Hydrological response to climate change in the Krishna basin

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Projected climate change depend on illustrative scenarios (storylines) of greenhouse gases emissions:

Special Report on Emission Scenarios (SRES)





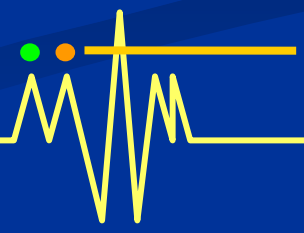



Based on different plausible pathways of future:

- development of the world
- population growth and consumption patterns
- standards and life style of living
- energy consumption & energy sources (e.g. fossil fuel usage)
- technology change
- land use change

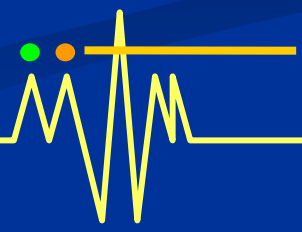
Scope of the study

- To quantify the impact of climate change on the water resources of the Krishna river basin using hydrological model.
- PRECIS
- SWAT



PRECIS

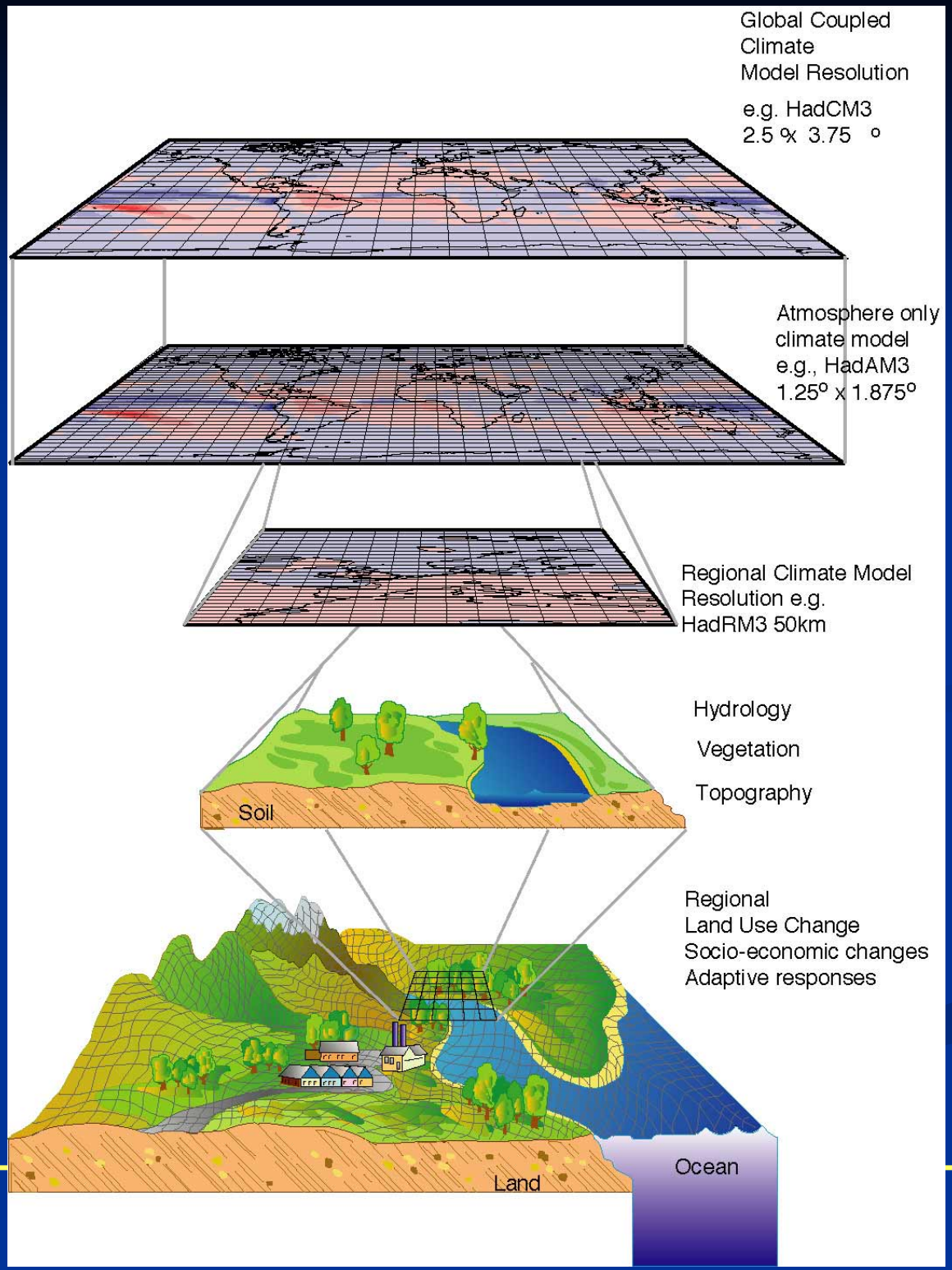
- **P**roviding **RE**gional **C**limates for **I**mpact **S**tudies
- High-resolution limited area model driven at its lateral and sea-surface boundaries by output from HadCM
- PRECIS runs on Linux PC (horizontal resolutions: 50 x 50 & 25 x 25 km).
- Needs data for the selected domain on lateral boundary conditions (LBC) from the driving GCM (e.g., HadCM3/ HadAM3) and the associated ancillary files (e.g., sea surface temp, vegetation, topography, etc).
- Hadley Centre, UK has been providing PRECIS as well as the driving data to several regional groups.
- Baseline (1961-90), A2 & B2 scenarios (2071-2100). Reanalysis-driven runs provide comprehensive regional data sets representing current conditions, which can assist model evaluation as well as assessment of vulnerability to current climate variability.
- Ensembles to estimate model-related uncertainties.



GCMs to Regional Adaptive Responses : Modelling Path

$Cs = f(Cl, Øs)$

Cs - small scale climate
Cl - large scale climate
Øs - physiographic details at small scale

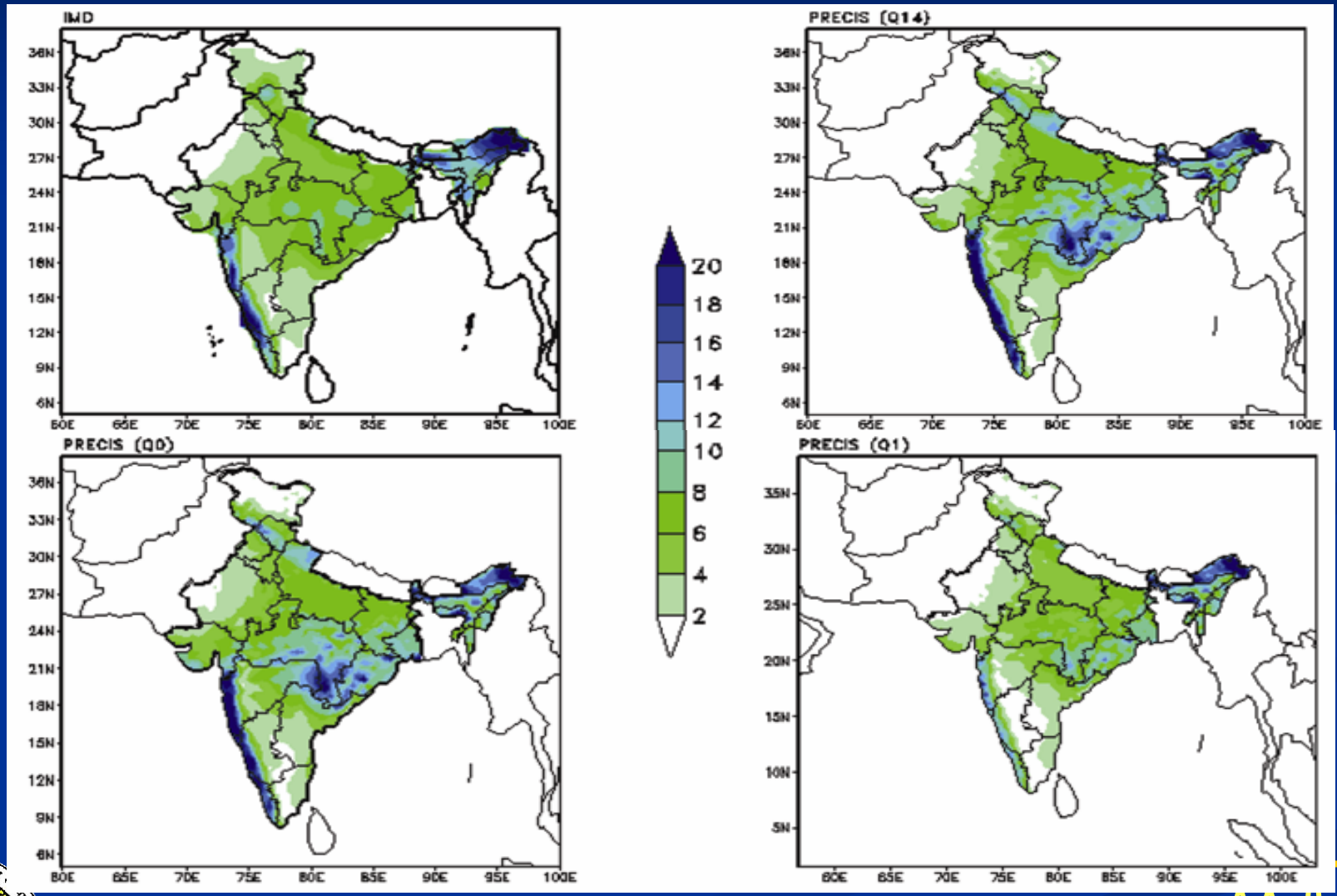


PRECIS Runs at IITM

(Resolution: 50km)

- LBCs derived from HadAMH. HadCM3 provided SST as boundary conditions for HadAMH.
- PRECIS runs on Linux PC (horizontal resolutions: 0.44° x 0.44°)
- The LBCs have a length of 138 years, and are available for Baseline (1961-90), A1B scenario (1961-2098), with the sulphur cycle.
- The basic parameters analyzed are the mean surface (1.5 m) temp and total precip.
- The precip & temp obs data ,IMD Grided precipitation and (CRU20, 1961-90) temperature is used to validate model performance in simulating current climate.
- The analysis comprised of both annual mean and seasonal mean for DJF, MAM, JJA and SON.
- Continuous simulations of provide an opportunity to assess the impact of climate change on the Indian monsoon for three time slices representing the near, medium and long-term with implications for policy on these timescales.

Spatial patterns of summer monsoon rainfall climatology as simulated in the three simulations of PRECIS (Q0, Q1 and Q14). The observed monsoon rainfall climatology (Obs) is based on the gridded IMD rainfall data. The climatologies correspond to the period 1961–1990. (17 Members perturbed Physics ensembles (PPE) using HadCM3



Materials and Method

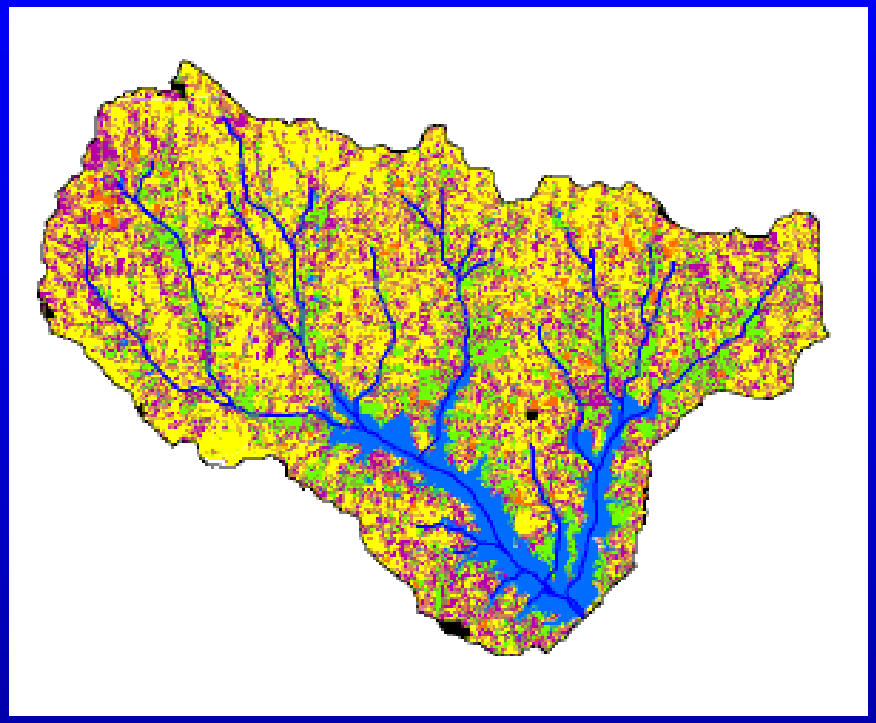
- SWAT (Soil and Water Assessment Tool)
- Physically based ,continuous-time model, developed by Dr. Jeff Arnold (2005)
- The model has capability of being used for watersheds as well as the major river basin systems.
- ArcGIS interface for pre and post processing of the input and output data.

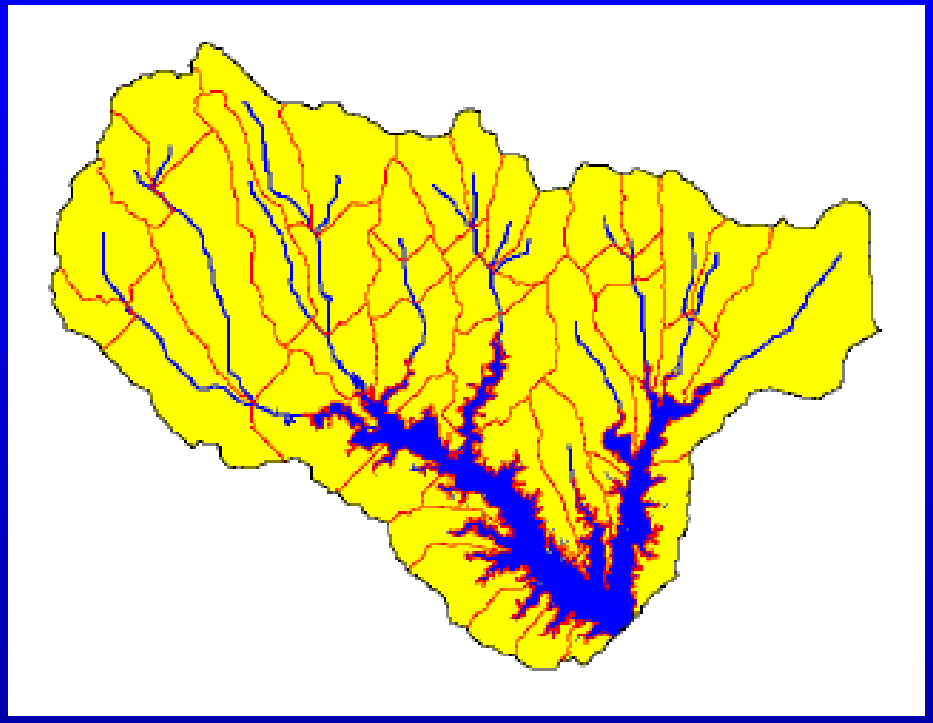
General Description

- Continuous Time
  - Daily Time Step
  - One Day ⟶ Hundreds of Years
- Distributed Parameter
  - Unlimited Number of Subwatersheds
- Comprehensive – Process Interactions
- Simulate Management

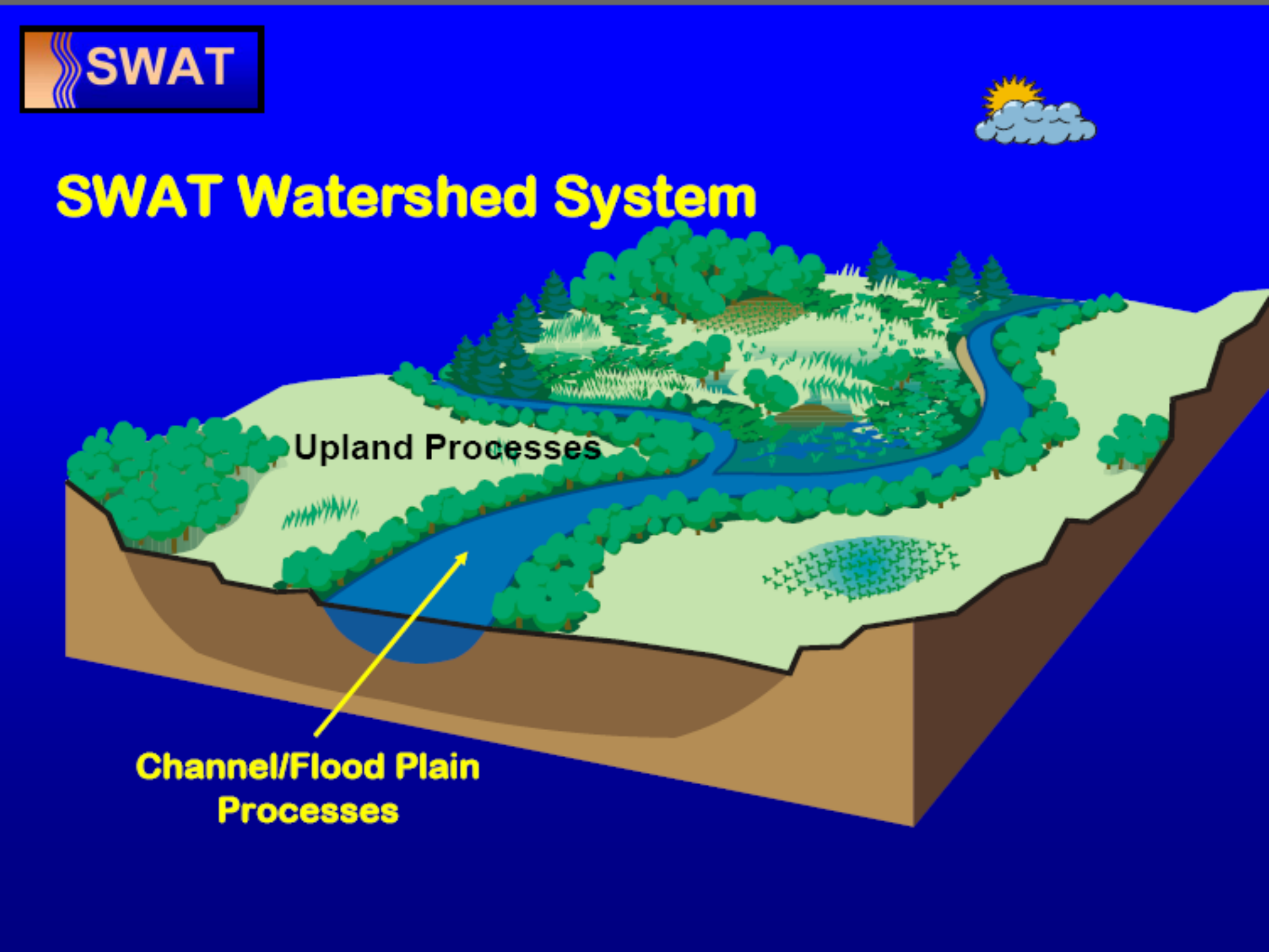
SWAT

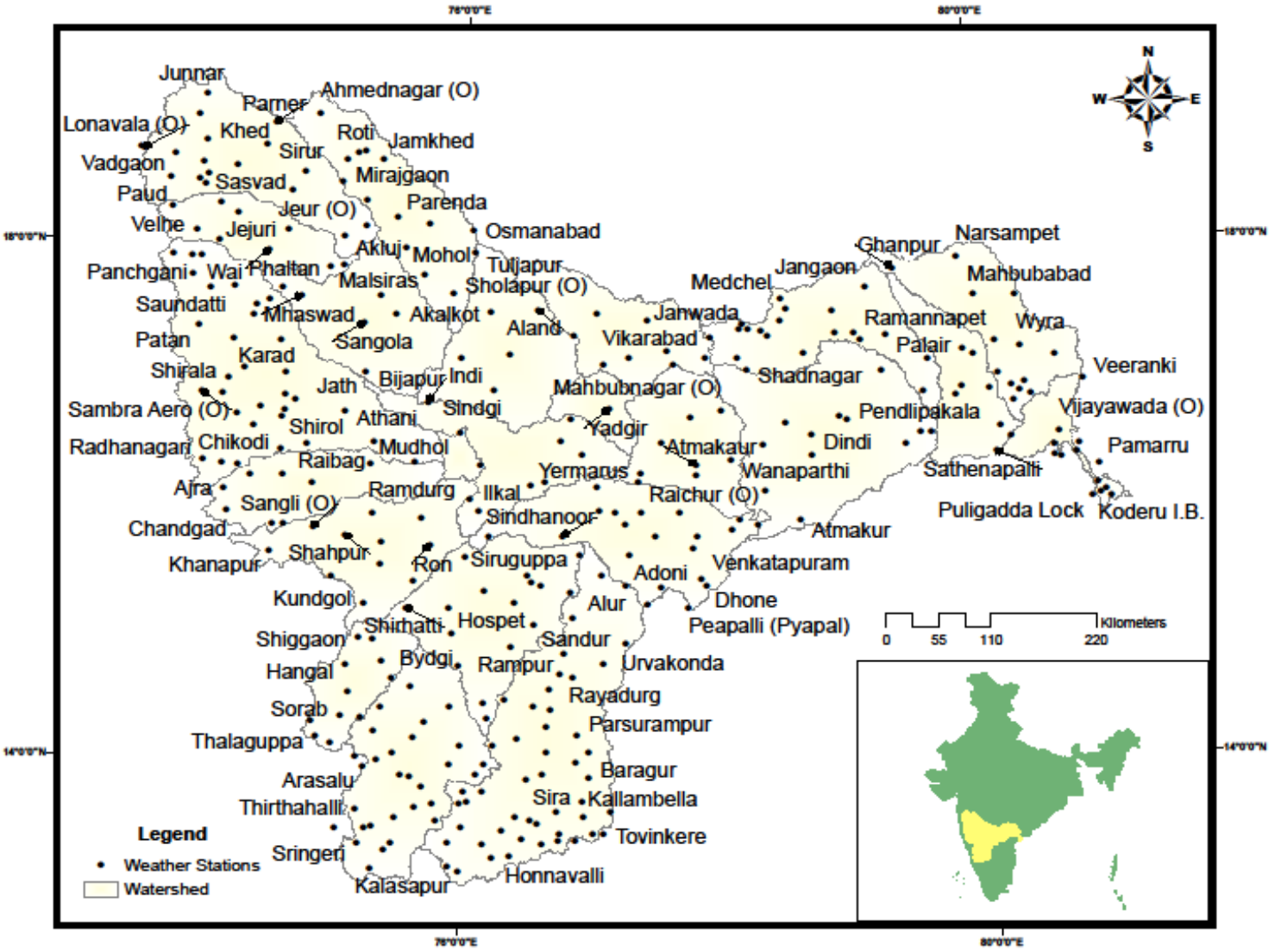
Example Configuration





- Cells/Subwatersheds
- Hydrologic Response Units
- Output from other Models
- Point Sources - Treatment Plants


SWAT
SWAT Watershed System
Upland Processes
Channel/Flood Plain
Processes


Junnar
Parner
Ahmednagar (O)
Lonavala (O)
Khed
Roti
Jamkhed
Sirur
Vadgaon
Mirajgaon
Sasvad
Paud
Parenda
Jeur (O)
Velhe
Jejuri
Osmanabad
Akluj
Mohol
Tuljapur
Panchgani
Wai
Phaltan
Malsiras
Sholapur (O)
Saundatti
Mhaswad
Akalkot
Aland
Jahwada
Patan
Sangola
Vikarabad
Karad
Shirala
Jath
Bijapur
Indi
Mahbubnagar (O)
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Sindgi
Shirol
Athani
Yadgir
Radhanagari
Chikodi
Mudhol
Atmakur
Raibag
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Ajra
Ramdurg
Ilkal
Wanaparthi
Sangli (O)
Raichur (O)
Chandgad
Sindhanoor
Shahpur
Ron
Siruguppa
Khanapur
Adoni
Venkatapuram
Kundgol
Alur
Dhone
Shirhatti
Hospet
Peapalli (Pyapal)
Shiggaon
Sandur
Bydgi
Hangal
Rampur
Urvakonda
Rayadurg
Sorab
Parsurampur
Thalaguppa
Baragur
Arasalu
Sira
Kallambella
Thirthahalli
Tovinkere
Sringeri
Honnavalli
Kalasapur
Legend
Weather Stations
Watershed
Medchel
Jangaon
Ghanpur
Narsampet
Mahbubabad
Ramannapet
Wyra
Palair
Shadnagar
Veeranki
Pendlipakala
Vijayawada (O)
Dindi
Pamarru
Sathenapalli
Puligadda Lock
Koderu I.B.
Atmakur
Kilometers
0
55
110
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DATA INPUTS FOR HYDROLOGICAL MODELING

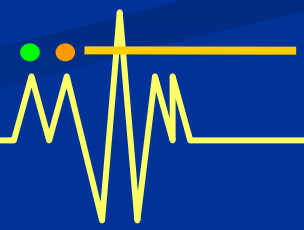
Weather Gen.

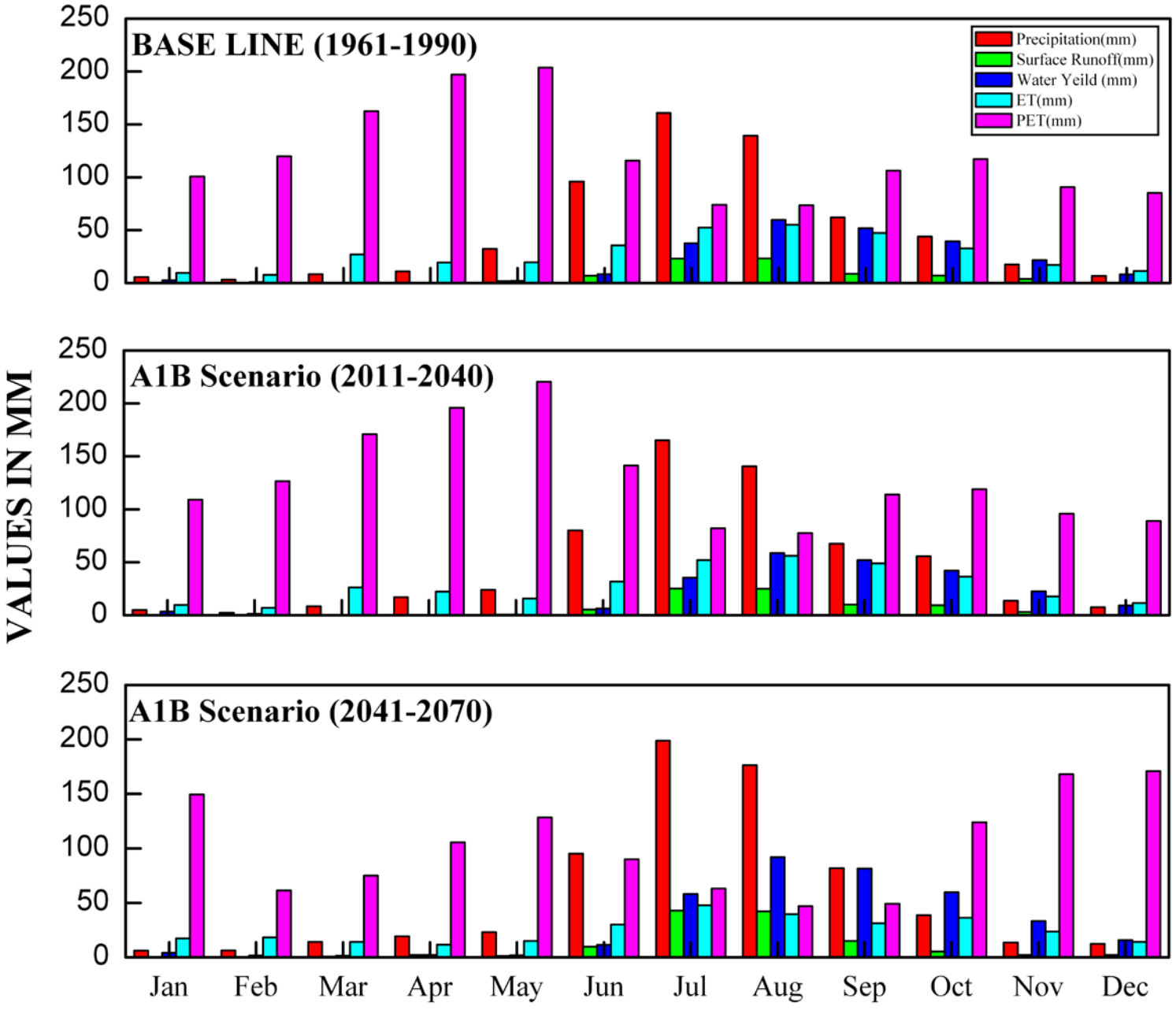
DEM

Soil

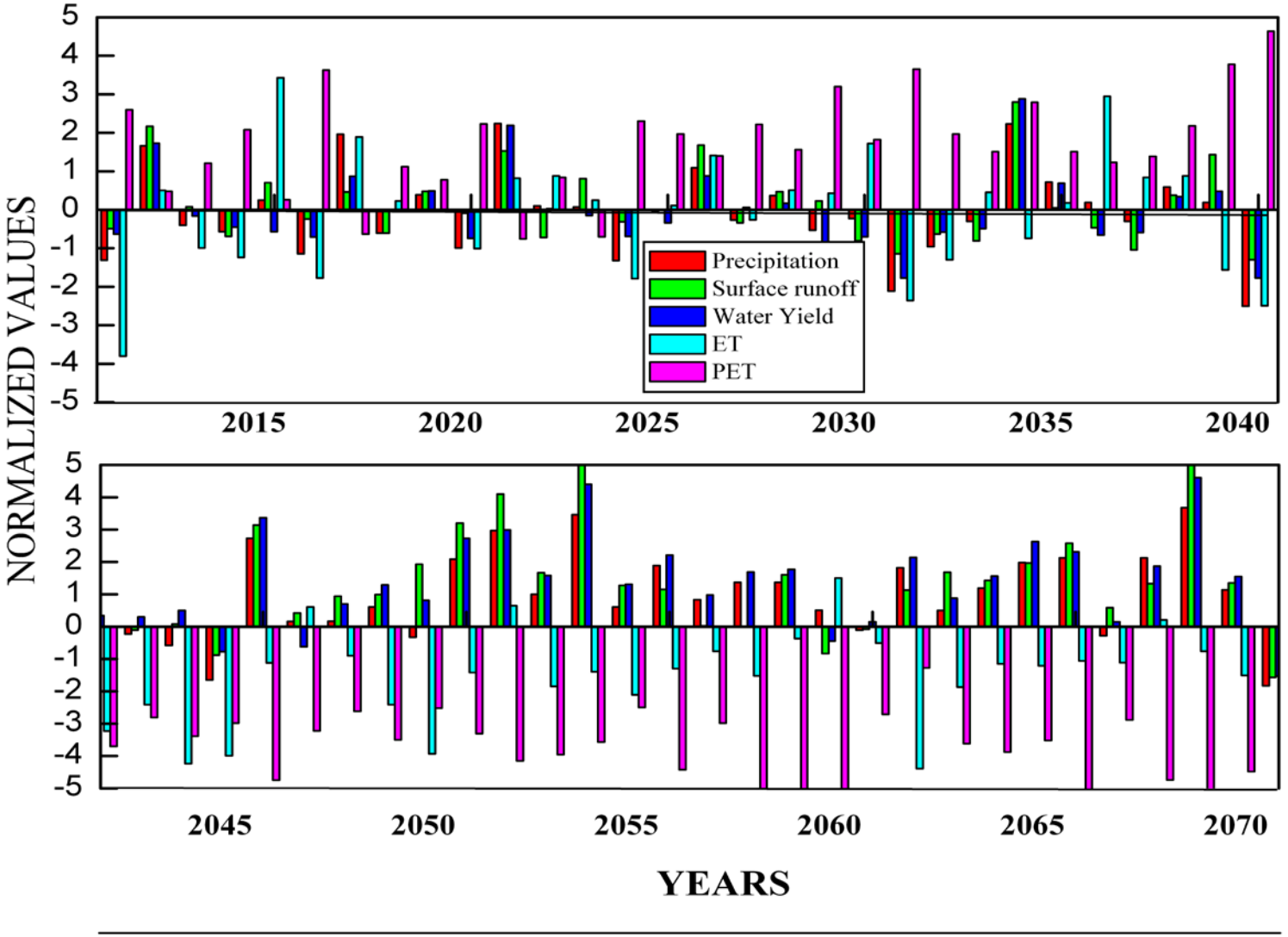
Climate Model.

Land Use

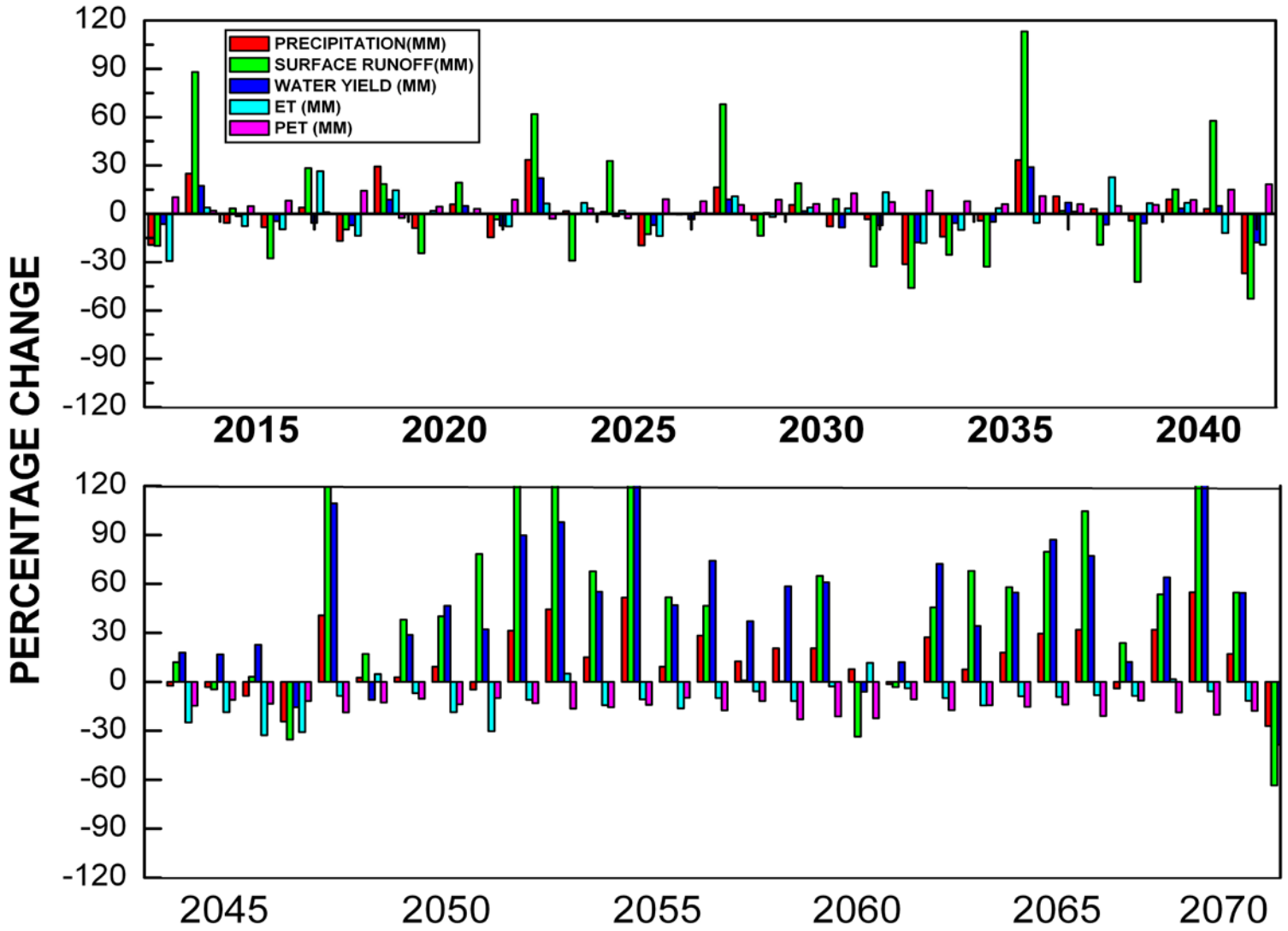




Mean monthly water balance components for control & A1B Scenarios



Normalized Water Balance components



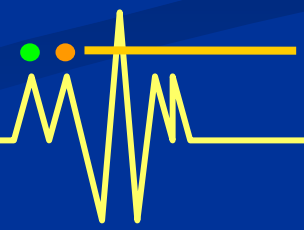
CHANGES IN WATER BALANCE COMPONENTS

LIMITATIONS OF THE STUDY

1. It also should be noted that future flow conditions cannot be projected exactly due to uncertainty in climate change scenarios and GCM outputs.

2. Climate change impact assessment on water availability based on two model analyses and out puts, which are depends on simplified assumptions Hence, it is unquestionable that the uncertainties presented in each of the models and model outputs kept on cumulating while progressing towards the final output. These Uncertainties include: Uncertainty Linked to Data quality, General circulation Model (GCMs), Emission scenarios.

3. The model simulations considered only future climate change scenarios assuming all other things constant. But change in land use scenarios, soil, management activities and other climate variables will also contribute some impacts on water availability and crop production.



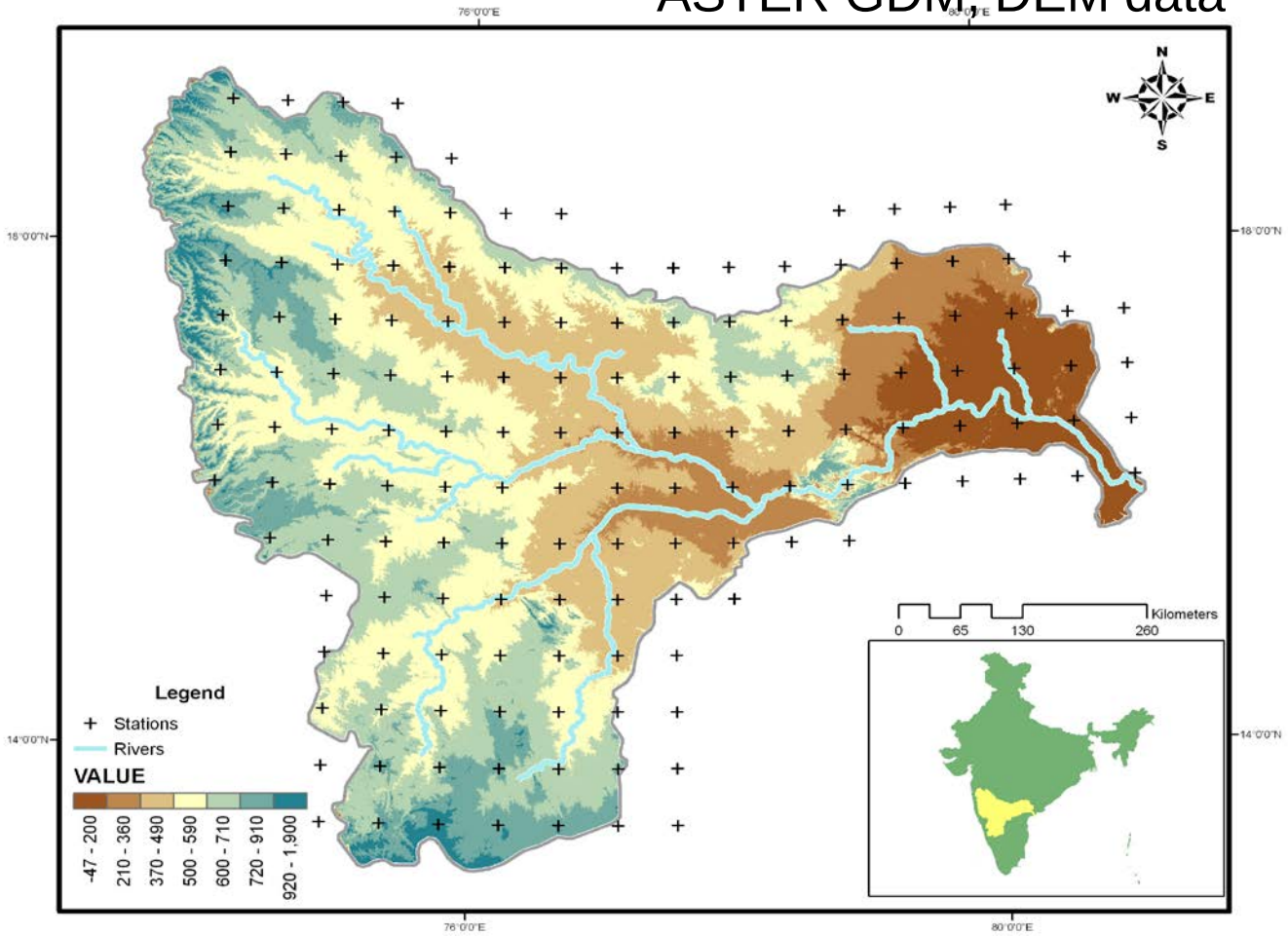
CONSULISIONS

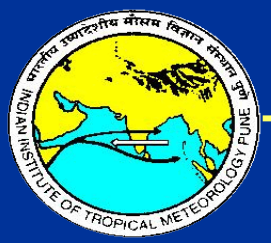
- In this study projections of precipitation and evaporation change and their impacts on stream flow were investigated in the Krishna river basin for the 21st century. The SWAT model is well able to simulate the hydrology of the Krishna river Basin. The future annual discharge, surface runoff and baseflow in the basin show increases over the present as a result of future climate change. However, water resources in the basin will be less reliable in the future.

- This study used future climate series for one of the RCM, PRECIS for the impact analysis. Due to uncertainties in climate forecasting, the use of climate model ensembles and multiple scenarios will be useful for understanding the range of climate change impact that can be expected on the water resources in the Krishna river basin.

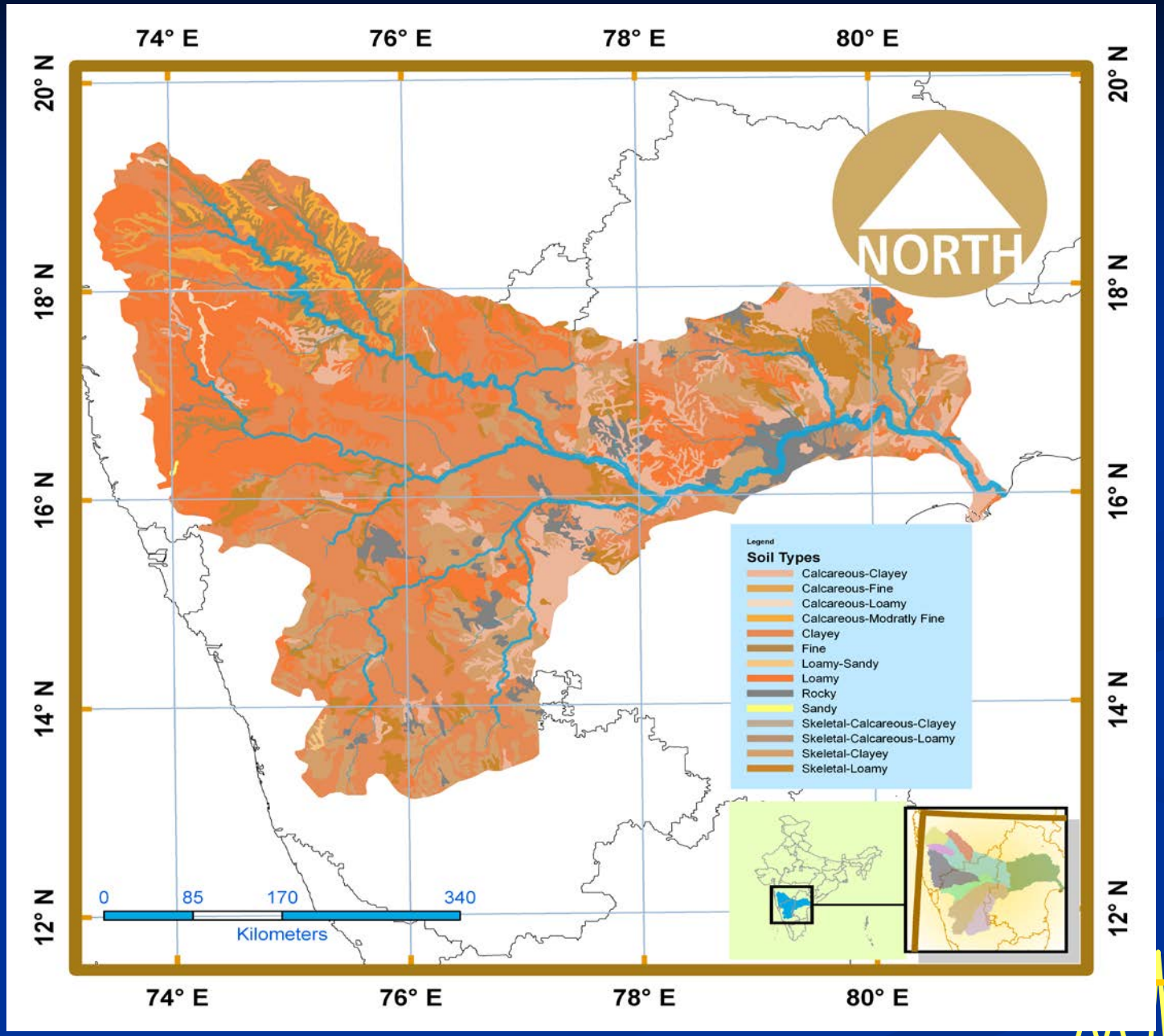
Thank you!

ASTER GDM, DEM data

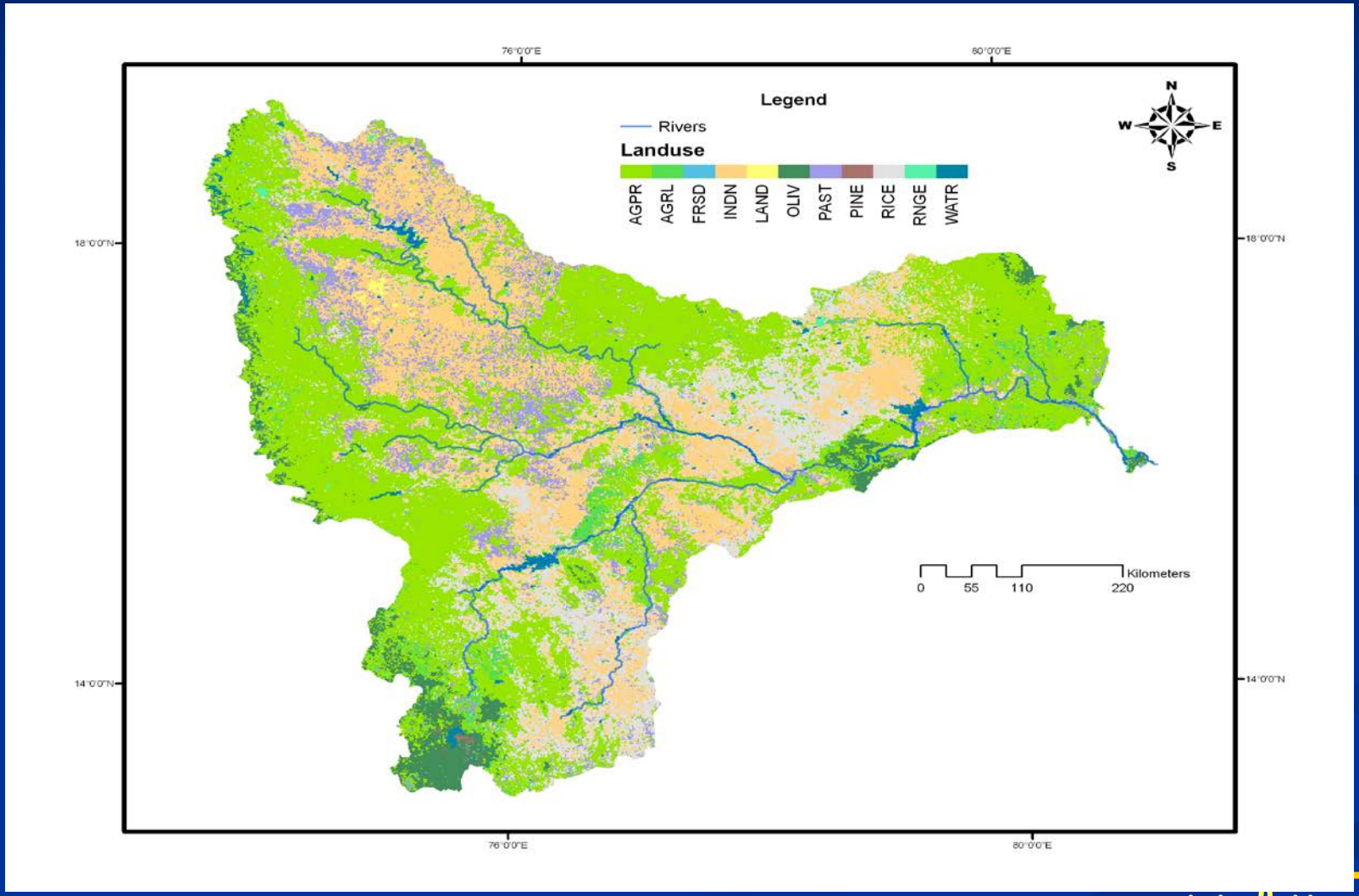




Soil Data (NBSS &LUP)

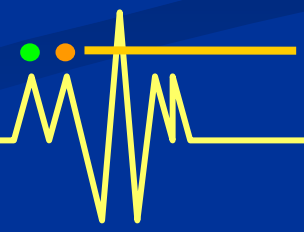


Land use and land cover layer of the Krishna basin (source: University of Maryland Global land cover Facility (13 categories) , resolution 1 km grid cell.



Weather Generator Data

- Daily Precipitation
- Maximum and Minimum Temperature
- Solar Radiation
- Relative Humidity
- Wind speed



Climate Model Data

- PRECIS simulated data from IITM
- Resolution 50 km x 50 km
- Simulated daily weather data viz. precipitation, maximum and minimum temperature, solar radiation for A1B Scenarios for the period
- 1960-1990 (baseline), 2011-2040 and 2040-2070