A TOOL TO ANALYZE AND PRESENT LARGE VOLUME OF MODEL OUTPUTS: GANGA BASIN SWAT MODELING CASE STUDY

Introduction

- The study presents the results generated for assessing implications of future water resource developments in the Ganga Basin on water quantity and quality using hydrological model SWAT
- The study has been commissioned by the World Bank

Analyzing SWAT Outputs

- The output files are well-organized but large and cumbersome at times
- Volume of outputs
  - 414 sub-basins
  - 5 scenarios
  - 30 - 33 years simulation period for each scenario
  - Parameters: Water balance, sediment and water quality
- Organisation of the output
  - Segregation for simplicity into Wet, Normal and Dry years

Methodology

- Wet Year – year having maximum annual rainfall in majority of the sub-basins
- Normal Year – year having average annual rainfall in majority of the sub-basins
- Dry Year - year having minimum rainfall in majority of the sub-basins
- International BOD Standards
  - > 3 ppm - hazardous for health and environment
  - 2-3 ppm – marginal or impaired water bodies
  - < 1ppm BOD – Safe

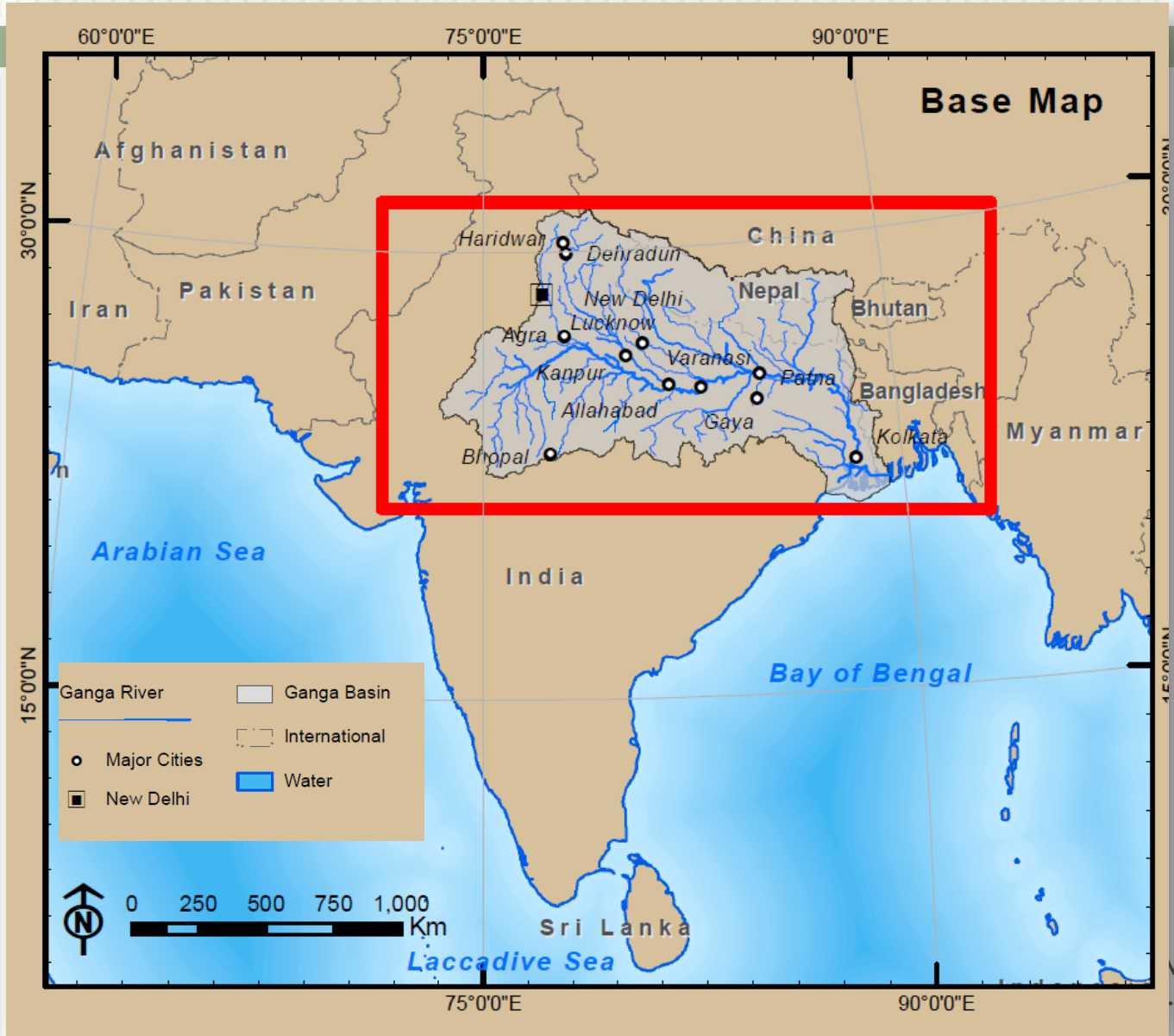
Scenarios

- **Scenario A (BAU):** Current Baseline , Existing major water resources infrastructure, current management/operation practices, existing crop water demand through irrigation.

Note: Current crop management practices (irrigation from Surface and Ground water) + Point source (average BOD and the average sewer generation per capita and converting total load based on subbasin population)

- **Scenario B:** Scenario A + eflow by reducing diversion flow
- **Scenario C (2025):** Scenario A + Increased irrigation and domestic water demand (2025 population)
- **Scenario D:** Scenario C + Increased irrigation and domestic water demand (2025 population) + Planned structures
- **Scenario E (Climate Change):** Scenario D + IPCC SRES A1B Climate Scenario (baseline, mid century)

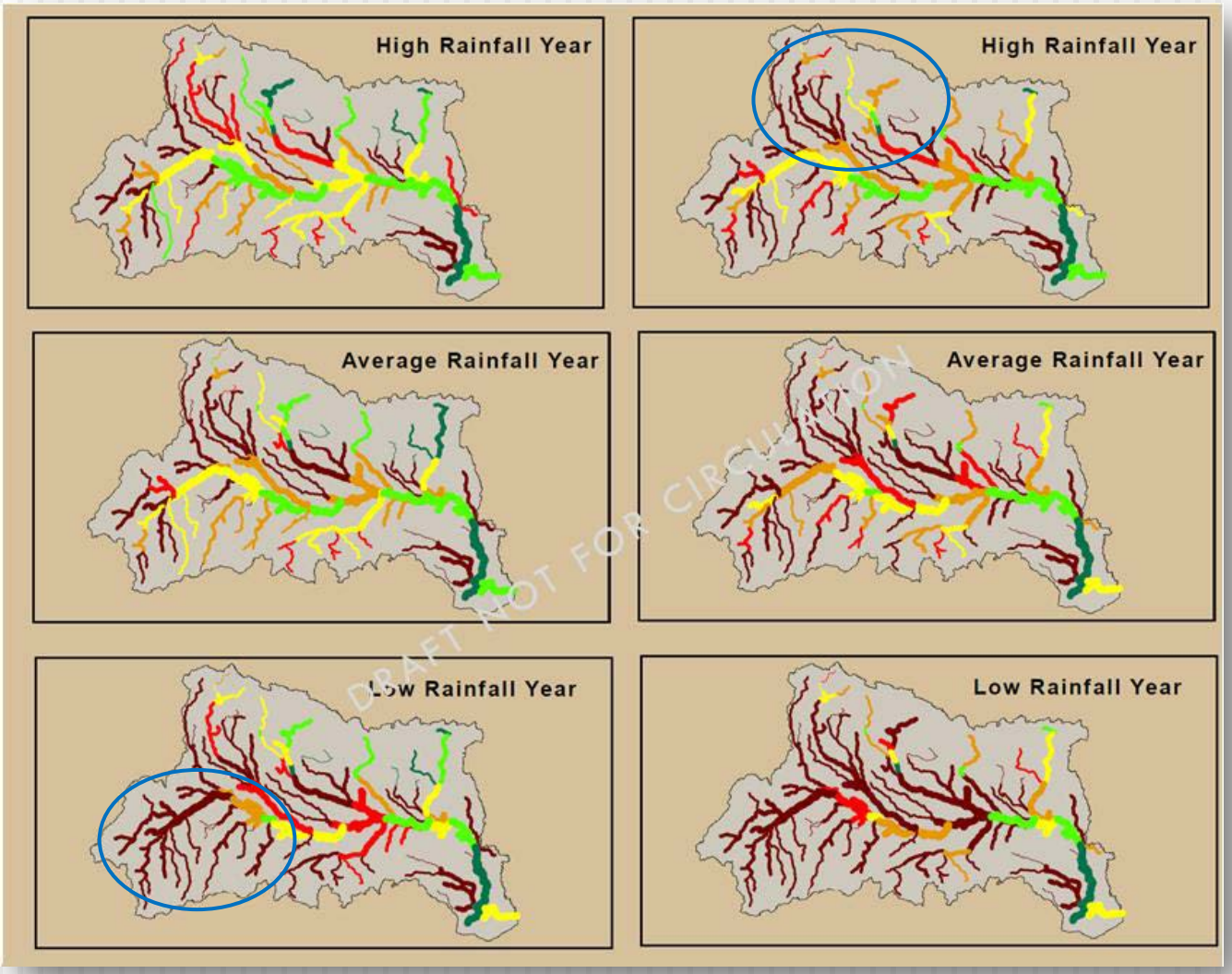
Area of Interest



Average Annual BOD Load – Observed Weather

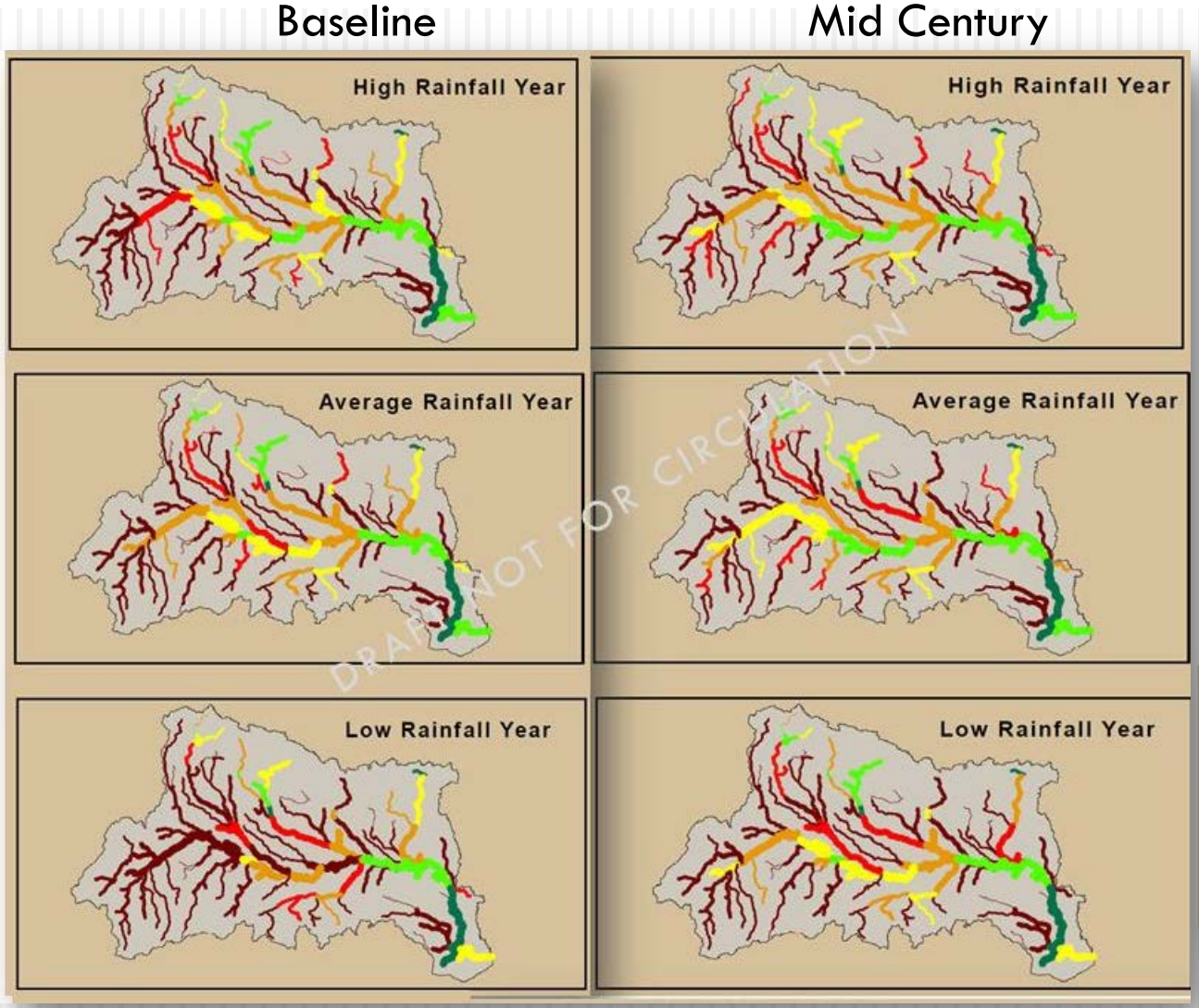
BAU

2025 (population + irrigation)



- In wet year BOD standards are met, normal year show BOD exceeding standard and in dry year BOD is high
- Increased water demand results in deterioration of BOD even in High rainfall years

Average Annual BOD Load – Climate Change Scenario (IPCC SRES A1B)



- In wet year BOD standards are met, normal years show BOD exceeding standard and in dry years BOD is high
- Owing to increased rainfall in the mid century water quality has improved as compared to the baseline in Wet , normal as well as dry season

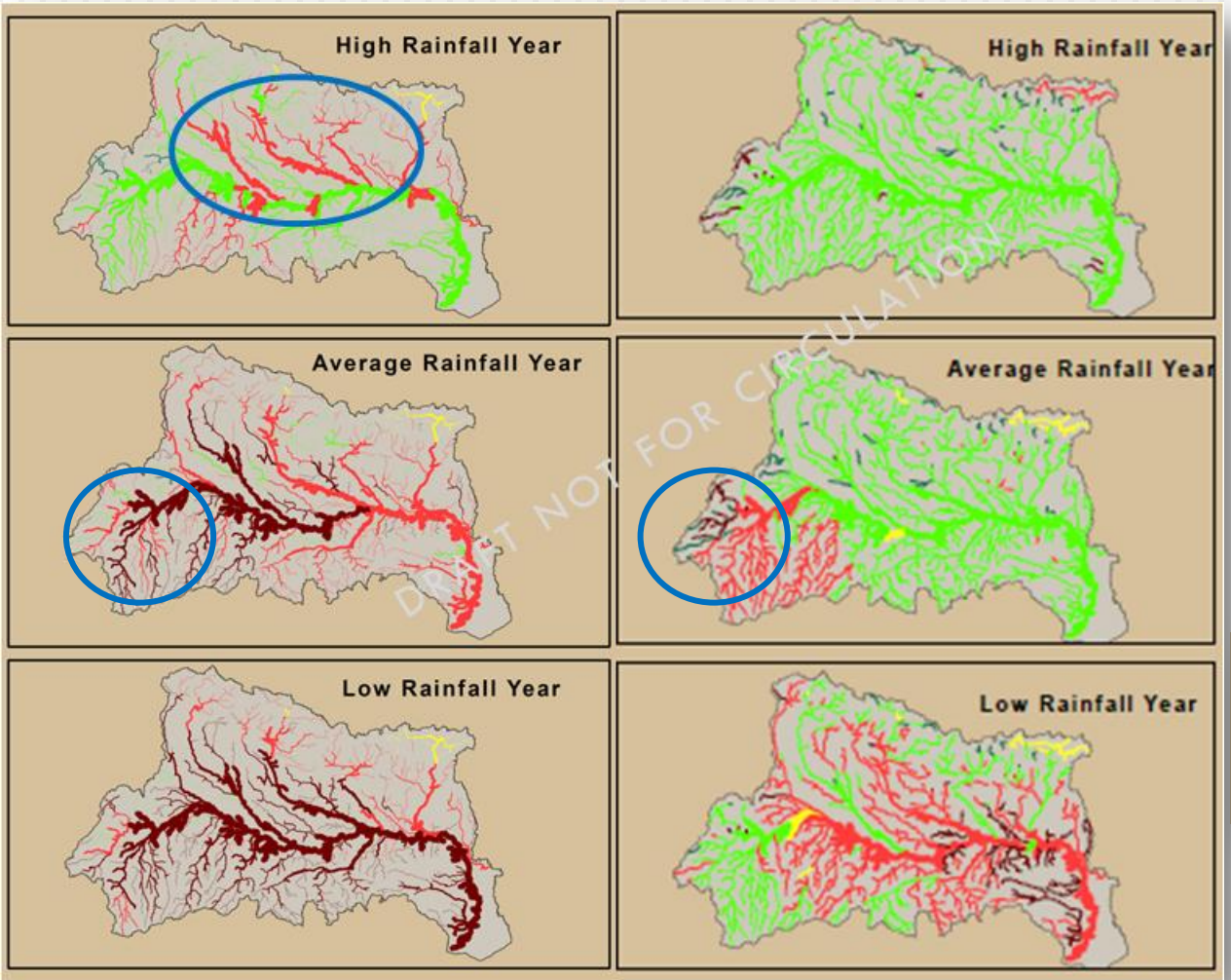
Analysis – percent change

- Change in observed weather from BAU to 2025
  - Scenario A (BAU): Current population, current water demand
  - Scenario C (2025): 2025 Population – Increased Irrigation and water demand
- Change in Climate Change Scenario (IPCC SRES A1B)
  - Scenario E (Baseline): Increased irrigation and domestic water demand (2025 population) + Planned structures + IPCC SRES A1B Climate Scenario (baseline)
  - Scenario E (Mid Century): Increased irrigation and domestic water demand (2025 population) + Planned structures + IPCC SRES A1B Climate Scenario (mid century)
- Sediment yield: Negative change implies deterioration from base scenario
- BOD: Negative change implies deterioration from base scenario

Percent Change in Average Annual BOD Concentration

Observed Weather

Climate Change

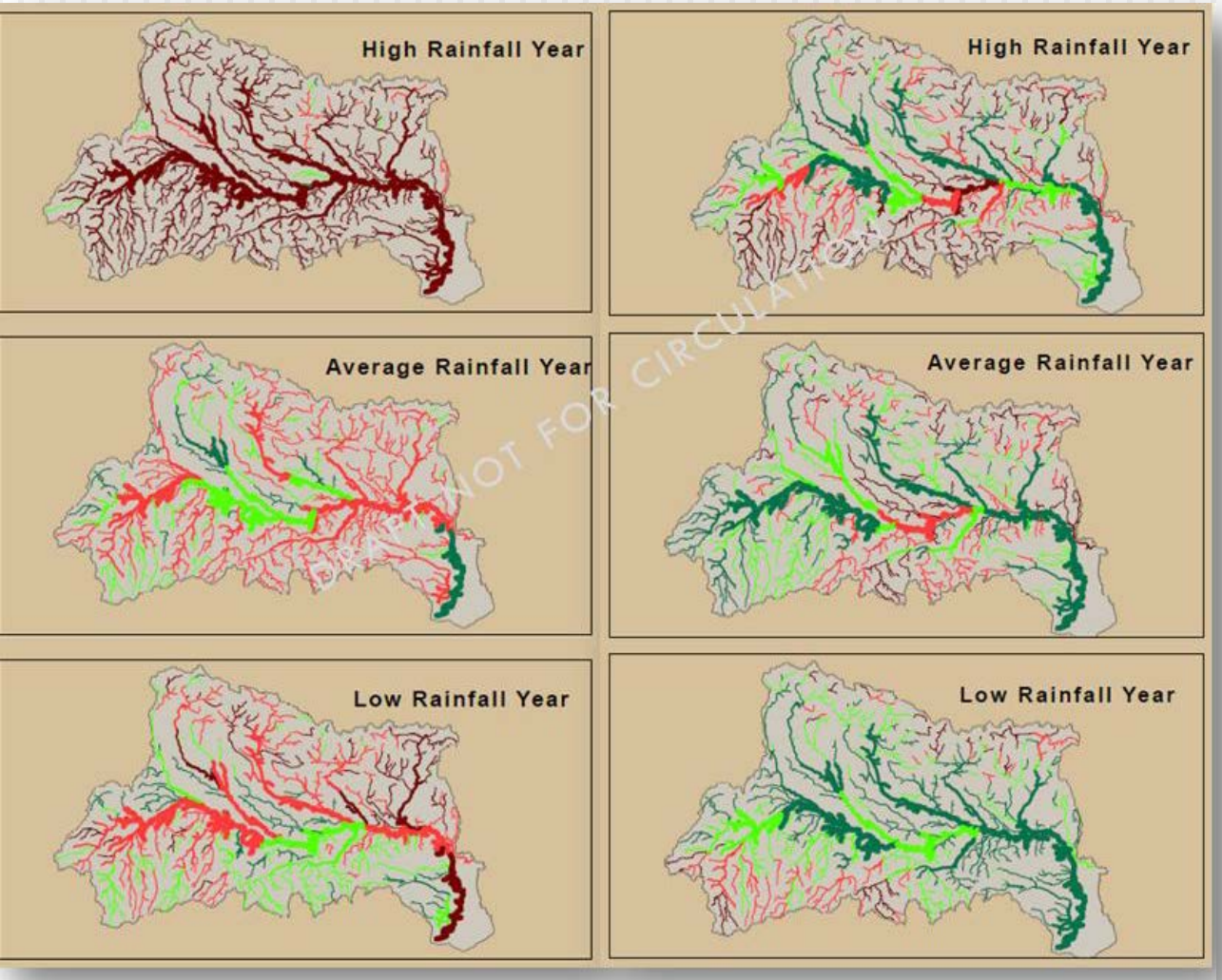


- Ramganga, Upper-ganga, Gandak, Kosi, Ghaghra, Tons and Sone have high BOD concentrations of 50% or more in wet, normal and dry year in future
- Mid century scenario show improvement in water quality in wet, normal and average years due to higher rainfall in mid century

Percent Change in Average Annual Sediment Load

Observed Weather

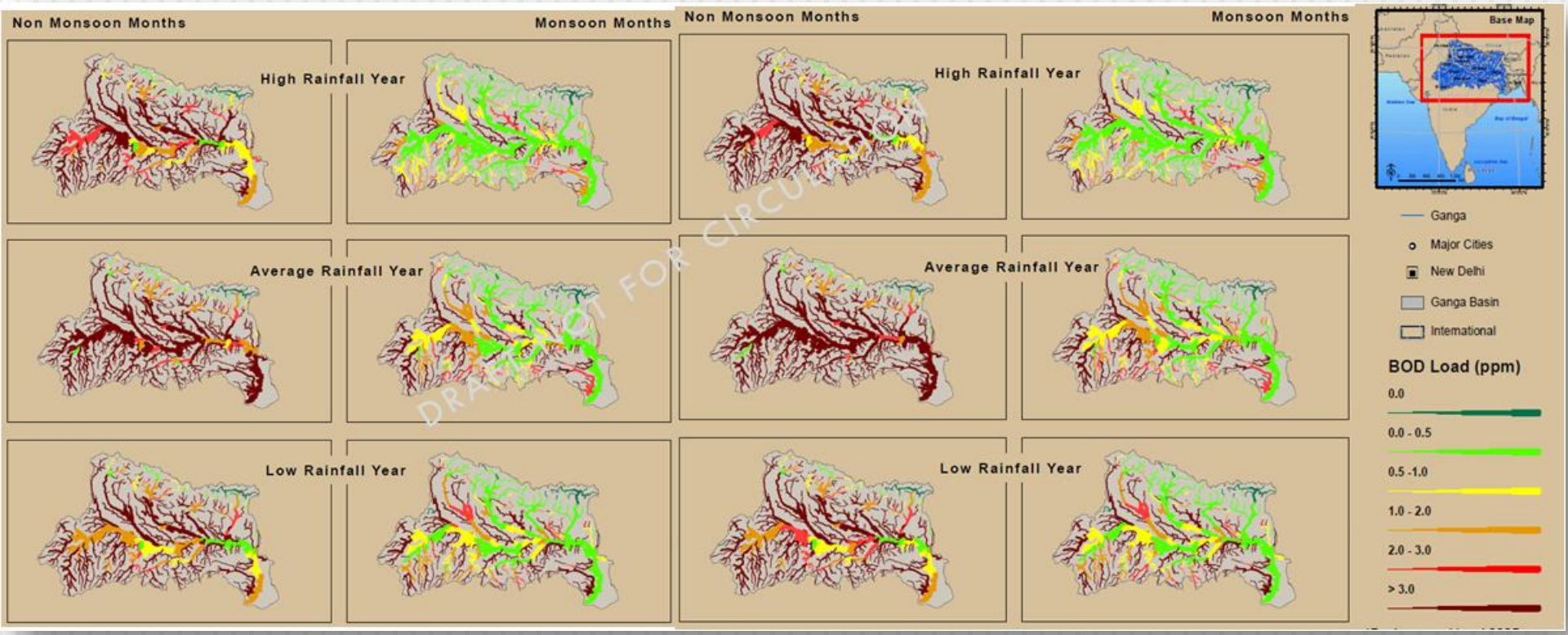
Climate Change



- For observed weather the sediment load in the main river is greater than 50% in wet year and somewhat low in normal and dry year due to less rain and less runoff
- Sediment load increases in future for climate change scenario due to increase in intensity and magnitude of rainfall towards mid century

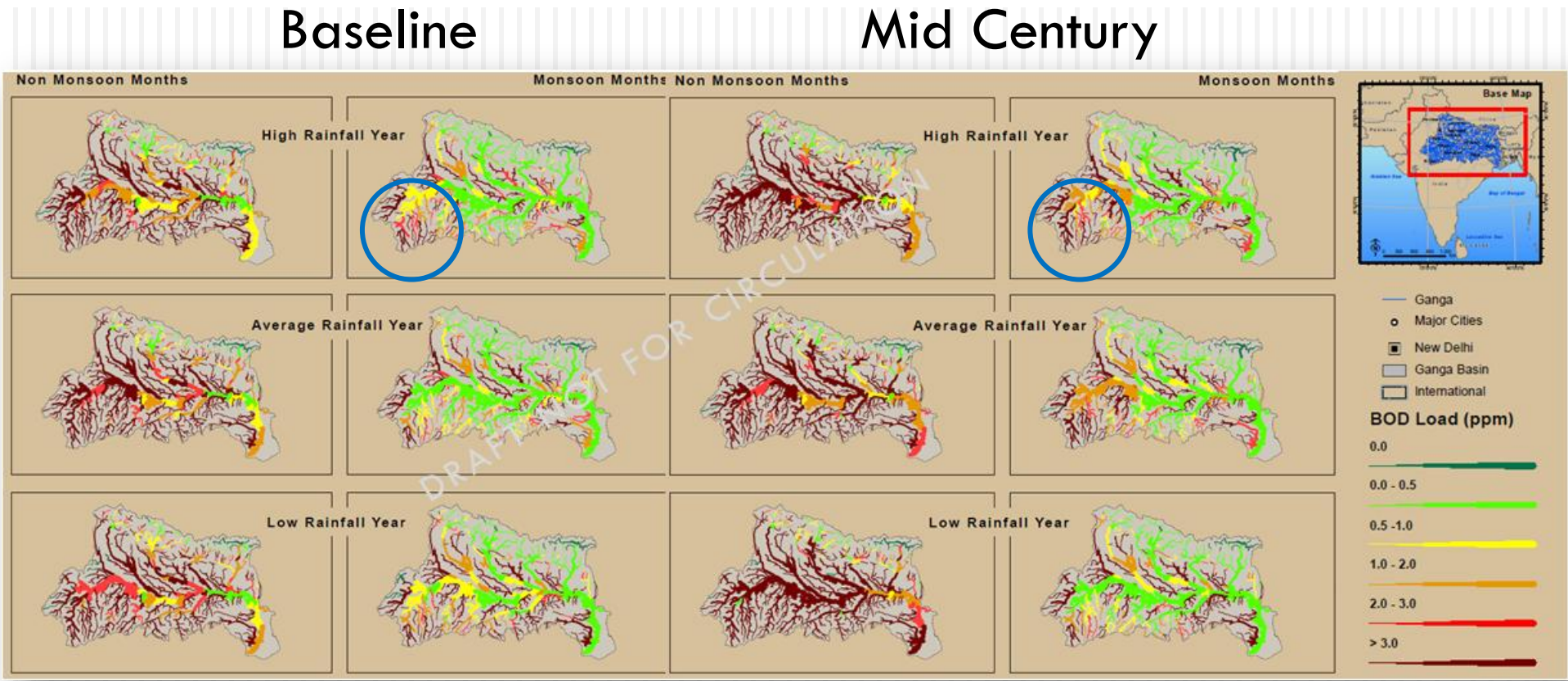
Average Monthly BOD Concentration - Observed Weather

BAU 2025 (population + irrigation)



- Water quality is better only during monsoon season along the main stem of Ganga river
- During non monsoon season entire river reaches have high BOD level

Average Monthly BOD Concentration –Climate Change Scenario IPCC SRES A1B

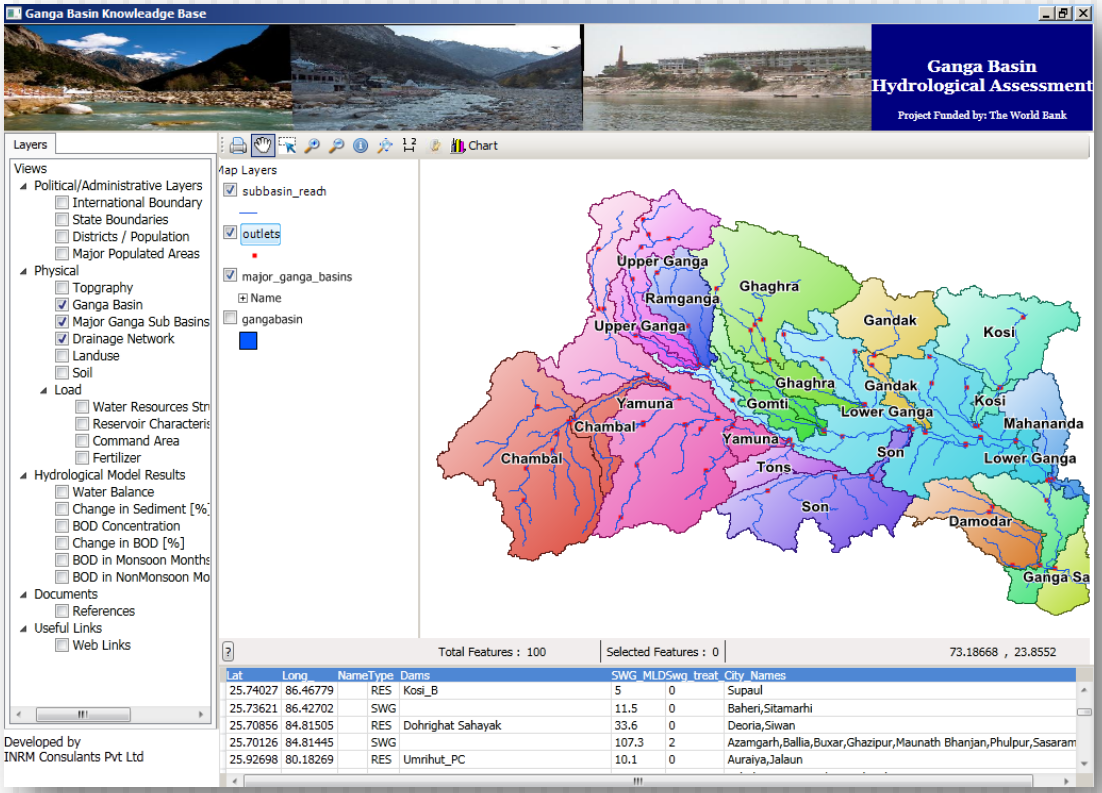


- Similar to Observed weather, water quality is better during monsoon season
- Higher water demand in future makes the situation worse in mid century scenario even during wet year

Ganga Basin Knowledgebase

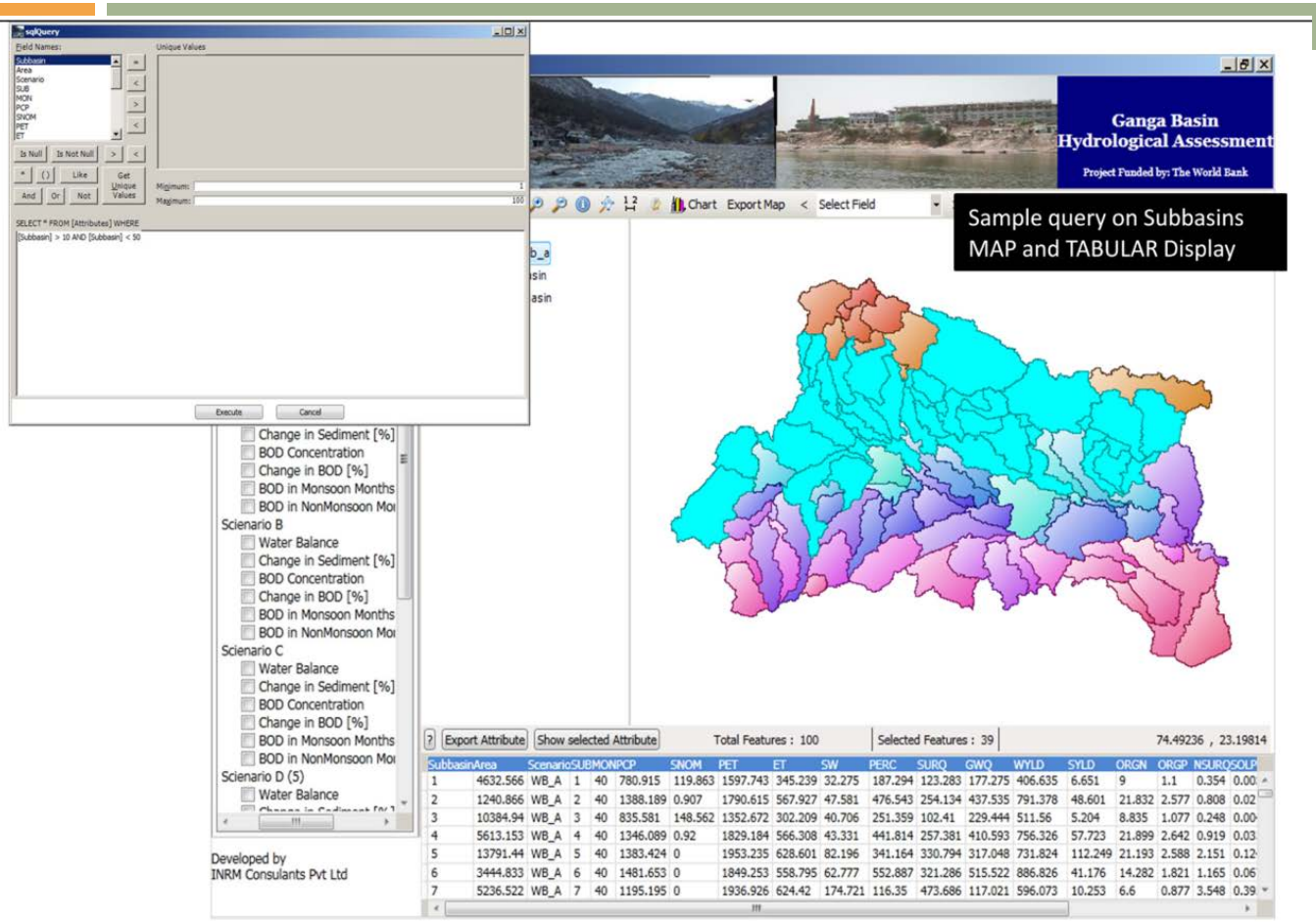
- Features
  - User Friendly
  - Open source GIS
  - View spatial distribution of Hydrological model SWAT outputs
  - View time series data as Graphs
  - Add new Shape file
  - Export selection as new GIS layer
  - Export attribute to excel
  - Query and thematic map creation

Map and Tabular Display



- Layers - Enlists available data (Shape files)
- Map layers - Enlists the layers displayed in the map area
- Map Area - Displays the loaded layers
- Attribute Table - shows the attribute table of the layer selected in the map layer

Data Query



- SWAT modelled outputs on all the Scenarios can be viewed by clicking the radio buttons on the left panel.
- The change from the baseline to other scenarios are also available for viewing from the left panel.
- User can also create a query and view maps.

Graphs

Selection of parameter and subbasins for time series graph – Default option

- Create Time Series graphs for all SWAT Output Parameters

SWAT Output for Health Applications

- Malaria
  - The model uses SWAT soil moisture and temperature variables to predict the generation cycle of mosquito growth
  - 4 growth cycles (egg, larvae, pupa, adult)
  - Alternation of generations were counted
  - Compare the model outputs with the seasonal population densities observed at selected locations.

Thank you