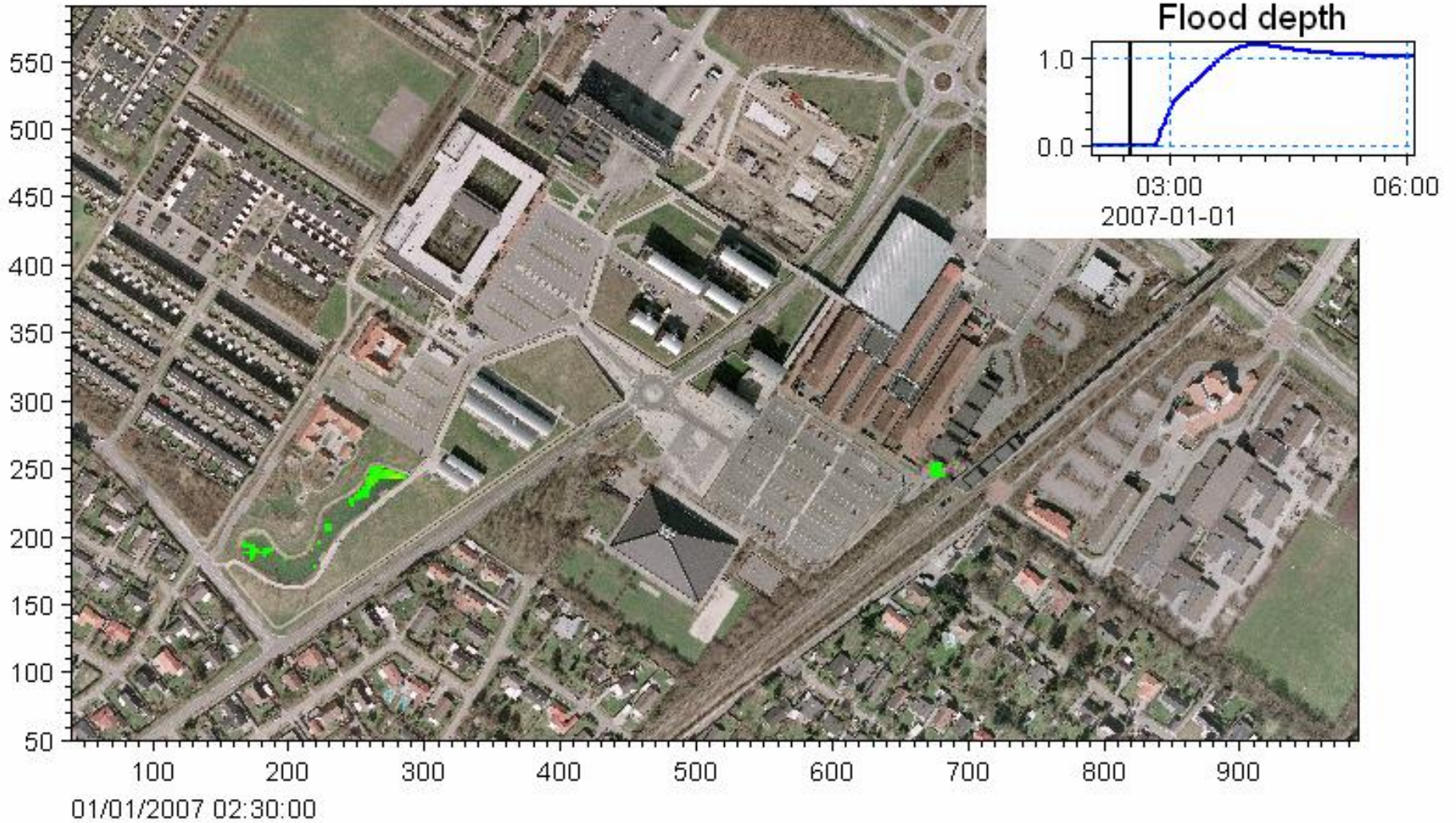


2-d urban flood

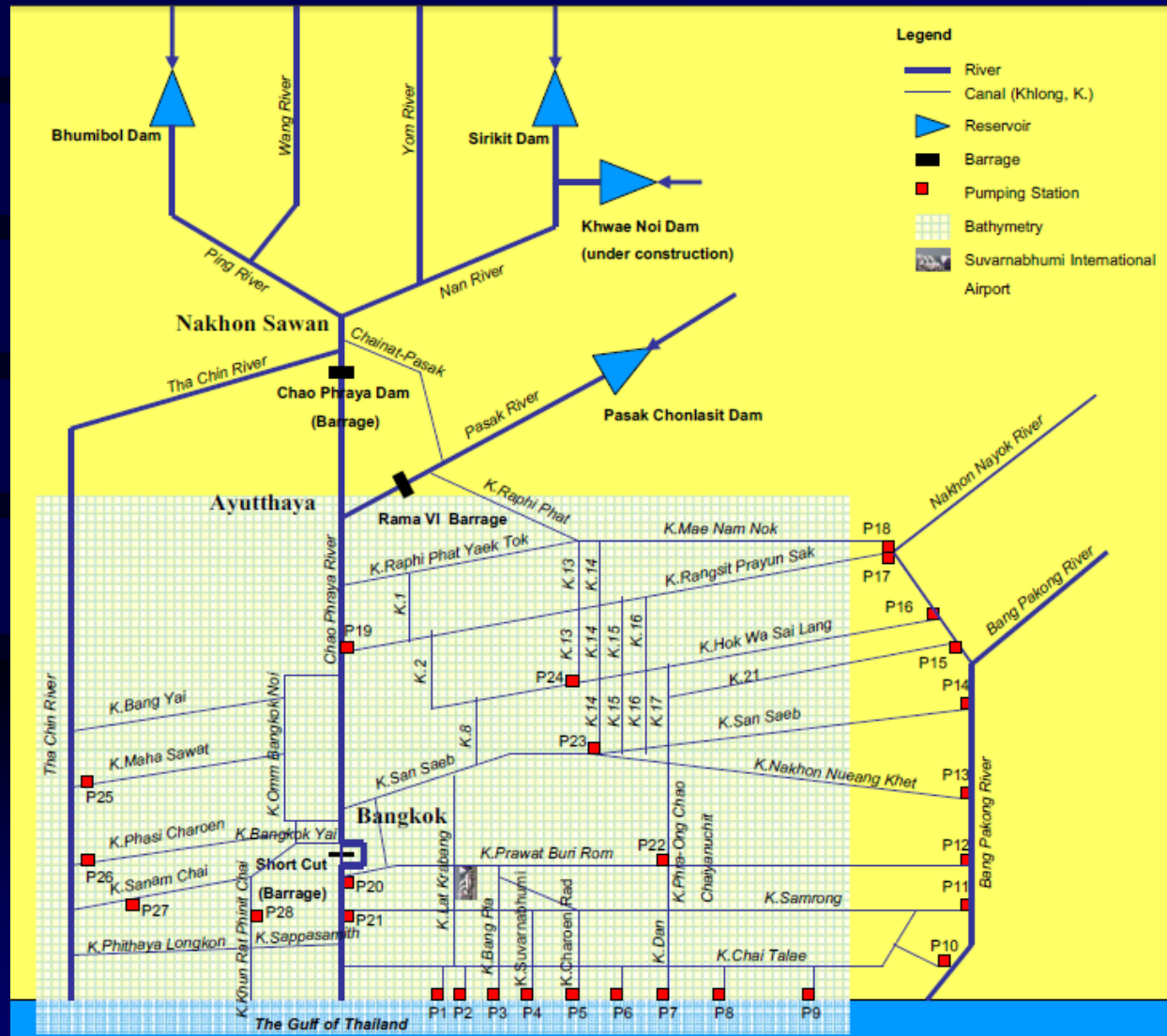


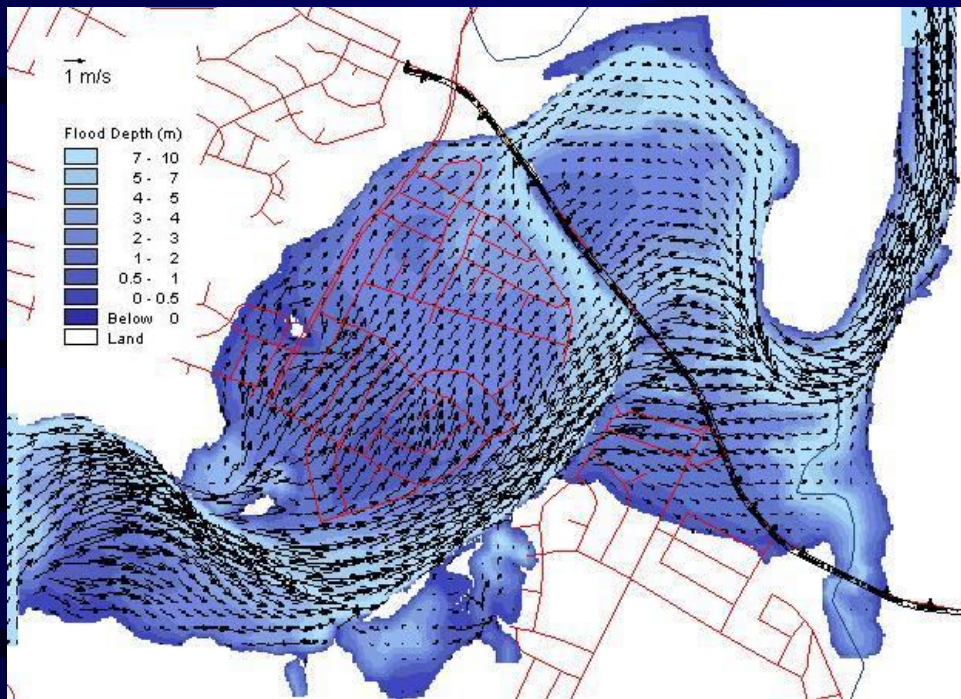
River & Flood plain



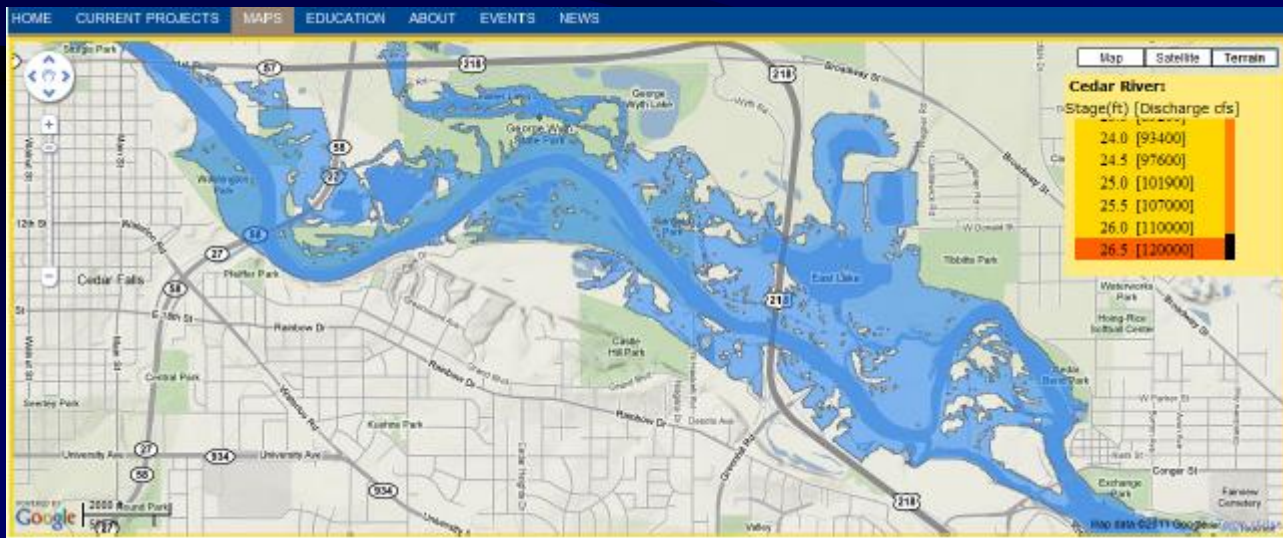


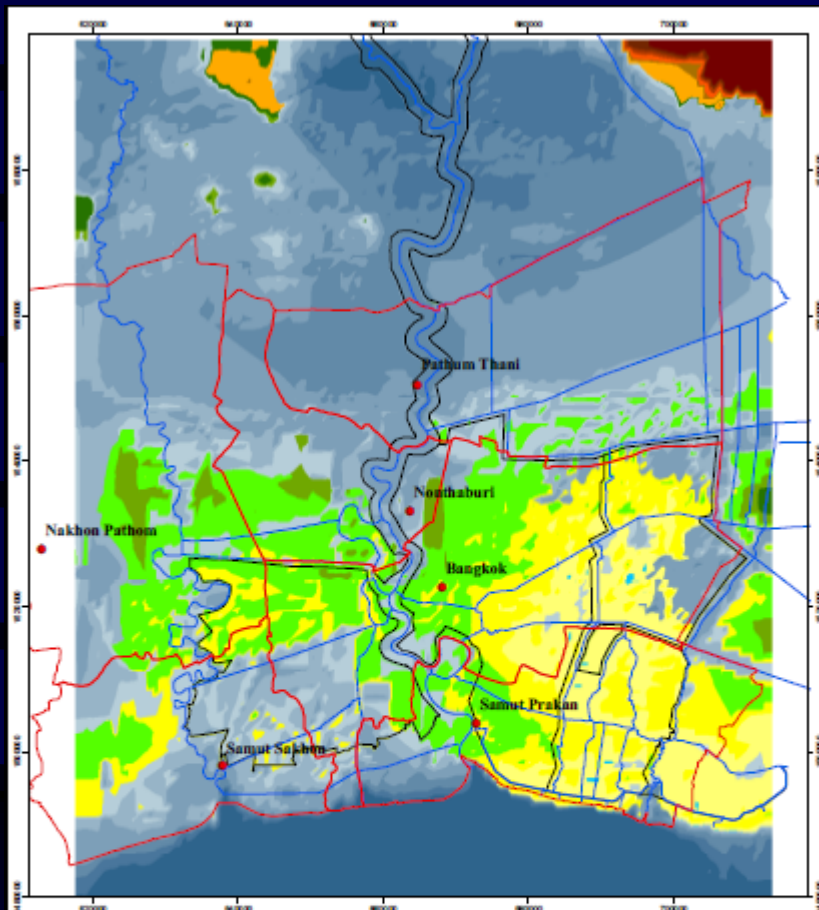
Flood Modelling of complex systems - Chaophraya river Basin: Thailand



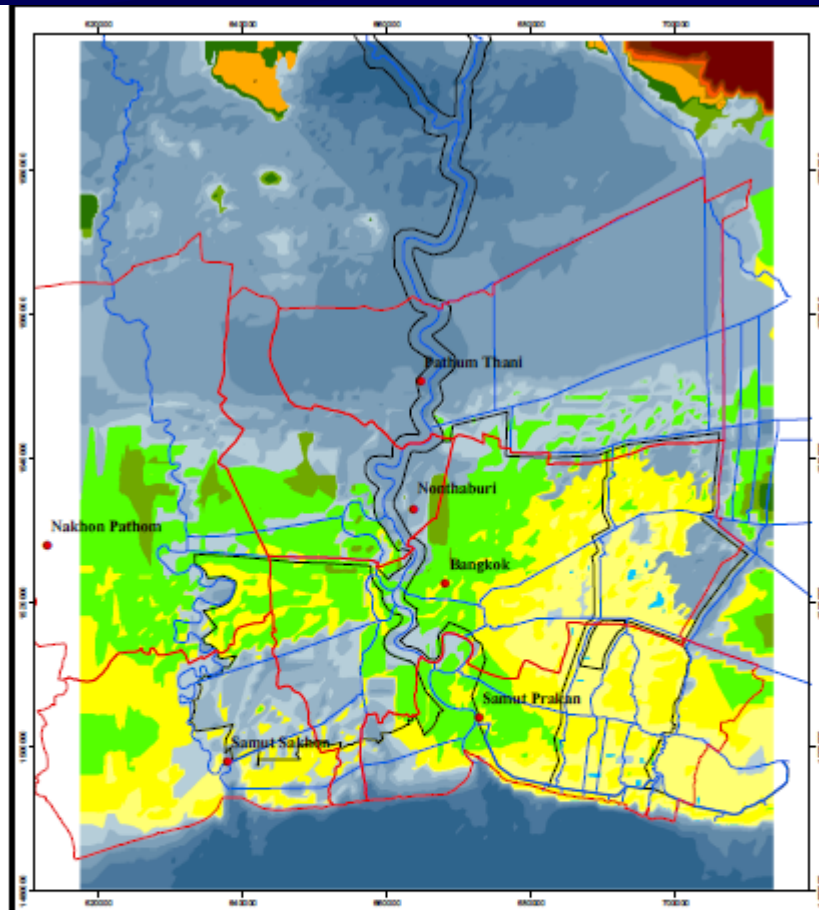
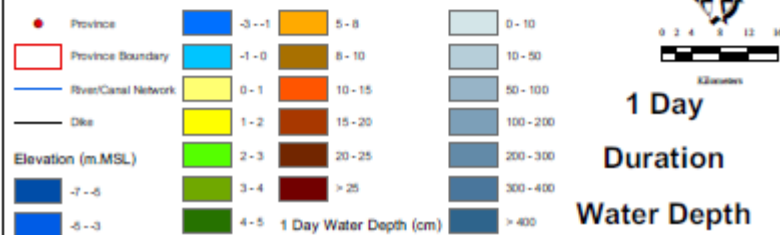


Fully hydrodynamic 2-dimensional modelling for better flood risk assessment

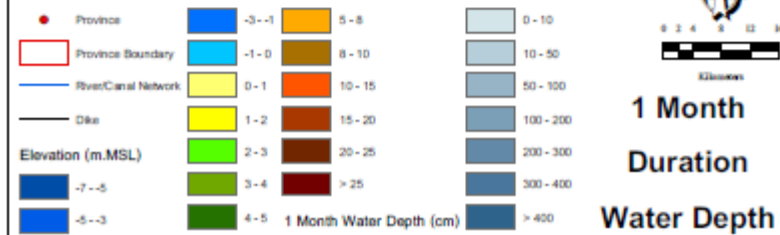




Legend



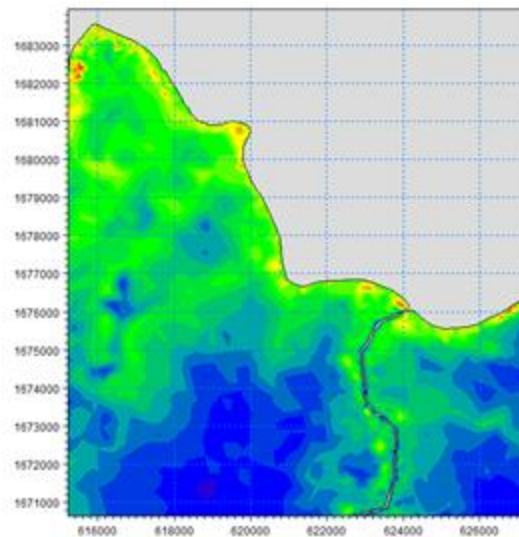
Legend



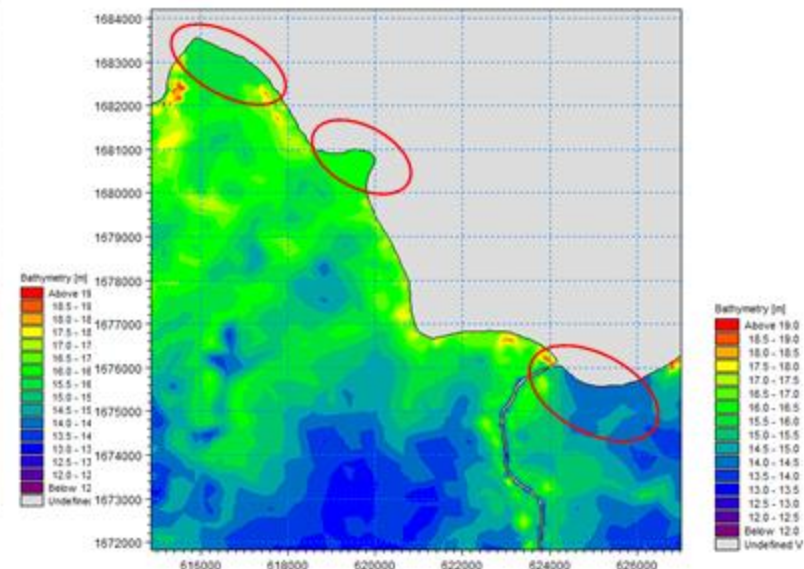
Example of 2-dimensional flood modelling in Thailand



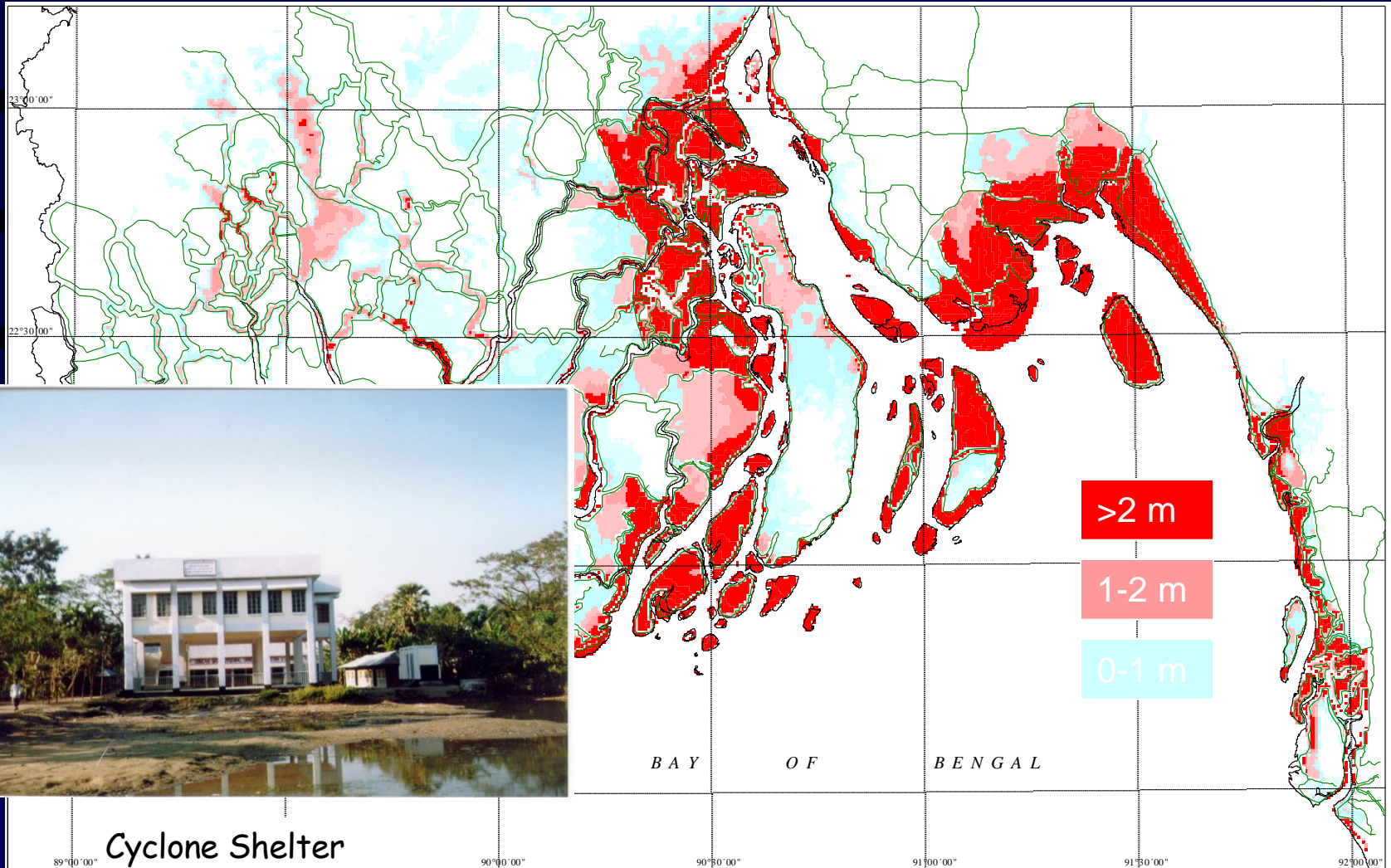
Inundation under Existing conditions



With embankment failure.

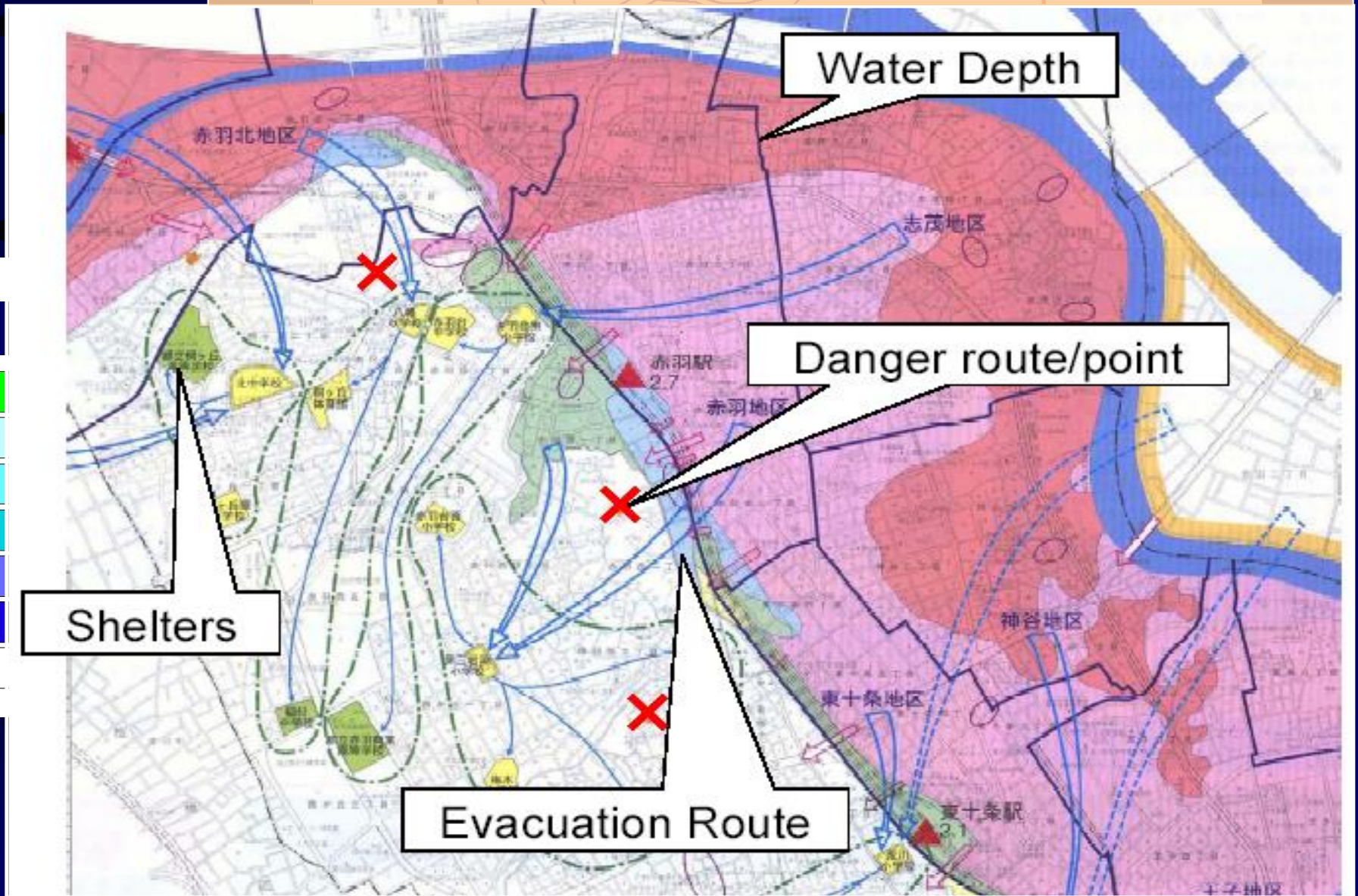


Example from Bangladesh: High Risk Area from flooding due to 100 year storm

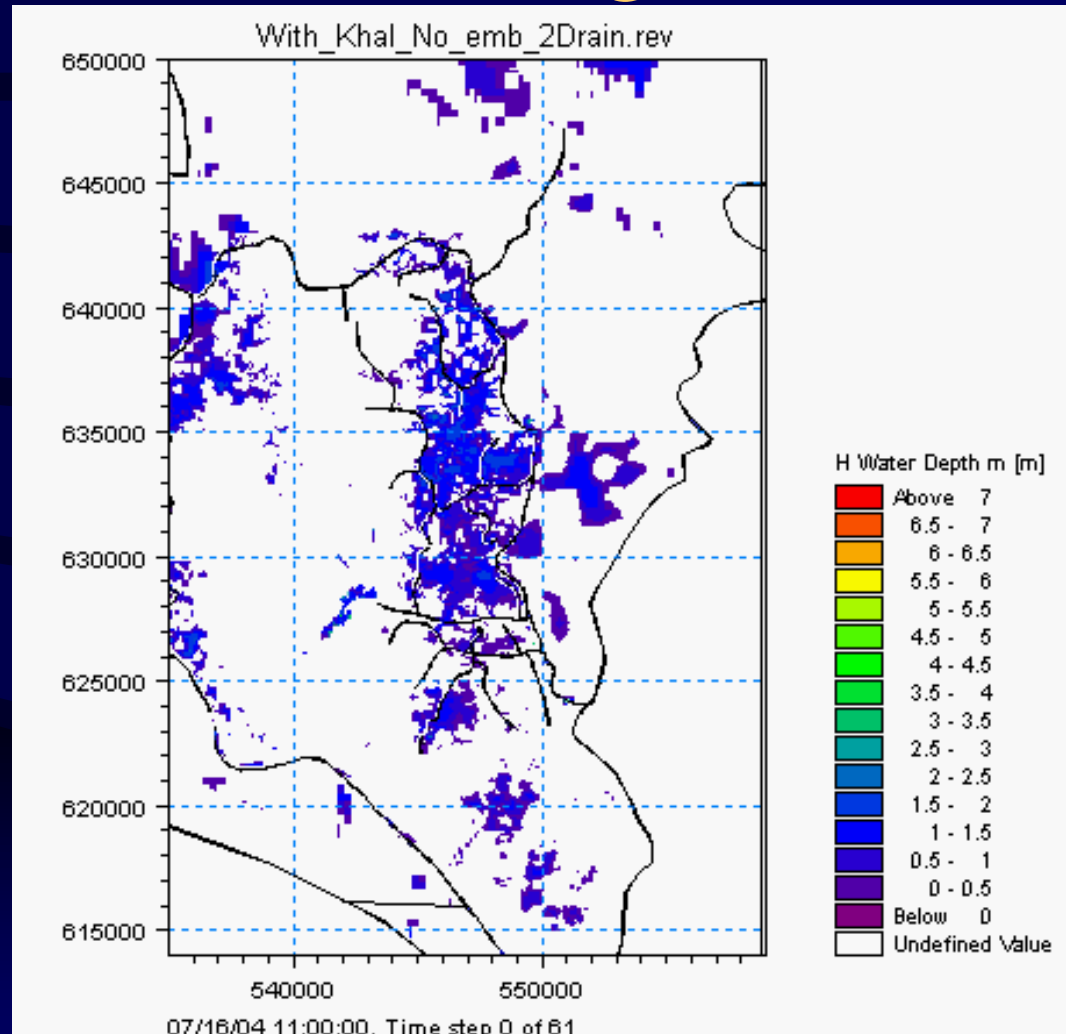


Storm Surge Hazard Map

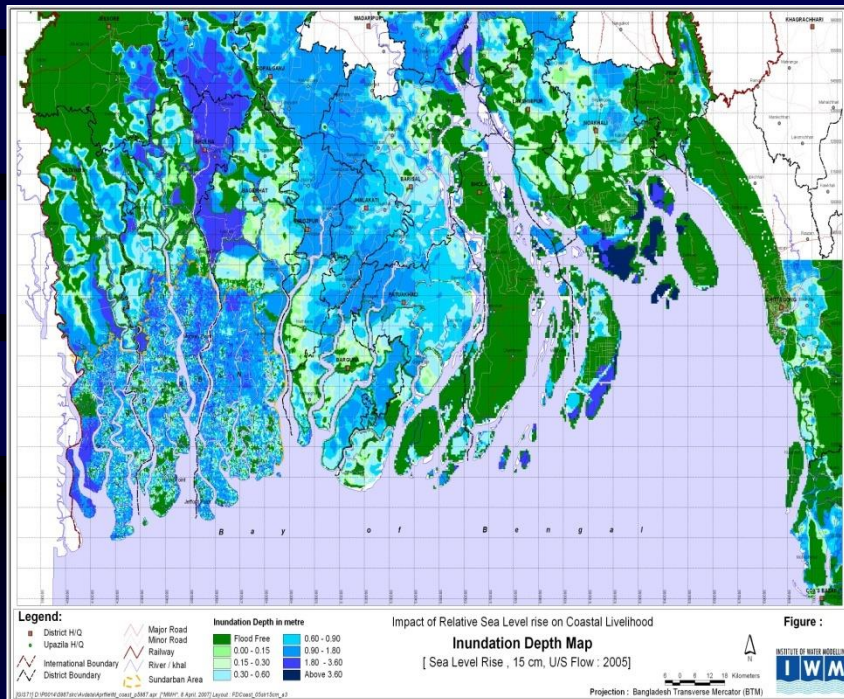
Flood Hazard Map



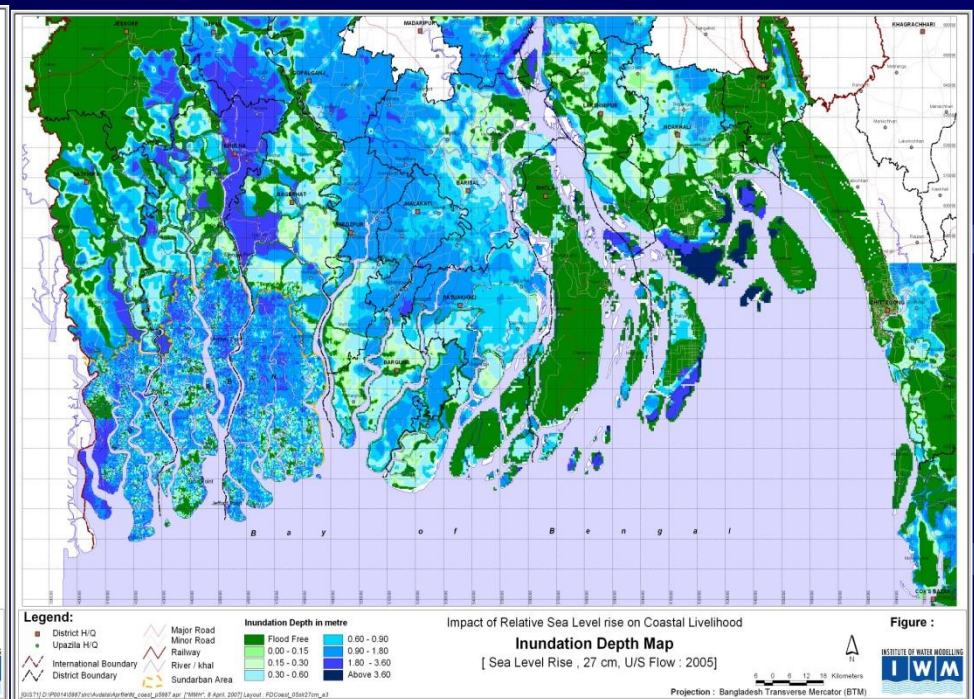
Simulation of Embankment breach scenario (Bangladesh)



Modeling of Impact of Sea level rise on coastal area flooding (Bangladesh)



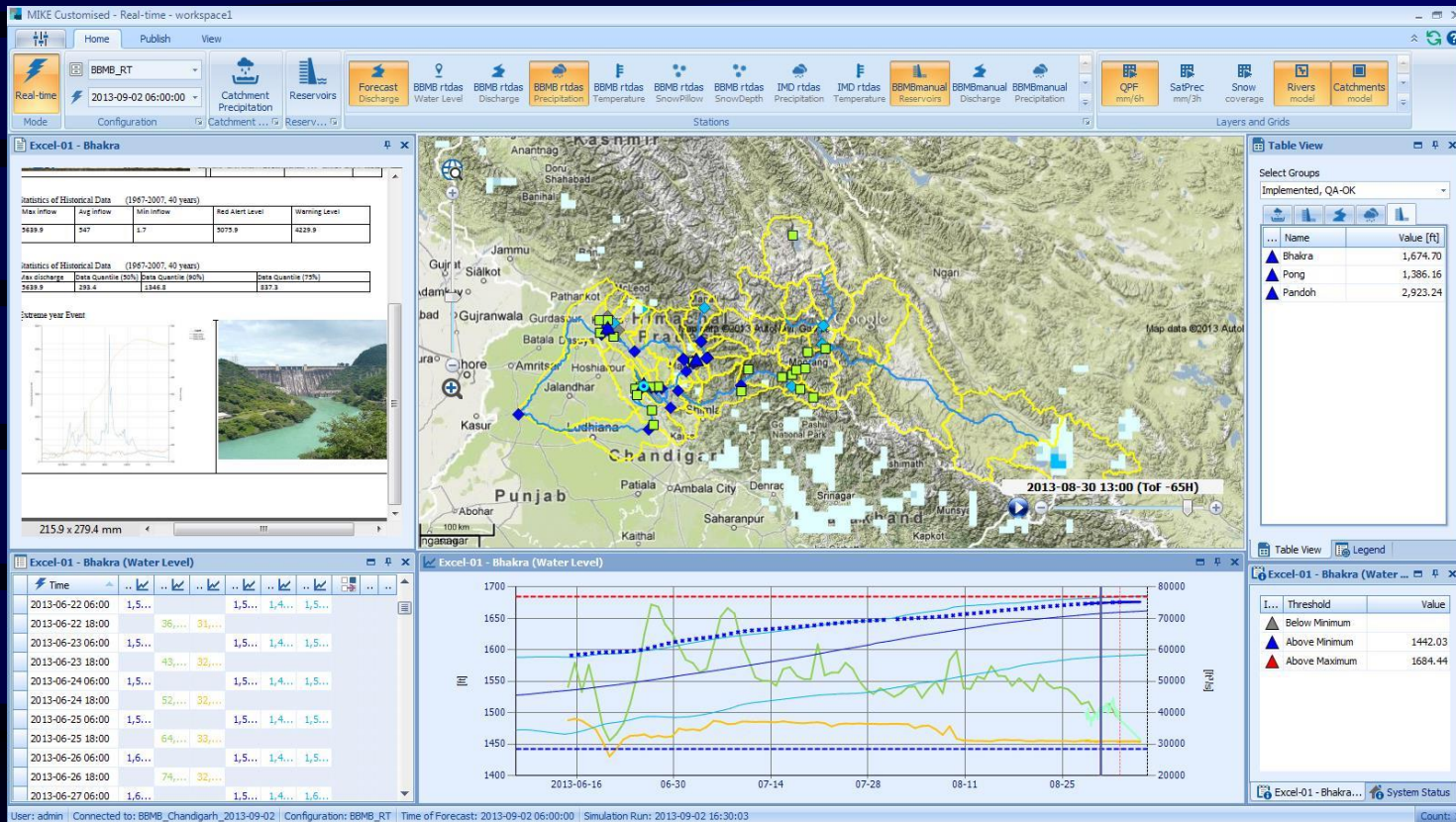
SLR 15 cm



SLR 27 cm

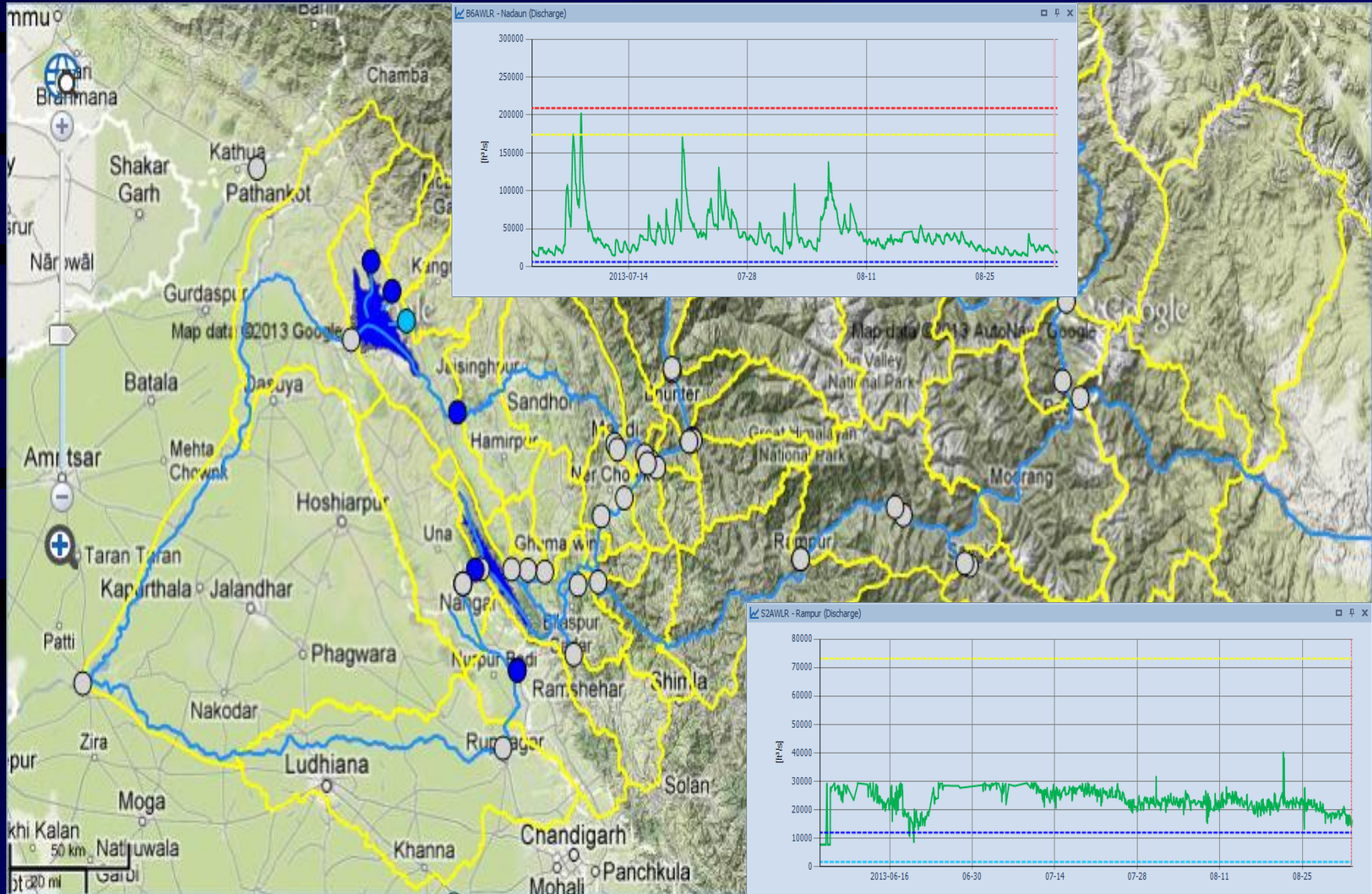
Integrated Real Time DSS Tools

Example: Bhakra Beas Real Time Decision Support System



RTDAS, Real time platform to access RTDAS and other data sources. Hydrological modelling (rainfall/snow-runoff), hydrodynamic modelling, inflow forecast, flood forecast, reservoir operation, water management)

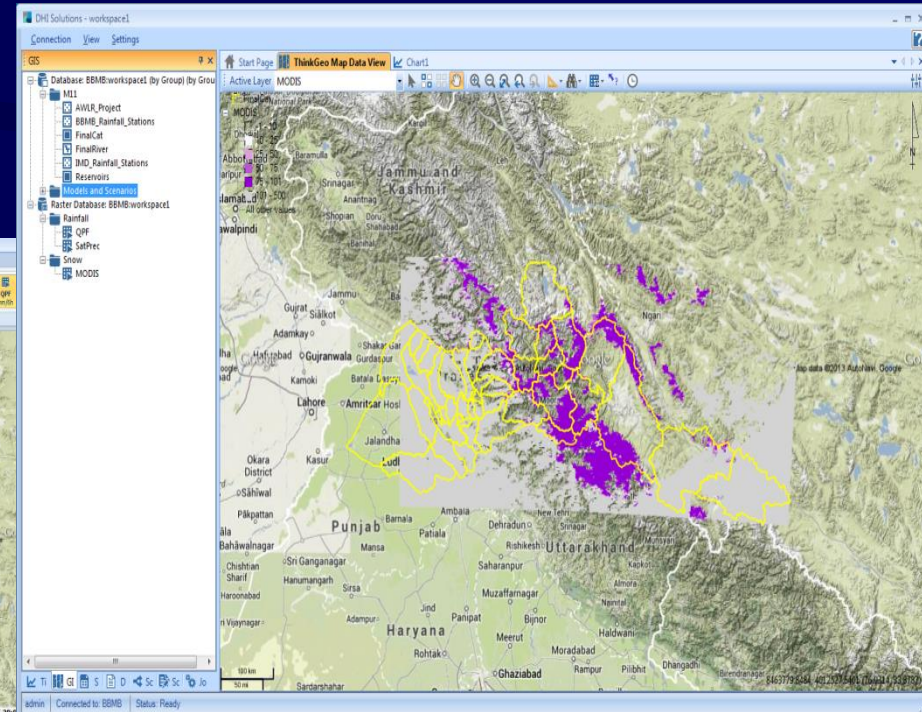
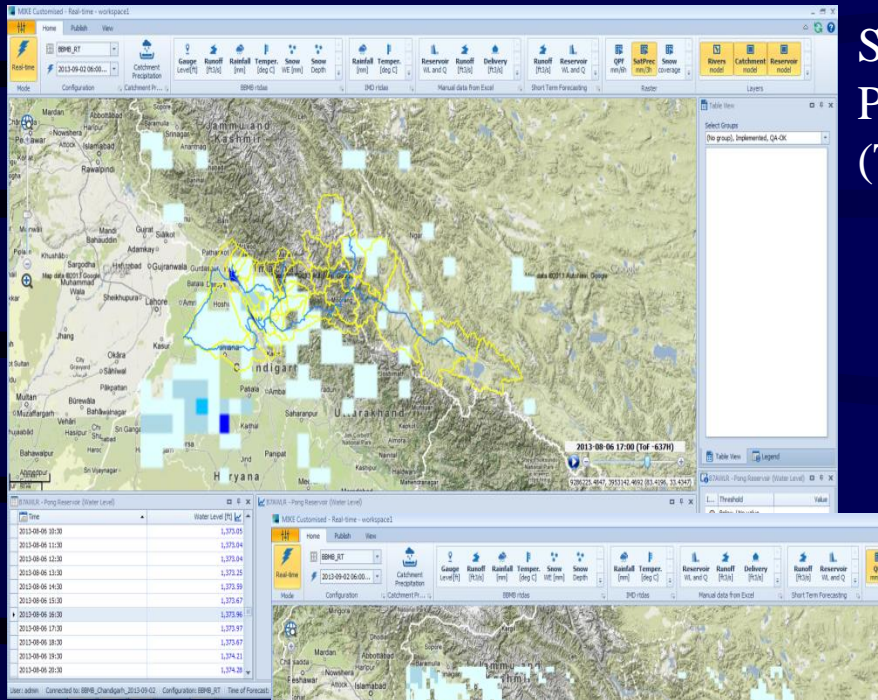
Example of Online data access



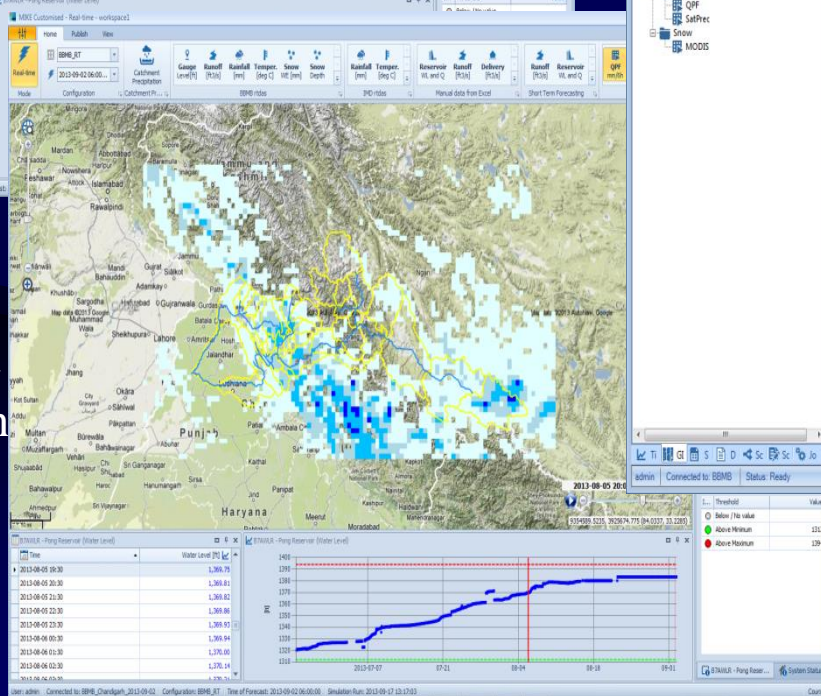
Other Online Data sources used in modelling —

Satellite
Precipitation
(TRMM)

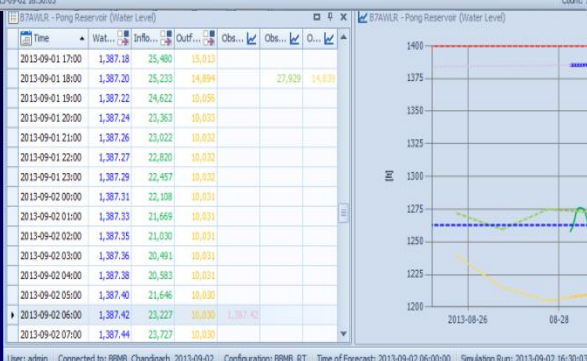
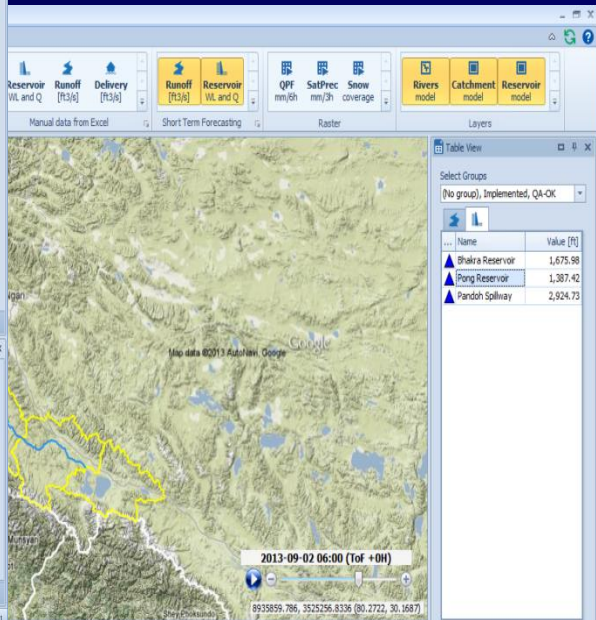
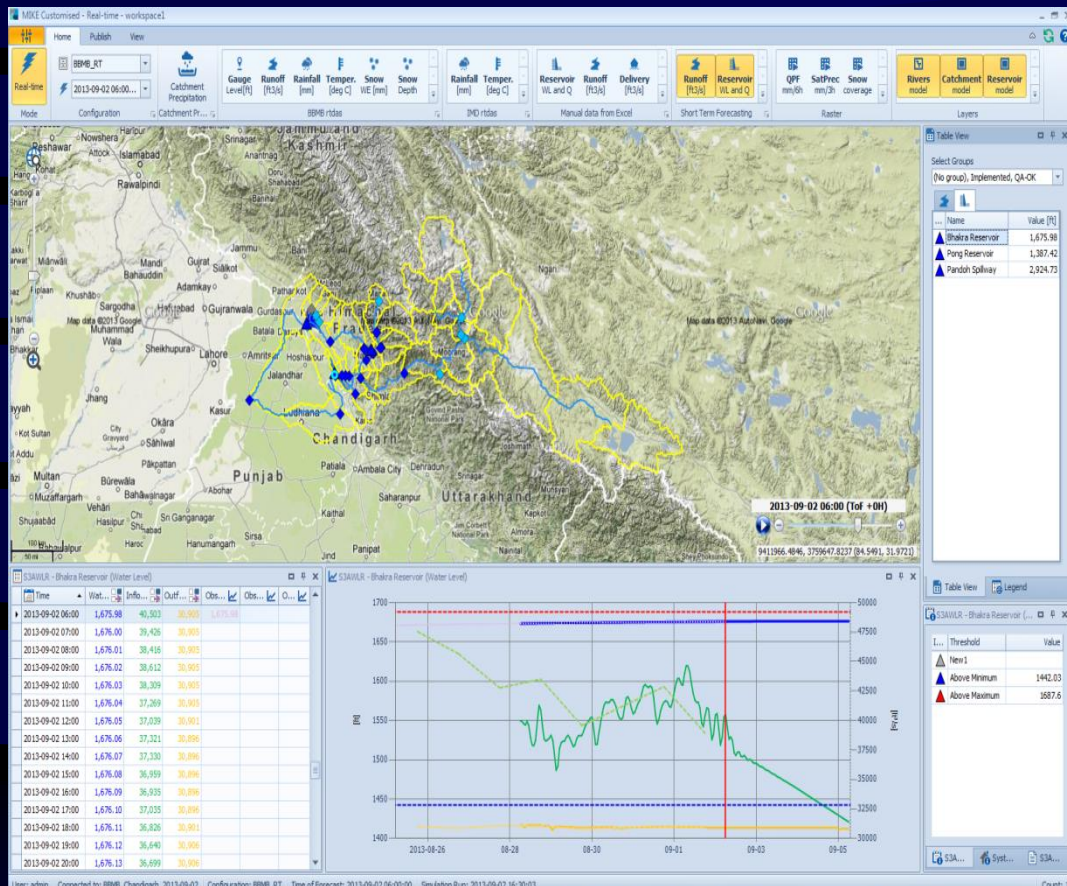
Snow Cover (MODIS)



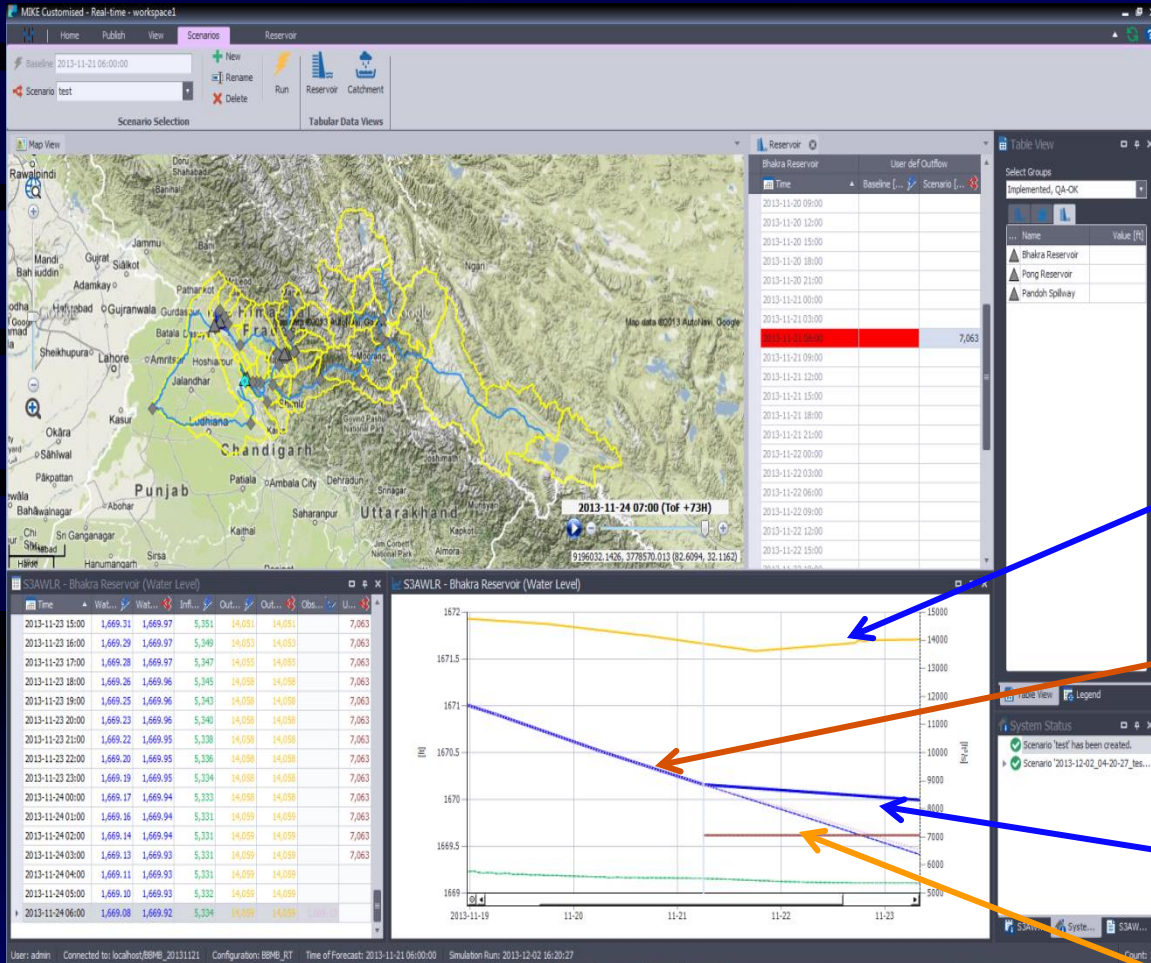
Quantitative
Precipitation
Forecast
from
RIMES



Inflow forecast Bhakra/Beas



User defined Operation Scenarios



Forecasted release =
14,000 cusecs

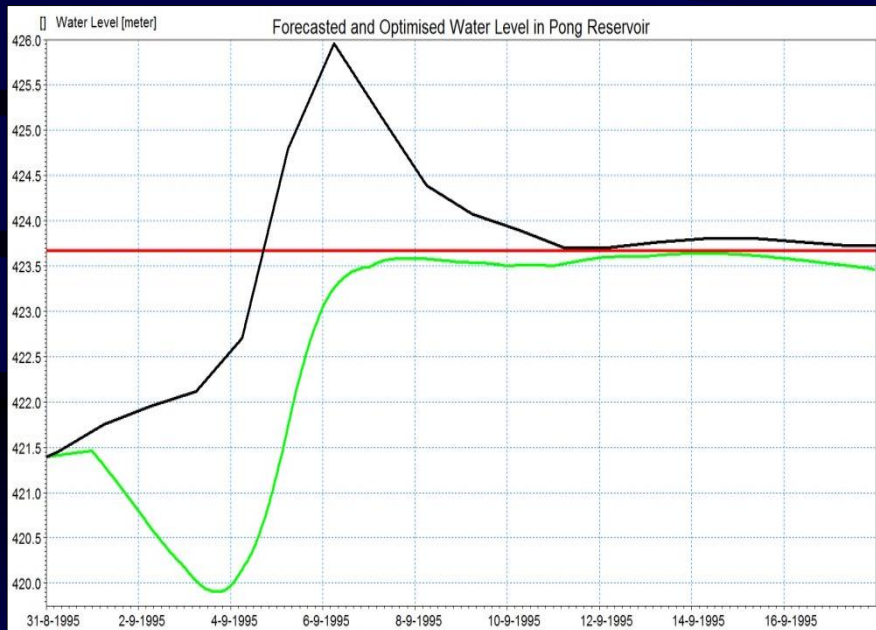
WL: 21-14 Nov, 2013

WL: (increase by 0.20 ft.)

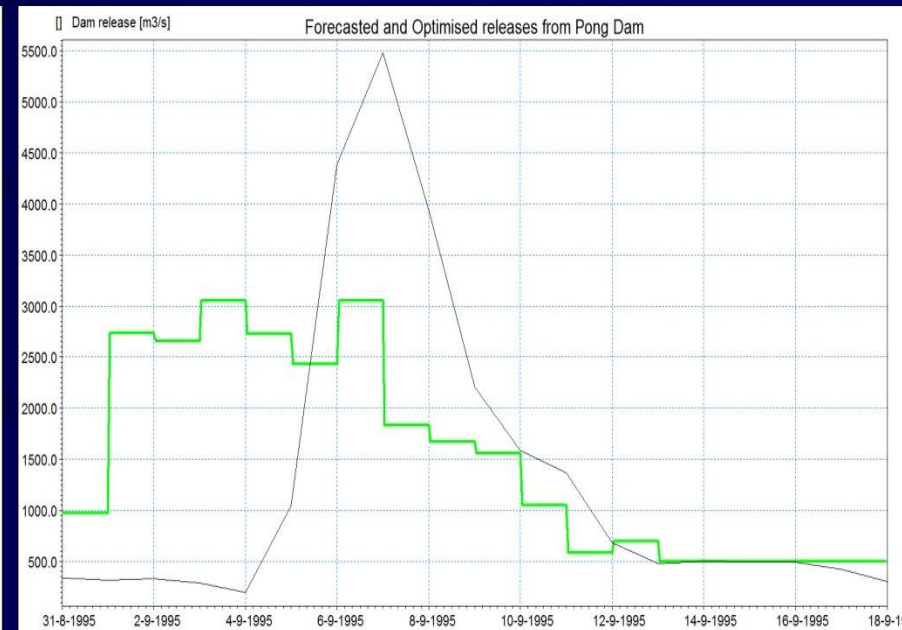
Decreased release
= 7,000 cusecs

Optimization of reservoir release from

- To minimise d/s flooding
- Optimisation is performed if the forecast shows maximum water level in one or more reservoir will exceed at the end of the forecast period.
- The optimisation will suggest some pre-releases from the reservoirs.



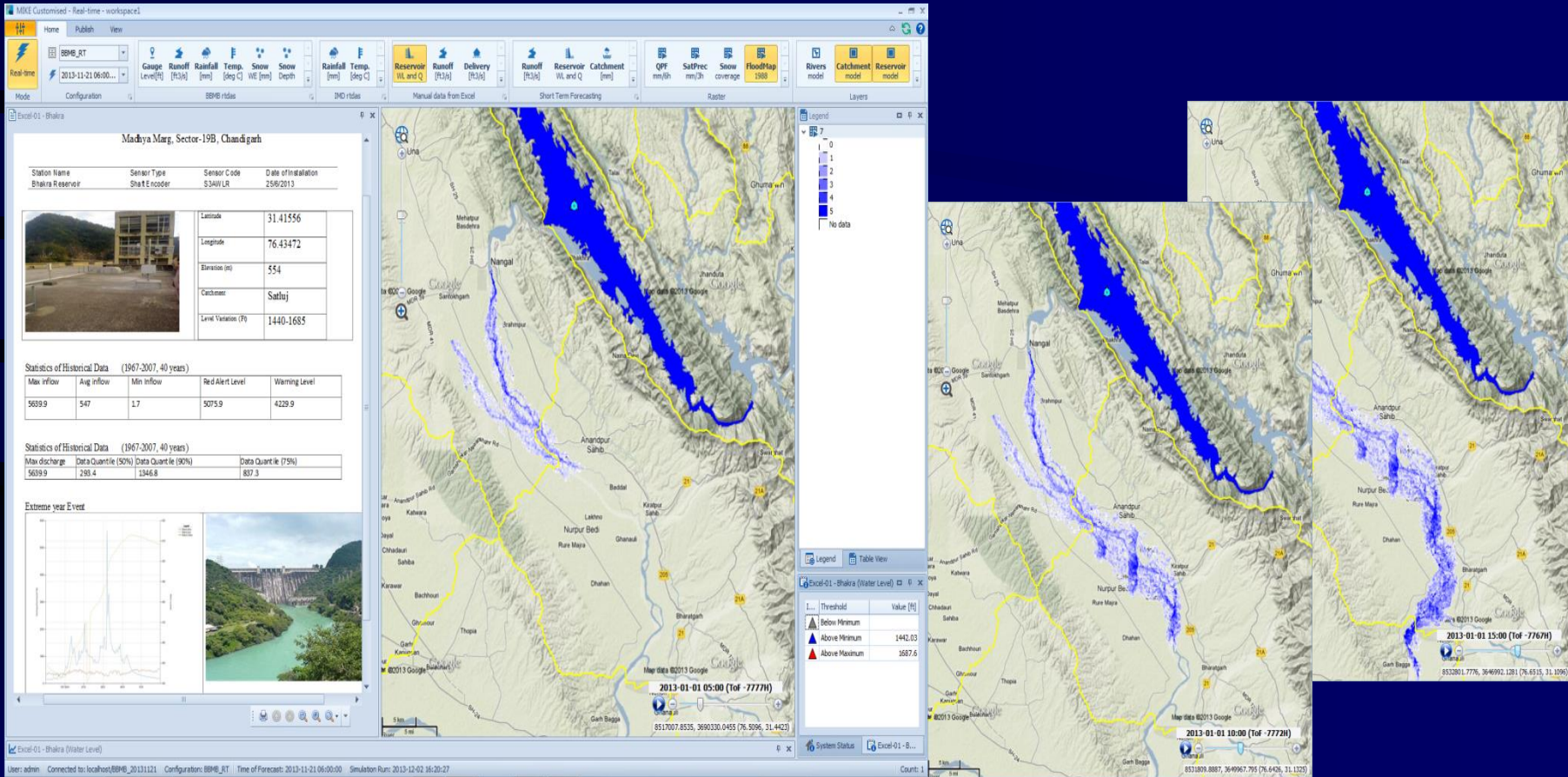
Maximum Water Level in Pong Dam (red), Forecast Water Level (black), and Optimised Water Level (green)



Spill during Actual Event (black) and Spill suggested by Optimisation (green)

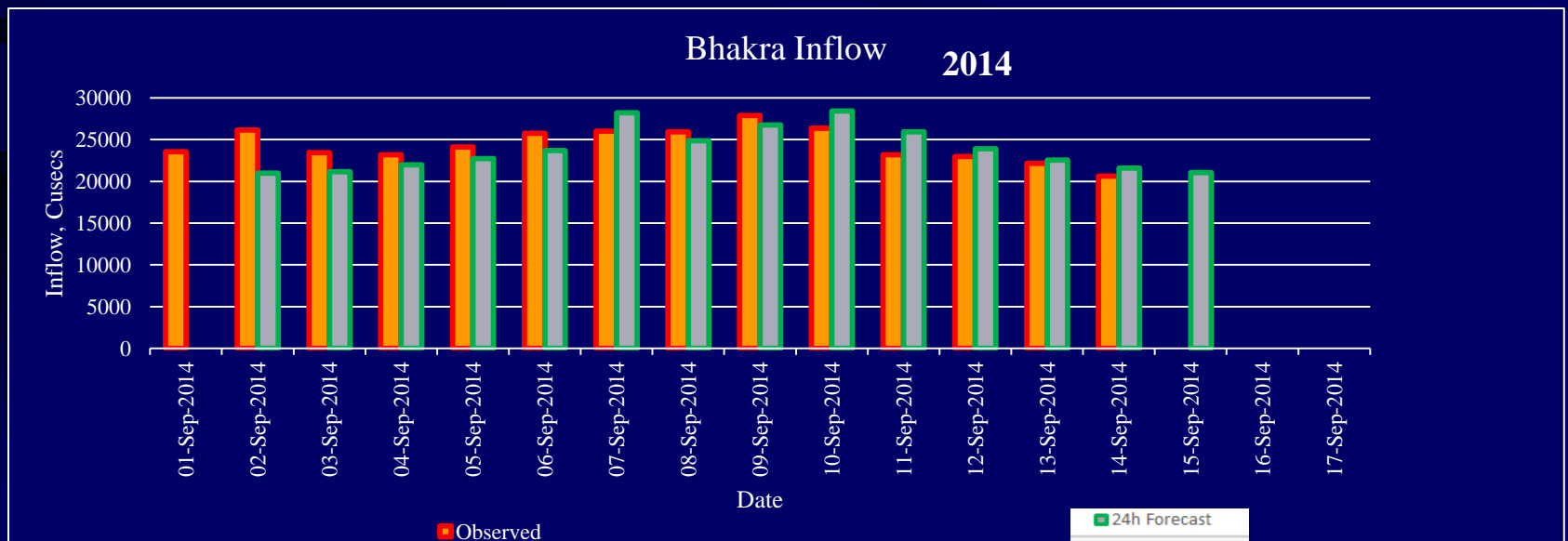
Flood Mapping

Downstream Flood Map: 5, 10 and 15 hours after peak release from Bhakra

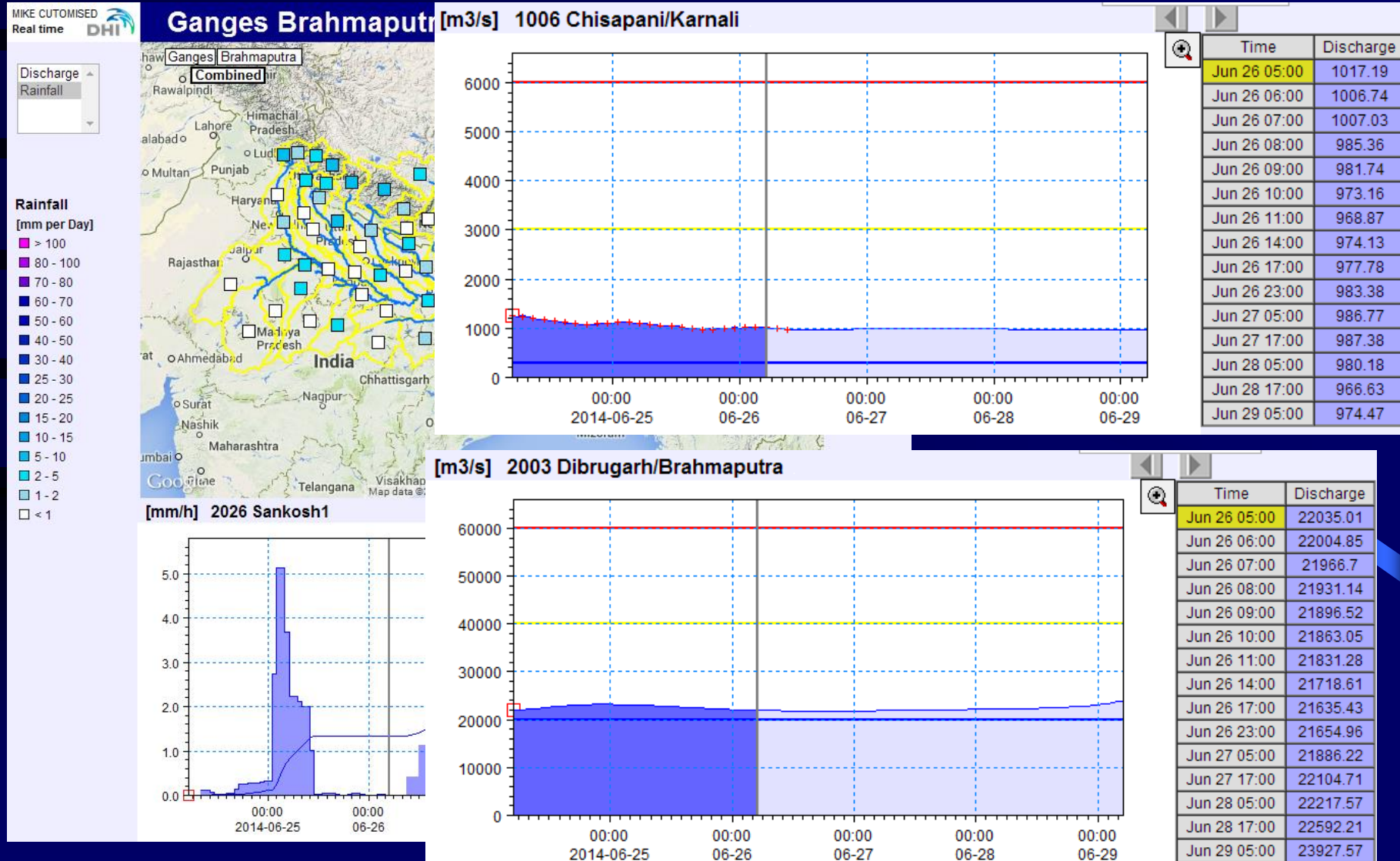


Benefits of RTDSS

The year 2013 was similar to 2008. Using the RTDSS, it was possible to control the flood spills and store the water in the reservoirs, thus limiting flood damages, while increasing power generation.



Large Basin scale flood forecasting



Kashmir flood toll crosses 175 even as Army evacuates 23,500 people

Srinagar Seems To Have Turned Into A Lake

TIMES NEWS NETWORK

New Delhi/Srinagar/Jammu: Aided by a dry spell, the Army scaled up its air-lift operations on Monday, rescuing close to 23,500 flood-stricken people, including around 2,000 from Srinagar alone. The Army chief, Gen Dalbir Singh Suhag, told reporters that the military "won't move back to the barracks till the last man is brought to safety". As security forces and the ill-prepared state administration struggled with Kashmir's worst calamity since independence, fatalities crossed 175, with 27 people killed by landslide in remote Pancheri village in Udhampur district. A higher death toll is feared



A picture provided by the defense ministry shows an IAF helicopter rescuing flood victims in Kashmir

RESCUE MISSION

- 20,000 soldiers deployed
- 65 medical teams and 15 engineer task forces spread out in Kashmir valley
- 45 IAF planes and helicopters flew 200 sorties to airlift 1,800 people and drop 315 tonnes of relief material on Monday
- 2,000 rescued from Srinagar alone
- Over 10,000 blankets, 150 tonnes of rations and 4 lakh litres of milk flown in
- 5-7 days before road link between Jammu and Valley is restored

“We won't return to barracks till the last man is brought to safety”
—GEN DALBIR SINGH SUHAG | ARMY CHIEF

with scores of people trapped in areas isolated by landslips in Jammu region. Naval and marine commands were deployed for the first time on Monday as water levels remained steadily high, hampering distribution of relief supplies. Desperate people were seen huddled on rooftops in Srinagar as the military choppers tried to pluck some of them to safety. There was complete breakdown of telecommuni-

cation network with both mobile phone and landline links paralysed. Army sources said, began airlifting communication and BSNL loads to Srinagar to restore connectivity. Power supply remained disrupted across the state with hospitals bearing the brunt of the crisis. The Border Roads Organization has assessed the damage to the three highways connecting Kashmir with Jammu and said it will take

five to seven days to restore the vital road link. “The Army has deployed around 20,000 soldiers in its Operation Megh Rahat to rescue stranded people, with 215 columns, 65 medical teams and 15 engineer task forces spread out in the Kashmir valley,” said additional director general (public information) Major-General Shokin Chauhan on Monday evening.

► Continued on P 10



- Do the Affected people get the information?
- Do they understand the forecast ?
- Is the Information useful ?

Conclusion



▶ 🔊 1:11 / 1:32
Athletics - Men's



▶ 🔊 1:16 / 1:32
Athletics - Men's 4X100M Relay - Beijing 2008 Summer Olympic Games

COMMUNICATION

COMMUNICATION IS THE KEY TO SUCCESS...
PASS IT ON.

A stylized pyramid logo with a white border is positioned above the word "COMMUNICATION" in a serif font. Below this, the text "COMMUNICATION IS THE KEY TO SUCCESS..." is written in a smaller font, followed by "PASS IT ON." in a larger, bold font.