

# Climate Variability in South Asia

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# Introduction

- It is well understood that from a utilitarian perspective, 'climate variability' has significant implications for the way climate change predictions need to be made
- Understanding of 'climate variability' (spatial and temporal) and its impact on hydrological systems would also help understand the likely impact of the change in climate over time on the hydrological system and water resources
- Unfortunately, these concerns were very narrowly addressed by the advocates of climate change, with the key contention being the variability in precipitation would increase with greater frequency of extreme events such as floods and droughts.

# Introduction

- There are several other important climate parameters one needs to deal with for analyzing climate variability issues which include the following
  - number of rainy days;
  - wind speed;
  - wind directions;
  - humidity;
  - temperature and
  - solar radiation

# Rainfall variability in South Asia

- The mean annual rainfall across South Asia varies from 100mm to 3200mm
- India has diverse climates (hyper-arid to arid to semi arid to sub-humid to humid)
- Srilanka being an island country, has coastal climate in many parts
- Pakistan has true humid conditions after the rainfall increases to 750mm in plains and 625mm in highlands

# Rainfall variability in South Asia (Contd..)

- Nepal (Alpine to sub-alpine in higher Himalayas to temperate in lesser Himalayan region to sub-tropical in the Terai and Siwalik regions)
- Afghanistan has the central highlands, which are part of the Hindukhush Himalayan range, northern plains and south western plateau, which consists of sandy desert and semi desert.
- Bangladesh has tropical monsoon climate characterized by high seasonal rainfall, high temperature and high humidity.

# Temporal variability in rainfall

- Analysis of monsoon rainfall carried out by Physical Research Laboratories shows that the inter-annual variability (expressed in terms of CV) in annual rainfall is high in regions of low rainfall and low in regions of high rainfall
- In regions such as western Rajasthan and Kachchh, the CV in the rainfall is as high as 50 per cent and above.
- In the northeastern and western Ghat regions the CV in rainfall is very low, meaning high dependability

# Variability in climate in South Asia

- Climate is the net effect of the interplay of precipitation, humidity, temperature of the atmosphere and winds (speed) and rainfall
- **Humidity** is a measure of the amount of vapor in the air, and is measured in terms of vapor pressure of the air (measured in KPa/m<sup>2</sup>)
- The relative humidity (RH) is the measure of the vapor pressure of the air measured as a percentage of the saturated vapor pressure and this RH ranges from <25% to 100% across South Asia



# Variability in climate in South Asia (Contd..)

- Atmospheric **temperature** change is a result of change in energy balance, which is the net effect of the incident and reflected solar radiations
- **Speed of winds**, which occur as a result of atmospheric pressure gradients, is an important climate parameter as it can change the humidity of an area.
- There is significant variation in **solar radiation** flux across South Asia

# Spatial variability in climate

- Potential evaporation (expressed in mm), the amount of water an open water body can evaporate in a year, for a particular location is a net result of the solar radiation flux, wind speed and relative humidity experienced in that location and
- to a lesser extent the temperature, and is a strong indicator of the location's climate, along with rainfall.
- The variations in solar radiation, air temperature, wind speed and relative humidity across space ultimately results in significant variation in **potential evaporation** (PE).

# How South Asian rainfall has been changing over time?

- Understanding how the monsoon will change in the face of global warming is a challenge for climate science
- The general circulation models still have difficulty simulating the regional distribution of monsoon rainfall
- [Historical and Projection of South Asia monsoon rainfall \(1860 – 2100\)](#)
- The analysis by IITM is the only work which comprehensively examines the long term variations in Physiographic rainfall across India

# Conclusions

- We have seen that there is substantial inter-annual and inter-regional variations rainfall.
- There is also substantial variation in the annual potential evaporation rates, which is the result of variations in key climate variables with respect to space.
- We have also seen that there is significant variation in climate variable such as relative humidity, temperature and wind speed across seasons and years.

# Conclusions

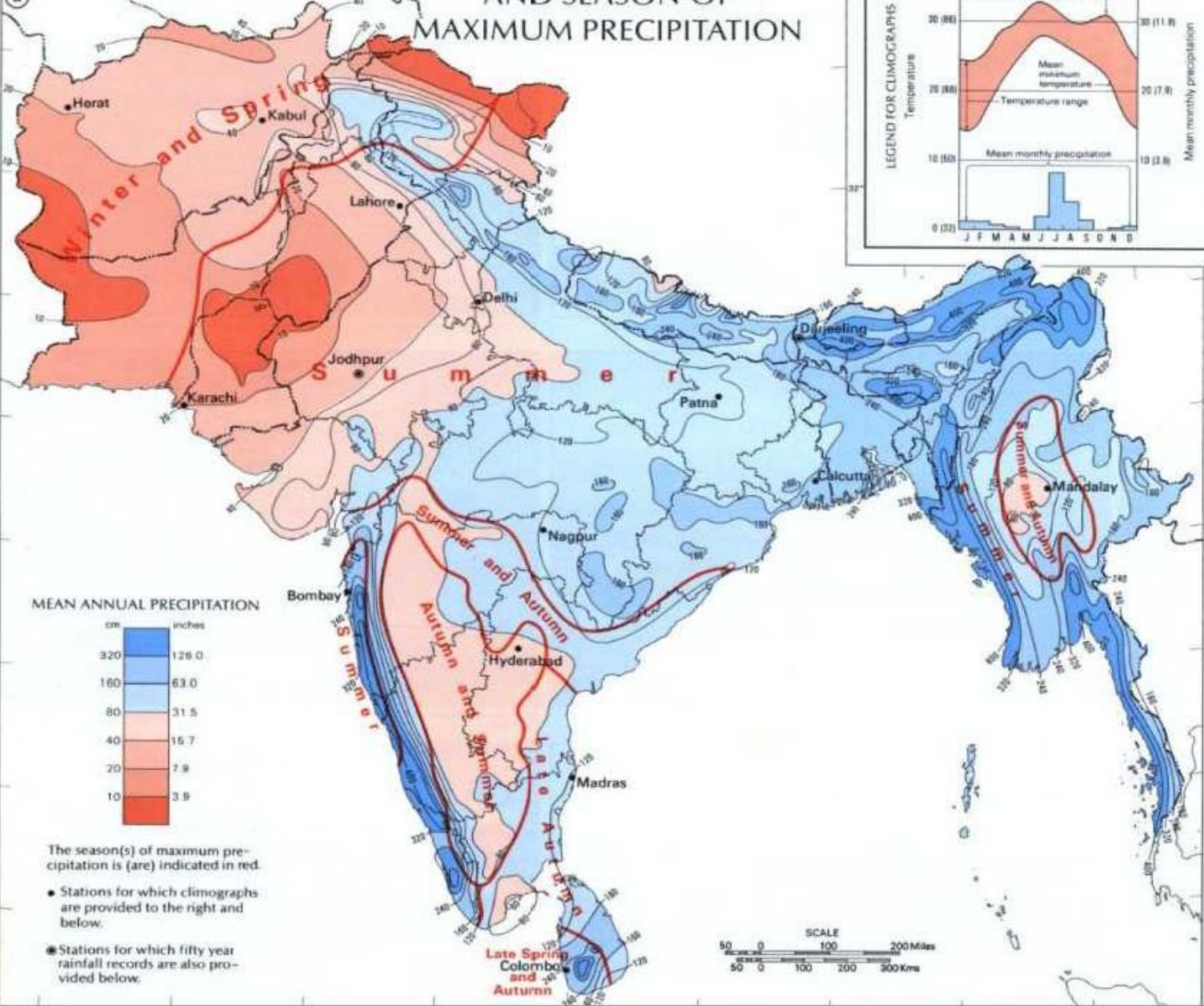
- These together can induce major changes in the physical and biophysical processes such as evaporation from soils and water bodies, and evapo-transpiration from plants, grass and trees.
- Understanding these characteristics is important as it has significant implications for the way climate change predictions need to be made for the sub-continent.
- Understanding of the impact of 'climate variability' on water resources and water demand would also help understand the likely impact of the change in climate over time on the hydrological system and water resources

**THANK YOU**

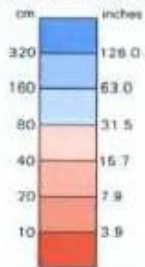
# CLIMATE

## MEAN ANNUAL PRECIPITATION AND SEASON OF MAXIMUM PRECIPITATION

(a)

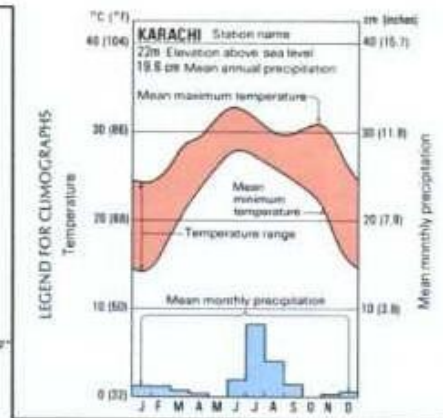


### MEAN ANNUAL PRECIPITATION

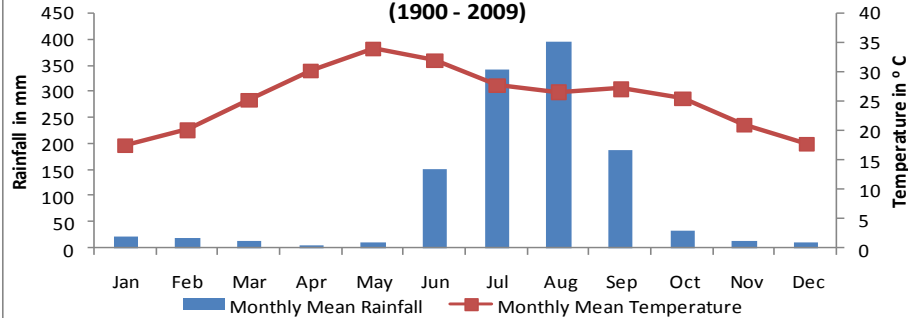


The season(s) of maximum precipitation is (are) indicated in red.

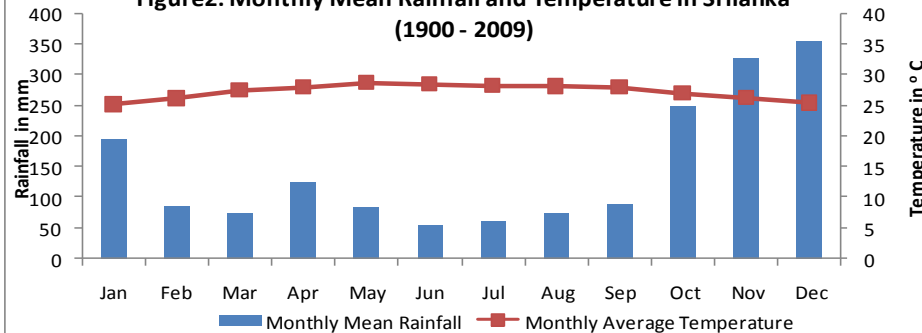
- Stations for which climographs are provided to the right and below.
- Stations for which fifty year rainfall records are also provided below.



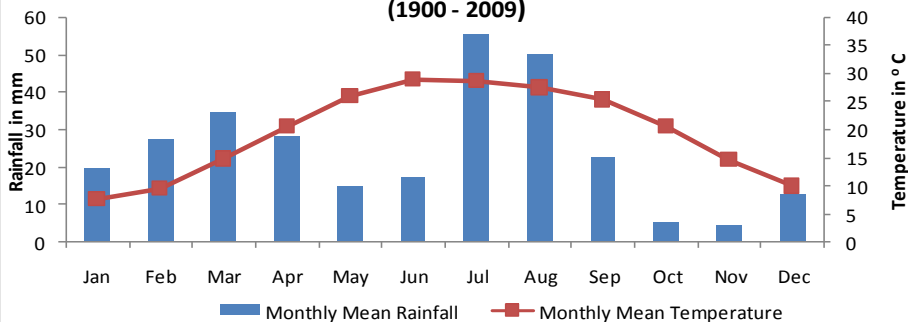
**Figure1: Monthly Mean Rainfall and Temperature in India (1900 - 2009)**



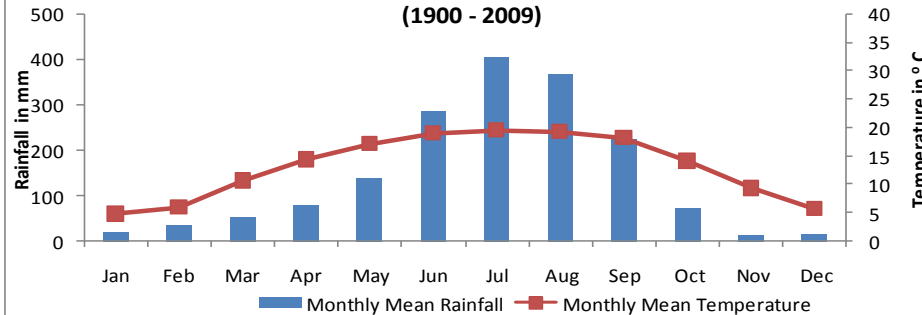
**Figure2: Monthly Mean Rainfall and Temperature in Sri Lanka (1900 - 2009)**



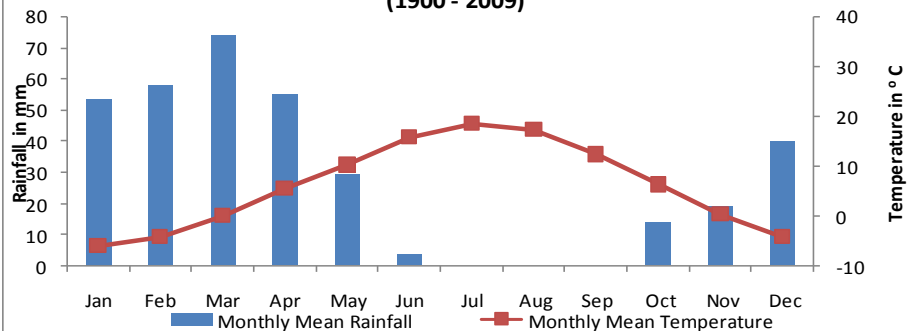
**Figure3: Monthly Mean Rainfall and Temperature in Pakistan (1900 - 2009)**



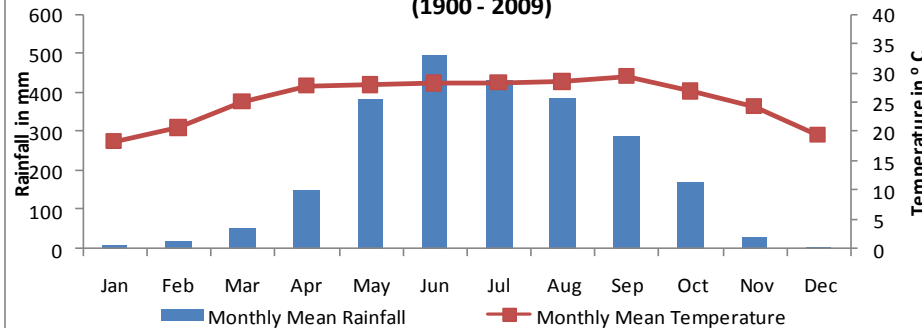
**Figure4: Monthly Mean Rainfall and Temperature in Nepal (1900 - 2009)**



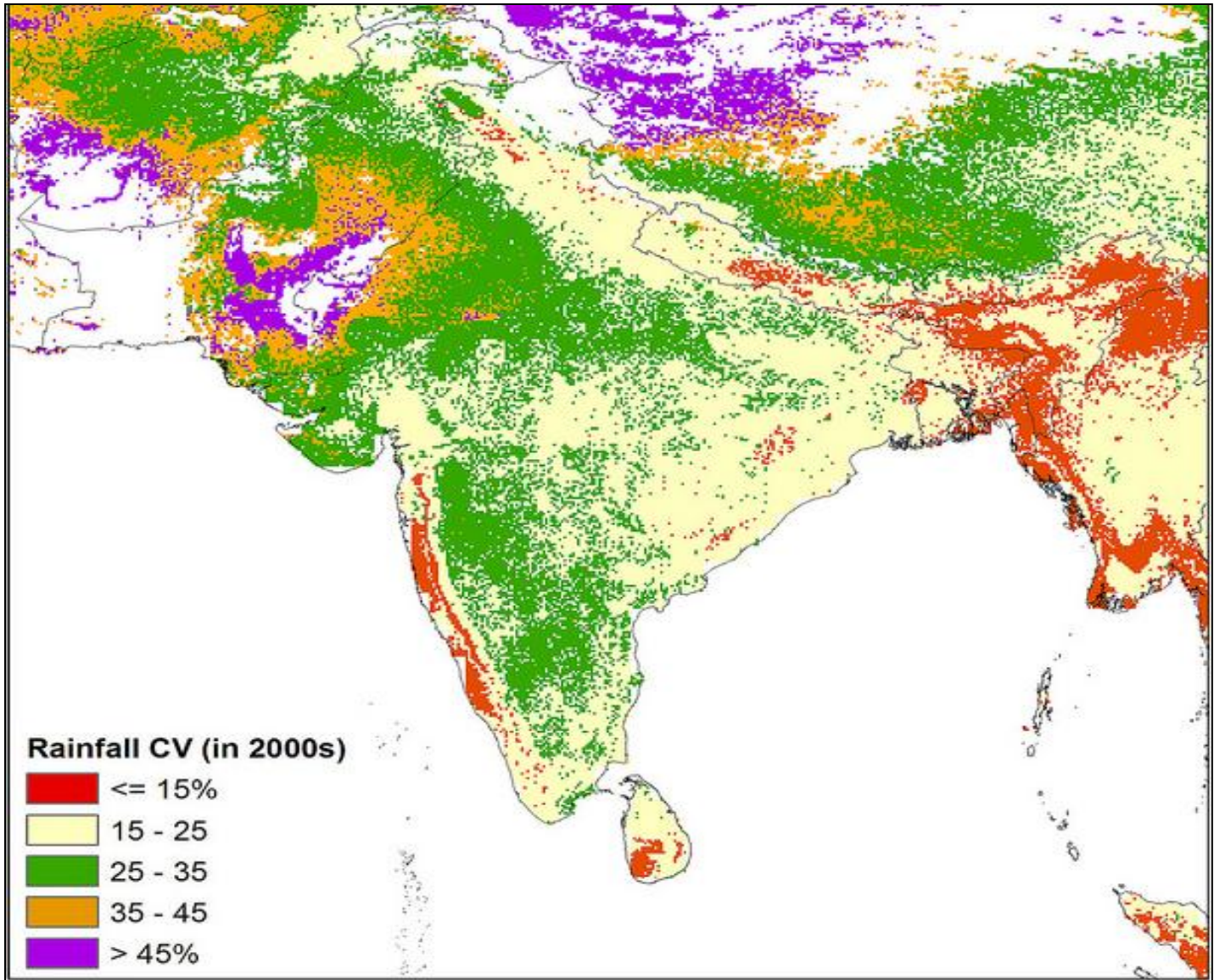
**Figure5: Monthly Mean Rainfall and Temperature in Afghanistan (1900 - 2009)**

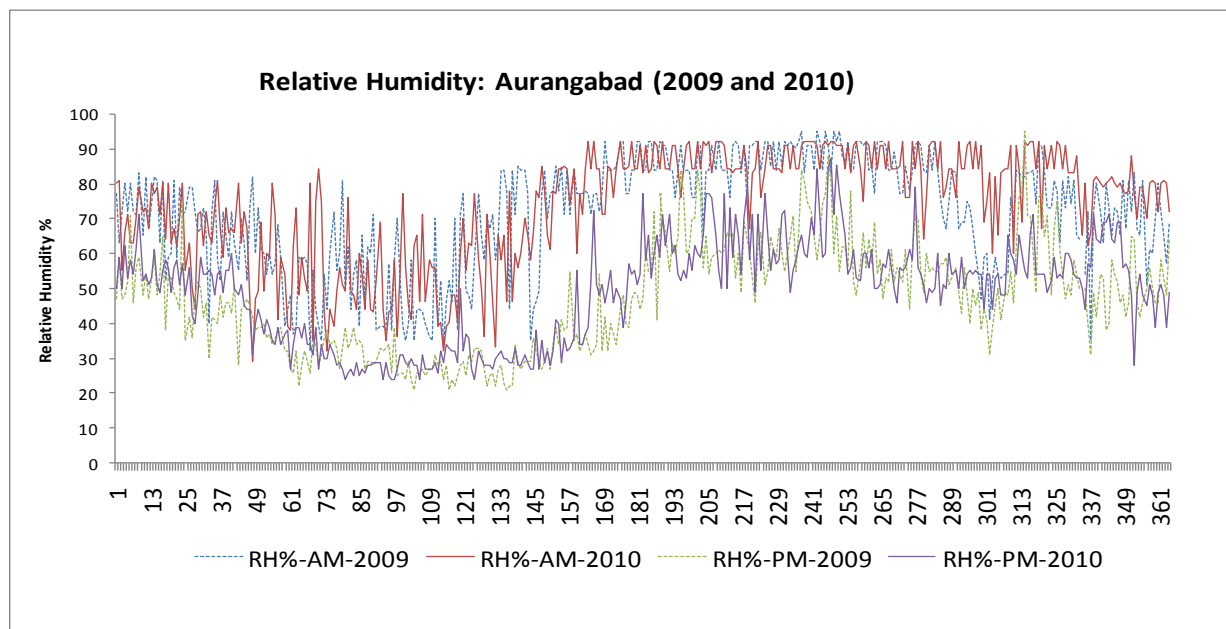
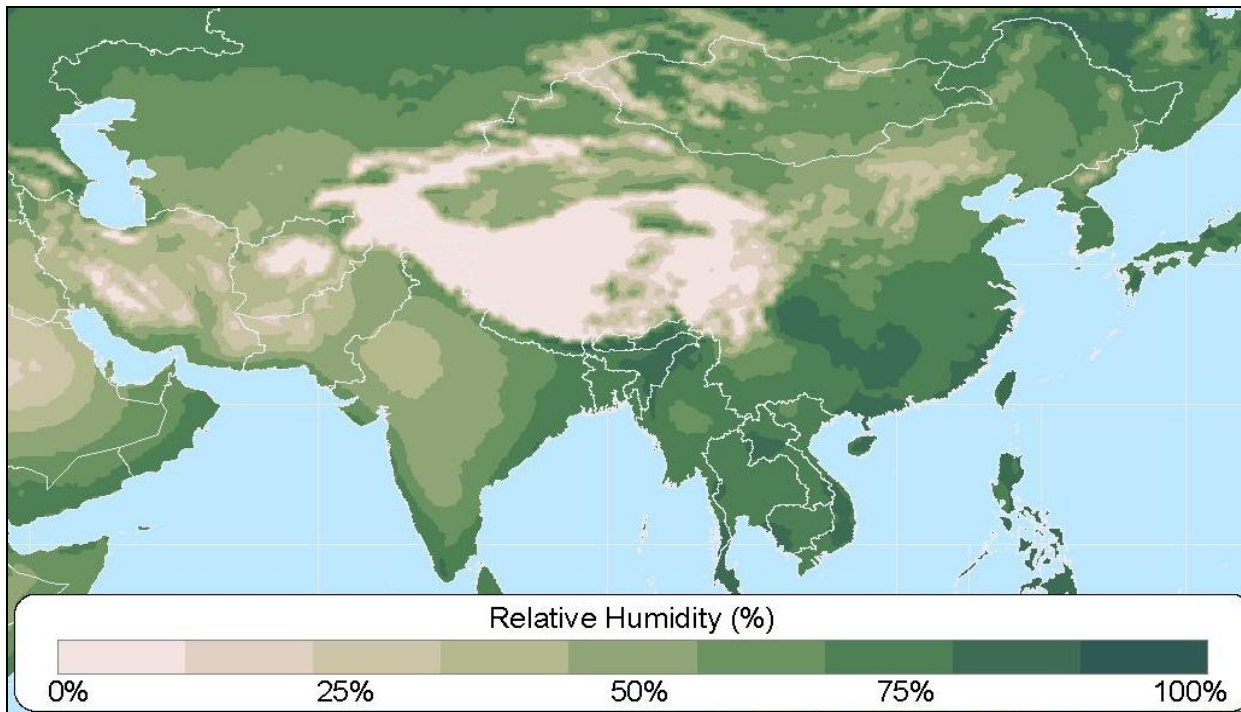


**Figure6: Monthly Mean Rainfall and Temperature in Bangladesh (1900 - 2009)**

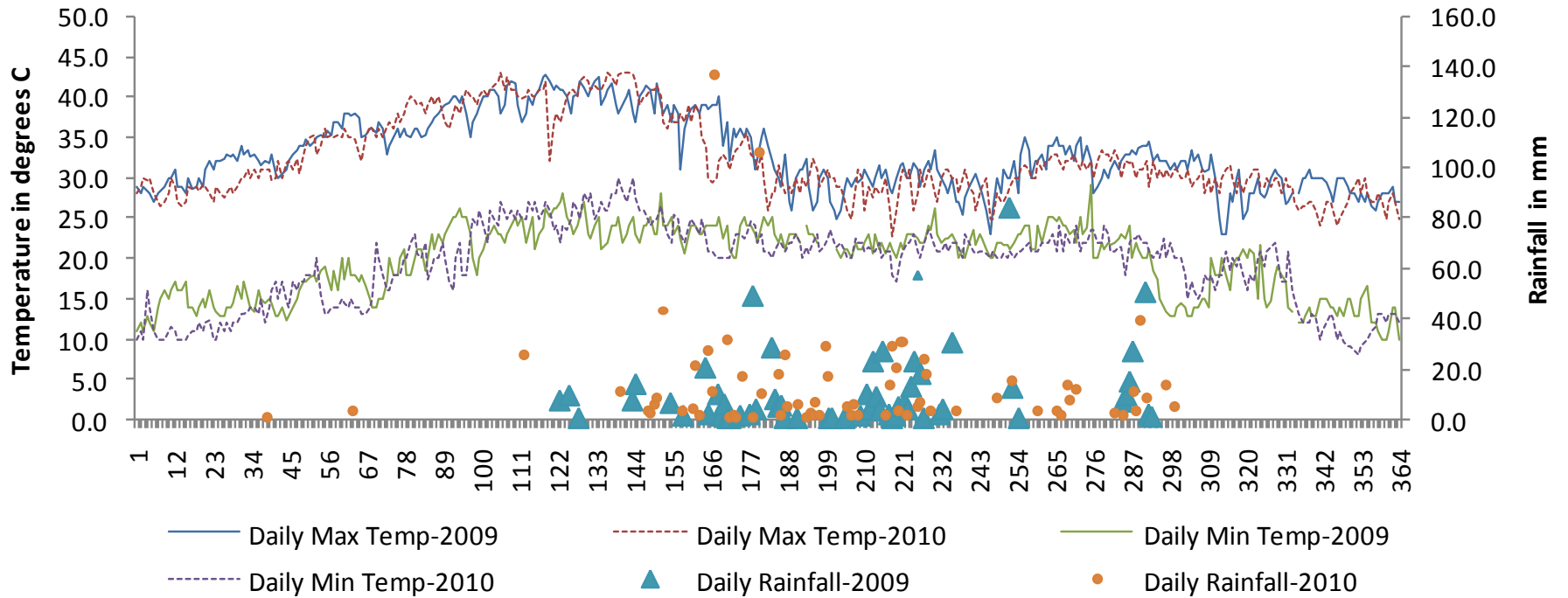


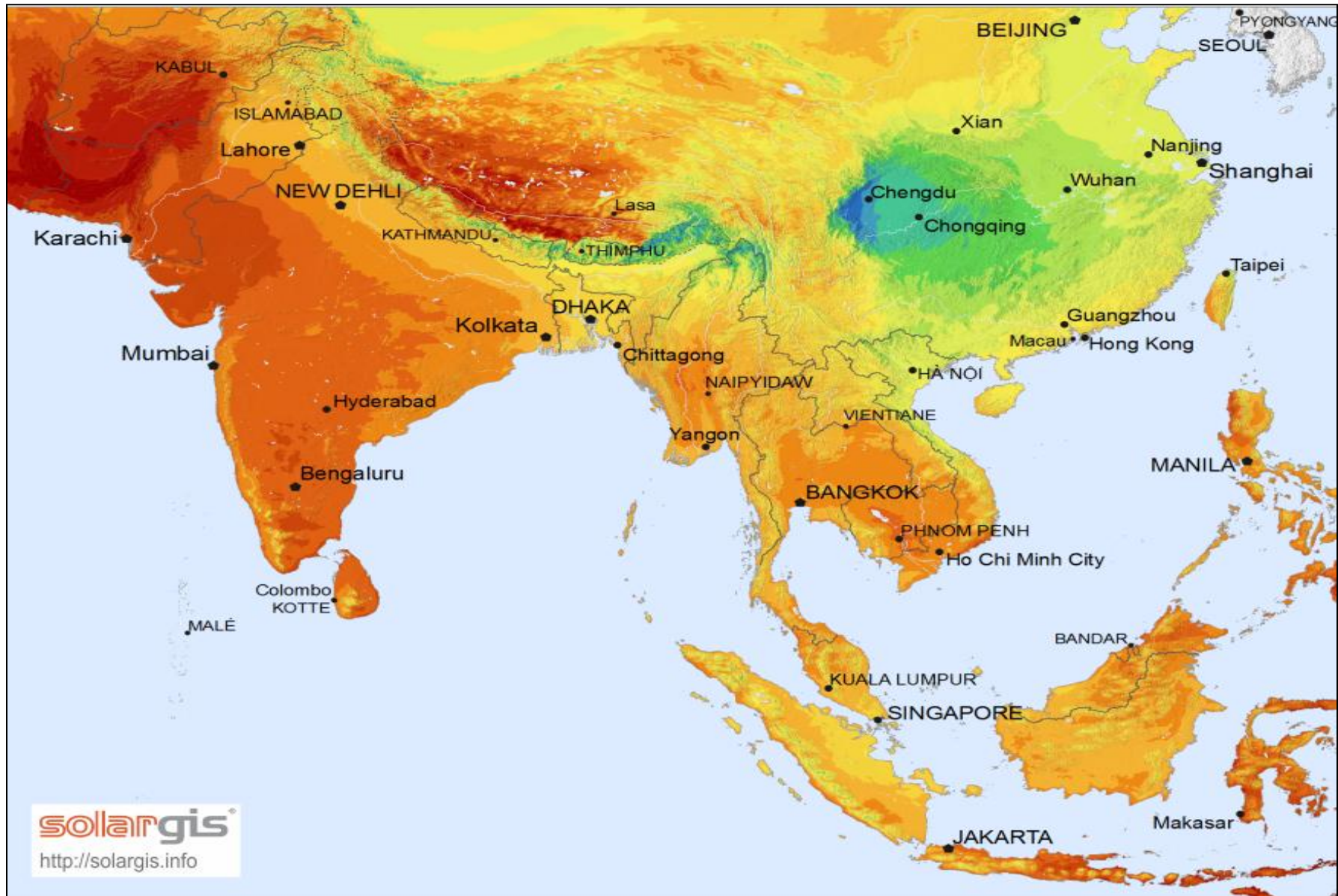






## Temperature and Rainfall of Aurangabad (2009 and 2010)





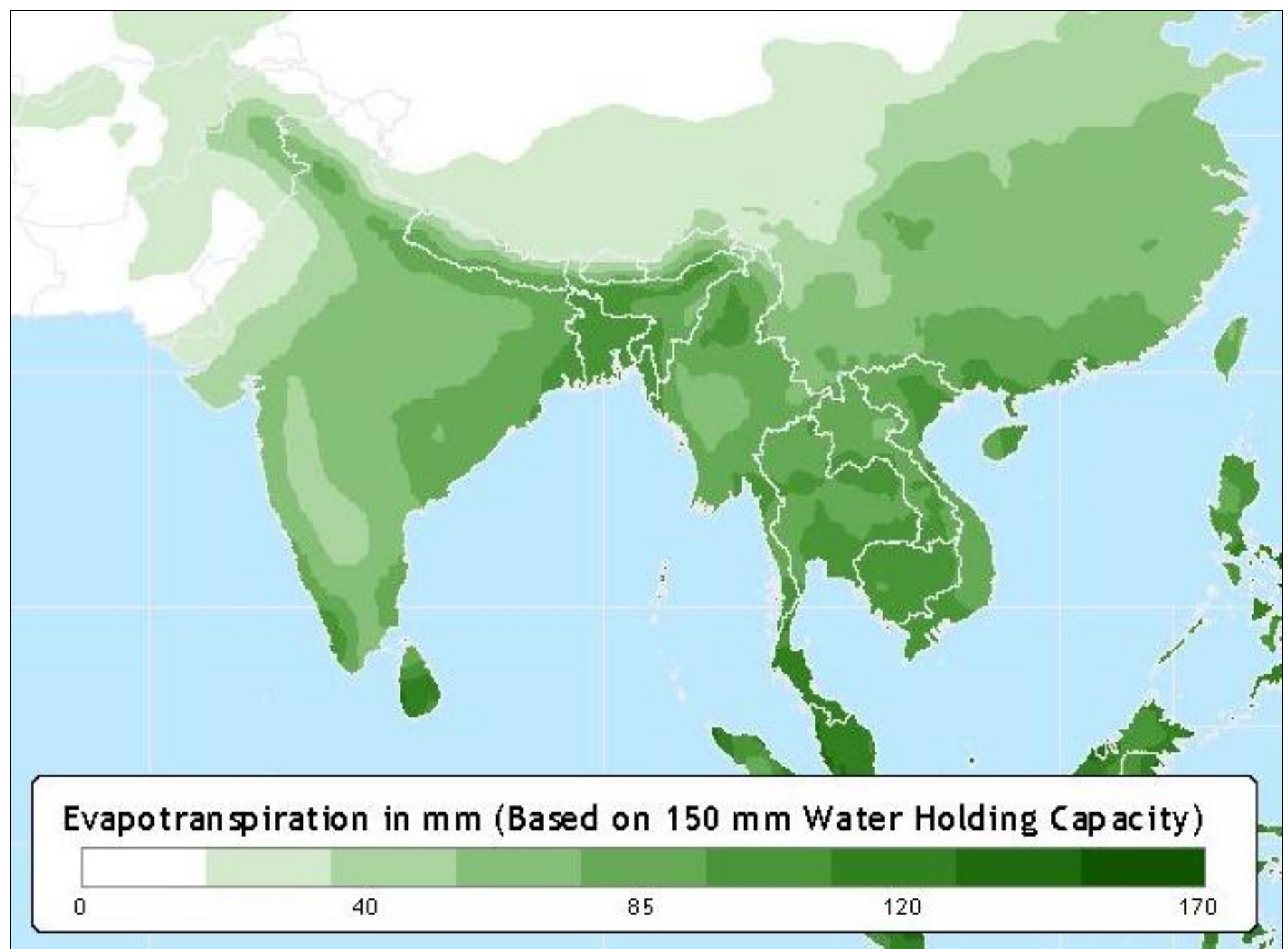
Average annual sum (1999-2011)



0 500 km

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■	obs: IMD	919; 101.0

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