Impacts of Climate Change on Water Resources of the INCCA Regions

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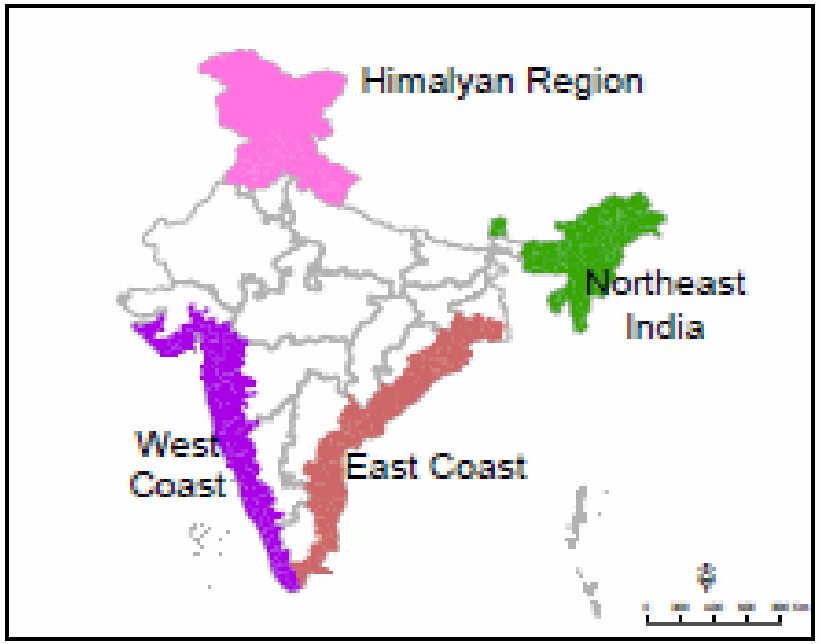
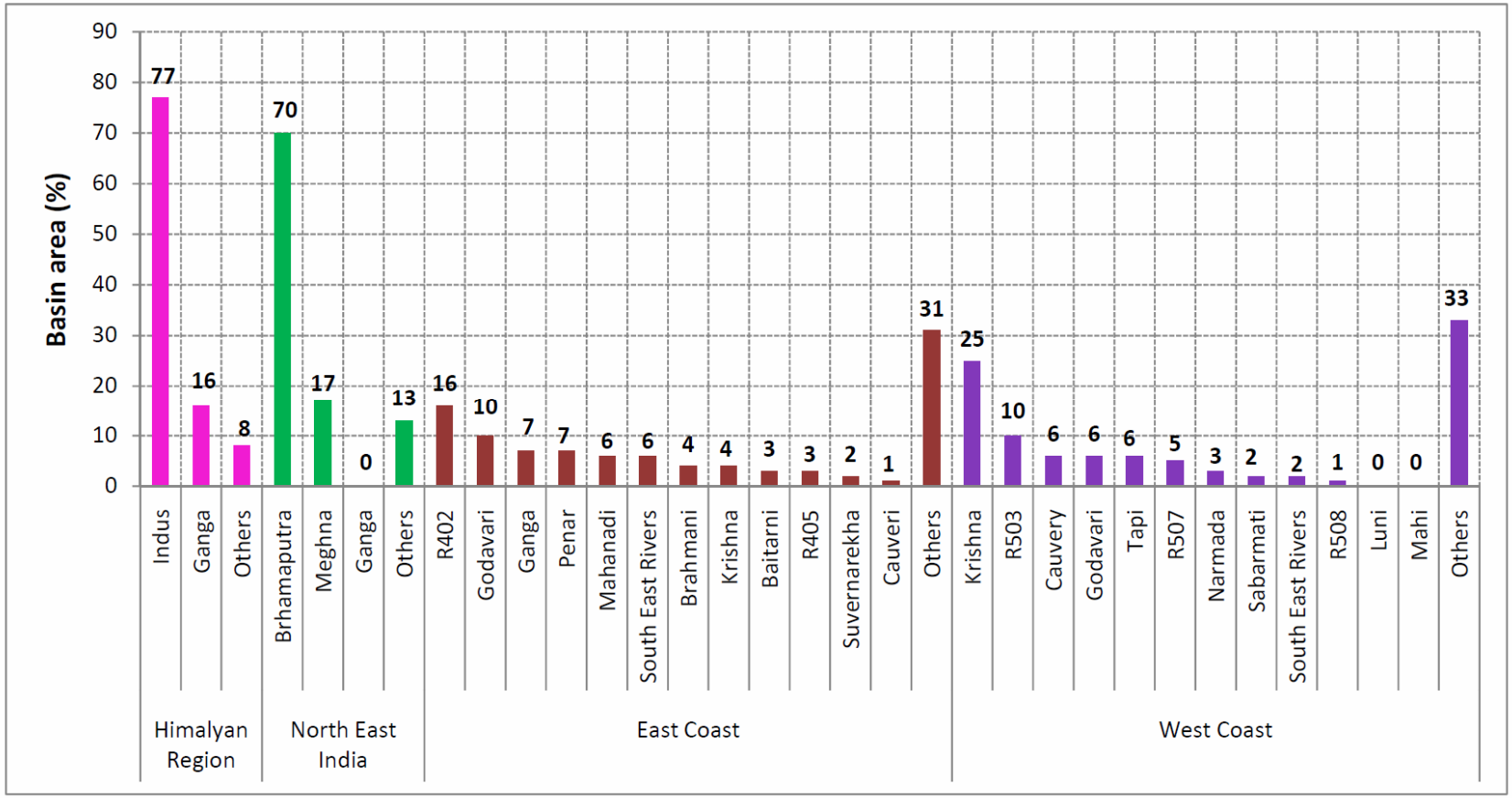
Impact of Climate Change



- The study evaluates the possible impacts of climate change on water resources of the various regional systems
  - Himalayan region (Indus)
  - West Coast
  - East Coast
  - North East region (Brahmaputra)

Proportion of various river systems that compose INCCA regions



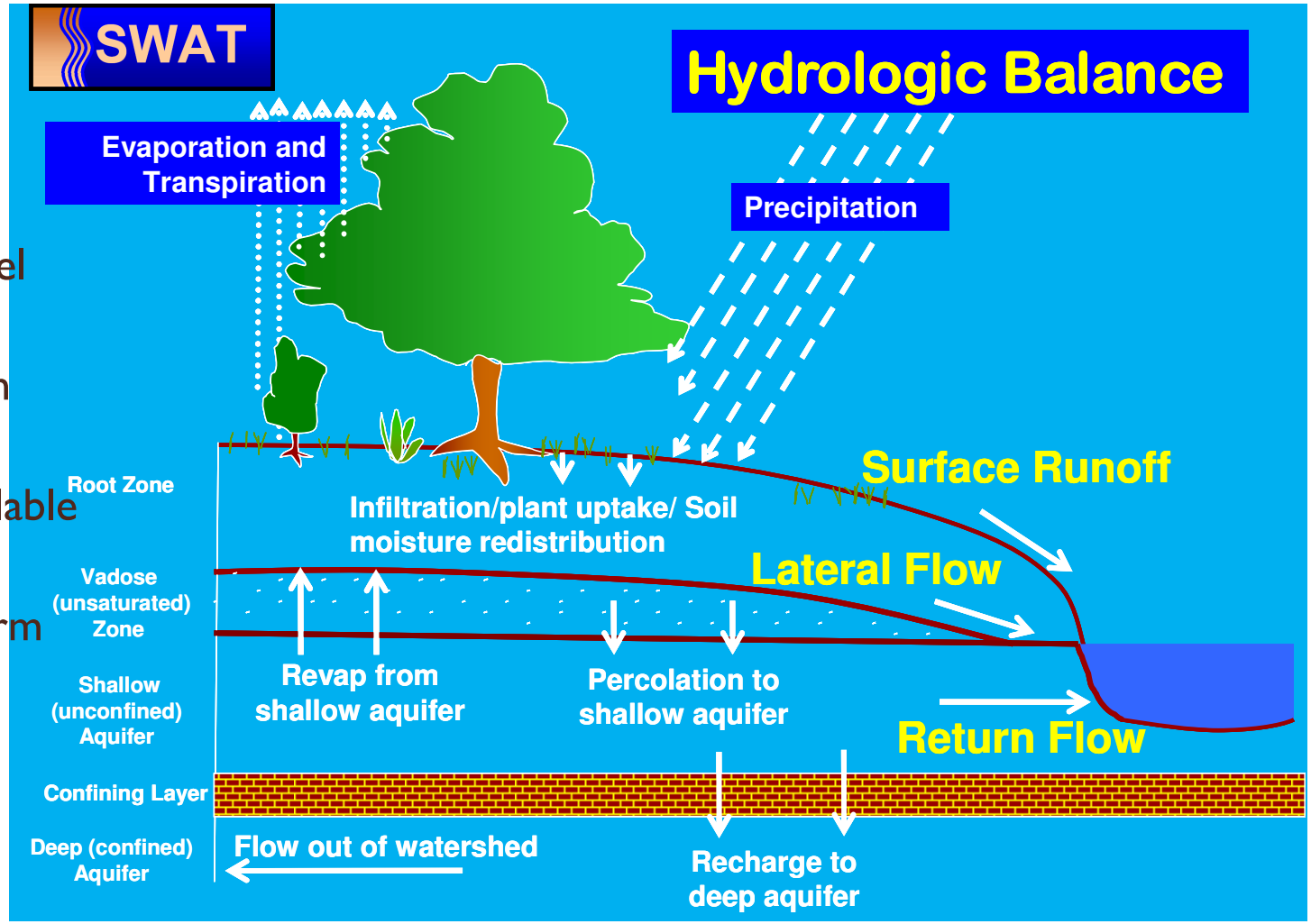
Tools Used

- Modelling: SWAT (Soil and Water Assessment Tool) model used - provides opportunity for scenario generation
- GIS framework: acts as a pre-processor for the distributed modelling and is also a powerful tool for visualization of the outputs/results in terms of V & A

SWAT (Soil and Water Assessment Tool) - Model

Features

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



Data Used for Modeling

- Digital Elevation Model: SRTM 90 m grid
- Land use: Global data, 1:2M USGS
- Soil: Global data, 1:5M FAO
- Drainage: 1:250,000
- Weather: Data generated in transient experiments by the "Hadley Centre for Climate Prediction" U.K. at a resolution of 0.44° X 0.44° latitude by longitude grid points obtained from IITM, Pune
  - PRECIS Regional Climate Model
  - A1B IPCC SRES Climate Change scenario
  - Q14 QUMP
  - Baseline (1961–1990, BL)
  - Near term (2021-2050, MC)

Impact studied

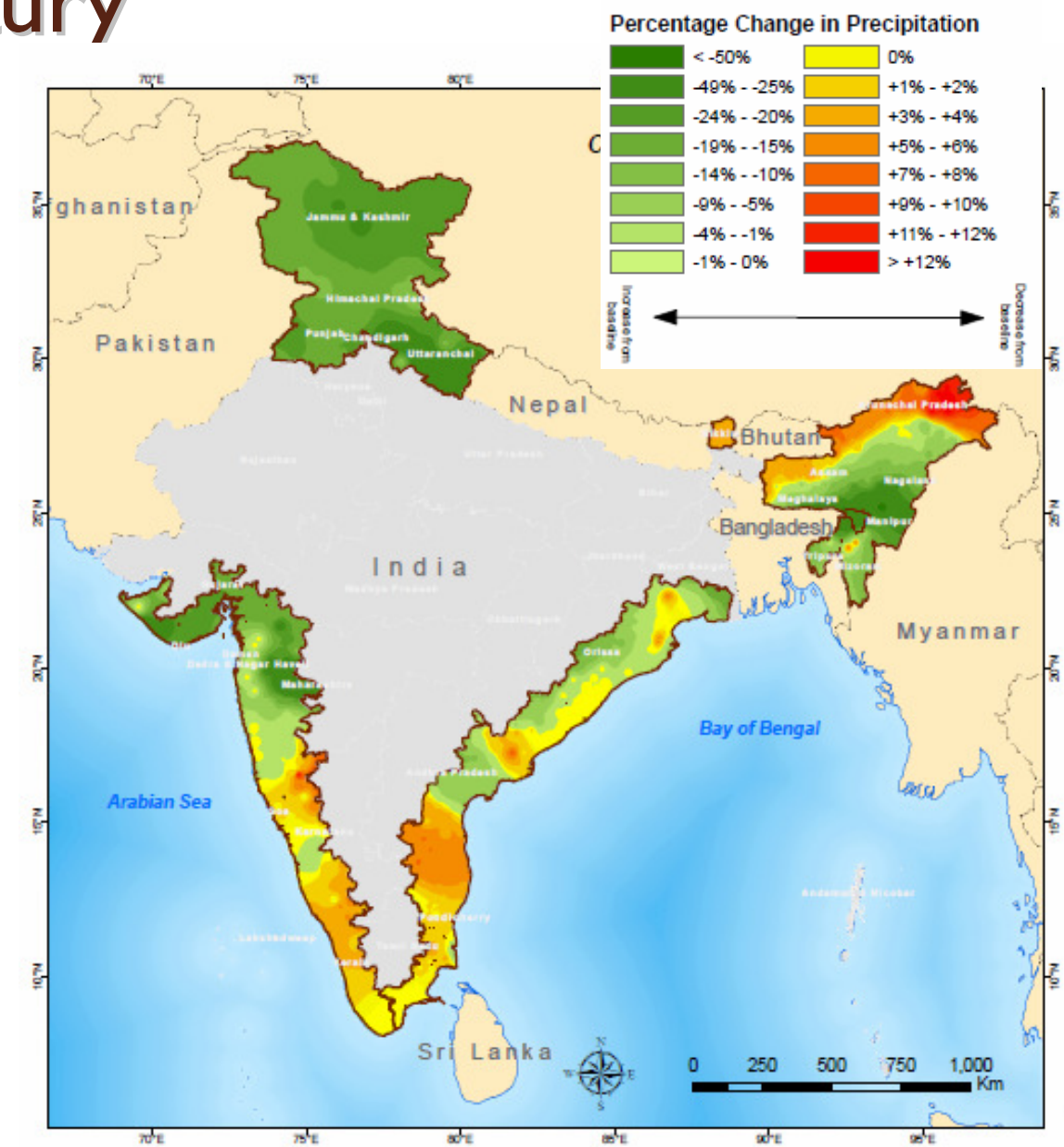
- Impact on annual water availability
  - Agriculture planning
- Impact on seasonal water availability
  - Irrigation water availability
- Impact on inter annual water availability
  - Planning for water resources structure
- Regional Variability of Water availability
  - Change in Cropping pattern
- Extreme events
  - Drought (Monsoon period)
  - Floods

Likely Impacts

- Impacts of climate change and climate variability on the water resources are likely to affect
  - irrigated agriculture
  - installed power capacity
  - reduced water flows in the dry season - droughts
  - higher flows and resulting flood problems during the wet season
  - Water supply, urban storm

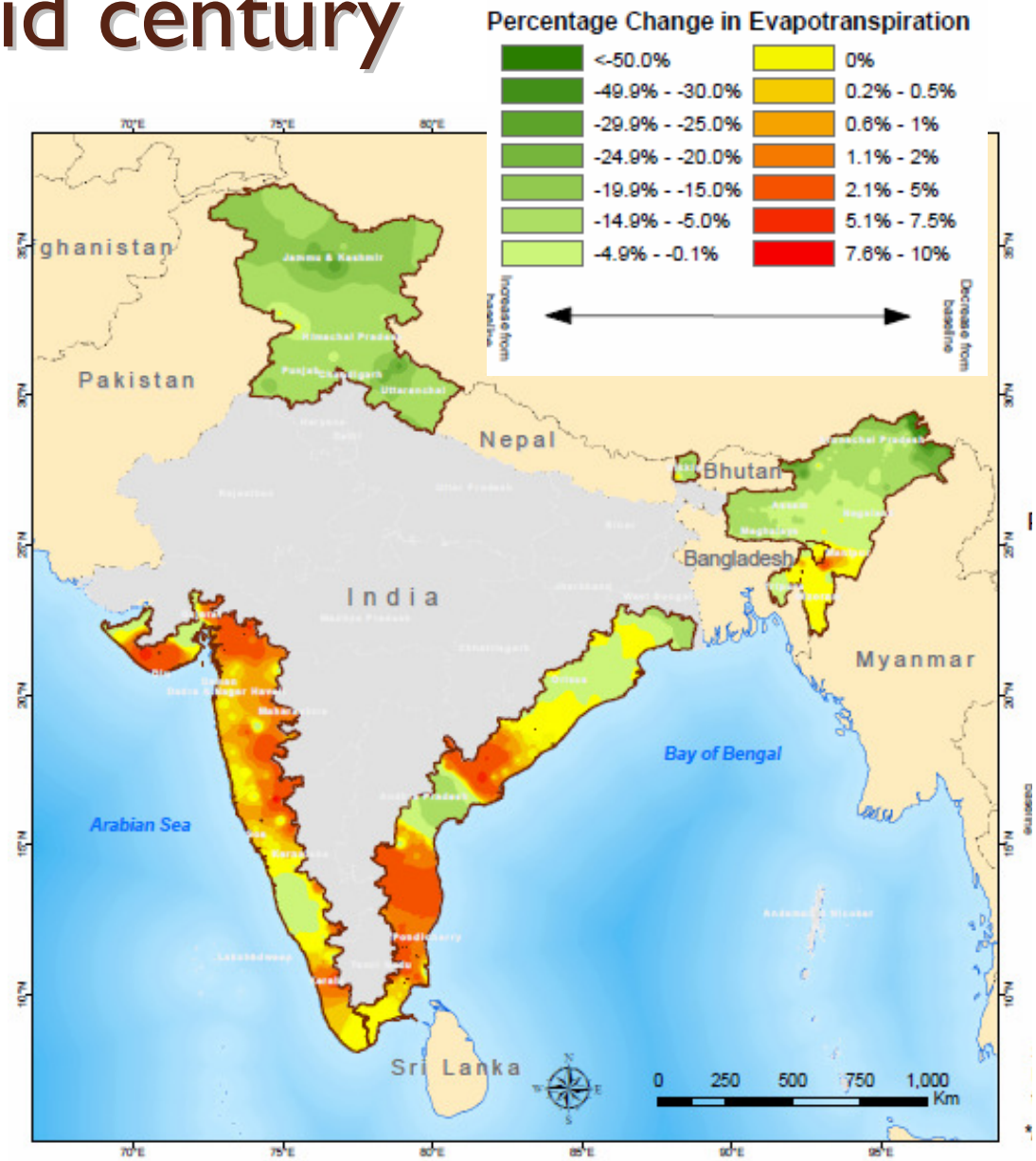
Precipitation Changes from Baseline to Mid century

- Himalayan region
  - Increase varying between 5 to 20%
- Northeast region
  - exhibit considerable spatial variability
  - northern part show a reduction
  - remaining part show increase (up to 25%)
- East Coast
  - West Bengal, Orissa and Andra Pradesh show an increase in precipitation a small fraction to 10%
  - Southern parts show a marginal reduction of up to about 3%
- West Coast
  - increase vary from 4% to 25%
  - Some areas of Karnataka and Kerala marginal decrease from a small fraction to about 4%



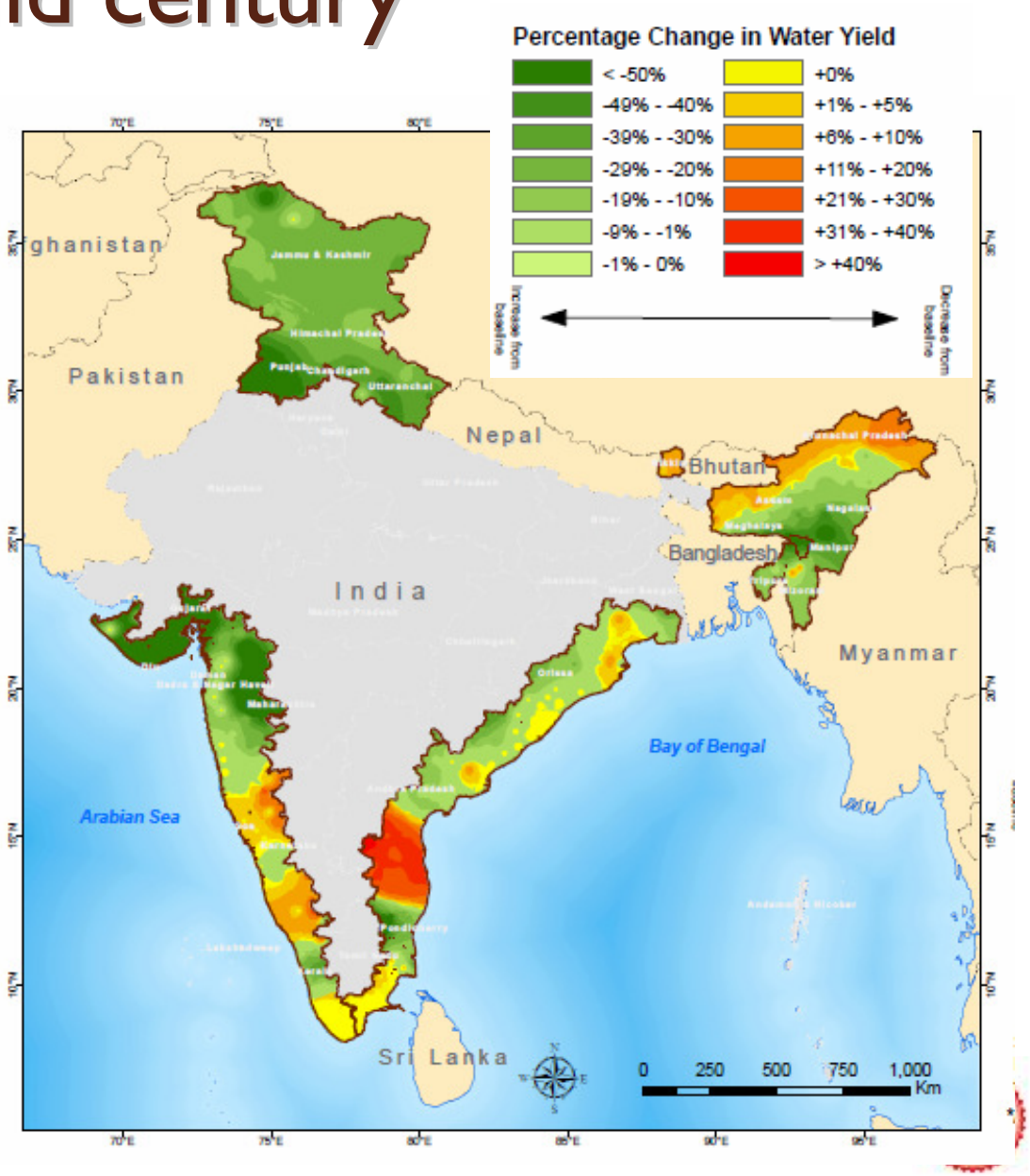
Crop water Demand Changes from Baseline to Mid century

- Himalayan region
  - Increase in Evapo-transpiration
    - Due to increase in the amount of moisture in the soil and the land surface
    - Due to the increase in the temperature
- Northeast region
  - Majority of the northeast region but for some parts of Mizoram, Tripura, Manipur and Assam show an increase in the evapo-transpiration (a small fraction to about 20%.)
  - Margin reduction in the ET in the southern portion
- East Coast
  - is general reduction in the ET which varies from a very nominal value to about 5%
  - some increase in ET for some areas of West Bangal and Orissa
- West Coast
  - general reduction in the ET which varies from a very nominal value to about 5%



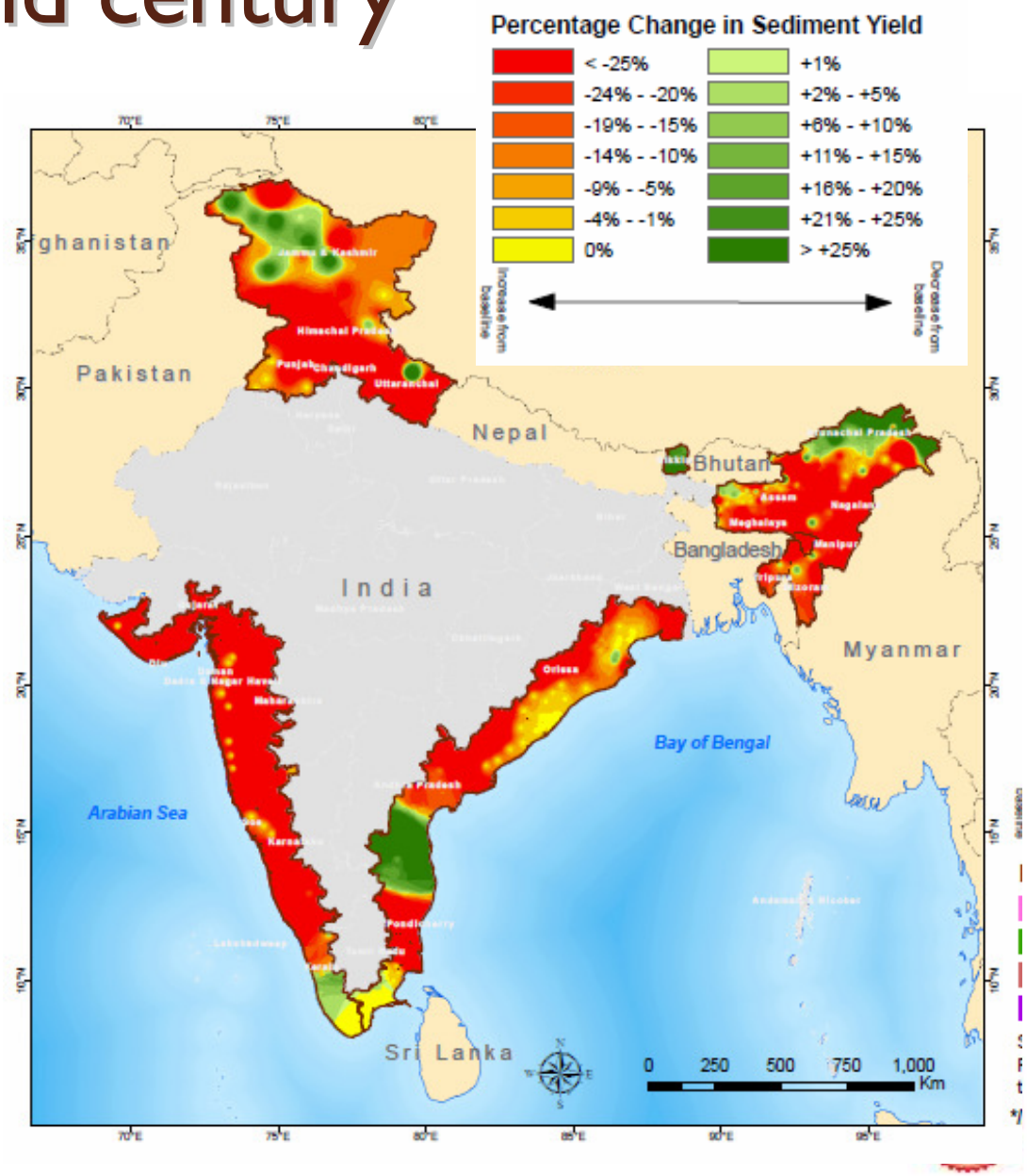
Water Availability Changes from Baseline to Mid century

- Himalayan region
  - Increase of about 50% for some areas of Indus river
- Northeast region
  - reduction in water yield for the Arunachal Pradesh is upto about 20%
  - increase in the water yield in Assam and Manipur areas is upto about 40%
- East Coast
  - Spatial variability
  - The reduction in water yield over the region is upto about 20% - souther part
  - and the increase in the water yield in the region is upto about 20%. - away from coast
- West Coast
  - Mixed trend
  - reduction in water yield for the Karnataka and Kerala is upto about 10%
  - increase in the water yield in Gujarat and Maharashtra areas is upto about 50%



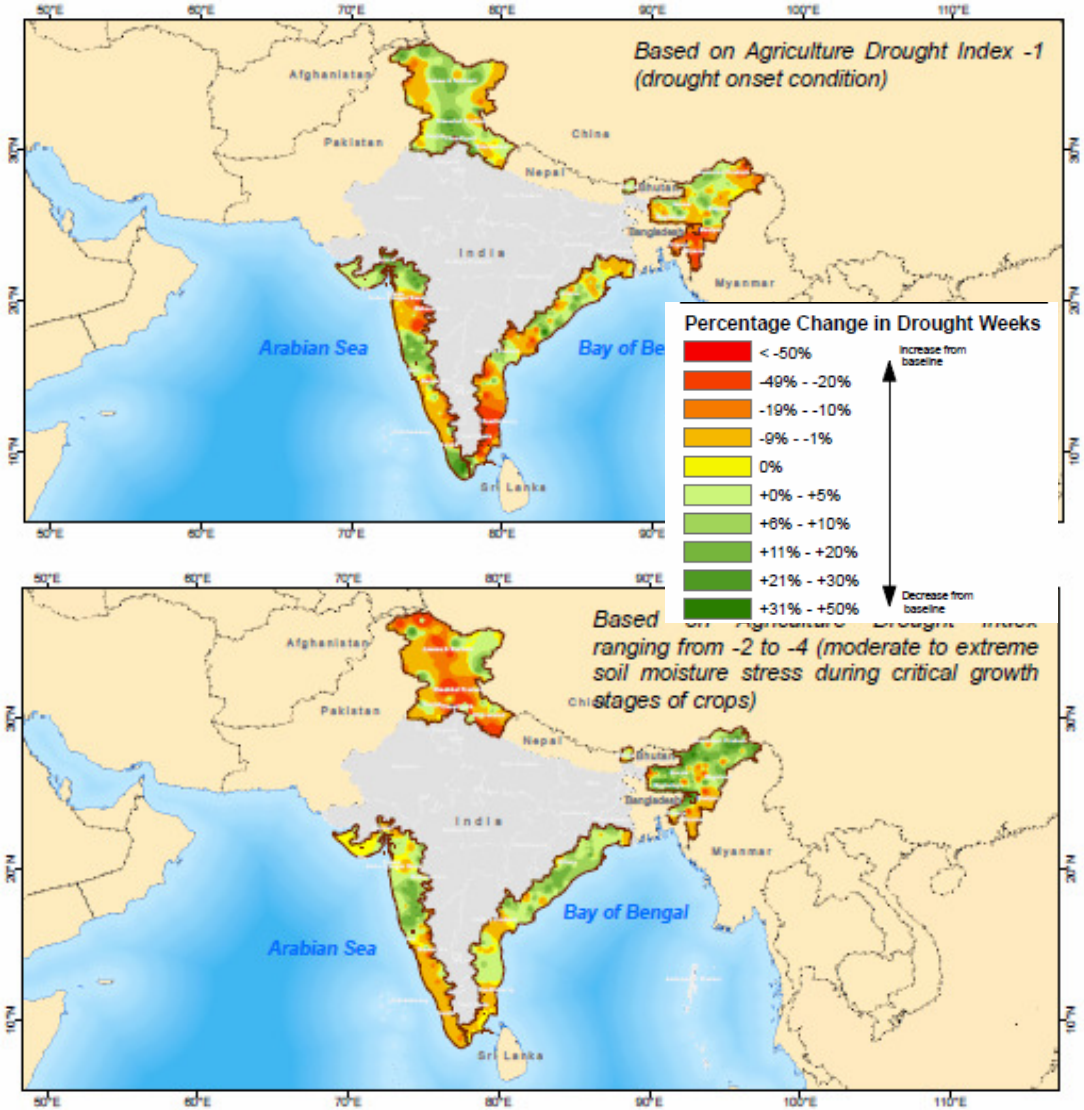
Sediment Load Changes from Baseline to Mid century

- Himalayan region
  - Increase in sediment yield due to increase in the precipitation
- Northeast region
  - increase in the sediment yield in the Northeast region is upto 25%
  - few areas of Arunachal Pradesh that are expected to receive less rainfall show reduction in the sediment yields of up to 25%
- East Coast
  - increase in the sediment yield of upto 25%
  - few areas show some reduction in the sediment yield
- West Coast
  - increase in the sediment yield of upto 25%



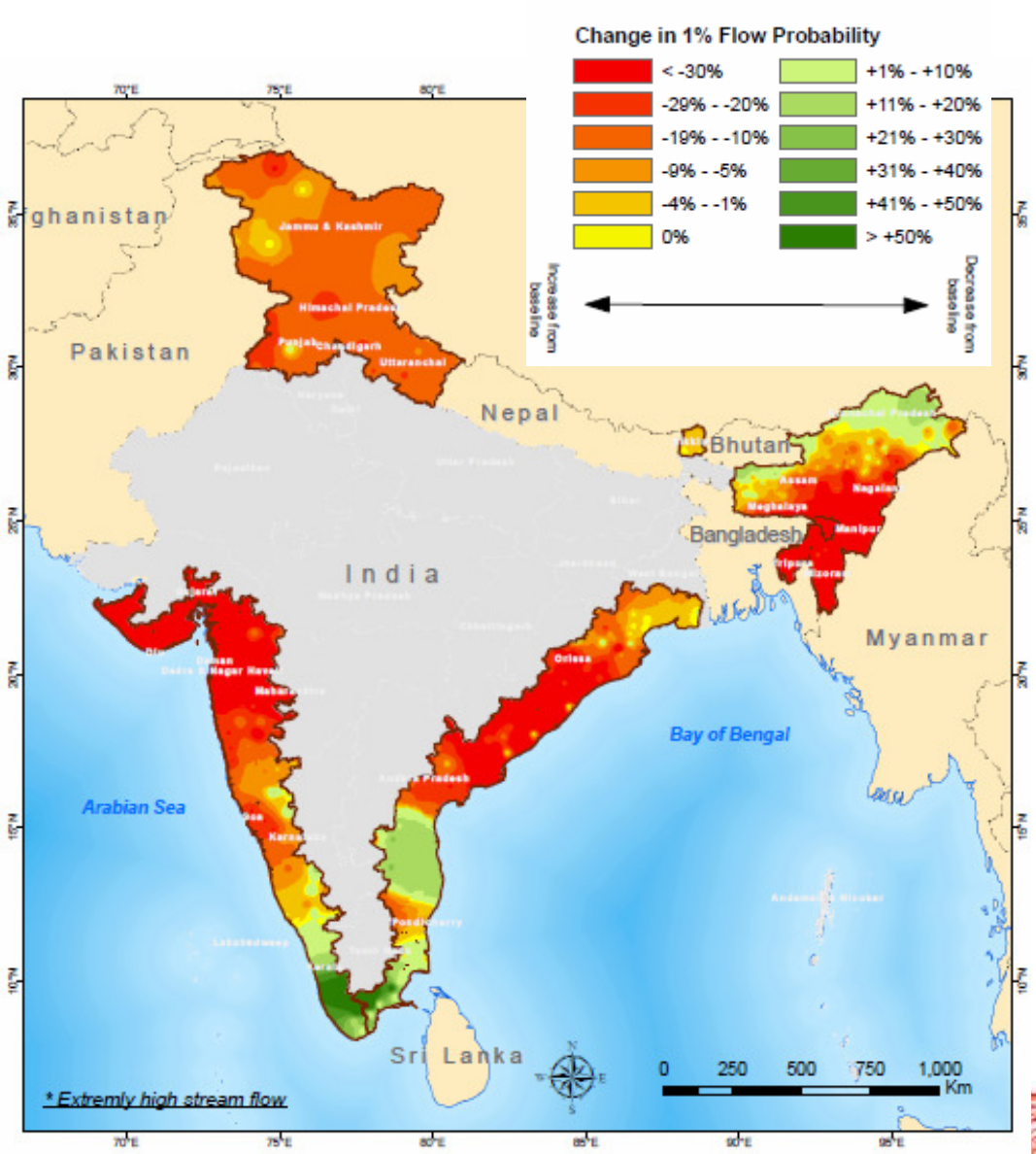
Impact Assessment - Drought

- Weeks when the soil moisture deficit may start drought development (drought index value between 0 to -1)
- Weeks fall under moderate to extreme drought conditions (drought index value between -2 to -4)
- Himalayan region
  - Increase in drought weeks under moderate to extreme drought
- Northeast region
  - Spatial variability
  - Southern part show increase
- East Coast
  - Marginal increase in drought weeks
- West Coast
  - Increase in drought weeks under moderate to extreme drought



Impact Assessment - Floods

- Peak discharge equal to or exceeding at 1% frequency
- Himalayan region
  - Marginal increase from 5 % to 10%
- Northeast region
  - Spatial variability
  - Southern part show increase up to 30%
  - Northern part show marginal decrease of 5%
- East Coast
  - Increase 20% to 25%
  - Decrease of about 5 % in the south eastern coast
- West Coast
  - Increase 20% to 25%
  - Decrease of about 5 % in the south western coast



Uncertainties

- Uncertainties in Climate Simulation
- Assumptions and Coarseness of the Data
  - Landuse has been coarse
  - detailed data on the agricultural land use and the cropping pattern has not been used
  - Soil type and profile has also been scanty
  - Water bodies including reservoirs were not incorporated due to lack of data on their capacities and the operation rules

Adaptation Issues

- Strategy for coping can be no different from the present day strategy of coping with the ever increasing demands and other environmental impacts
  - Prerequisite is the application of Integrated Water Resources Management strategy at different levels of usage starting from individual households to local communities, watersheds to catchments
- Some of the current strategy which need to be strengthened
  - Command Area Development programme
  - Crop Diversification, Irrigation Water Management
  - Conjunctive use of Surface and Ground Water, Reuse of Waste Water
  - Flood Control and Flood Management , Inter-Basin Transfer of Water
- There is no single "best" coping strategy to enhance the coping capabilities to climate variability and change
  - choice is a function of many factors pertaining to economic efficiency, risk reduction, robustness, resilience, reliability etc.
  - emerging technologies for short-term weather forecast for real-time water management and operations

Additional Improvements

- Incorporate man made interventions like reservoirs, dams etc
- Snow hydrology
- Identify hotspots with respect to drought, floods, incorporating socioeconomic and other desired parameters
- Pilot level flood zone mapping for river basin
- Integration of the results from water sector with other sectors to formulate coping strategies

THANK YOU