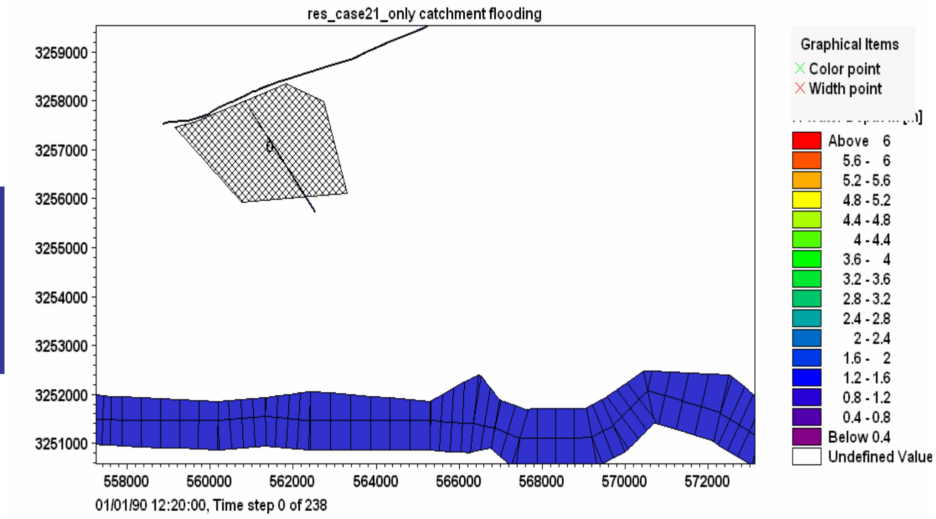
AWCI Phase 2 Implementation Plan–Proposal from India



Dr Rakesh Kumar
NATIONAL INSTITUTE OF HYDROLOGY
ROORKEE - INDIA

India – A Comparison with the World

India's Land Resources	2% of the World
India's Freshwater Resource	4% of the World
India's Population	16% of the World
India's Cattle Population	10% of the World

India's Land Resources

Geographical Area	329 mha
Non-cultivated Area	7%
Barren/Waste Land	23%
Forested Area	23%
Cultivated Area (CA)	47%
Irrigated Area (produces 55%)	37% of CA
Rainfed Area (produces 45%)	63% of CA

Annual Water Availability in India

Total precipitation	4000 BCM
Annual water availability	1869 BCM
Utilizable water	1123 BCM
- Surface water - Ground water	690 BCM 433 BCM

Rainfall Patterns in India

Long-term average annual rainfall is 1160 mm.

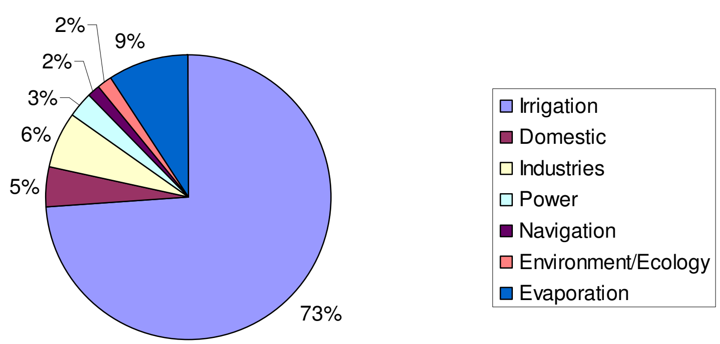
Highly Variable in space (about 11,690 mm at Mousinram near Cherrapunji in Meghalaya and 150 mm at Jaisalmer)

Highly Variable in time (Three-quarters of the rain in less than 120 days during June to September)

Average number of rainy days in a year is 40


Impact of Climate Change
Temperature increase
Change in Monsoon Pattern
Increase in Rain Fall Intensity
Decrease in No. of Rainy Days
Decrease in Snow Fall
Increase in Glacier retreat
Increase in Evaporation rate
Change in Runoff Pattern
Change in Ground water Recharge
Increase in Extreme Events
Sea Level Rise
Change in water quality

India - Water Requirements for Different Uses (Year 2010)



Source : Ministry of Water Resources, 1999

National Issues of Interest

Water availability

- How do water fluxes vary on catchment scale in response to global climate events?
- Impacts on Water Quality

Water Demands

- Crop Evapo-transpiration

Association of Hydrologic Extremes of Floods and Droughts with Large Scale Global Climate Events

- Change in Frequency and Magnitude of extreme events ;
- Impact of year to year variations of the Monsoon will continue to be dominant even in the presence of global warming

National Issues of Interest (contd)

- Design storm intensities - Urban stormwater drainage
- Delays in onset of monsoon
  - Over-year storage policies; Real-time adaptive decisions
- Salinity Intrusions due to Rising Sea Levels
- Robust & Resilient water management policies to offset adverse impact due to climate change
- Change in ground water recharge pattern
  - Long term adjustments in policies
- Scale Issues
  - Downscaling (space)
  - Disaggregation (time)
- Uncertainty
  - GCMs and Scenarios
  - Lack of good quality data

Eight National Missions

- National Solar Mission
- National Mission for Enhanced Energy Efficiency
- National Mission on Sustainable Habitat
- National Water Mission
- National Mission on Sustaining the Himalayan Ecosystem
- National Mission for a Green India
- National Mission for Sustainable Agriculture
- National Mission on Strategic Knowledge for Climate Change

Strategy 0.3

Setting up of Climate Change Cells in various organizations in MoWR (NIH, CWC, BB, CGWB)

Strategy 1.2

Development/implementation of modern technology for measurement of various data. (CWC, NIH)

Strategy 1.5

Research and studies on all aspects related to impact of climate change on water resources including quality aspects of water resources with active collaboration of all research organizations working in the area of climate change (NIH, CWC, CGWB, BB and Research Stations)

Strategy 1.7

Projection of the impact of climate change on water resources (CWC & NIH)

Indian National Committee on Hydrology for UNESCO-IHP

- Processes R&D Proposal for funding by MoWR, Govt. of India
- Publishes Journal of Hydrological R&D
- Publishes State of Art Reports on key themes of Hydrology & Water Resources
- Organizes International & National Symposia.

Technology Transfer Activities

- Organizes International & National Training Programs.

International Collaboration in R&D Activities

- International Collaboration in R&D Activities with UNDP, UNESCO, CEC, World Bank, Netherlands, DHI, Denmark etc.

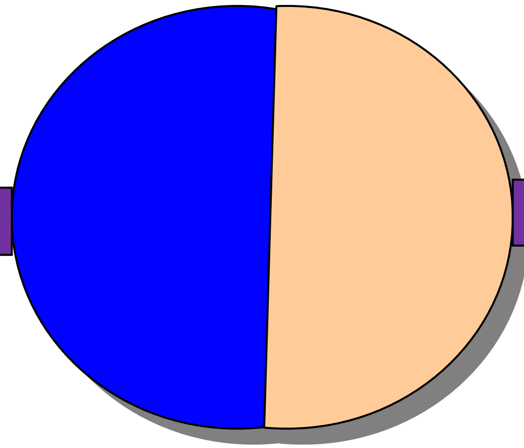
Basin-wise studies on Impact of Climate Change on Water Resources

- Nodal Agency for Invitation and Processing of R&D Proposals for Basin-wise studies for Impact of Climate Change on Water Resources.

HYDROLOGIC EXTREMES

Excess water that cause damage

Deficit water that cause scarcity in sustaining usual activities and life



Climate Change may affect other Extreme Events too

- Glacial Lake Outburst Flood (GLOF)
- Landslides (due to increased precipitation)
- Storms, cyclones and tornadoes
- Ocean and coastal surges and related flooding (due to atmospheric pressure changes and sea level rise);
- Heat spells and cold snaps.

Floods and Droughts

"A warmer climate, with its increased climate variability, will increase the risk of both floods and droughts"   IPCC AR4, 2007

Difficulties in creating scenarios of changes in rainfall as applied to flood-producing events

Influence of geology

Anthropogenic changes may be more pronounced

Critically dependant on water management practices

Intense Rains and Floods

Serious and recurrent floods in various parts of India

Droughts

Drought in Orissa (India) in 2000-2002: crop failures, mass starvation affected 11 million people

Cyclones / Typhoons

Increasing intensity of cyclones formation in Bay of Bengal and Arabian Sea

Cyclone in Orissa, 1999: 15, 000 deaths

Devastating Cyclone (Aila) in West Bengal , 2009

Challenges of Flood Management

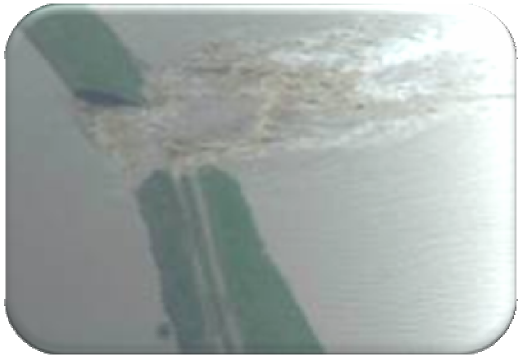
Population increase

Securing livelihoods

Changes in decision making processes

Ecosystem Conservation

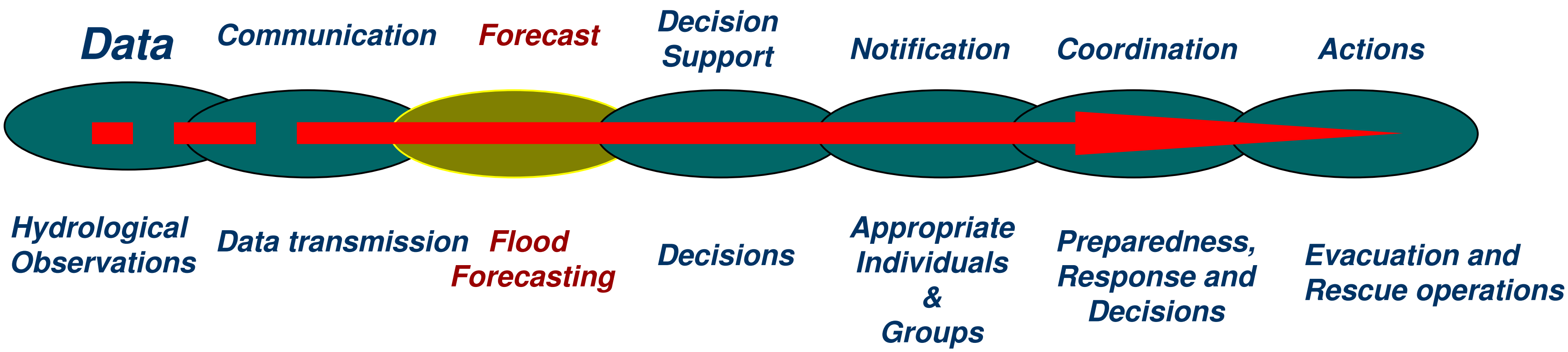
Climate variability and change



Absolute safety from flooding is a myth

Flood forecasting, warning and response system

A Critical Chain of Events and Actions



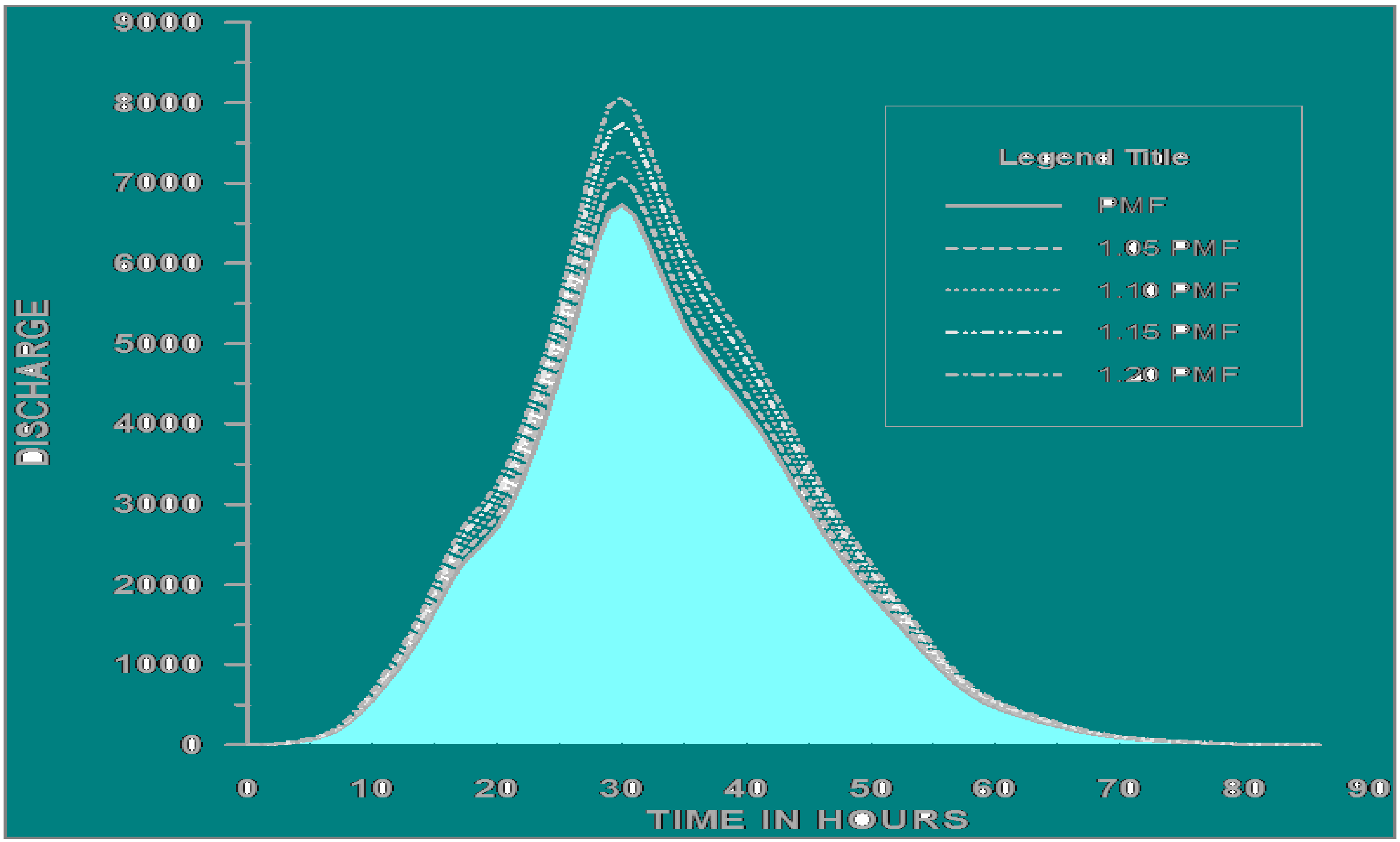
Estimation of floods of various return periods using L-moments approach for different Scenarios (m^3/s)

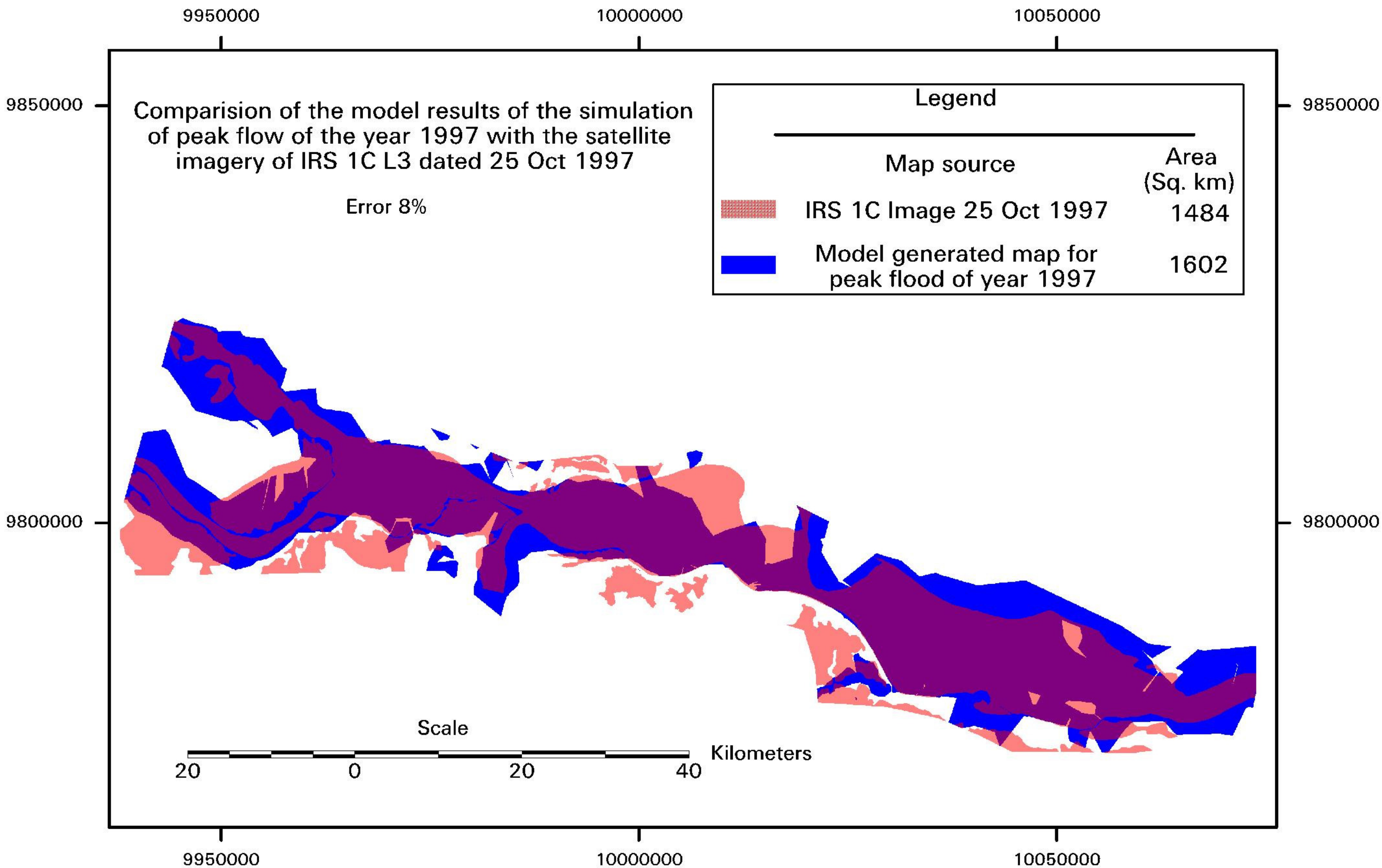
Return Periods	25	50	100	1000
Scenario 1	8978	10418	12042	19208
Scenario 4	9403	11049	12945	21676
Scenario 5	9408	11025	12868	21186
Scenario 6	10603	12896	15657	29802
Scenario 7	10685	12842	15358	27317

% Deviations in floods of various return periods for different Scenarios

Return Periods	25	50	100	1000
Scenario 4	4.73	6.05	7.50	12.85
Scenario 5	4.78	5.83	6.86	10.30
Scenario 6	18.0	23.8	30.0	55.2
Scenario 7	19.0	23.3	27.5	42.2

PMF 6842 m3/s	1.05 PMP	1.10 PMP	1.15 PMP	1.20 PMP
	Peak of PMF			
	7064	7401	7737	8073
	% Deviation in PMF			
	3	8	13	18



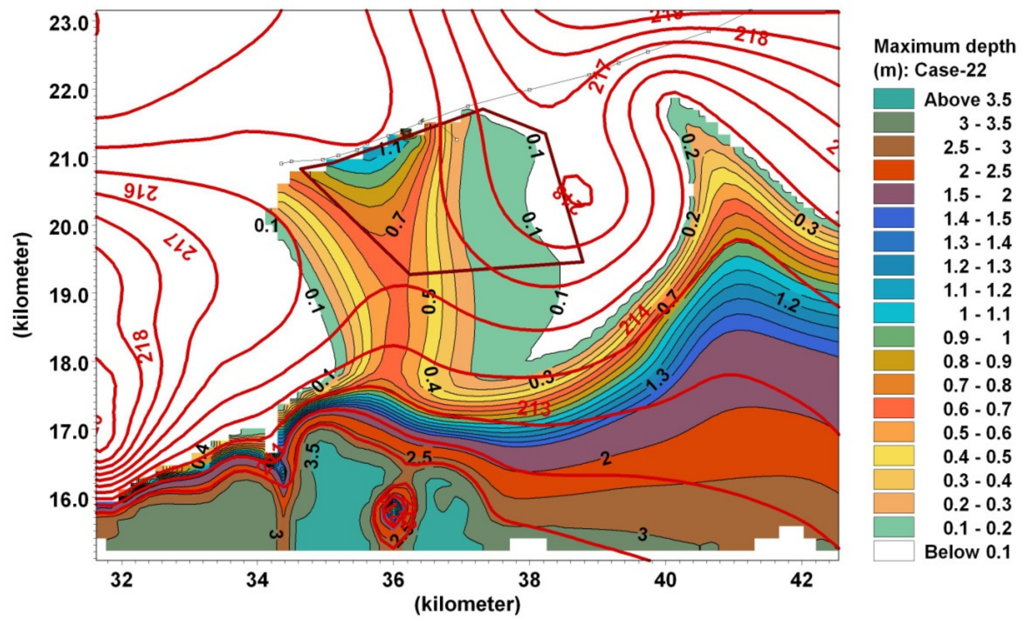


Comparison of Inundated area computed by hydraulic modeling and Inundated area mapped by satellite data for the year 1997

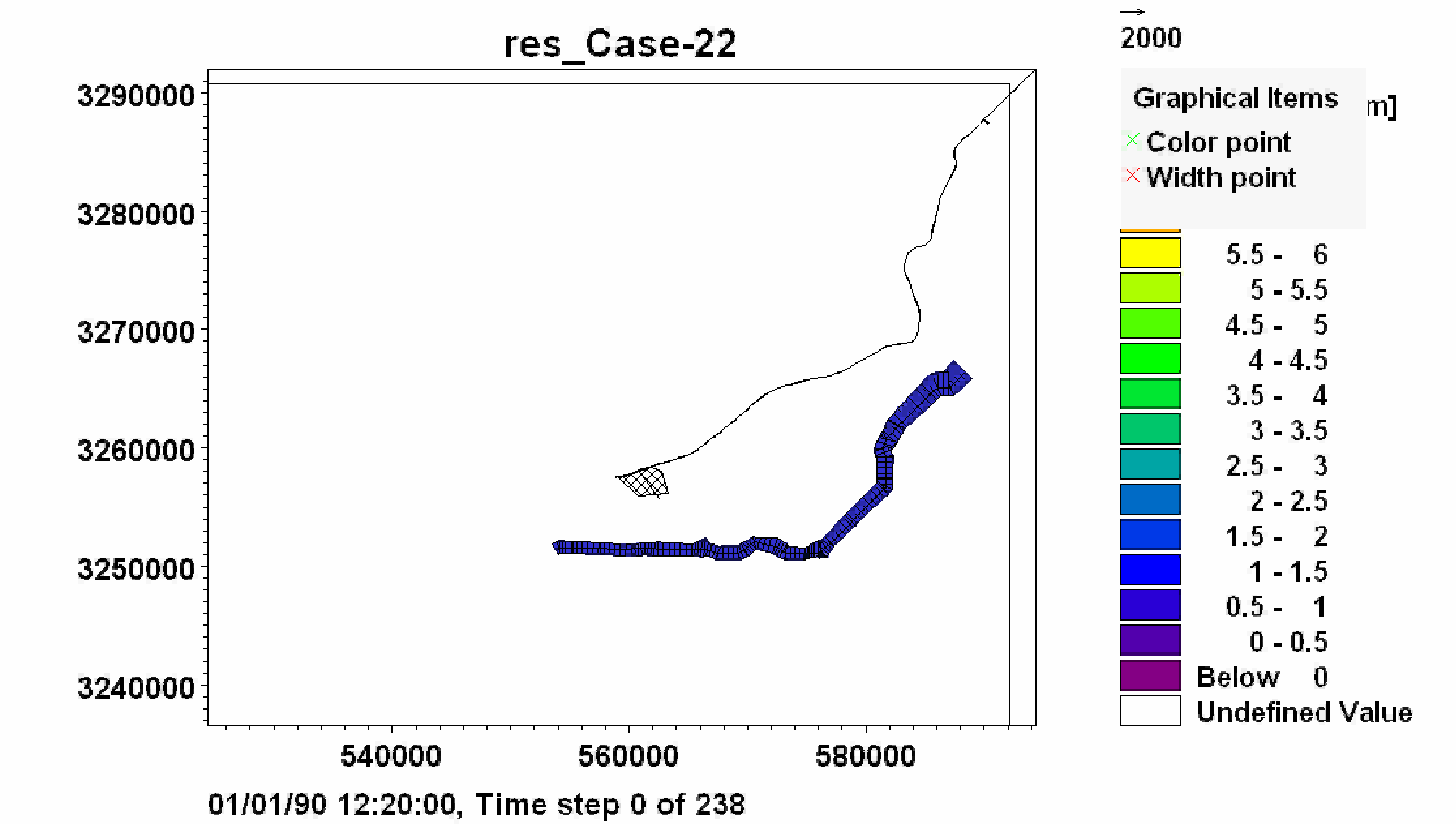
Estimation of Safe Grade Elevation for the Design Flood

Future climate change scenario

- Rainfall estimate is increased by 15% to account for the future climate change
- This makes case-22, the flooding scenario when bank full FBC flow is fully diverted towards plant site, local rain is 1000 yr + σ + 15% increase & catchment is flooded with 1000 yr + σ+15% increased rain
- Max flood depth = 1.17 m



FLOW MOVEMENT ANIMATION



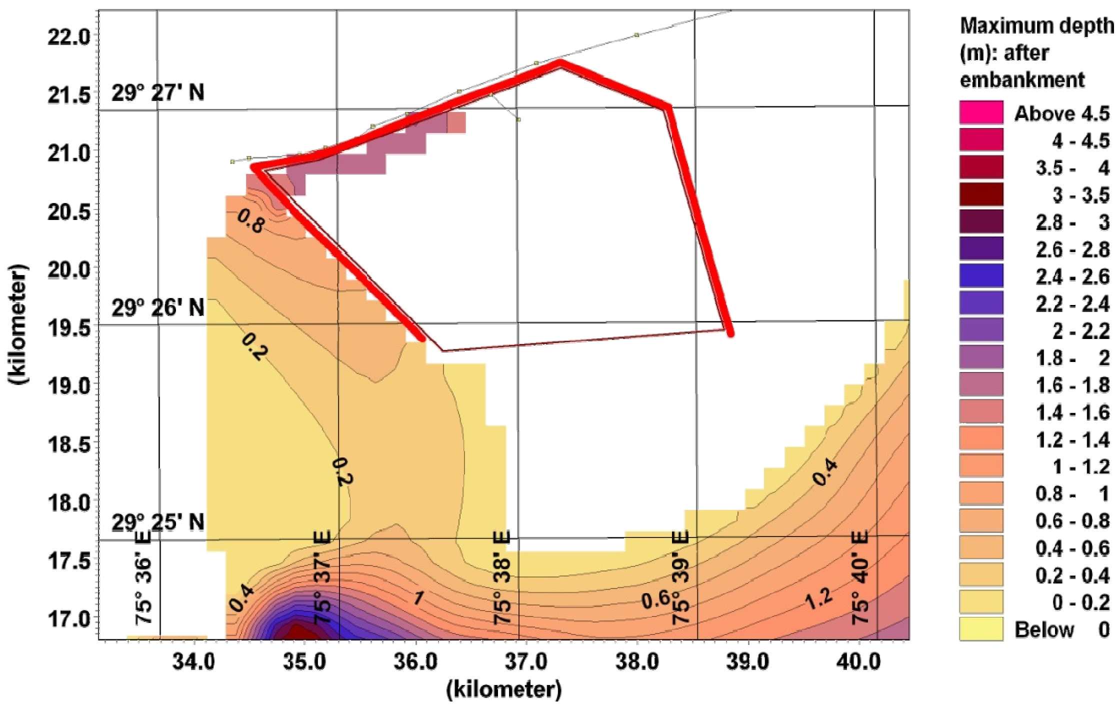
Case-22
Catchment flooding – 1000+σ+15%increase, local site rainfall – 1000+ σ +15%increase, Full flow divert from FBC & BML

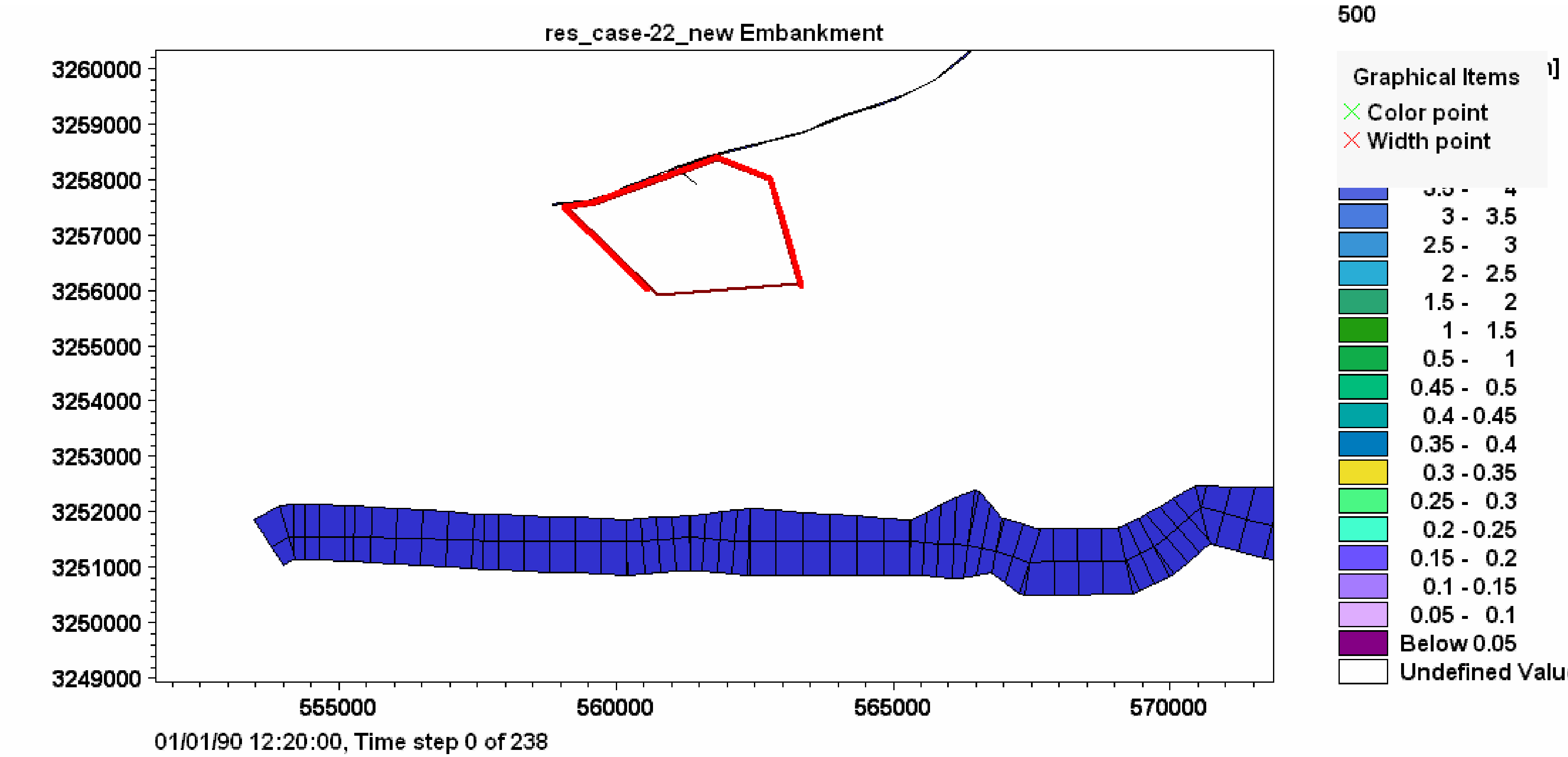
FLOOD PROTECTION MEASURE

Alternative-I:

A flood protection embankment with top elevation of RL 219.3 m and plinth level of structures at RL 219.1 m

(local 1000 yr rainfall with 15% increase for CC and 1 .0 m free board)

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res_case-22_new Embankment
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Graphical Items
Color point
Width point
3 - 3.5
2.5 - 3
2 - 2.5
1.5 - 2
1 - 1.5
0.5 - 1
0.45 - 0.5
0.4 - 0.45
0.35 - 0.4
0.3 - 0.35
0.25 - 0.3
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Below 0.05
Undefined Value

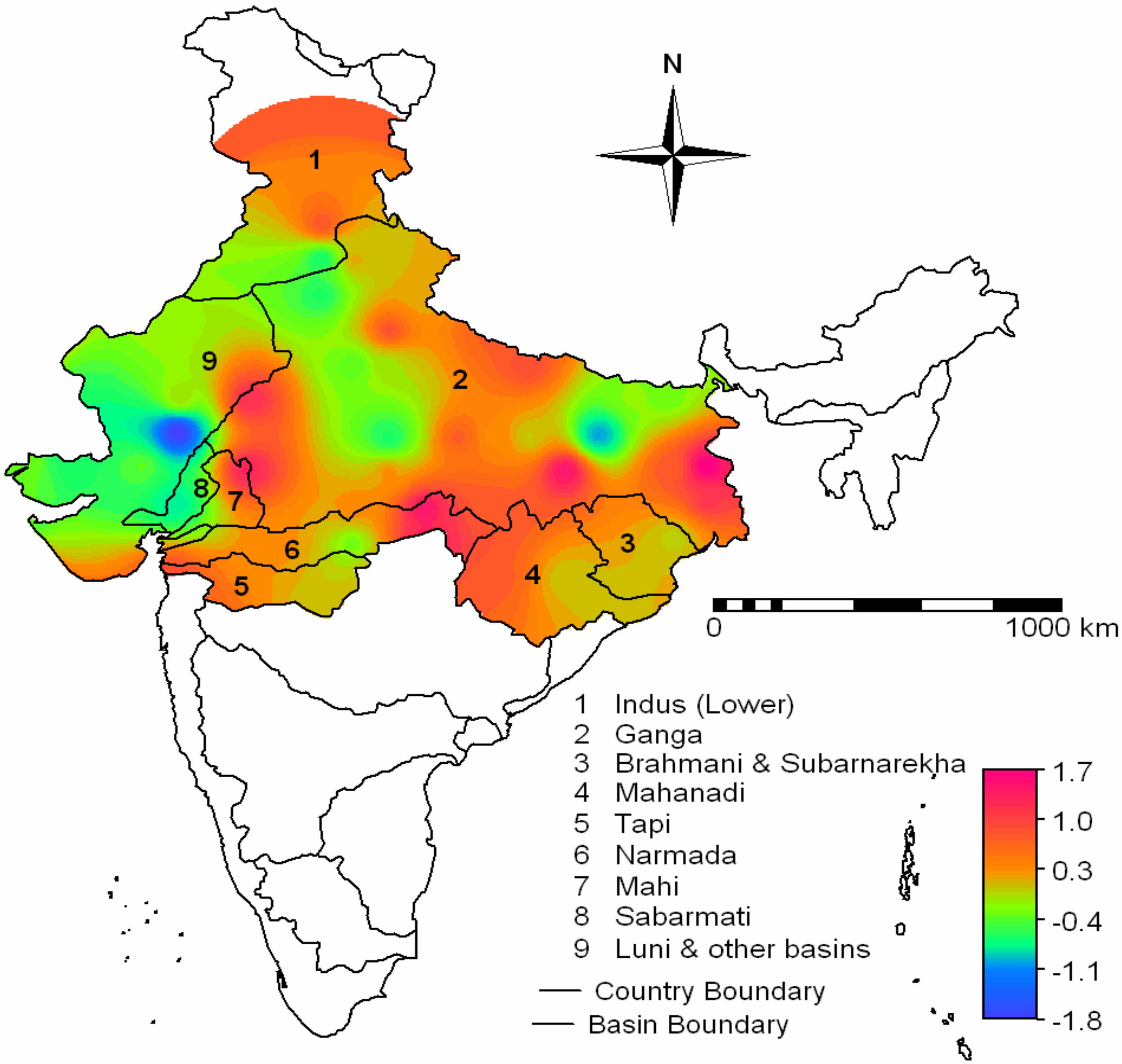


Figure 1: Spatial patterns of linear trends in annual mean temperature (oC/100 years) for different river basins during last Century (1901-2000).

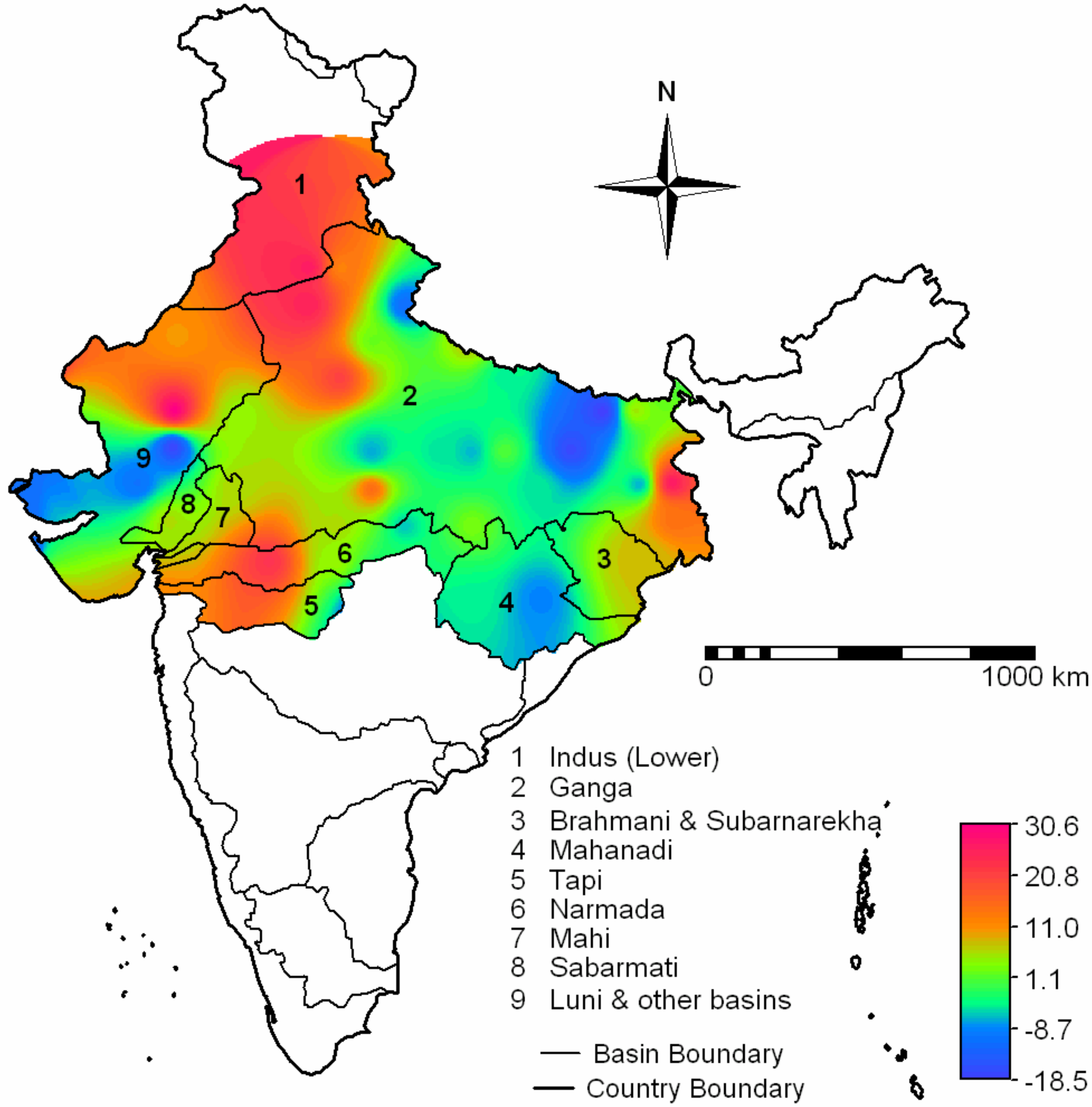


Figure 2: Spatial patterns of linear trends in annual rainfall (% of mean /100 years) for different river basins during last Century (1901-2000).

Climate variability analysis for Satluj Basin

- ***Basin Area (Indian part) : 22,275 km^2***
- ***Elevation Range: 500-7000 m.***
- ***Snow covered area : About 65% after winter***
- ***Glacierized area : About 10%***
- ***Important hydropower scheme: Bhakra Dam***

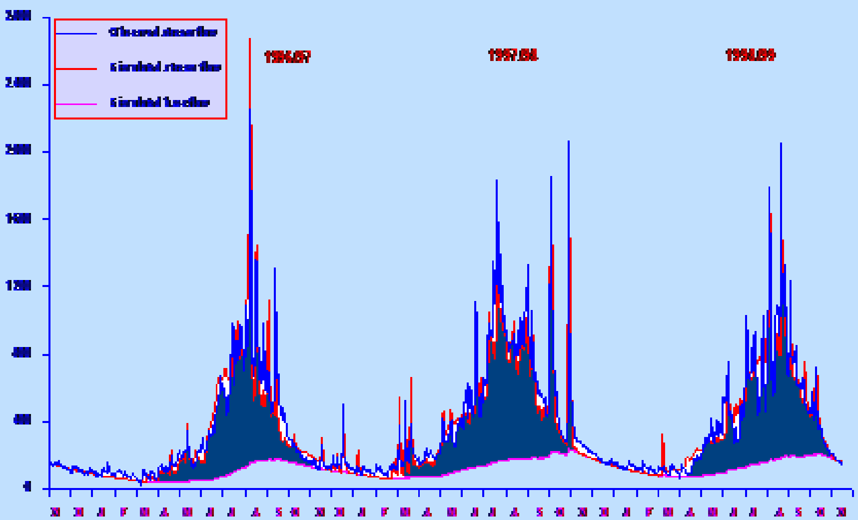
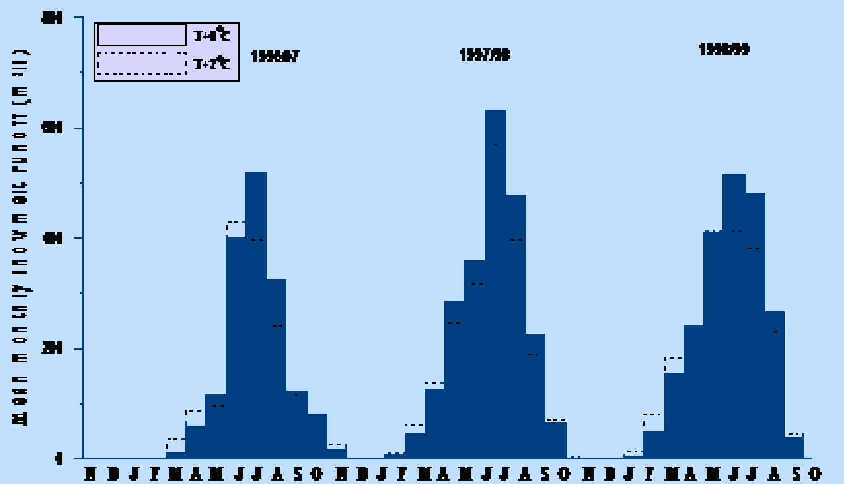


Figure 4: Observed and simulated daily streamflow for the Satluj River at Bhakra for a period of 3 years (1996/97 - 1998/99).

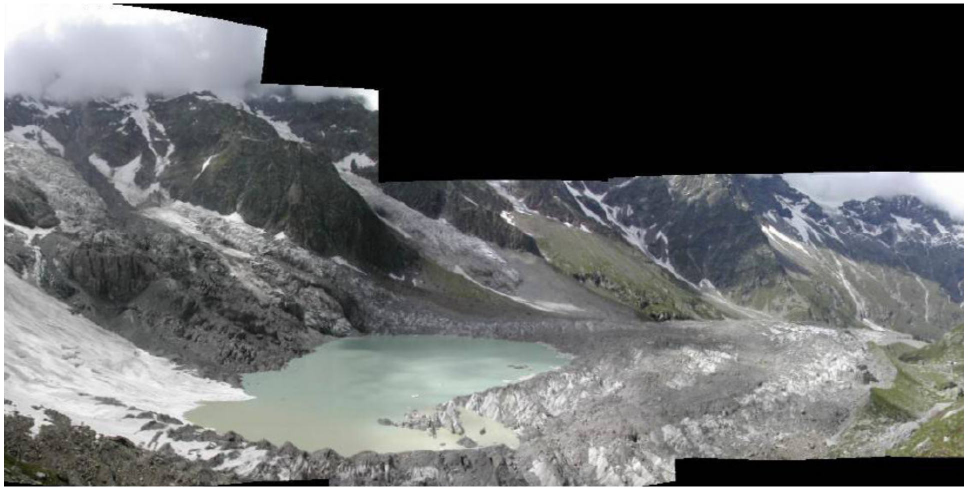


Effect of increase in temperature on mean monthly snow melt runoff for a period of 3 years (1996/97-1998/99) in the Sutlej River Basin.

Glacial Lake And Glacial Lake Outburst Flood (GLOF)

Glacial dammed lakes are formed by accumulation of water from the melting of Snow and Ice cover and by blockage of end moraines.

The bursting of moraine-dammed lakes is often due to the breaching of the dam by the erosion of the dam material as a result of overtopping by surging water or piping of dam material.



Impacts on coastal areas

- Coastal erosion and inundation of coastal lowland as sea level continues to rise, flooding the homes of millions of people living in low lying areas
- In India, potential impacts of 1 m sea-level rise include inundation of 5,763 km^2
- Significant losses of coastal ecosystems, affecting the aquaculture industry, particularly in heavily-populated mega-deltas
- Increase in Sea Water Intrusion through coastal aquifers

Climate Change and Adaptation

Assessment of projected water demands for irrigation, drinking water supply, industrial water supply , environmental requirements etc. based on climate change, demography, economic development and spatial planning

Assessment of projected water availability from the analysis of Hydrological and Hydro-meteorological data taking in to account impact of climate change

Optimal allocation of projected available water for future scenarios considering projected water demands using river basin simulation model

Review of hydrological design practices – Existing methodologies for computations of SPS, PMP, design storms, basin response and other design parameters are required to be reviewed.

Adaptation Strategies for Climate Change

In case of imbalance between projected demands and supply, design water resources management strategies (logical and/or promising combinations of structural and non-structural measures, allocation rules and water sharing options) to improve the situation

Assessment of the performance of the strategies, in terms of impacts on the water resources system, the socio-economic system and the environment.

Contd…

Adaptation Strategies for Climate Change

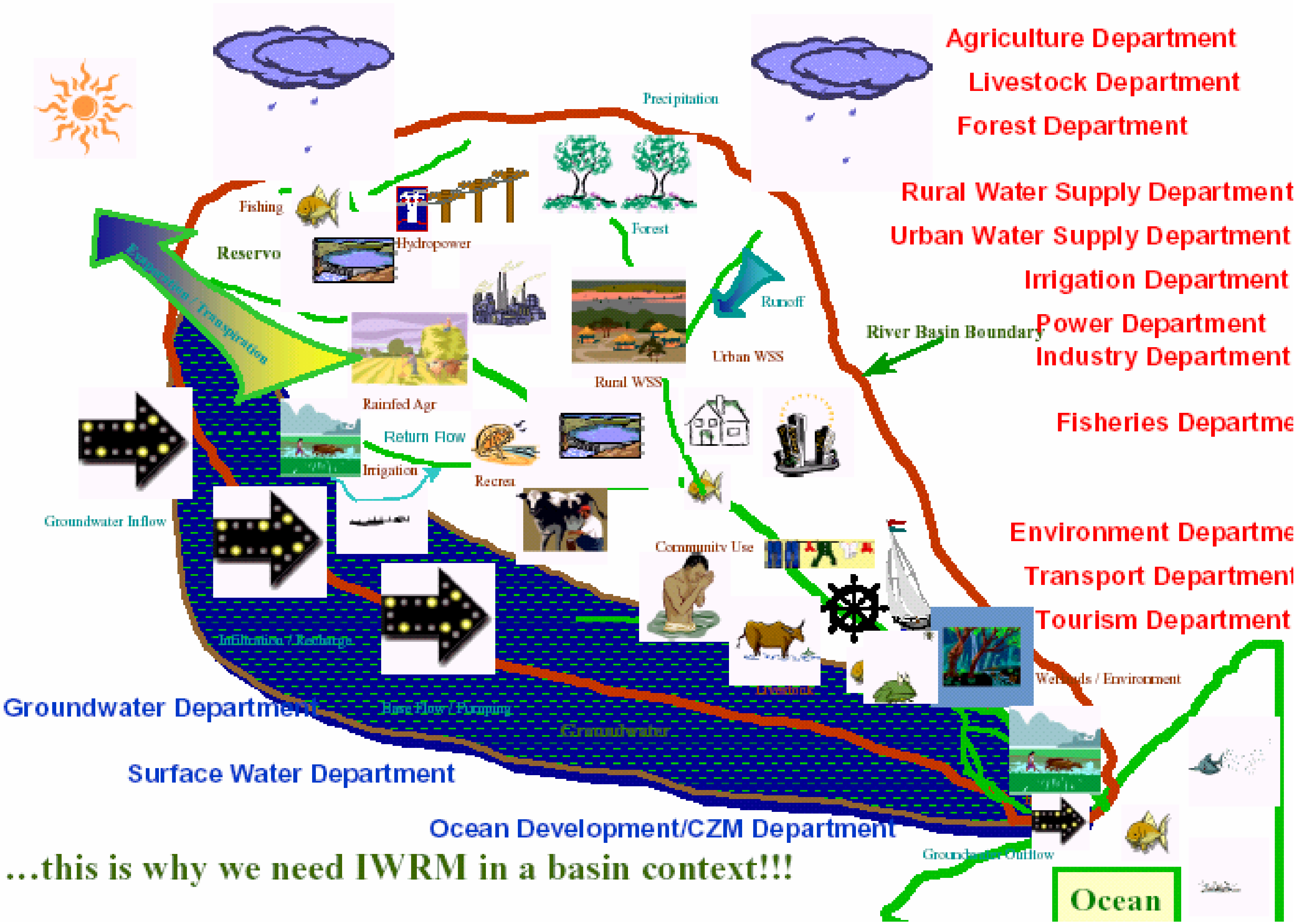
Flood Management Strategies – Long-term flood management strategies to be re-examined and accordingly actions to be planned.

Drought Management Strategies - Measures to augment supplies and decrease demands in the drought prone areas are needed.

Temporal and spatial assessment of water for Irrigation - Conjunctive use of surface water and groundwater needs to be encouraged.

Land Use and Cropping Pattern - Need to understand the possible coping strategies by different sections and different categories of farmers.

Why Integrated Water Resources Management?



...this is why we need IWRM in a basin context!!!

Prediction of Impact of Climate Change and Management Water Resources

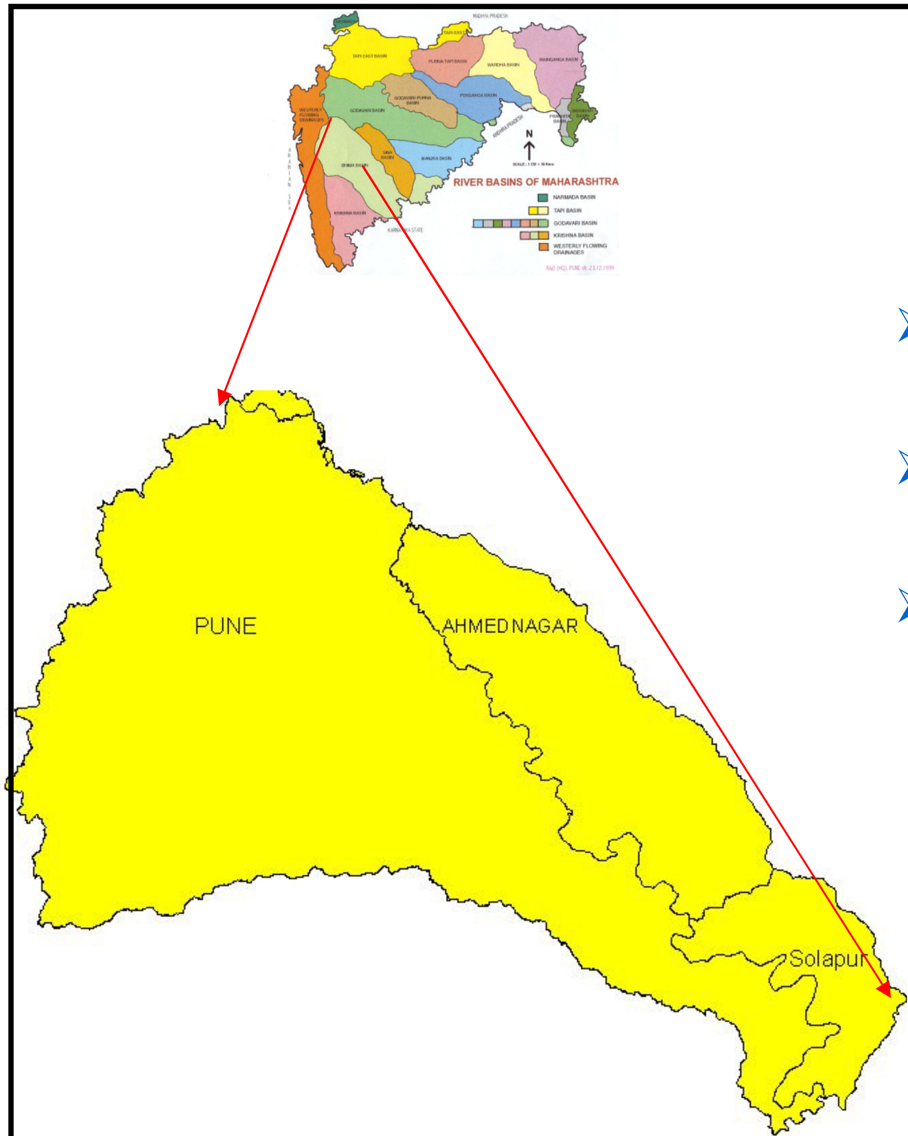
Downscaling of GCM Outputs for use in Hydrological Modeling on basin scale

Applications of distributed Hydrological Model for making future predictions considering all the processes of land phase of hydrological cycle

IWRDM, Development of DSS (Planning), DSS (Real Time), Policy & Operational Approaches to Manage Water Resources in Medium to Long Term

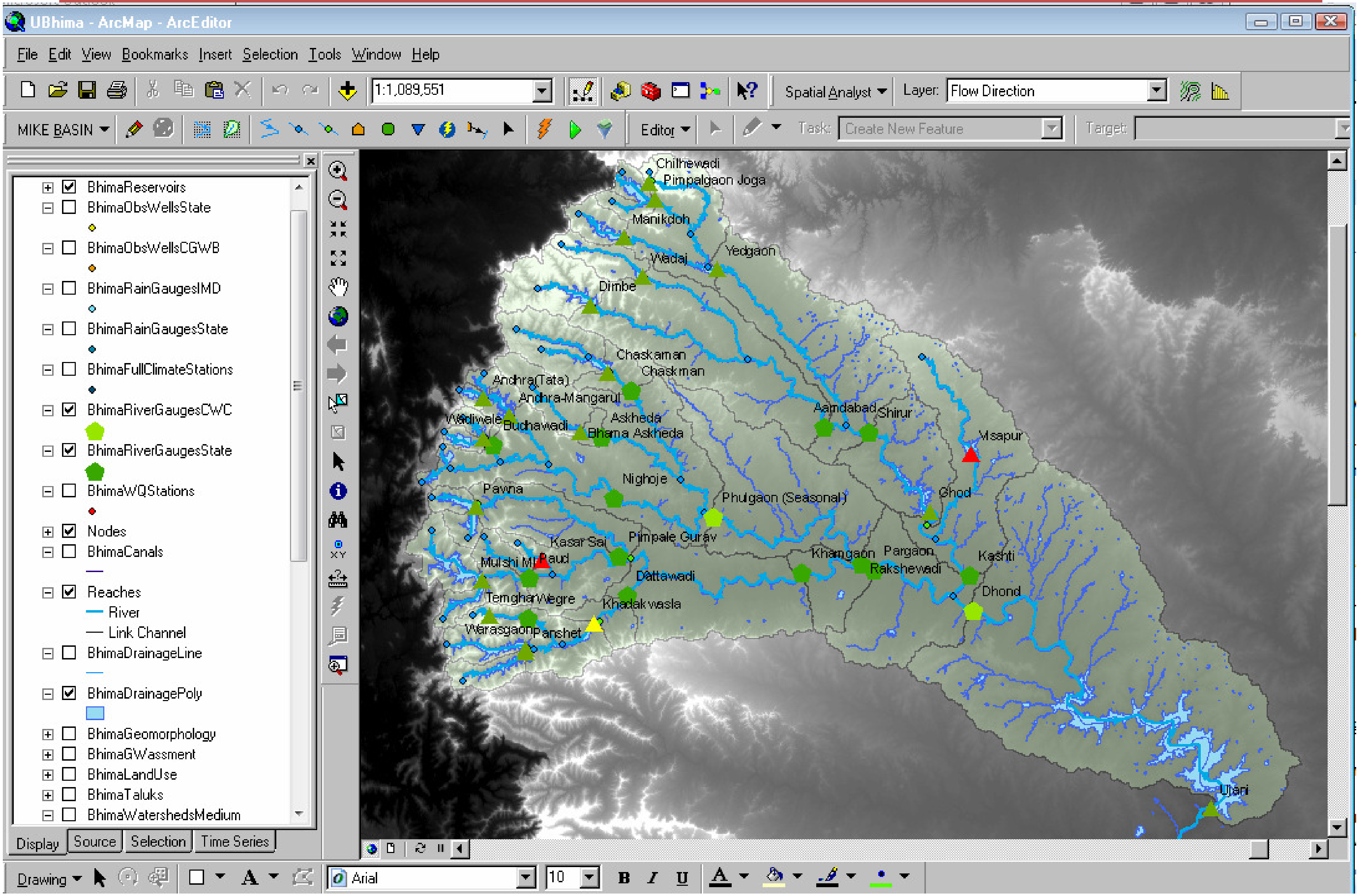
Training on the developed software and techniques.

Study Basin - Upper Bhima basin of India may be taken as project basin for AWCI Phase 2 Implementation Plan



- 18^0 3' to 19^0 24' North Latitude
- 73^0 20' to 75^0 18' East Longitude
- Covers an area of 14712 sq. km.

Mike Basin: Tracing of Rivers




THANKS!