Climate Change Impact Assessment on Indian Water Resources

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Groundwater Management in India: Issues and Challenges

IWRM a viable option

- River Basin is the basic unit
  - Makes possible to work out water balance
  - Understanding about spatial and temporal variability
  - Environmental Impacts assessment
  - Implications of manmade changes
  - Implications on account of Climate change and adaptation options thereof

Biodiversity & EIA

- EIA is usually limited to an audit of the present conditions
- Impact assessment due to the proposed intervention is usually missing
  - Worst affected is the biodiversity

Issues around water resources development

- Many parallel programs with competing demands
  - Such as watershed management, rainwater harvesting, water intensive industry, etc.
- No mechanism for tradeoffs between competing demands
- Ignoring environmental demand

Scientific base is essential

- Specific models to be deployed
  - Hydrological model
  - Hydraulic model
  - Water quality model
  - Groundwater model
  - Environment model
  - System model
  - Frameworks to allow interoperability

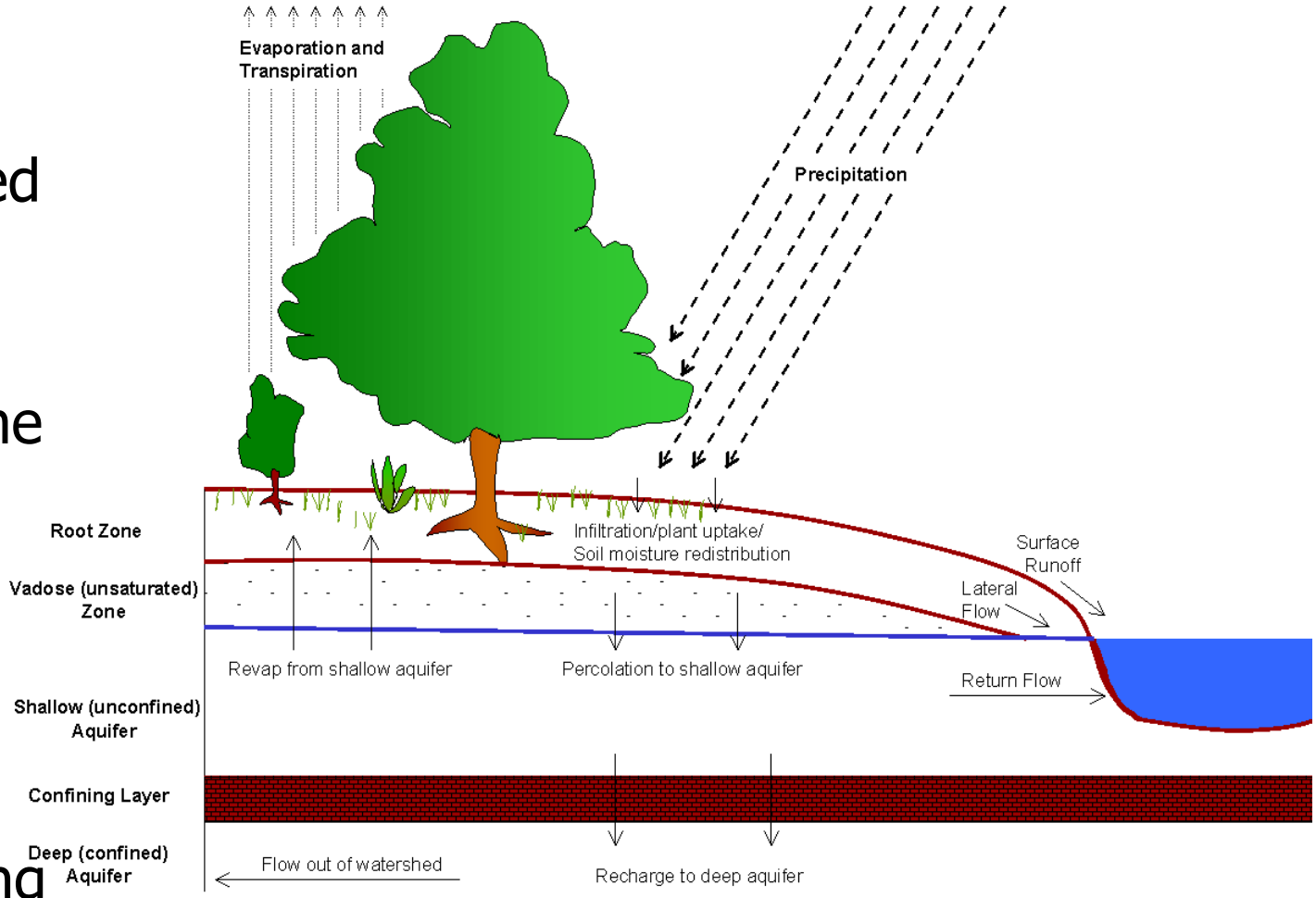
Some of the efforts made by IIT Delhi

- India's National Communications (NATCOM) to UNFCCC Coordinated by MoEF
- The first communication was made in 2004 and the Second in 2012
  - Work on quantification of climate change impacts on water Resources was entrusted to IIT Delhi

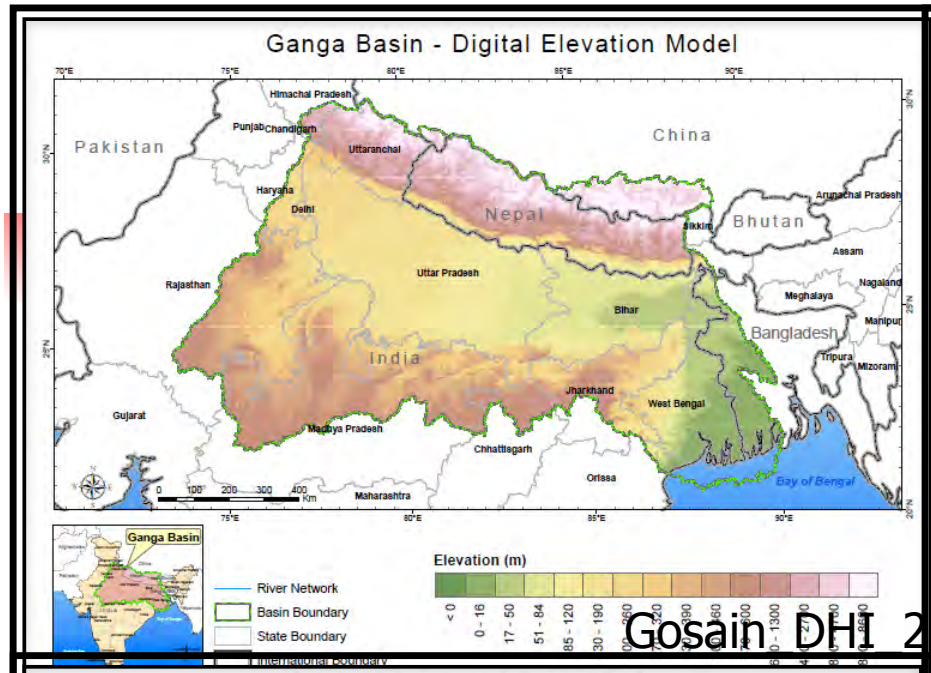
SWAT Model Components

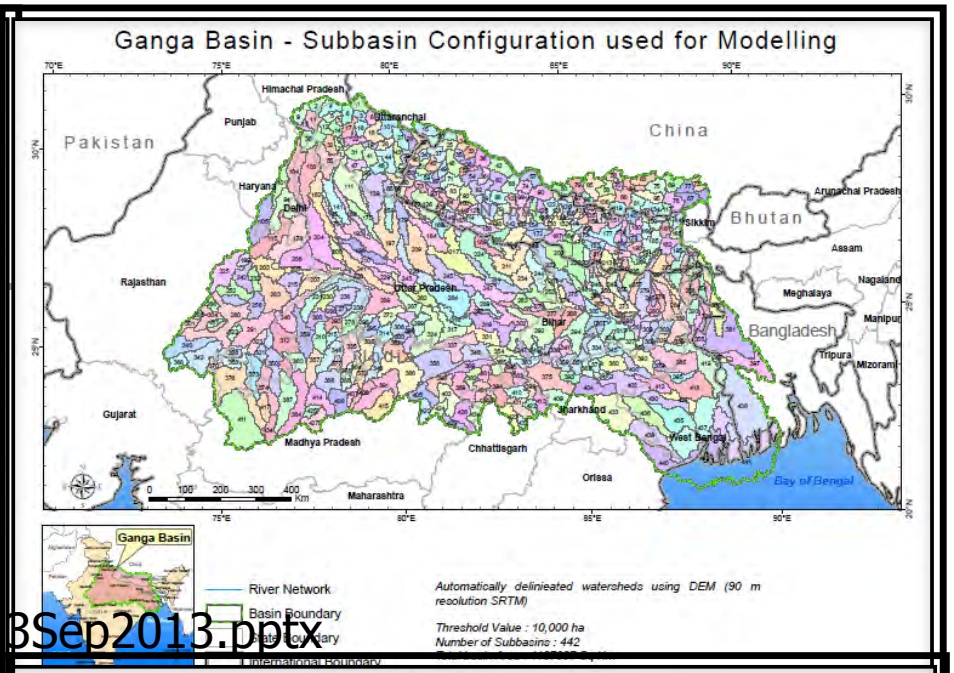
Features

- Physically based
- Distributed model
- Continuous time model (long term yield model)
- Uses readily available data
- Suitable for long term impact studies



Ganga Basin Hydrological Modelling – Base layers





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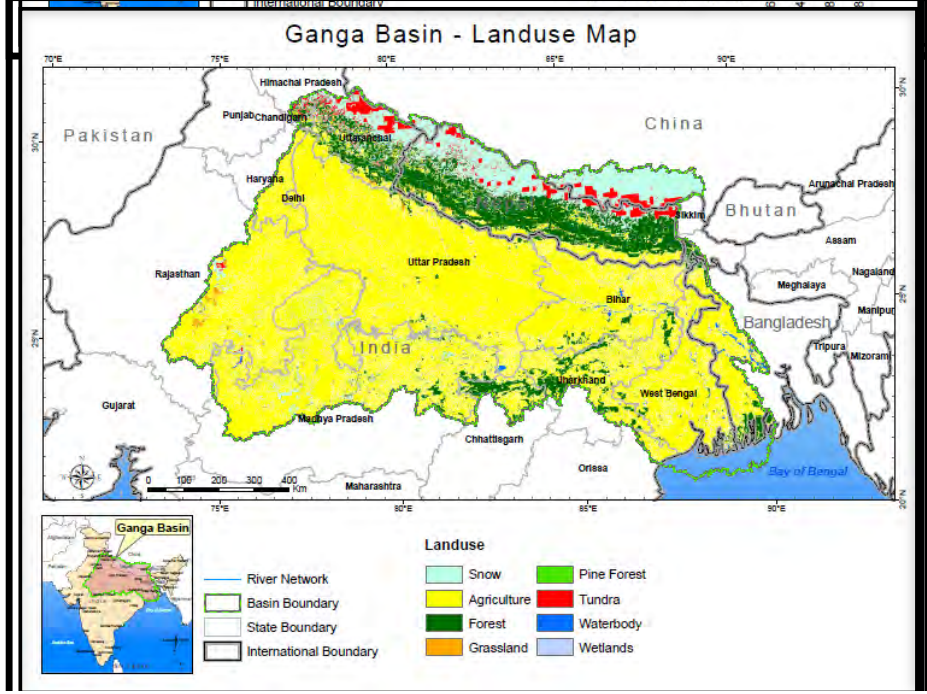
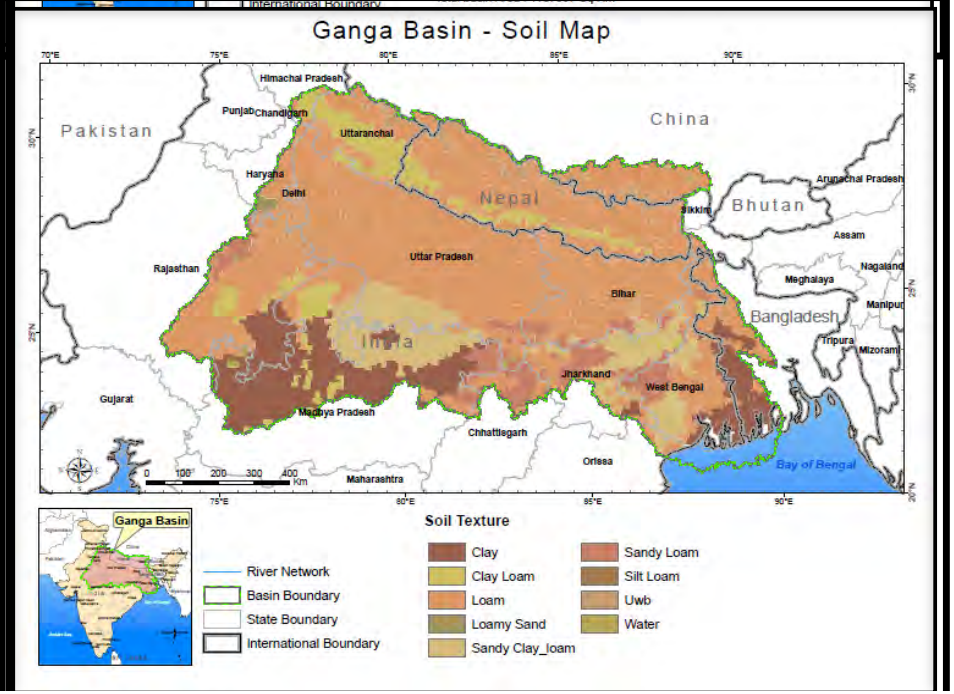
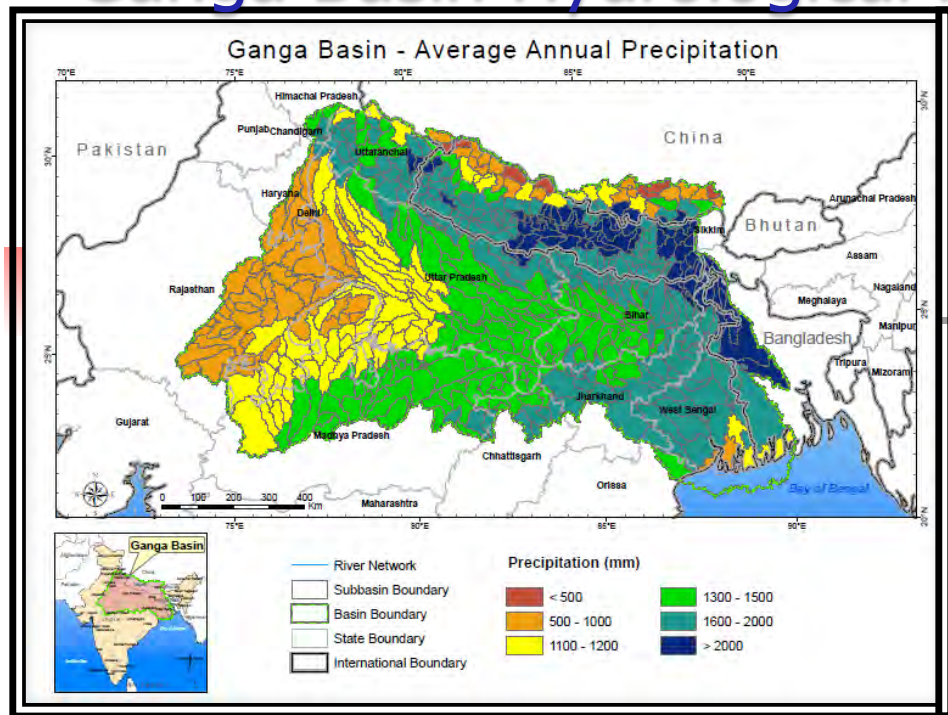
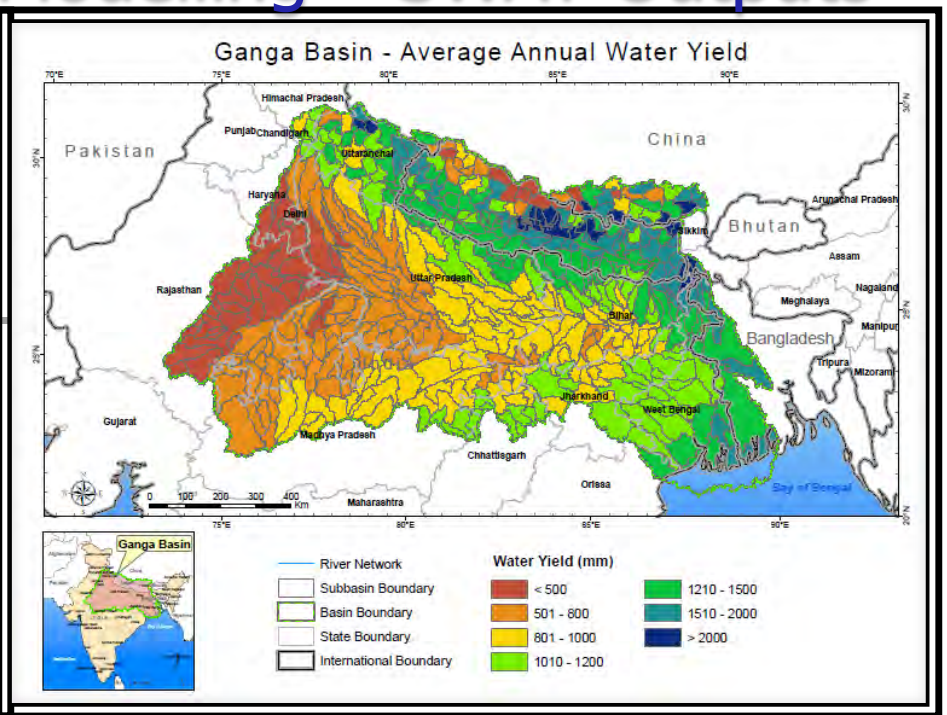
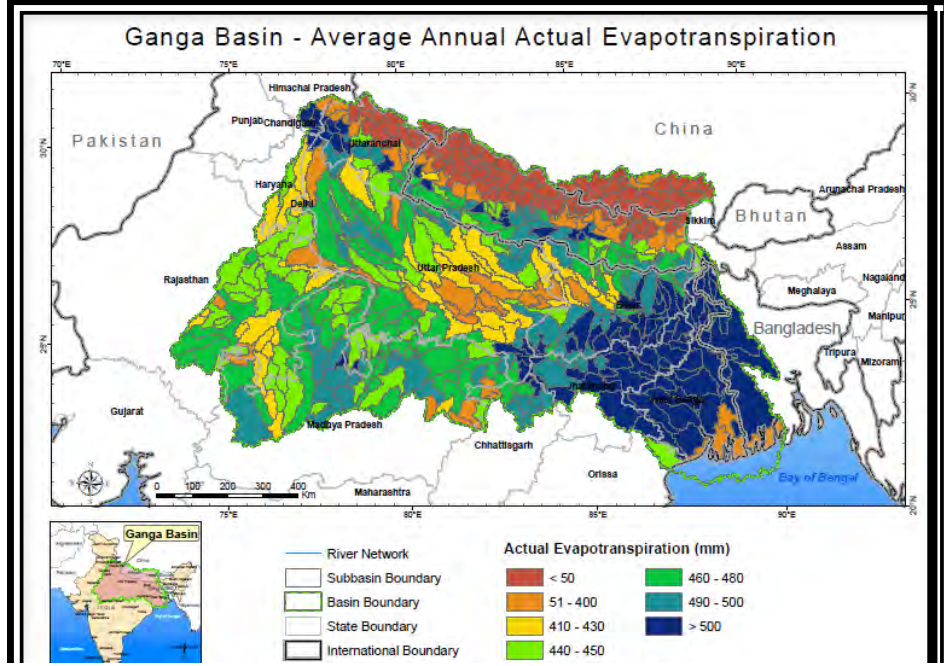


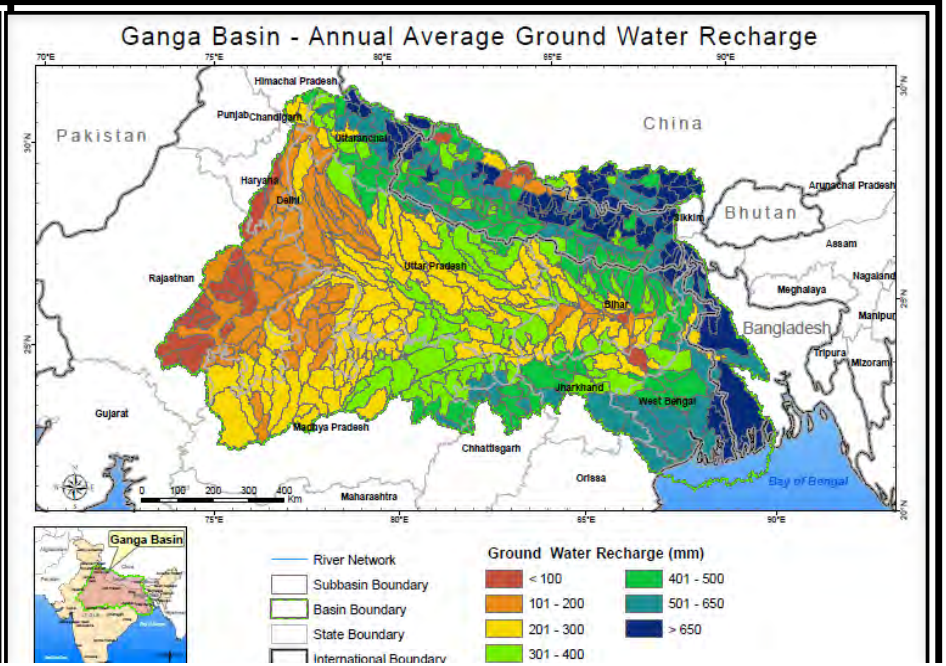


Ganga Basin Hydrological Modelling – SWAT Outputs

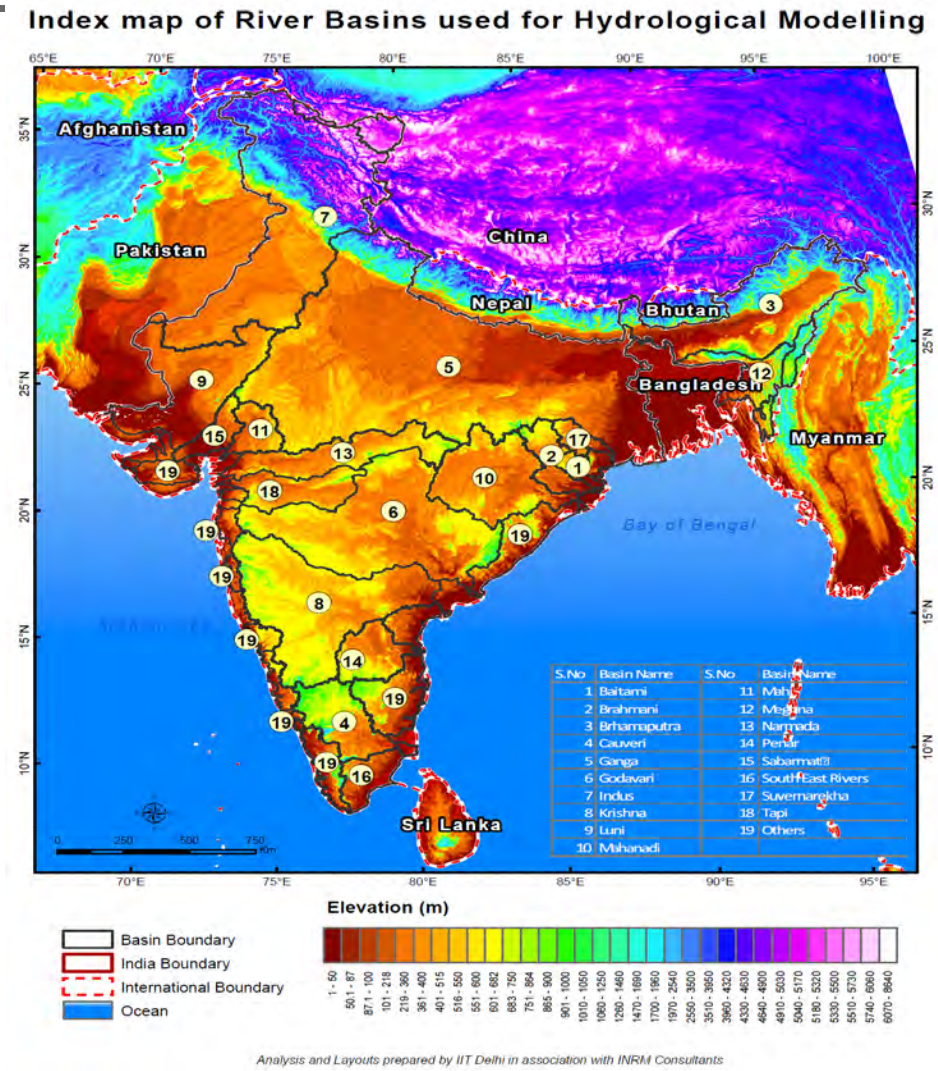








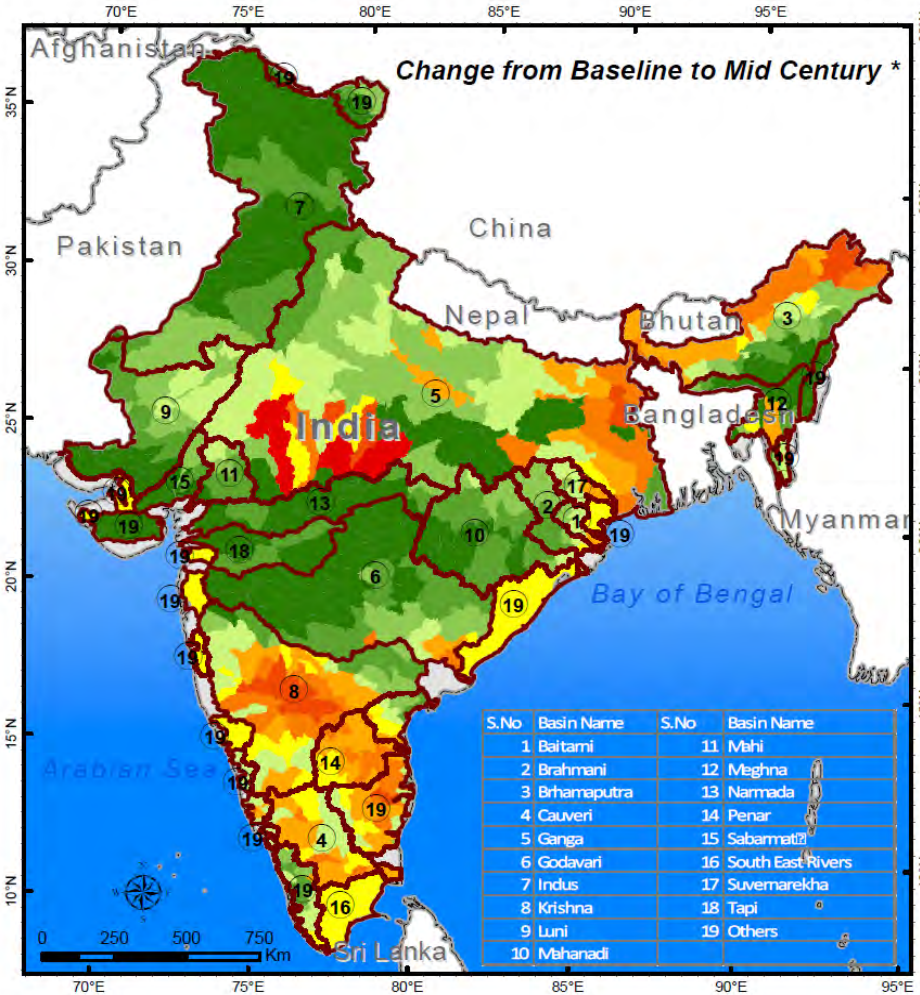
River Basins Modeled – NATCOM II



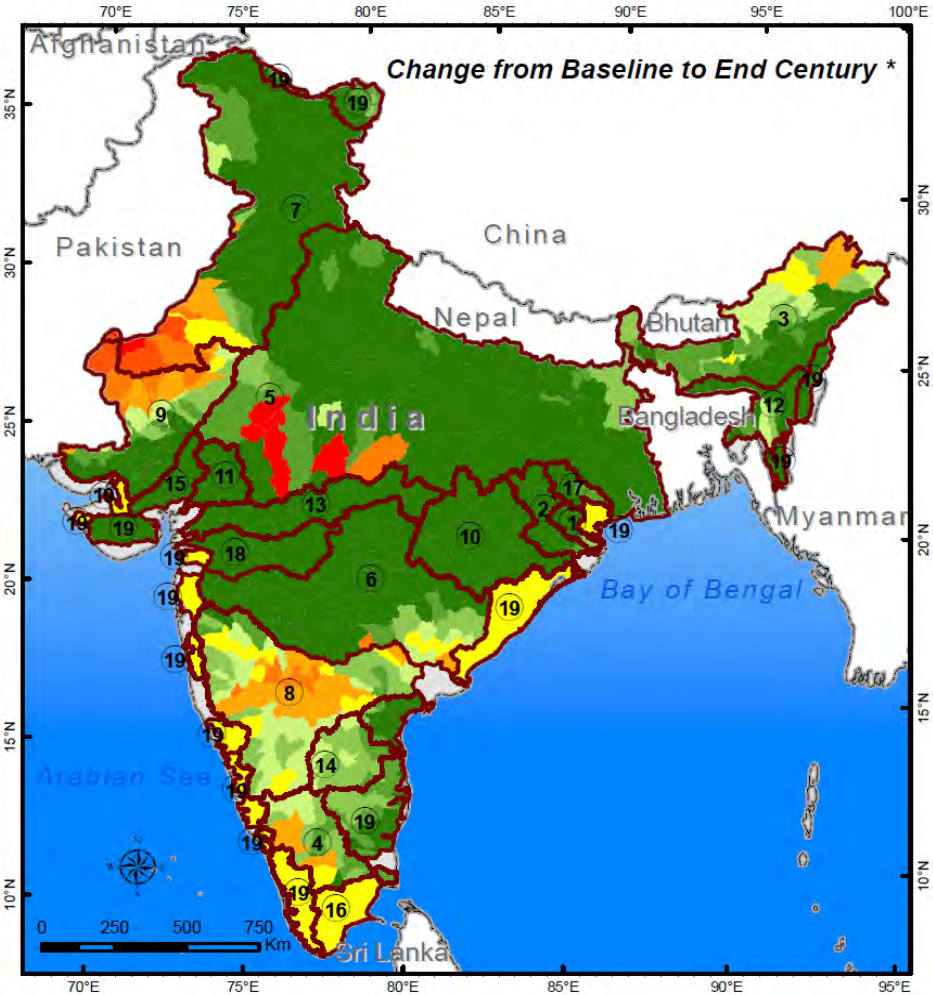
Modelling Outcomes

- Detailed outputs include all the water balance component at spatial and temporal scales which are analysed for
  - Changes in magnitude and frequency of flood peaks
  - Severity of droughts
  - Changes in flow patterns
  - Changes in groundwater recharge

Percent Change in Precipitation across India



S.No	Basin Name	S.No	Basin Name
1	Baitarni	11	Mahi
2	Brahmani	12	Meghna
3	Brhamaputra	13	Narmada
4	Cauveri	14	Penar
5	Ganga	15	Sabarmati
6	Godavari	16	South East Rivers
7	Indus	17	Suvernarekha
8	Krishna	18	Tapi
9	Luni	19	Others
10	Mahanadi		



Basin Boundary

International Boundary

Ocean

Change % in Precipitation

Increase from baseline

- < -15%
- -14% - -10%
- -9% - -5%
- -4% - -1%
- -1% - 0%
- 0 - +1%
- +1% - +5%
- +6% - +10%
- +11% - +15%
- > +15%

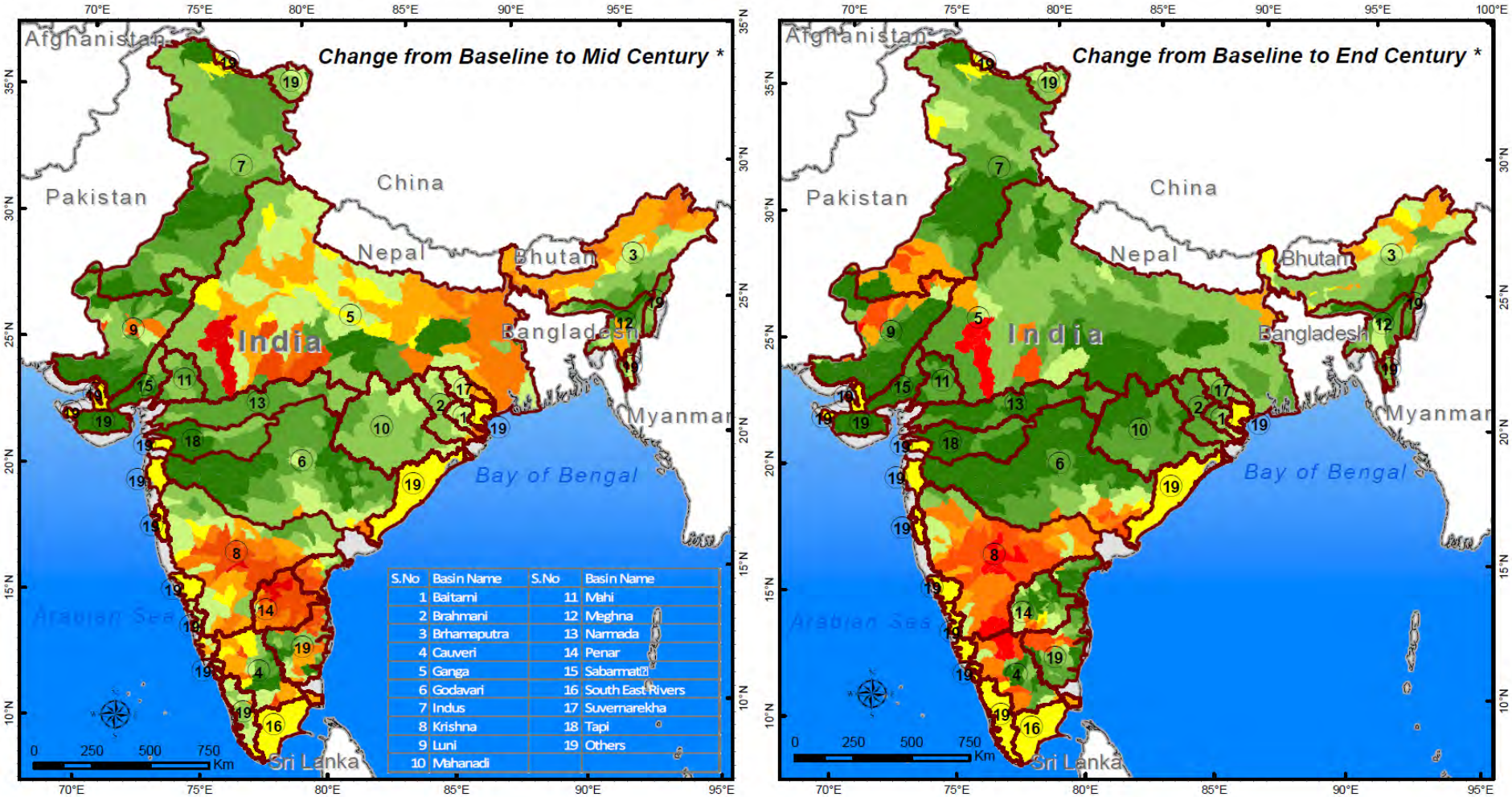
Decrease from baseline

SWAT hydrological model results simulated using PRECIS RCM daily weather datasets provided by the Indian Institute of Tropical Meteorology, Pune*

** IPCC SRES A1B Scenarios (Q14 QUMP ensemble) - Baseline (1961–1990), Mid Century (2021-2050) & End Century (2071-2098)*

Analysis and Layouts prepared by IIT Delhi in association with INRM Consultants

Percent Change in Water Yield across India



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7	Indus	17	Suvernarekha
8	Krishna	18	Tapi
9	Luni	19	Others
10	Mahanadi		

Basin Boundary

International Boundary

Ocean

Change % in Water Yield

Increase from baseline

- < -50%
- -49% - -25%
- -24% - -10%
- -9% - -1%
- -1% - 0%

Decrease from baseline

- 0 - +1%
- +1% - +10%
- +11% - +25%
- +26% - +50%
- > +50%

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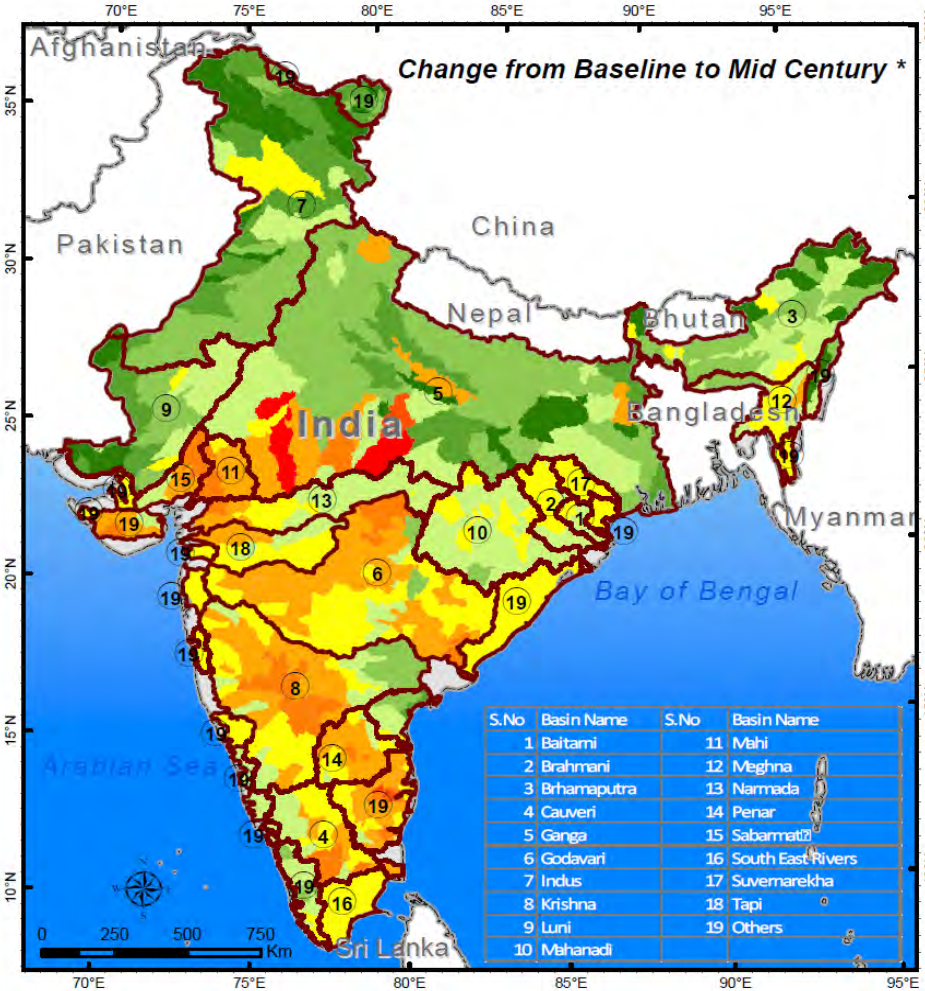
Percent Change in Actual Evapotranspiration across India



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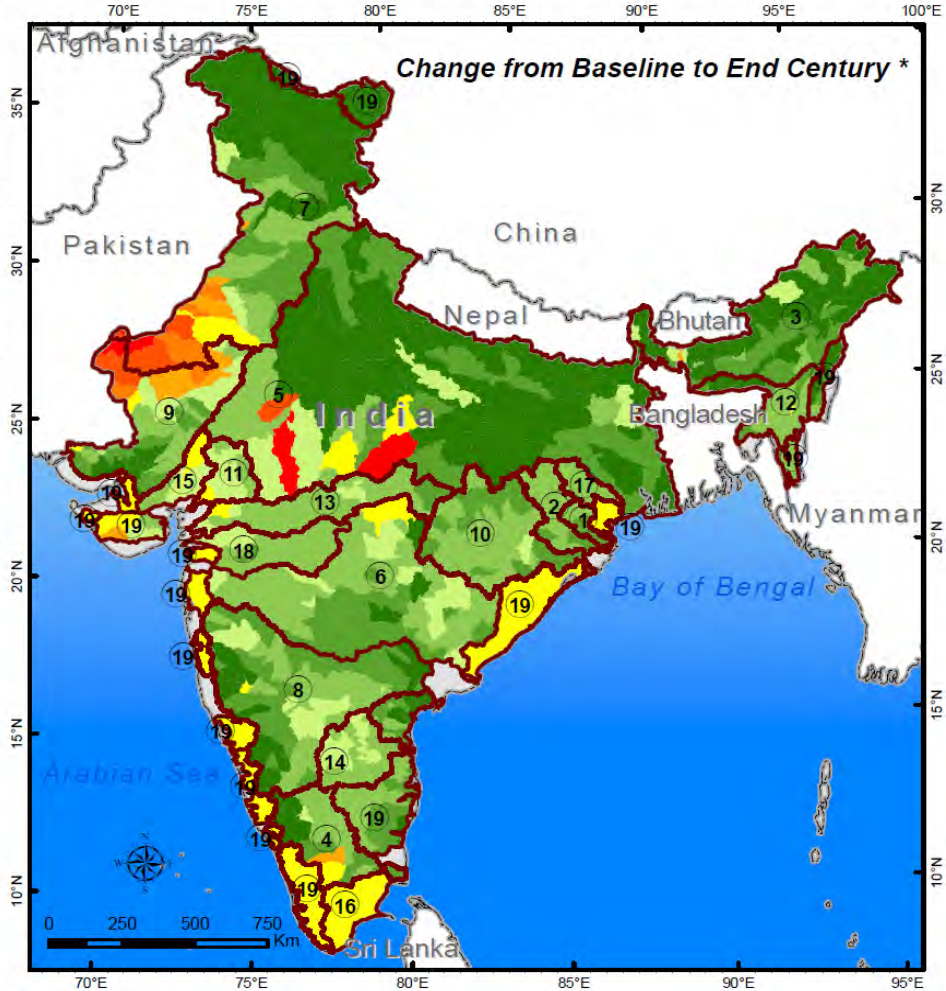

Basin Boundary

International Boundary

Ocean

Change % in Actual Evapotranspiration

Increase from baseline

- < -15%
- -14% - -10%
- -9% - -5%
- -4% - -1%
- -1% - 0%

Decrease from baseline

- 0 - +1%
- +1% - +5%
- +6% - +10%
- +11% - +15%
- > +15%

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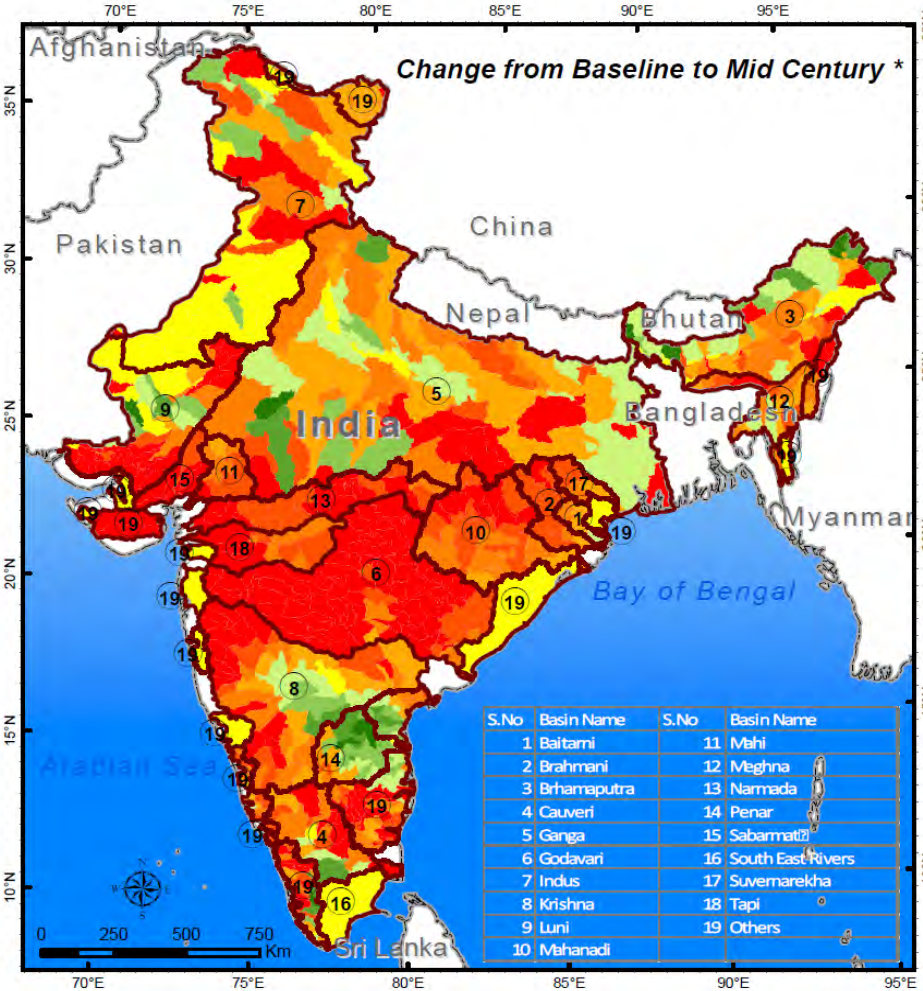
Percent Change in Sediment Yield across India



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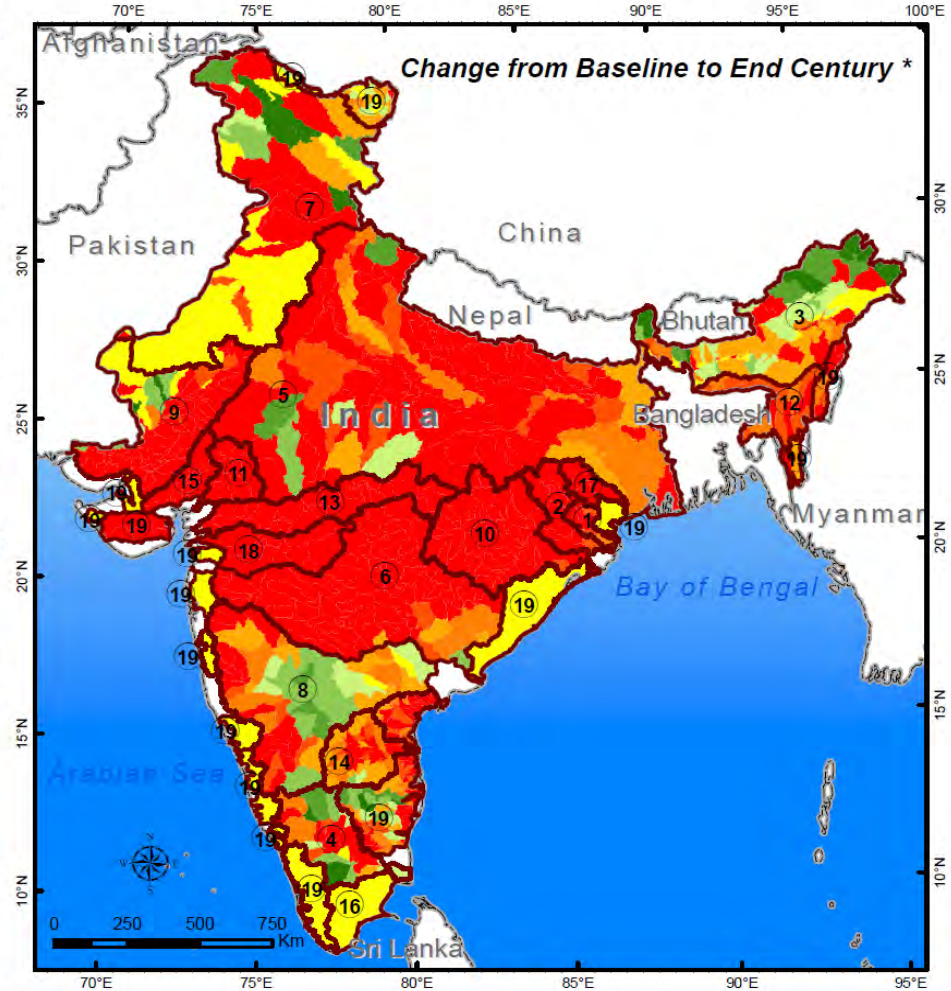

Change % in Sediment Yield

Basin Boundary

International Boundary

Ocean

Increase from baseline

< -75%

-74% - -50%

-49% - -25%

-24% - -1%

-1% - 0%

Decrease from baseline

0 - +1%

+1% - +25%

+26% - +50%

+51% - +75%

> +75%

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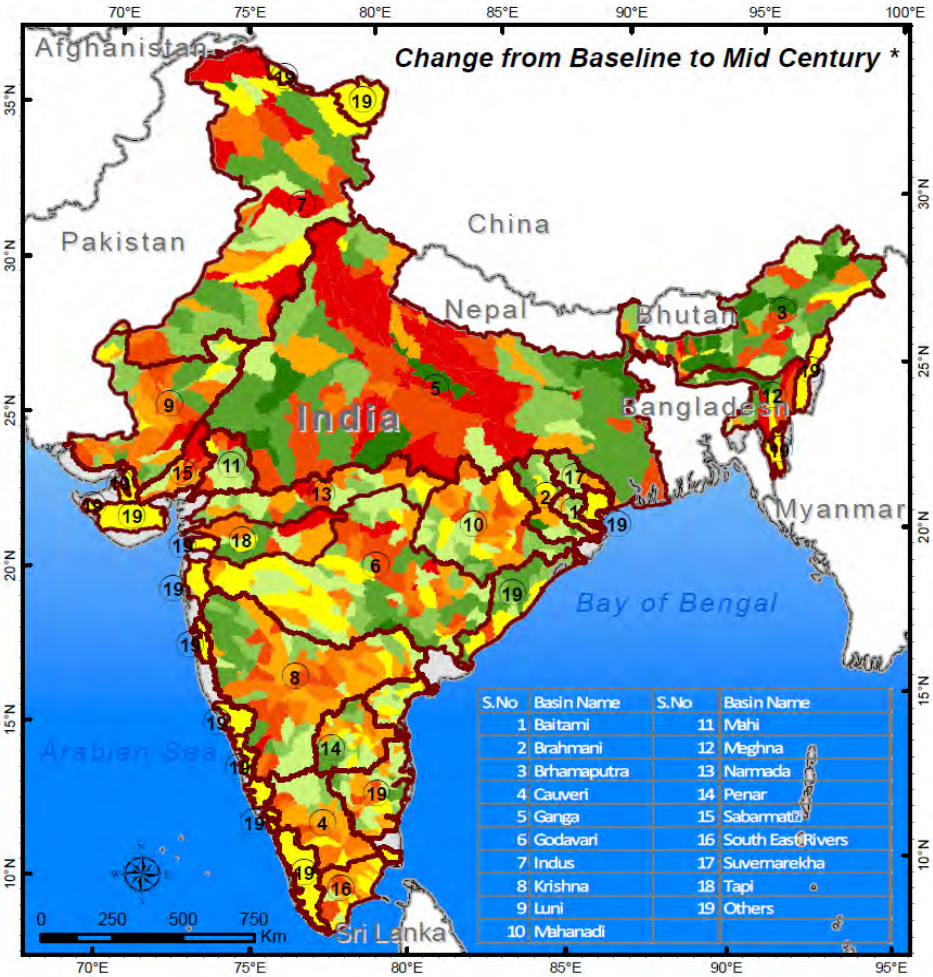
Percentage Change in Drought Weeks (JJAS) across India

Based on Agriculture Drought Index ranging from -2 to -4 (moderate to extreme soil moisture stress during critical growth stages of crops)



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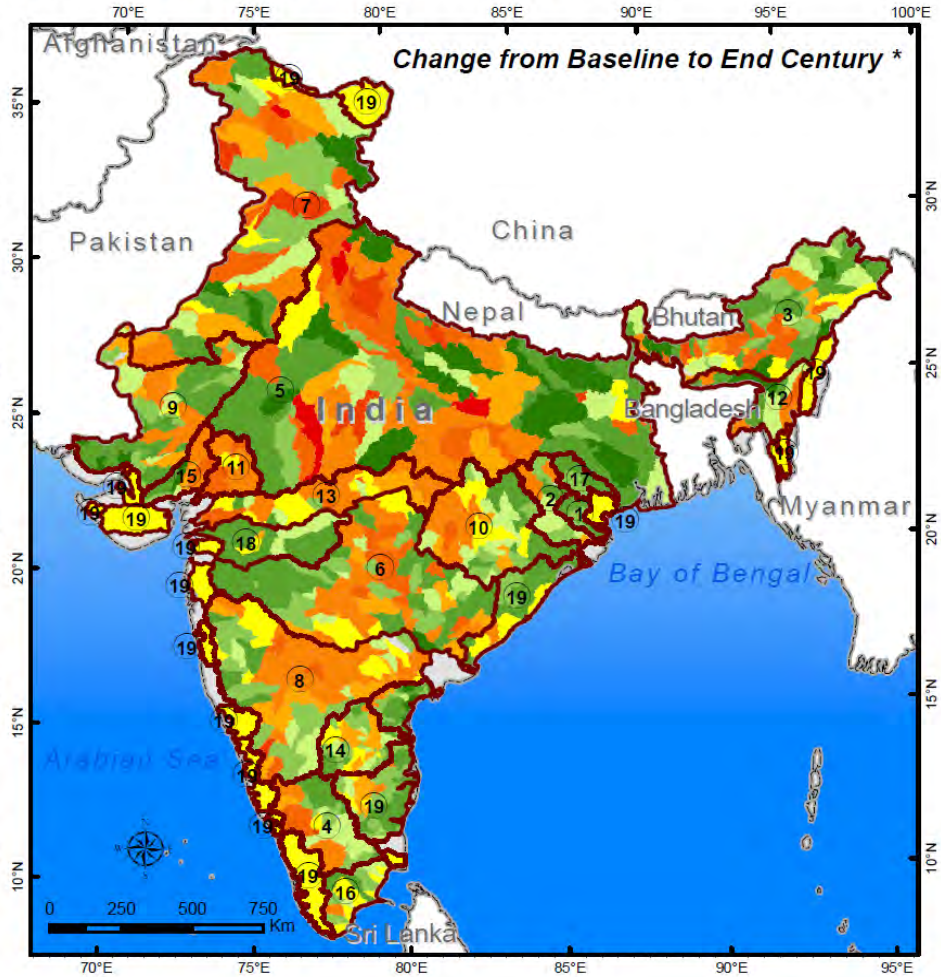

Basin Boundary

International Boundary

Ocean

Change % in Drought Weeks (JJAS)

Increase from baseline

- < -25%
- -24% - -10%
- -9% - -5%
- -4% - -1%
- -1% - 0%

Decrease from baseline

- 0 - +1%
- +1% - +5%
- +6% - +10%
- +11% - +25%
- > +25%

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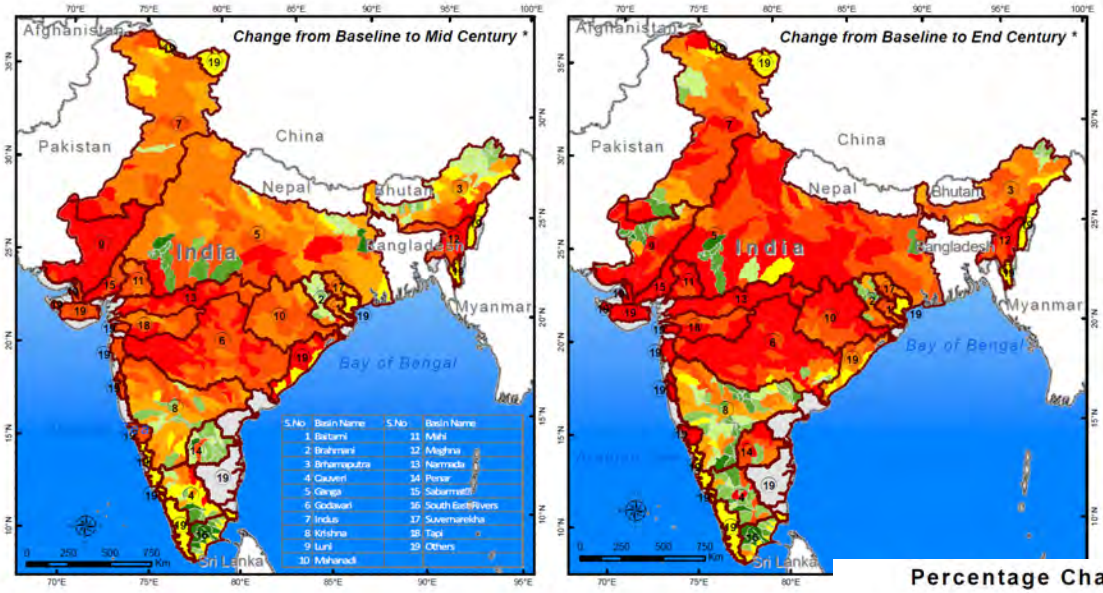
Percentage Change in Stream Discharge at 99th percentile** across India



Change in 1% Flow Probability

- Basin Boundary
- International Boundary
- Ocean

Increase from baseline

< -50%	0 - +1%
-49% - -25%	+1% - +10%
-24% - -10%	+11% - +25%
-9% - -1%	+26% - +50%
-1% - 0%	> +50%

Decrease from baseline

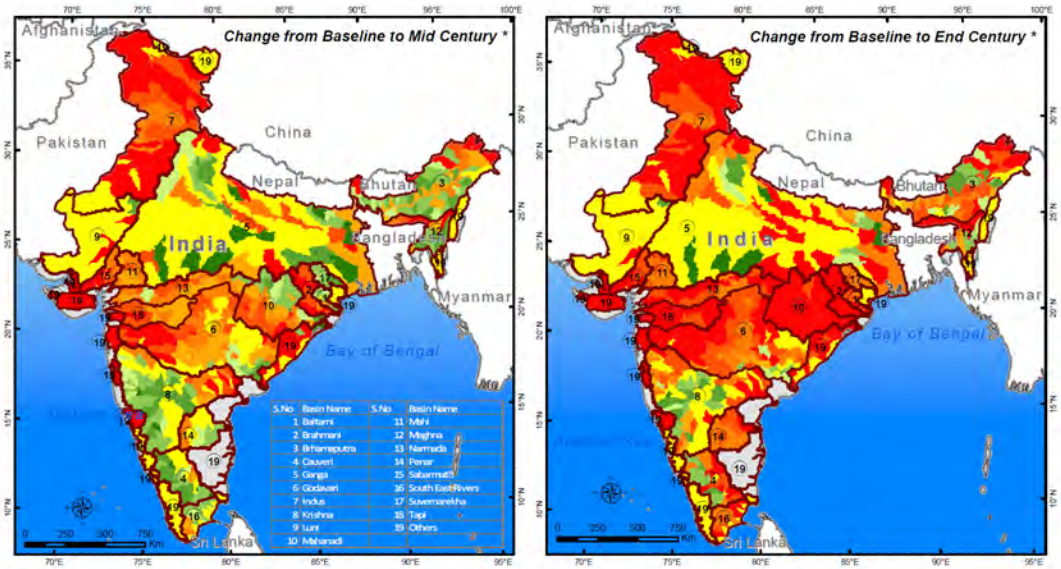
SWAT hydrol
PRECIS RCM
Indian Institute

* IPCC SRES
Baseline (1961
Century (2071-

** Extremly hi

Analysis and Layouts prepared by IIT Delhi in association with INRM Consultants

Percentage Change in Stream Discharge at 10th percentile** across India



Change in 90% Dependable Stream Flow

- Basin Boundary
- International Boundary
- Ocean

Increase from baseline

< -50%	0 - +1%
-49% - -25%	+1% - +10%
-24% - -10%	+11% - +25%
-9% - -1%	+26% - +50%
-1% - 0%	> +50%

Decrease from baseline

SWAT hydrological model results simulated using PRECIS RCM* daily weather datasets provided by the Indian Institute of Tropical Meteorology, Pune

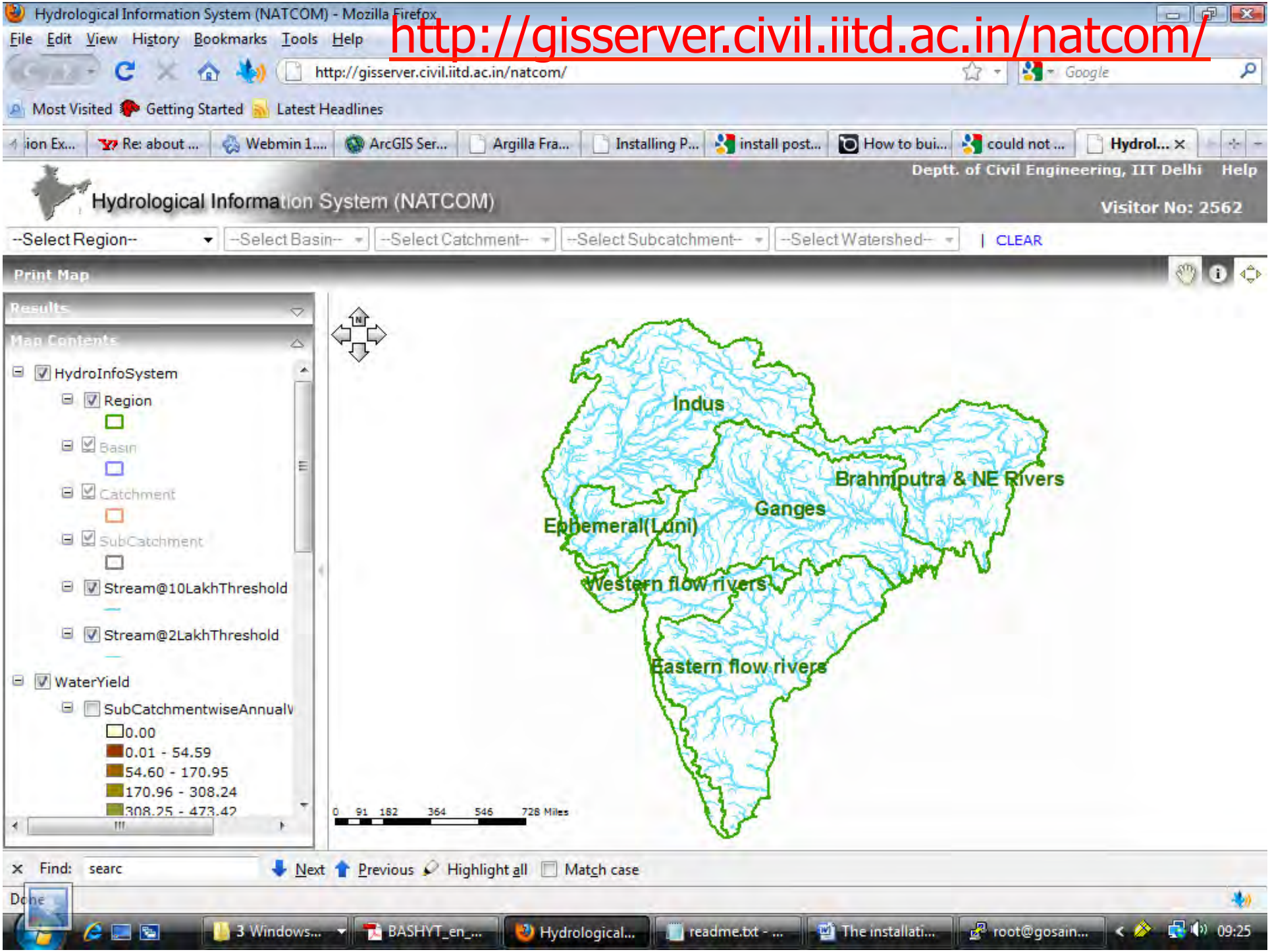
* IPCC SRES A1B Scenarios (Q14 QUMP ensemble) - Baseline (1961–1990), Mid Century (2021-2050) & End Century (2071-2098)

** 90% dependable stream flow

Analysis and Layouts prepared by IIT Delhi in association with INRM Consultants

A shareable information base

- To keep pace with the fast changing baseline
- To provide an integrated information for river basins including transboundary
- Generate scenarios and provide information on implications thereof
  - To create adaptation options
  - Can be used for disaster management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SubCatchment
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Brahmputra & NE Rivers
Ganges
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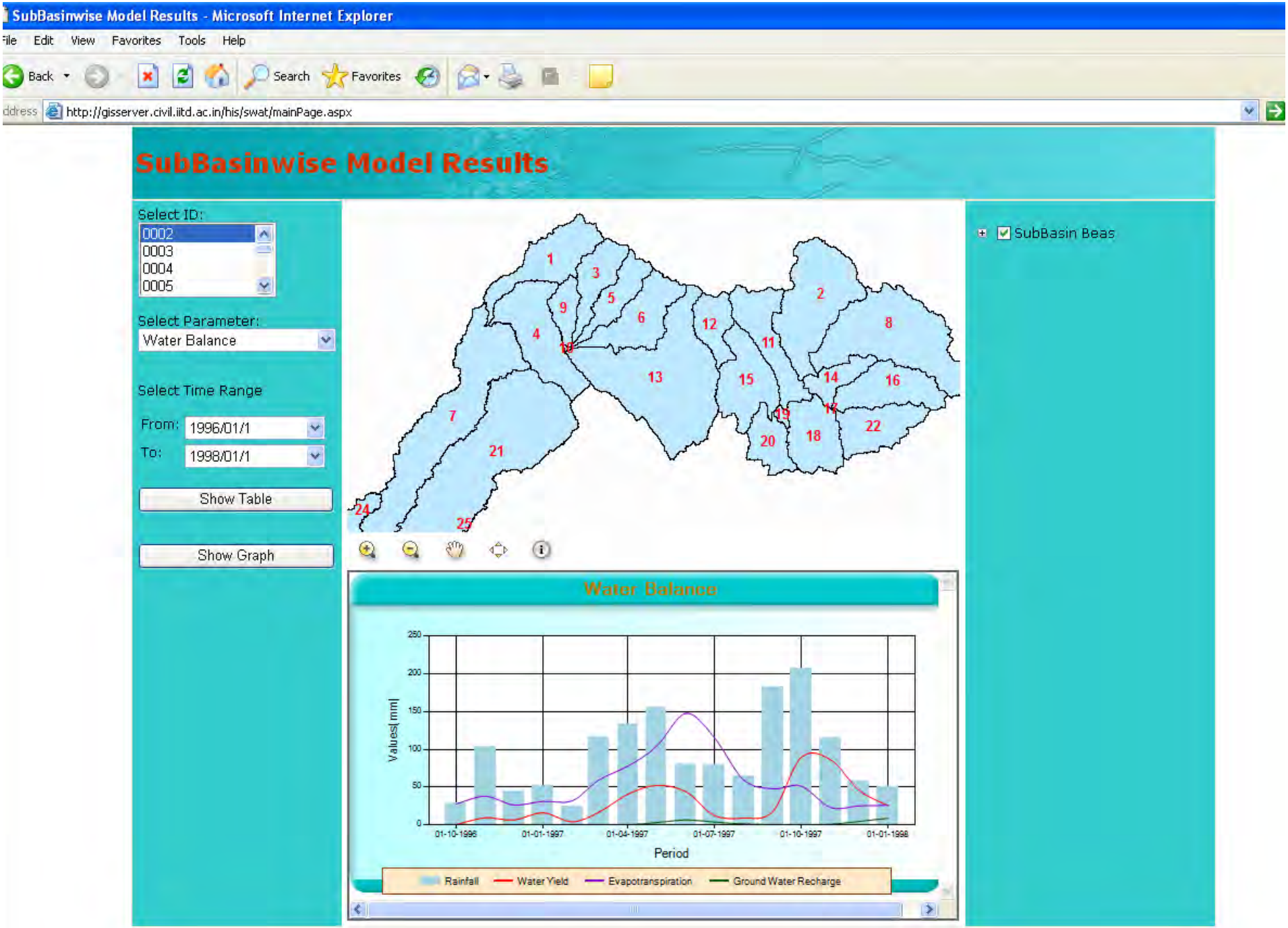
SubBasinwise Model Results - Microsoft Internet Explorer
File Edit View Favorites Tools Help
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Address http://gisserver.civil.iitd.ac.in/his/swat/mainPage.aspx
SubBasinwise Model Results
Select ID:
0002
0003
0004
0005
Select Parameter:
Water Balance
Select Time Range
From: 1996/01/1
To: 1998/01/1
Show Table
Show Graph
SubBasin Beas
Water Balance
Values[mm]
Period
01-10-1996
01-01-1997
01-04-1997
01-07-1997
01-10-1997
01-01-1998
Rainfall
Water Yield
Evapotranspiration
Ground Water Recharge

Hydrological Information System (NATCOM) - Windows Internet Explorer

http://gisserver.civil.iitd.ac.in/natcom/

Basinwise Model Results - Windows Internet Explorer

http://gisserver.civil.iitd.ac.in/natcom/wb.aspx

Basinwise Model Results (SWAT)

MODEL RESULTS | VULNERABILITY ASSESSMENT | CLIMATE CHANGE ANALYSIS | ADVANCED ANALYSIS

Model Results: Chambal 20322

- Virgin Condition
- BL Condition

Select Parameter: Discharge

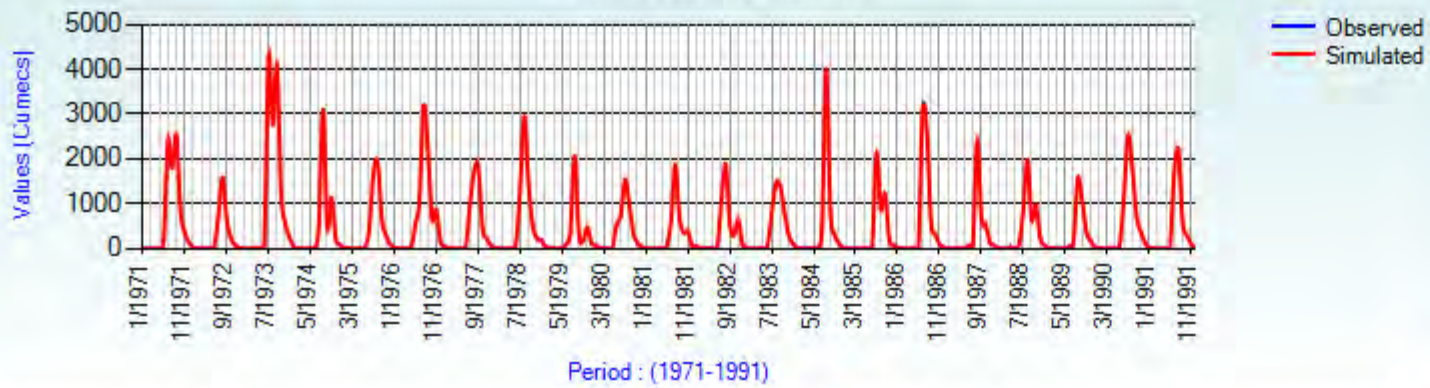
- Run with IMD Grid Data (1971-2005)
- HadRM3 Baseline (BL) (1961-1990)
- HadRM3 GHG Scenario (A2) (2071-2100)
- HadRM3 GHG Scenario (B2) (2071-2100)
- A1B Baseline Scenario (1961-1990)
- A1B Mid Century Scenario (2021-2050)
- A1B End Century Scenario (2071-2098)

Select Period: (Start-End) 1971 – 1991

Show Graph | Show Table

Discharge Graph: Chambal 20322

IMD Grid data: Virgin Condition



wb.aspx | Internet | Protected Mode: On | 100%

Conclusions

- To address water issues better:
  - IWRM principles should be deployed to formulate River Basin Management plans
  - Detailed climate change implication studies should be undertaken to quantify the implications
  - Use thus created science base for formulating effective adaptation options
  - Creation of sharable information is essential for sustainable use of water resources through engagement of stakeholders

Thank you