WEATHER
WHY STUDY WEATHER?

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Why study Weather?

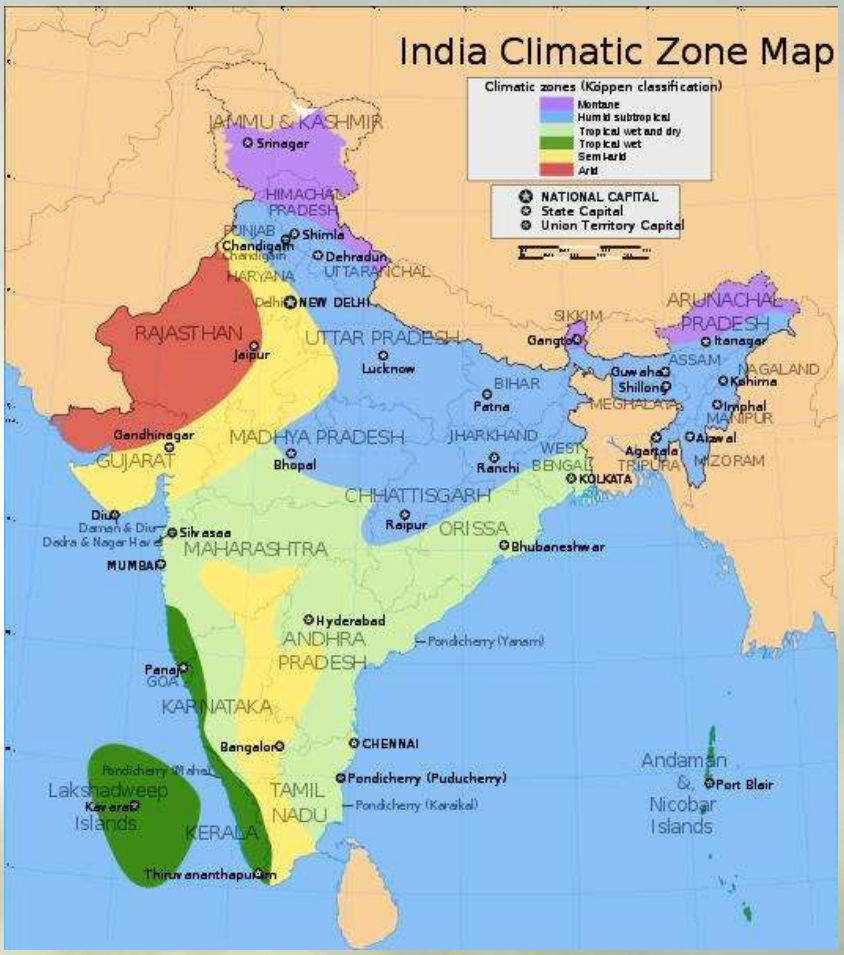
- More than ever, there is a need to study weather or climate today.
- Climate change is the buzz word.
- Before studying any changes in climate we need to understand what is weather and climate?
- How does it affect our lives and livelihoods ?
- Is there any need to study the weather parameters?

- Weather is one of the fundamental process that shapes the earth
  - Weathering
  - Erosion

- Human activities like industries cause adverse effects on climate
  - Acid rain due to excessive SO_2 and NO.
  - Air pollution due to CO_2 emitted from vehicles

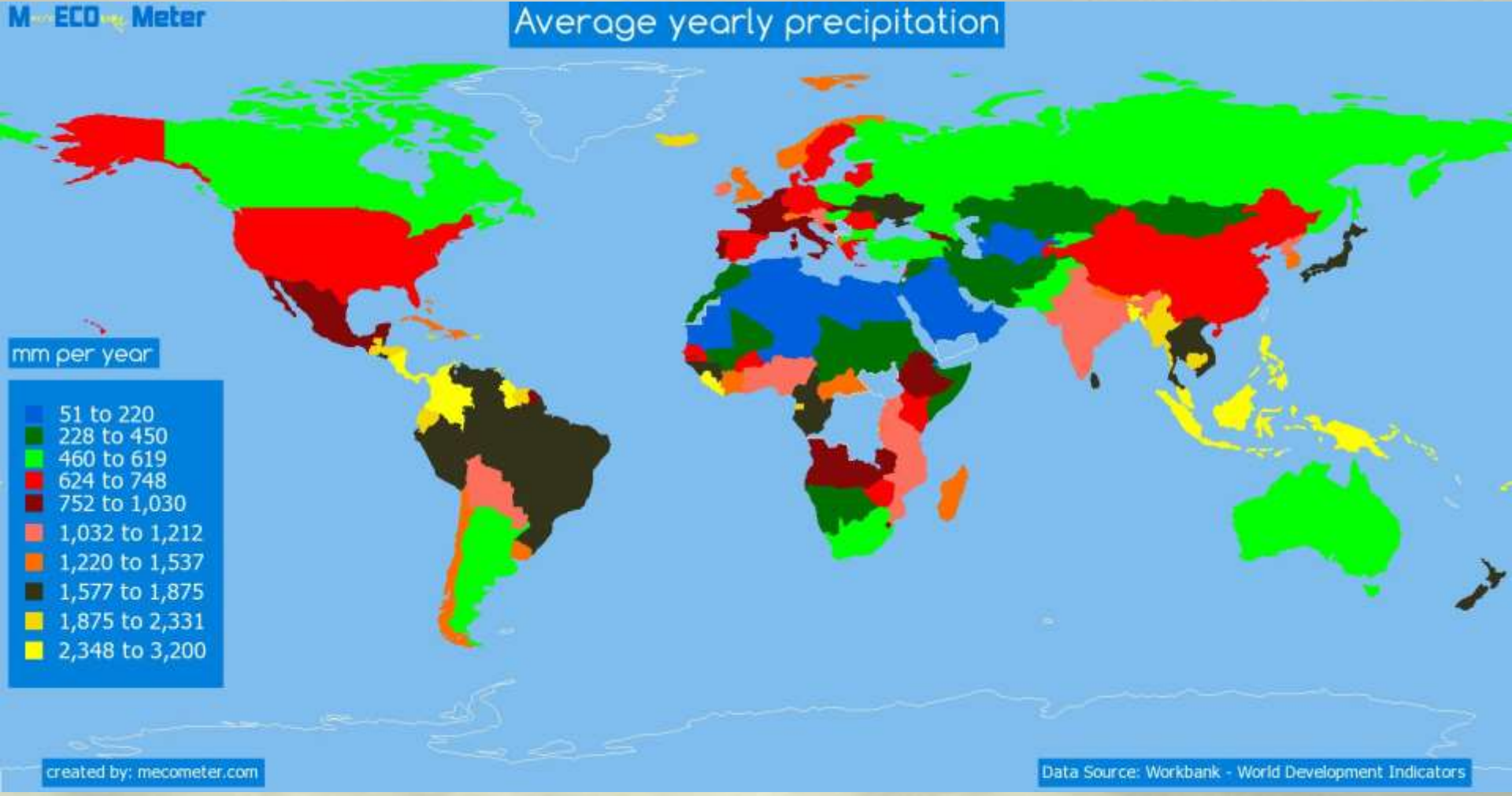
- In the past human settlements have been affected by the change in climatic conditions
  - Desertification of Middle East or Maya civilization

- In India:
  - ✓ **Diversity** in weather conditions or weather types
  - ✓ More than **70%** people are engaged in agriculture with almost **80%** of them depending on rain.
  - ✓ Weather data is necessary for any kind of **planning of watershed program**
  - ✓ For the study of **water balances**….
  - ✓ …And for the **sustainable development and management** of the program



The weather data in India is not easily accessible and available in the public domain.

There is a need to understand the weather science and generate the primary data .



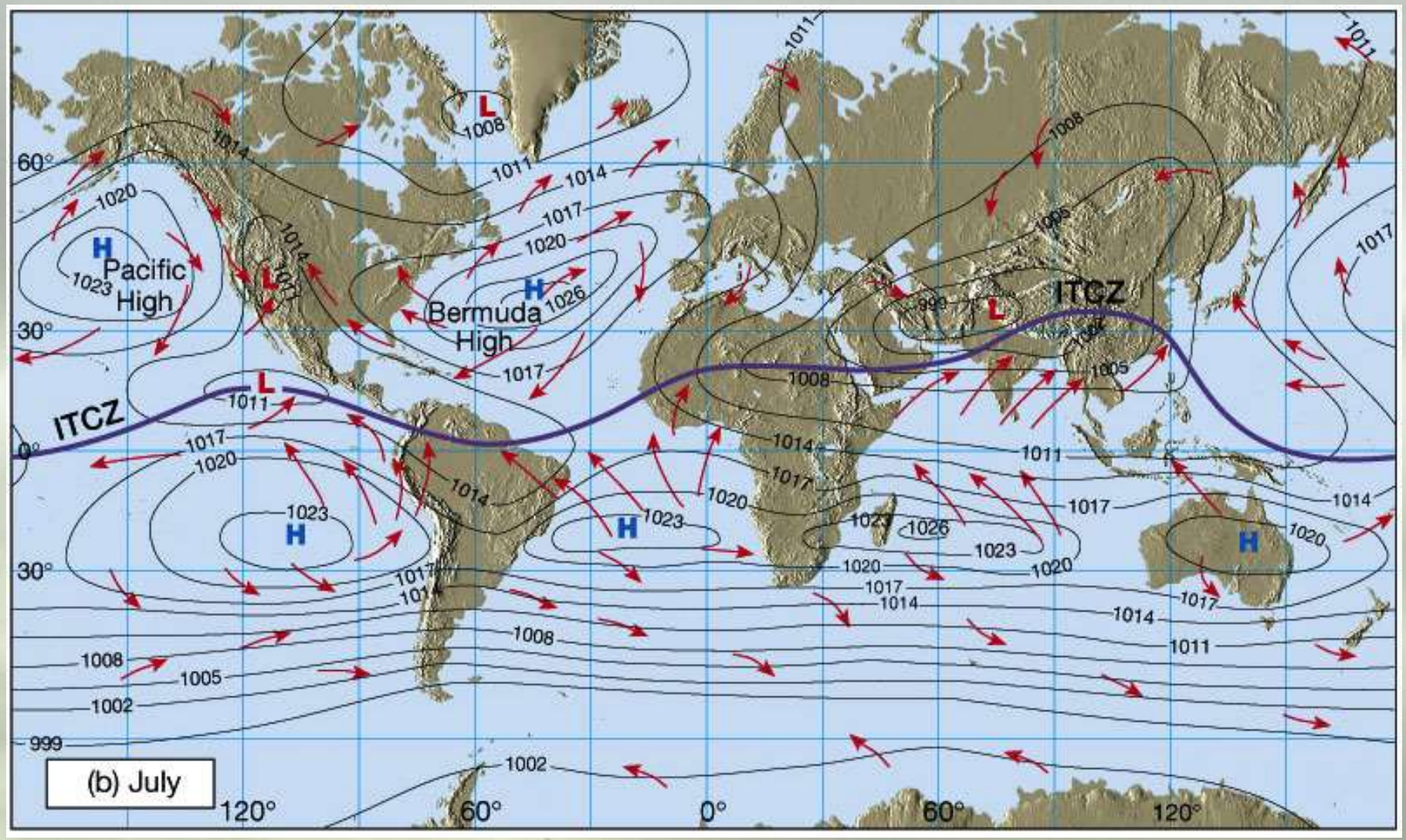
Average yearly precipitation across 190 countries is 1124 mm

Long term average annual rainfall for India is 1083 mm

India's unique "Monsoon"

- The Indian Monsoon Current refers to the seasonally varying ocean current regime found in the tropical region of Indian ocean.

- During winter, the flow of the upper ocean is directed towards west while during summer, it is directed towards east from Somalia to Bay of Bengal.



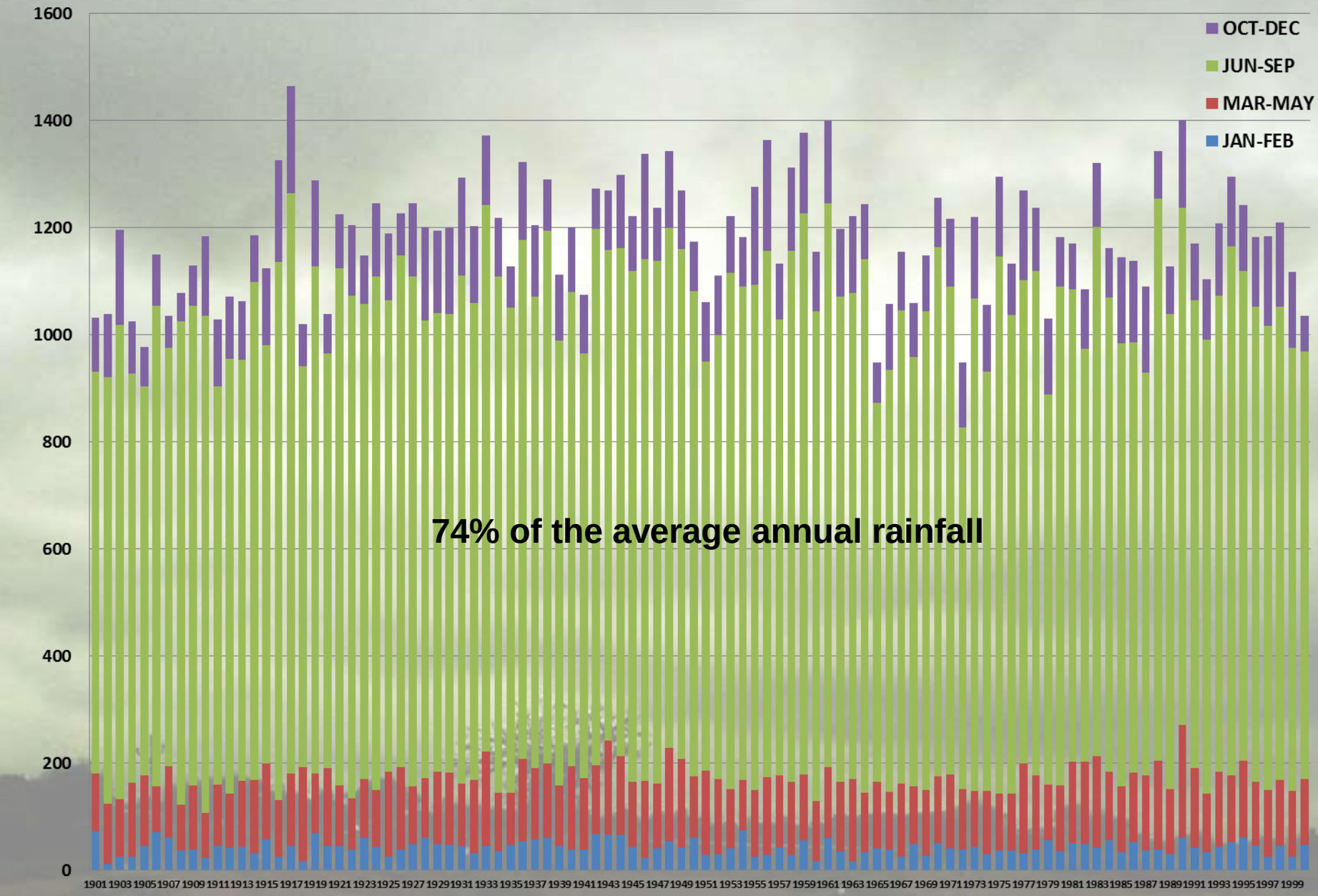
Atmospheric circulation

In weather studies, factors like El Nino also play a critical role.

Some facts about Indian Monsoon

- Average annual rainfall for India is around 1100 mm. (Long term avg. of 100 years)
- 80% of average annual rainfall is received during 4 months (June to September)
- Among the four rainy months, the major rainfall occurs in July and August followed by June and September.
- Contribution of pre and post monsoon rainfall is almost same. (11%)

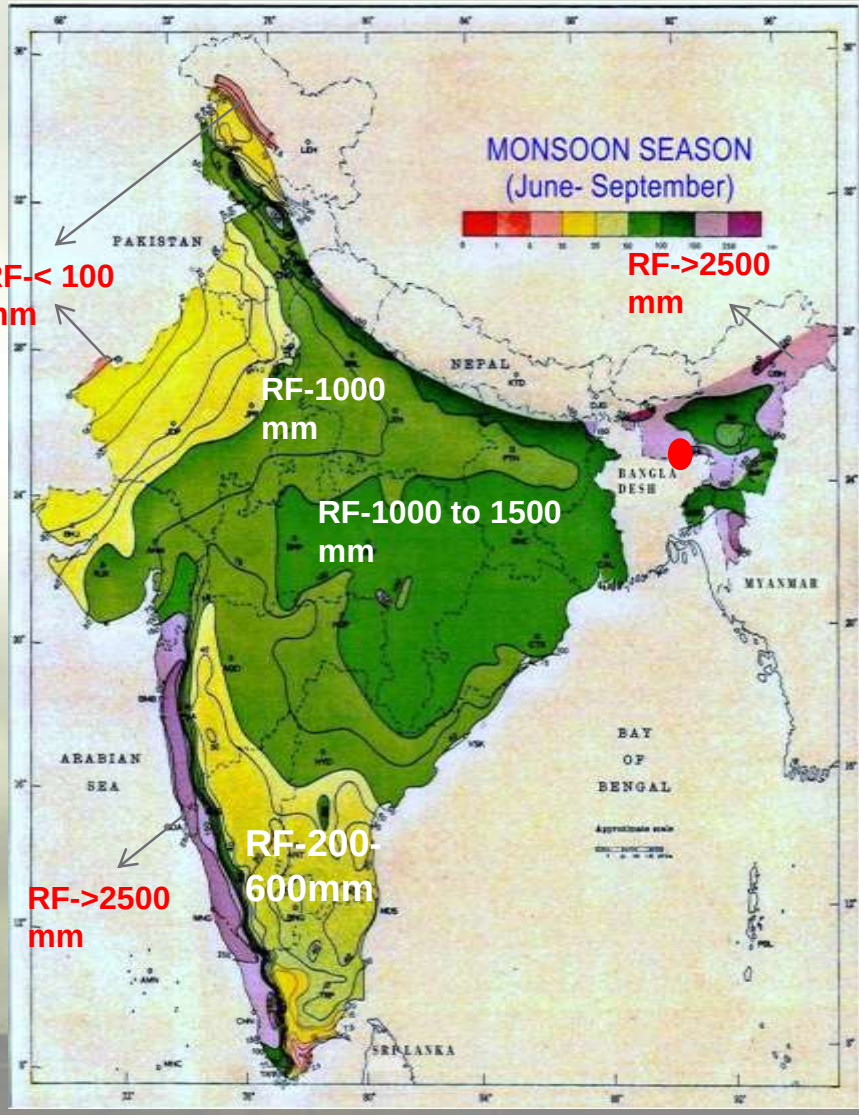
India seasonal rainfall 100 years (1901 to 2000)



Variability in monsoon

- Variability in the rainfall – from less than 100 mm to more than 10000 mm.

- There is spatial variation as well as temporal variation observed throughout the country.



Weather science

The science of studying weather is called as **Meteorology**

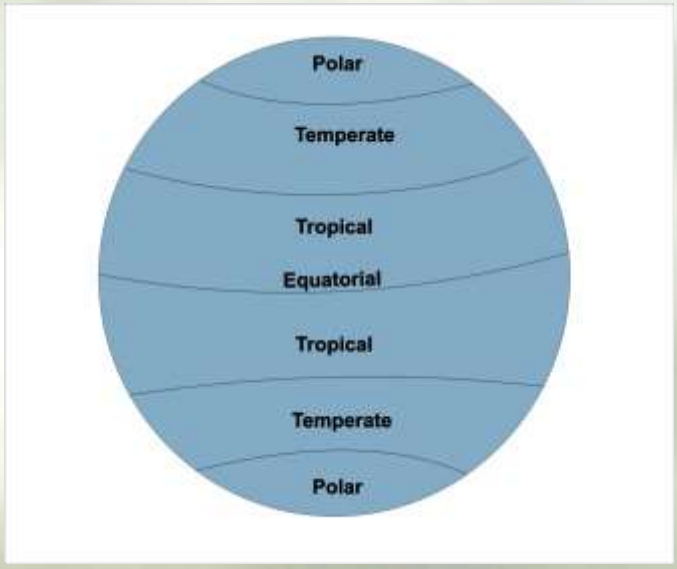
- Or some data can be generated using simple equipments.
- where some predictions can be made using atmospheric conditions.
- Which in turn can be used for better implementation of a watershed project

Weather

- Weather is the specific condition of the atmosphere at a particular place and time.
- It is measured in terms of **wind**, **temperature**, **humidity**, **atmospheric pressure**, **cloudiness**, and **precipitation**.
- In most places, weather can change from hour-to-hour, day-to-day, and season-to-season.
- The average weather over a longer period is known as the ***climate***.

Weather factors

- Some other factors influencing weather are:
  - Geographic location: whether it is in the tropics, equator or temperate region
  - Surface features and terrain: Whether it is an island or peninsular region, hilly area or plains
  - Altitude: whether it is closer to the sea or is located at a high elevation



Rainfall event

- Each separate period of rainfall which contributes enough rain to produce significant rise in streams and rivers is called as rainfall event.

- Each rainfall event where rainfall is more than 0.5 mm is measured using rain gauge.

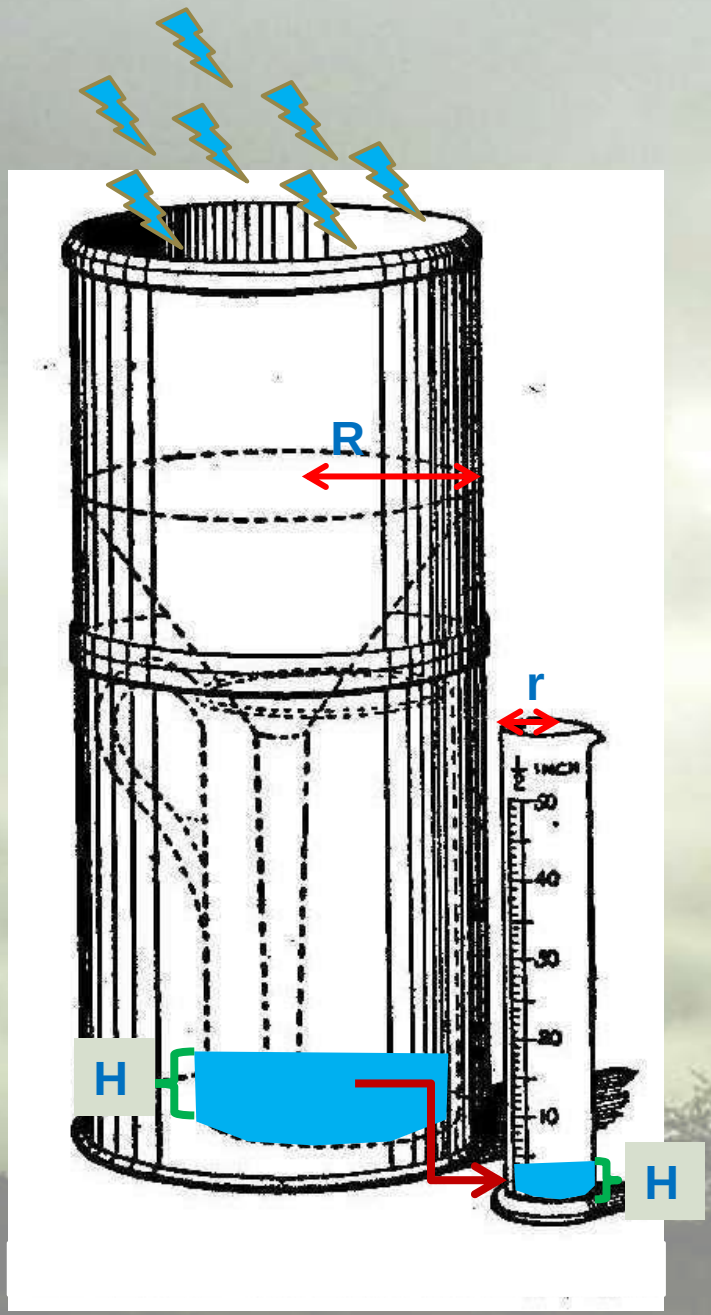
If rainwater falling on a horizontal projection of earth's surface, stands 1mm high, then depth of rainfall is 1mm.

So 1 cm of rainfall over a catchment area of $1km^2$ represents a volume of water equal to 10^4 m^3.

Rainfall processes

- Convection rainfall
- Cyclonic wedging
- Orographic rainfall

RAINGAUGE TYPES



Volume of water in cylinder = Pie * r* r* H

Rainfall is collected in the container using a funnel.

Volume of 'rain water' = Pie * R*R* h

Therefore Amount of Rain water (h)in cm=

$$(r*r)H/(R*R)$$

Specifications

Diameter of collector rim – 159.6 mm for 200^2 cm rain gauge and 112.9 mm for 100^2 cm rain gauge.

20 mm capacity suitable for collectors of 200 cm^2 area and 10mm capacity for 100 cm^2 area.

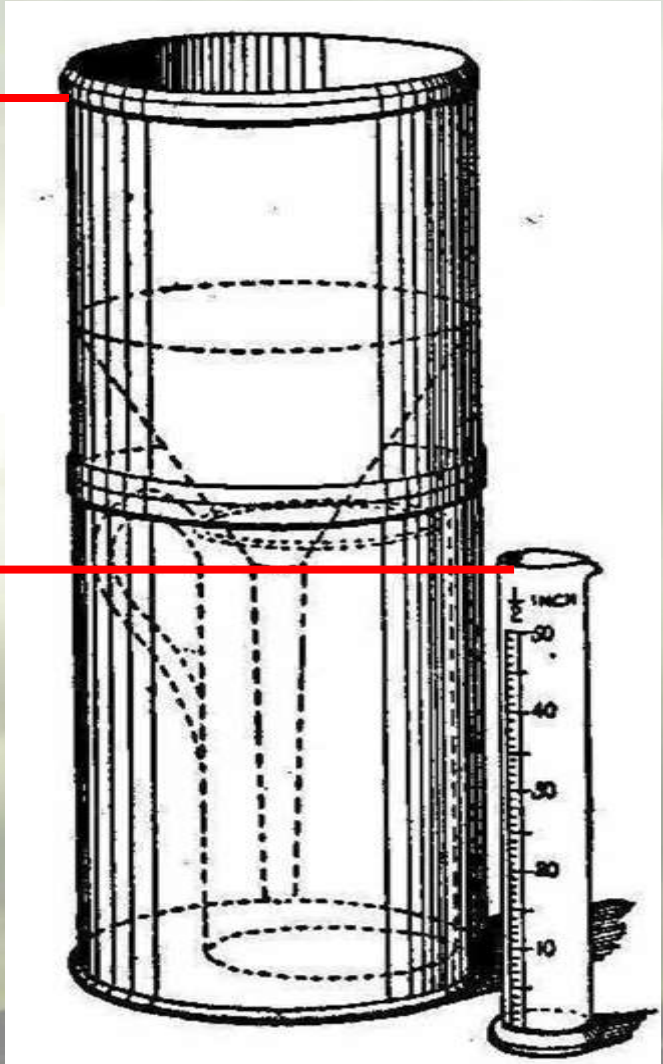
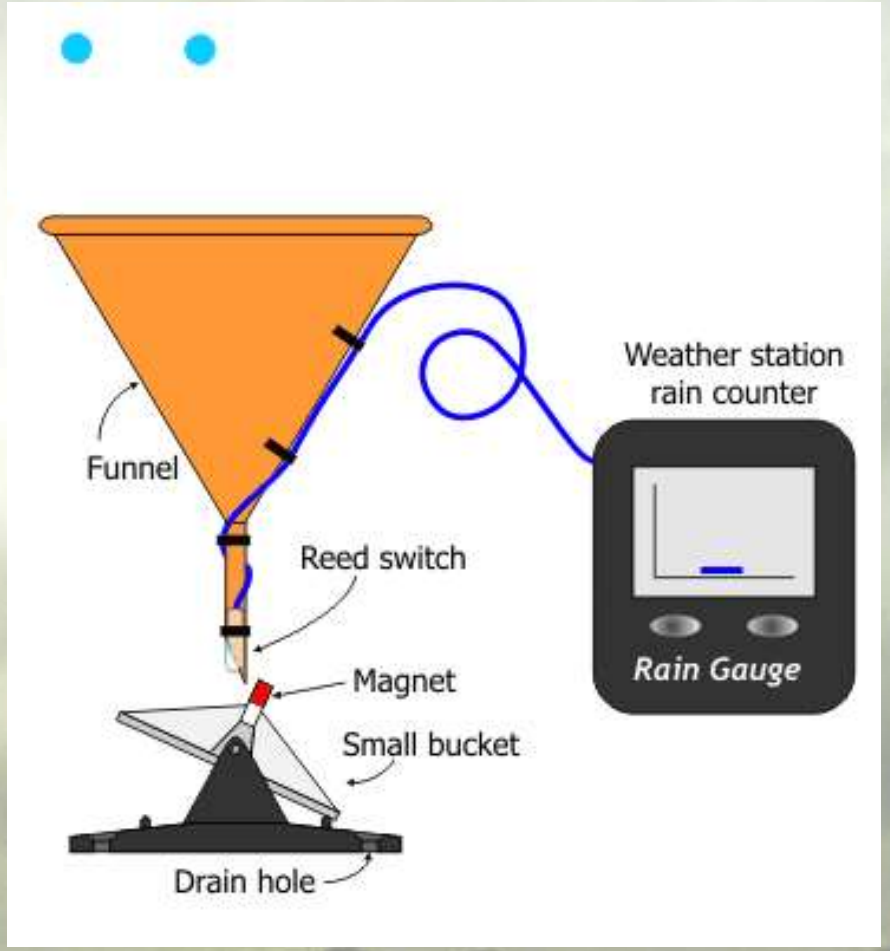


FIG. 151.—Standard rain-gauge.

Tipping bucket rain gauge

- It is an automatic rain gauge
- Recording type
- Connected to a sensor
- Continuously record rainfall
- Records up to 0.1 mm rainfall

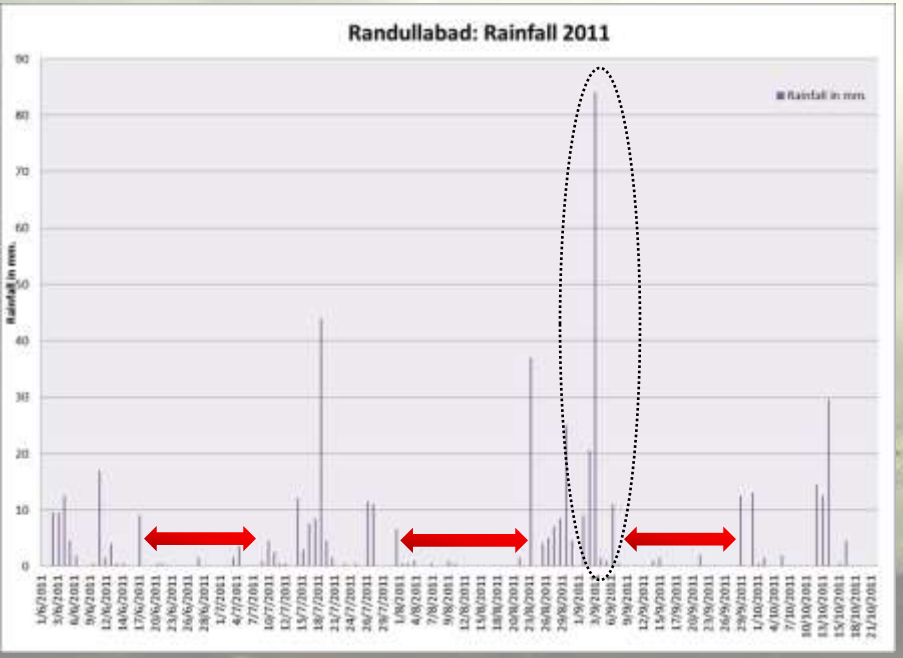


Selection of rain gauge sites

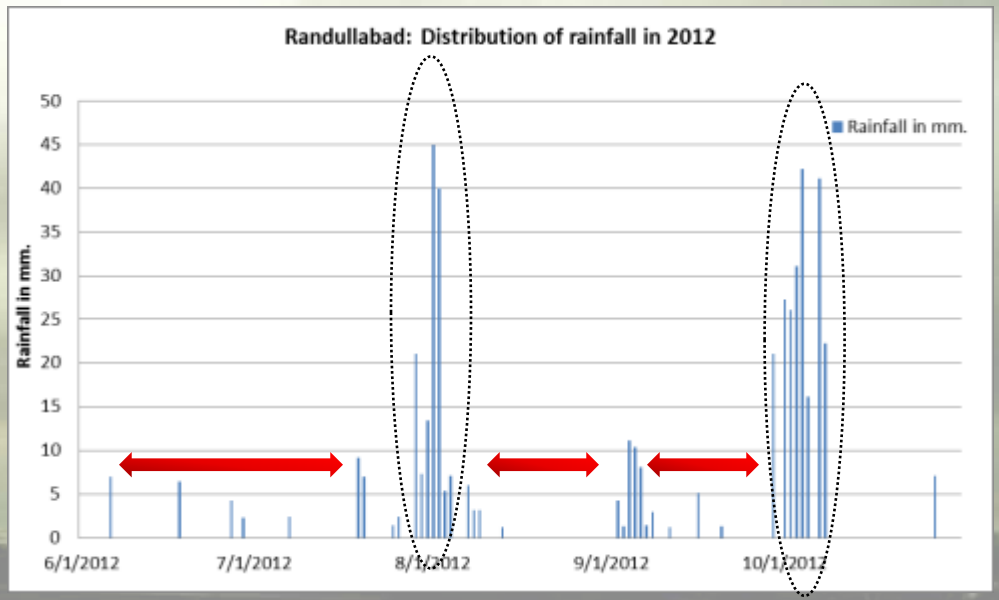
- The gauge should be away from an elevated object like tree, building which may have a negative effect on rainfall measurement.
- In mountain sections or rugged terrain, rain gauge should not be installed along the slopes or top or steep ridges.
- The rain gauge site should be easily accessible to the person who is collecting daily information, as missing data for a couple of days may affect the total data for the season.

Change in monsoon pattern

- It is observed that in the last two decades significant change in the intensity of rainfall- More rain in short duration of time.
- Higher intensity leads to more runoff (85-90 mm in 3-4 hrs.)
- Lesser time for infiltration & recharge
- Longer dryer spells for 20-30 days



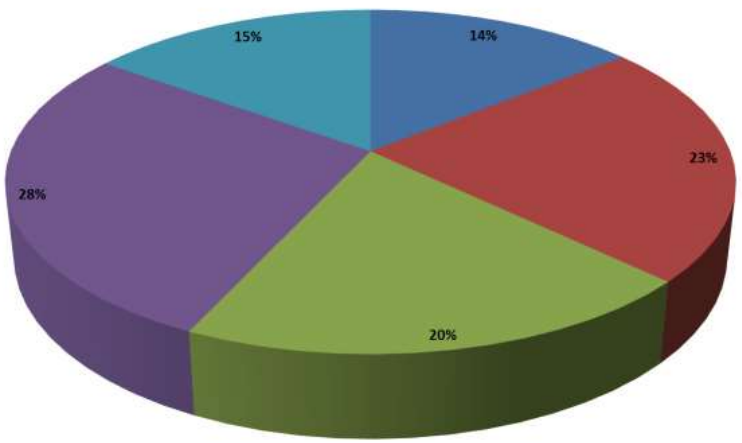
518 mm and in 50 days



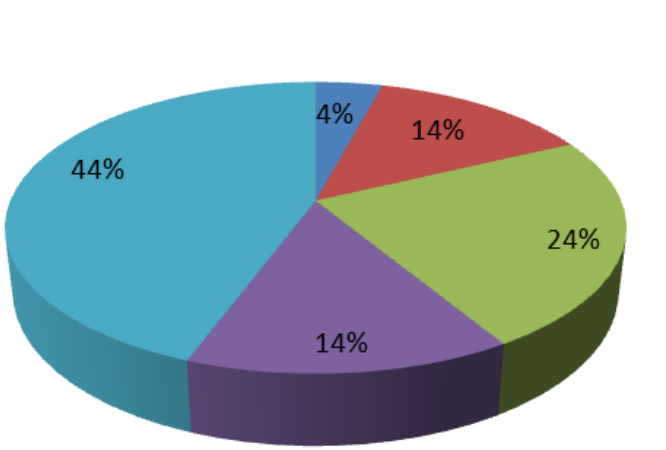
481 mm and in 38 days

Distribution of rainfall (Temporal)

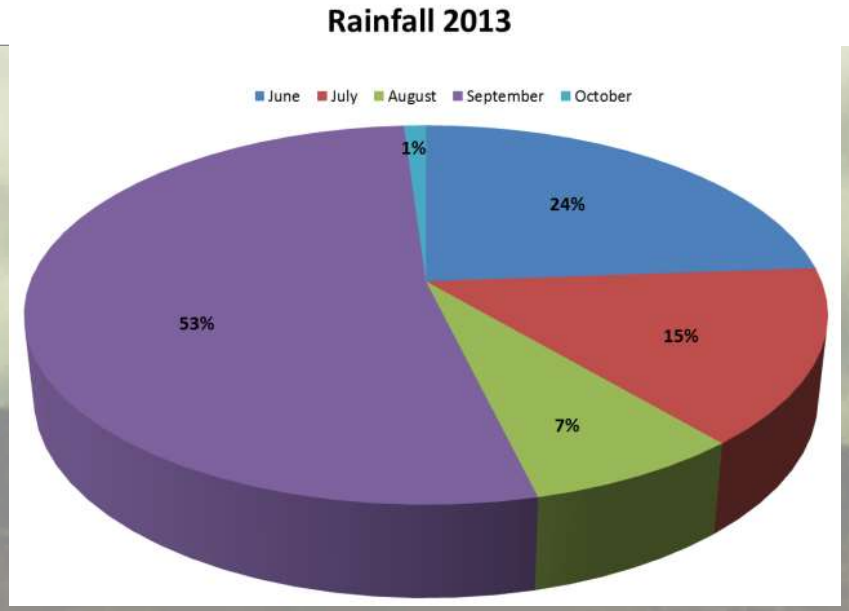
Randullabad village in Satara district (average rain: 650-700 mm)



518 mm in 50 days

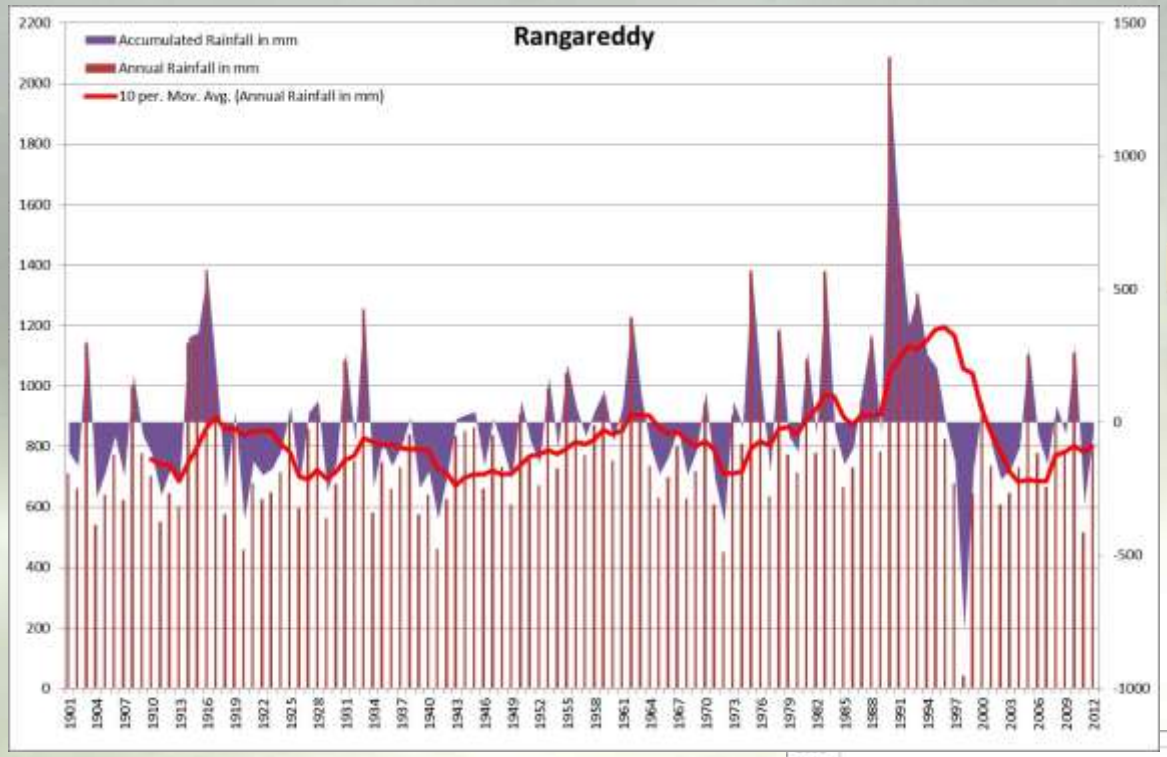


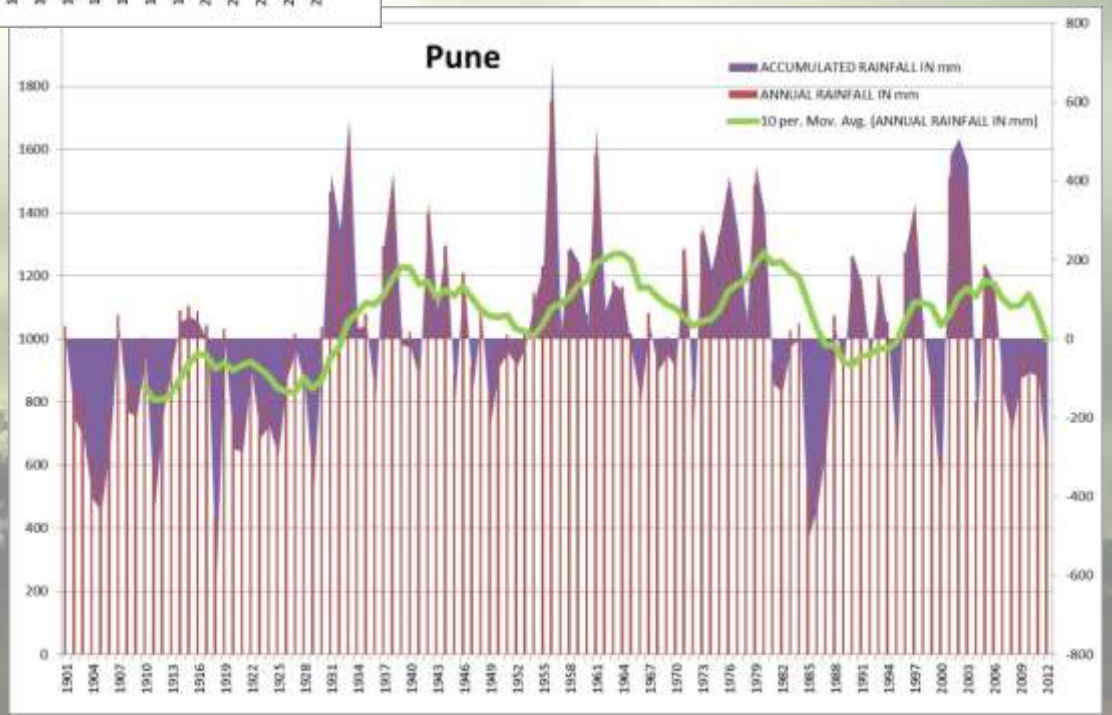
481 mm in 38 days

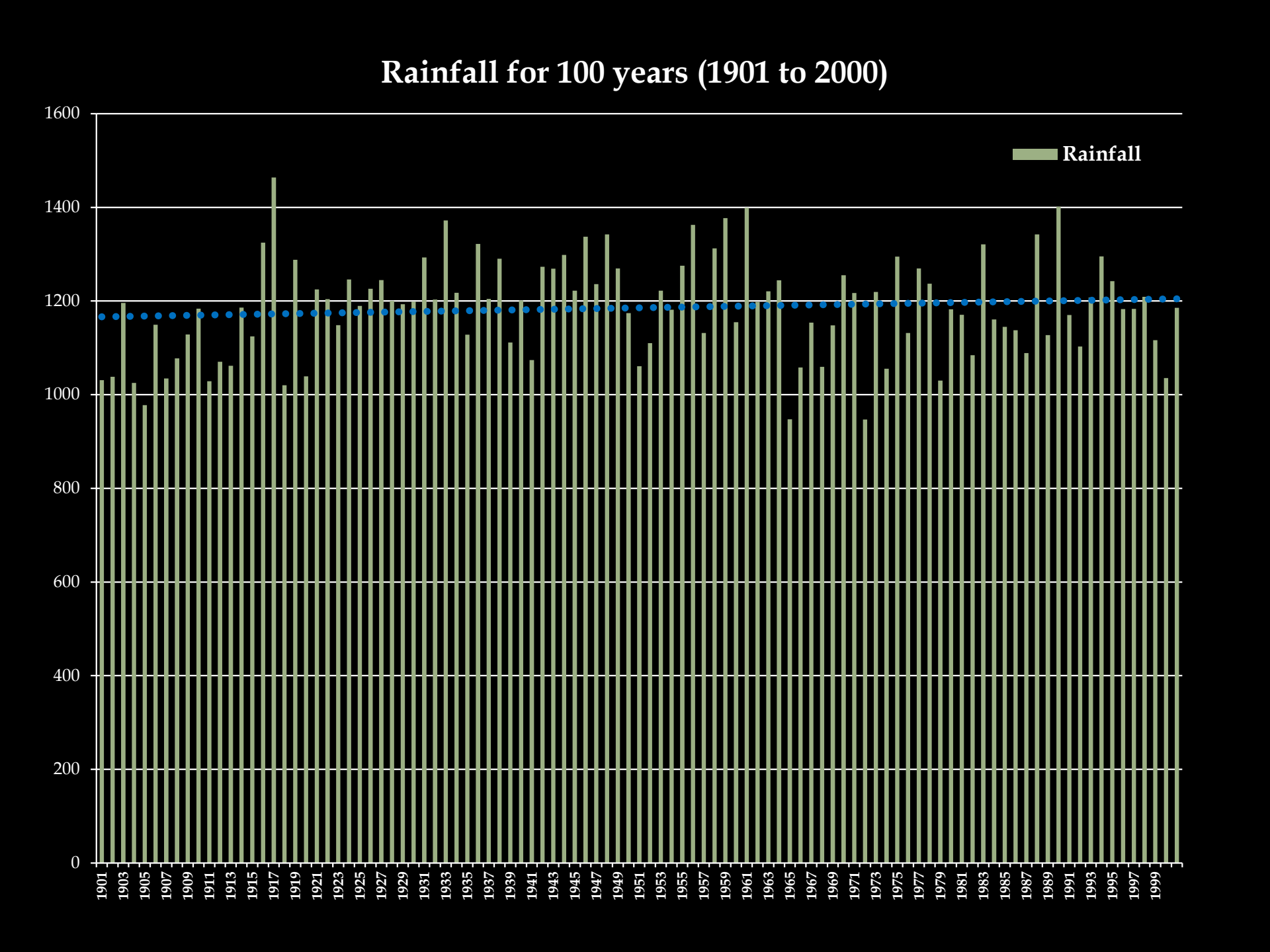


948 mm in 60 days

Long term rainfall pattern






Rainfall for 100 years (1901 to 2000)
Rainfall
1600
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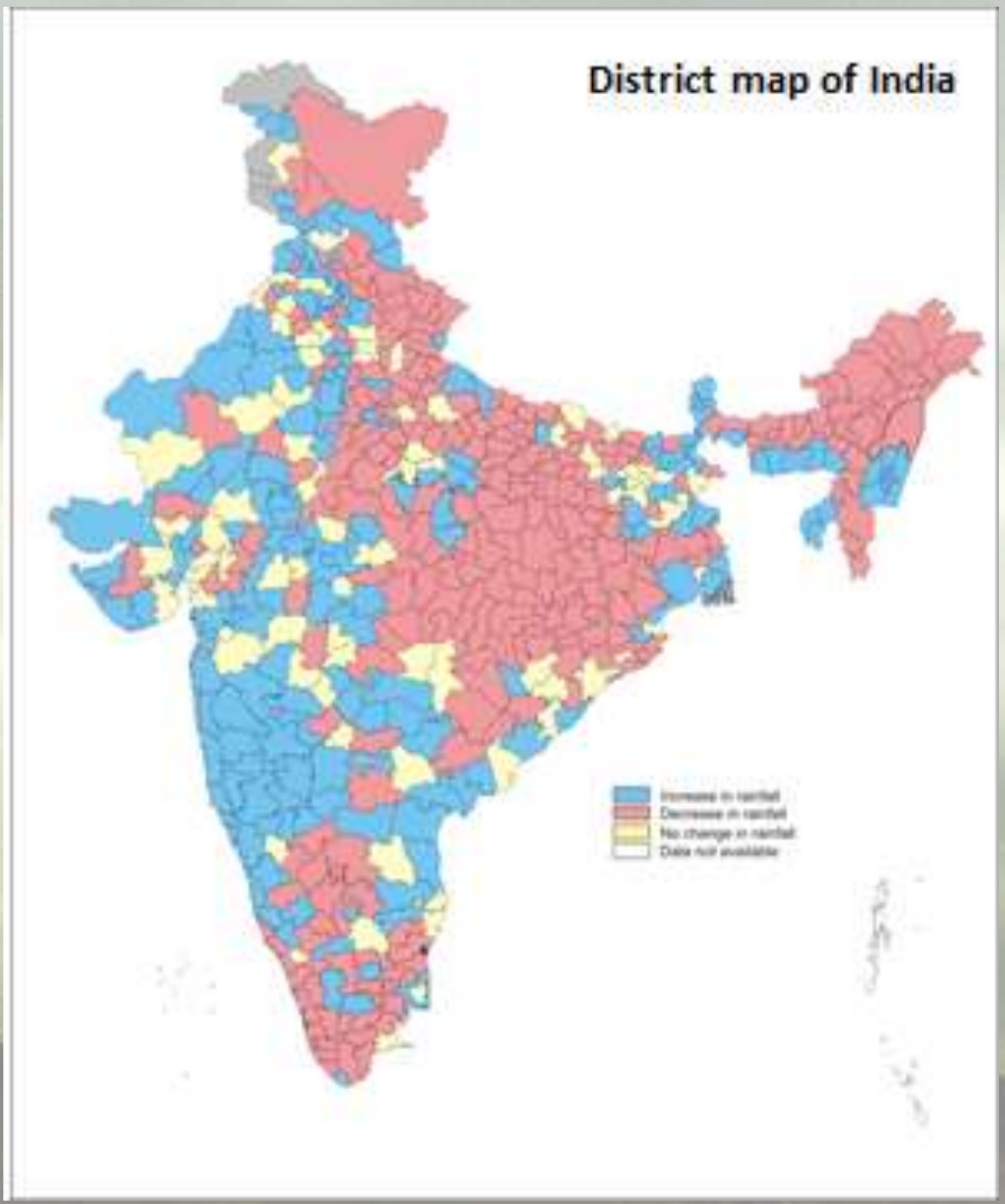
States with Increase in rainfall

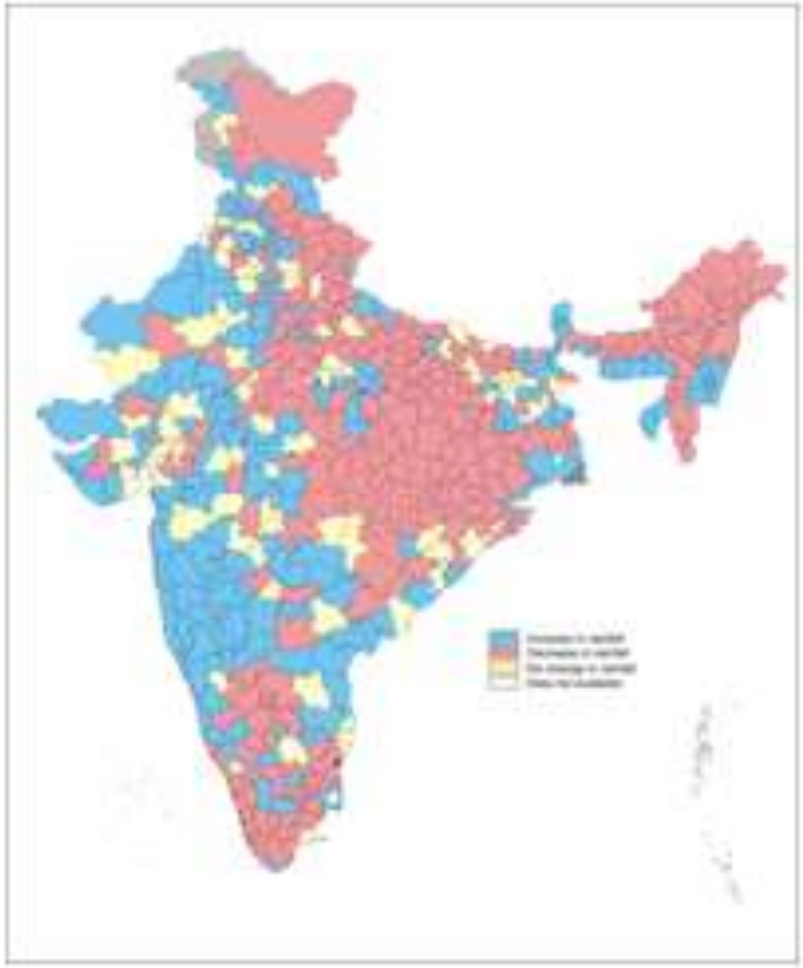
Punjab
Rajasthan
Gujarat
Maharashtra
Andhra Pradesh
Meghalaya
Tripura
Manipur
Sikkim



States with decreasing rainfall

Kerala
Bihar
Chhattisgarh
Jharkhand
Orissa
Uttar Pradesh
Assam
Arunachal Pradesh

Impact of changing rainfall on groundwater

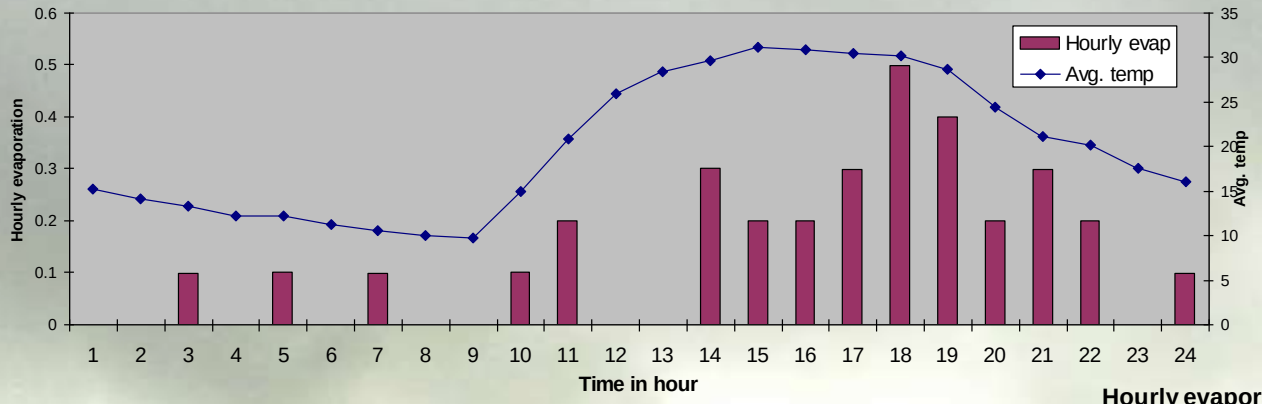


Change in rainfall during last 100 years

Evaporation

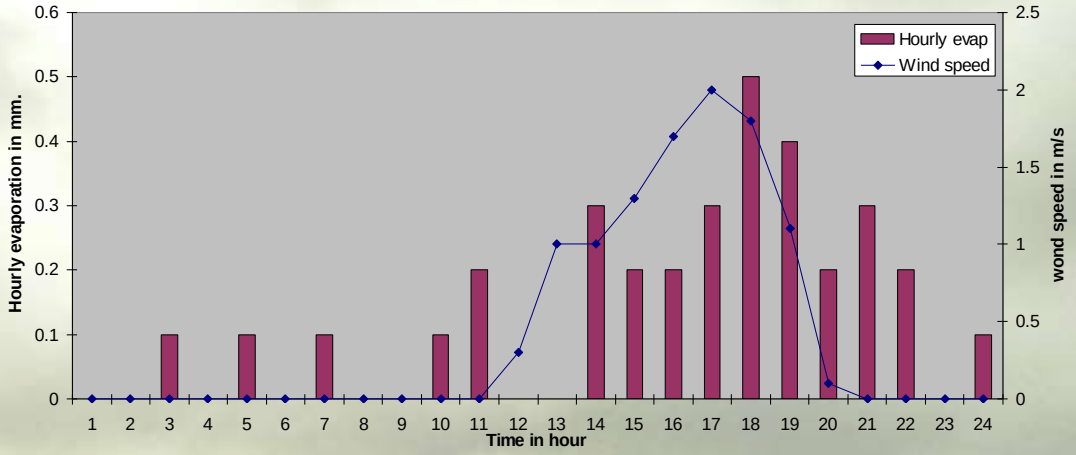
- Three broad approaches to measure evaporation are:
  - Measuring direct evaporation through use of evaporation pans;
  - Developing mathematical equations to estimate evaporation;
  - Developing specialist instruments to measure evaporation as the movement of water vapour from the land and water surfaces.

Hourly evaporation and avg. temp.



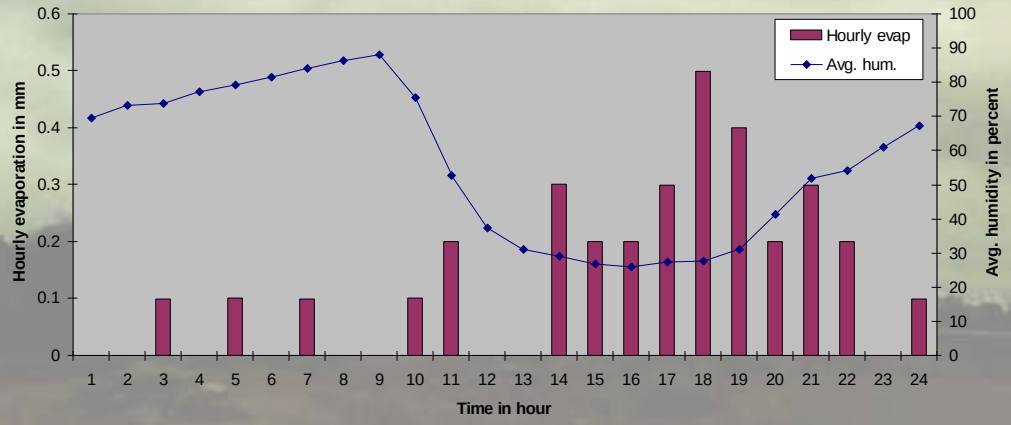
More is the temperature, more is evaporation

Hourly evaporation and wind speed



Wind speed is more, so is the evaporation

Evaporation as a function of avg. Humidity



Less is the relative humidity, More is the evaporation

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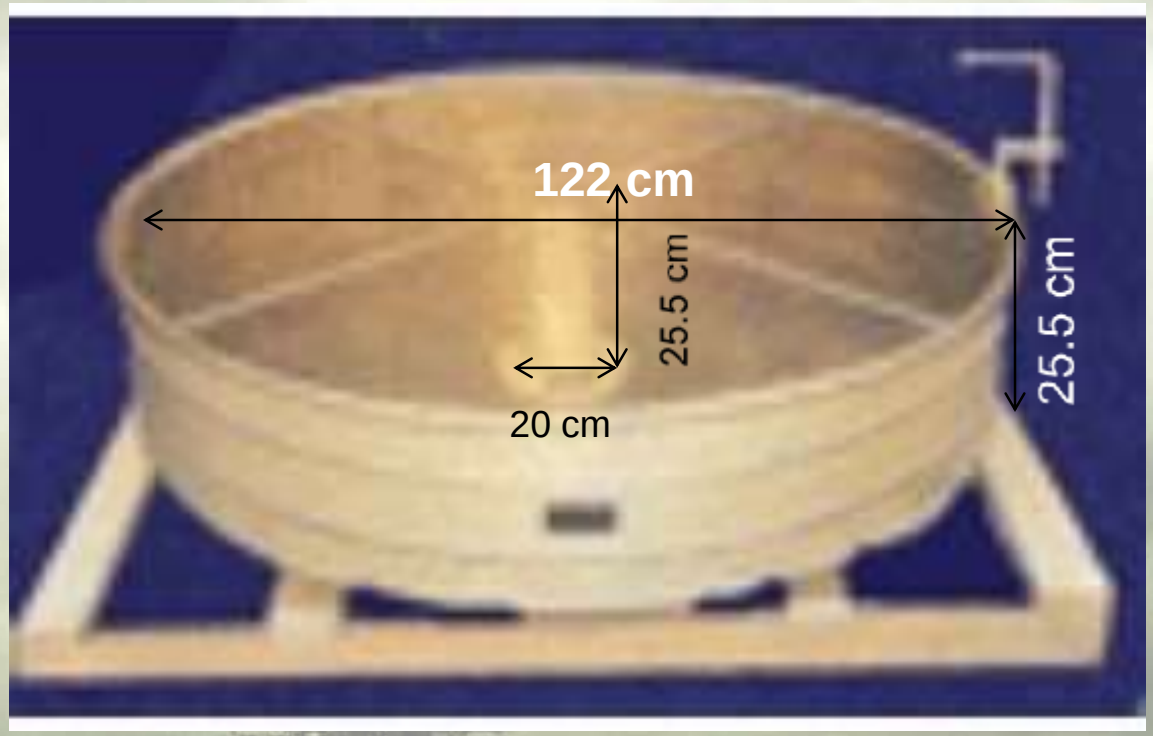
Evaporimeter-Specifications



Empirical formula used for calculating evaporation

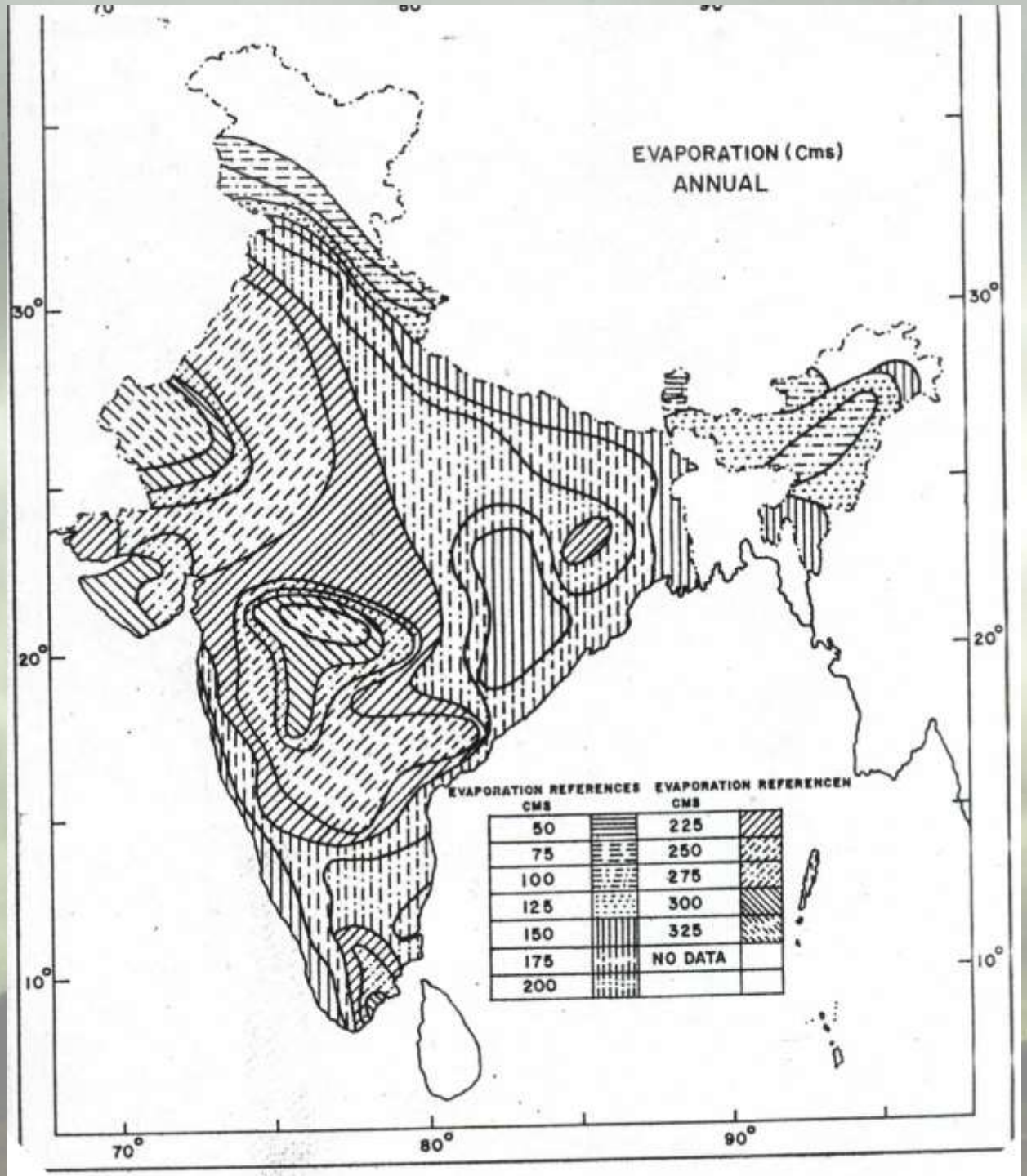
- The original equation was developed by Penman (1940).

- Today, most used versions are Peman-Monteith equation and Penman-Shuttleworth equation.

- In Penman equations following climatic data is required:
  - Air temperature: maximum and minimum temperature
  - Relative humidity
  - Solar radiation
  - Wind speed
  - Besides these major components other parameters needed for calculations like atmospheric pressure.

Penman Stutteworth equation:

$$E_p = \frac{\Delta}{\Delta + \gamma}(R_n + A_h) + \frac{\gamma}{\Delta + \gamma}\frac{6.43(1 + 0.536U_2)D}{\lambda}$$



Source: IMD, Pune

Evapotranspiration

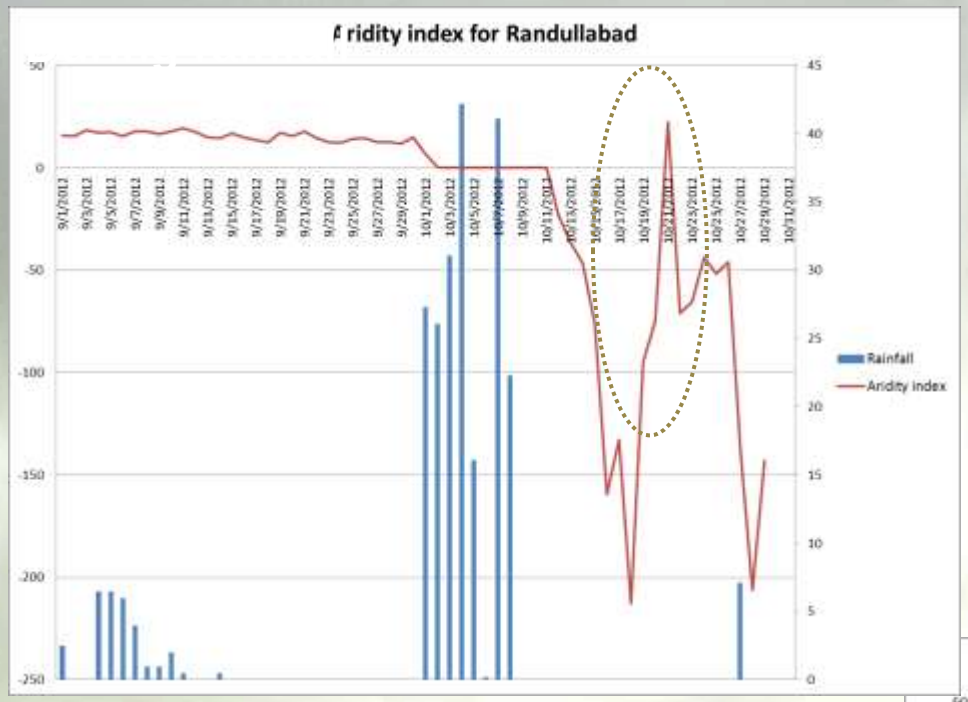
- Evaporation is
  - Direct loss of moisture/water from the soil surface
  - Transpiration from vegetation (loss of water through plants)

- Evapotranspiration is calculated using the same methods used for calculating evaporation but considering:
  - condition of the vegetation and
  - soil.

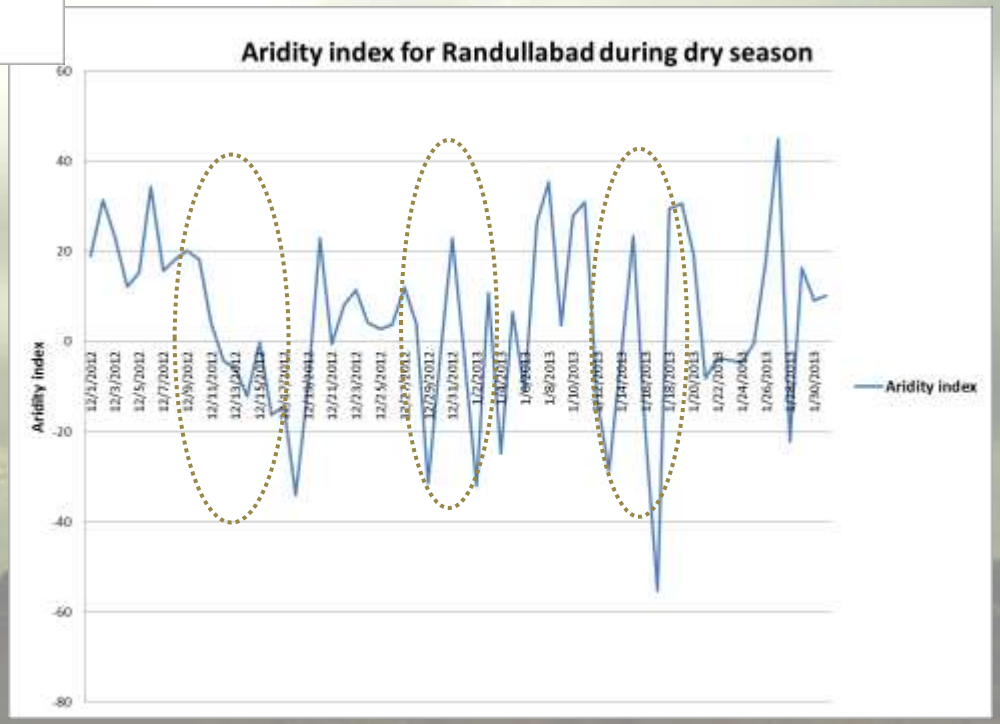
As one hectare has a surface of 10000 m2 and 1 mm is equal to 0.001m., a loss of 1 mm of water corresponds to a loss of 10 m3 of water per hectare.

i.e. 1 mm/day = 10 m^3/ha/day

Aridity index



Aridity index = ((PE-AE)/PE) *100



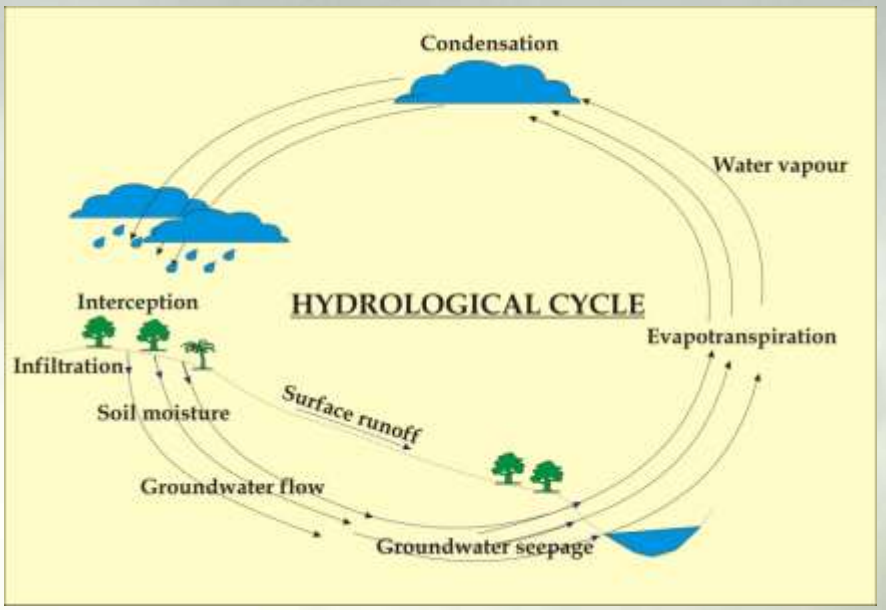
Aridity Anomaly Map gives information about the moisture stress experienced by growing plant.

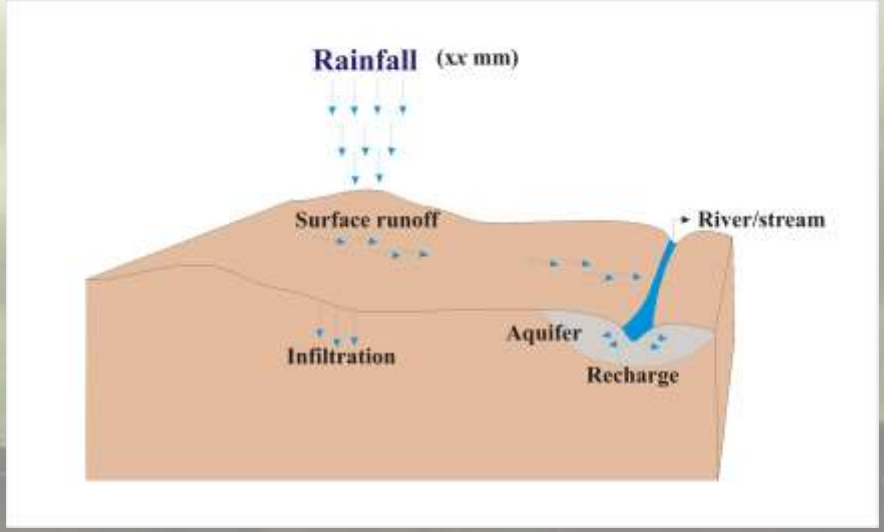
Helpful for irrigation scheduling

Measurement of rainfall gives a clear idea about excess or deficit of rainfall- Useful for calculating

1.Surface runoff
2.Infiltration
3.Recharge;

and also for planning the next crop using soil moisture content as an indicator.





Impacts on livelihood

- Different areas with different weather conditions (Micro climate)
- Weather conditions differ within 10 km.
- Example: Kolwan valley

  Area 80 sq/km

  E-W distance 12km.

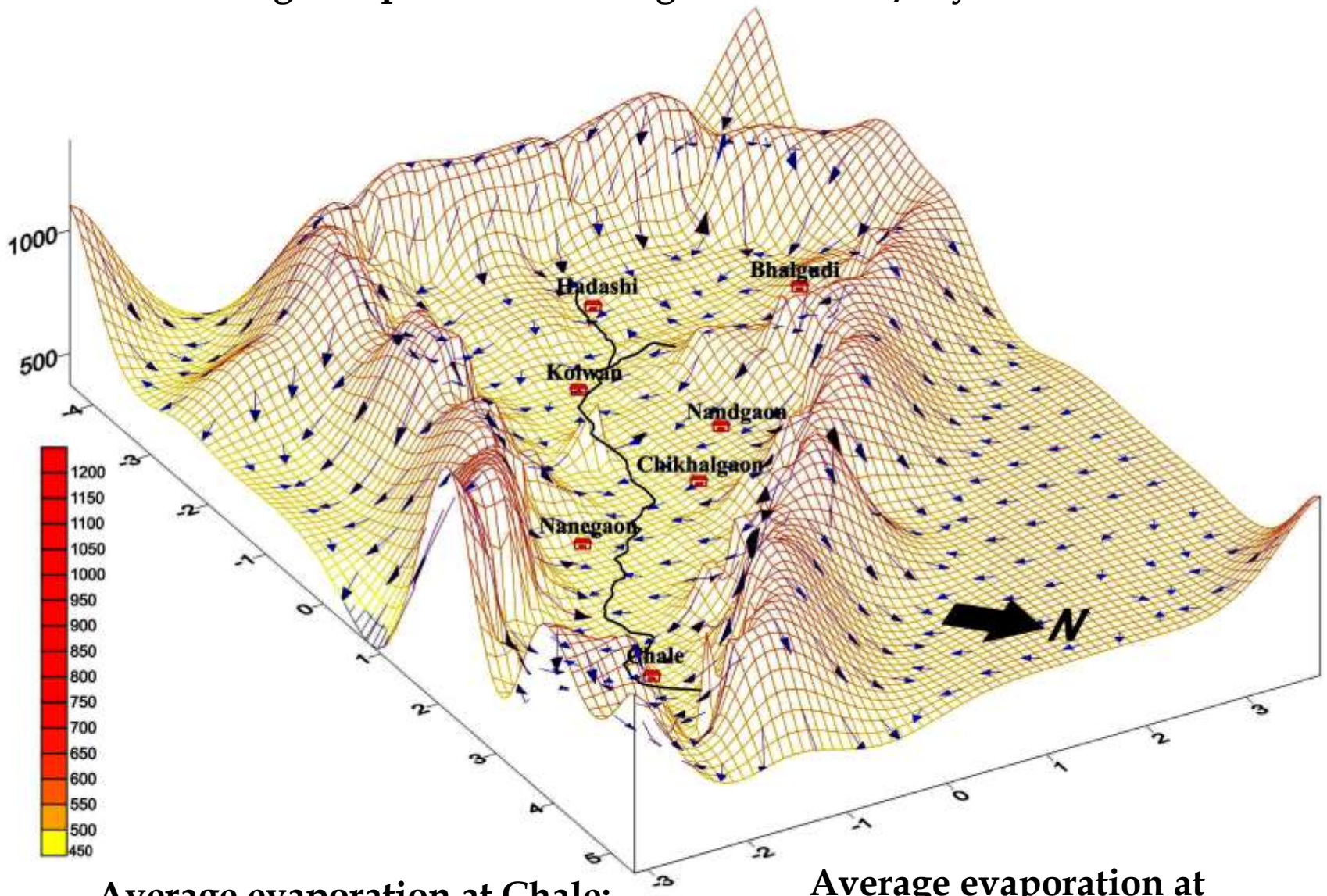
  Rain gauges installed at 8 villages

Average rainfall at Karmoli: 1400mm

Average rainfall at Chikhalgaon: 1800mm.

Average rainfall at Hadashi: 2200mm

Average evaporation at Bhalgudi: 7-7.6mm/day



Average evaporation at Chale: 6-6.5mm/day

Average evaporation at Chikhalgaon: 6.2-6.8mm/day

Two examples in Pune district illustrated bellow:

Kolwan valley

- Distance from Pune:40 km
- Geology: Deccan basalt
- Soil type: Red to reddish brown silty soils and black clayey soils (alfisols &vertisols)
- Average rainfall: 1800mm
- Climate: semiarid
- Crops: Rice, sugarcane & wheat
- Area covered under DPAP

Purandhar

- Distance from Pune:60 km
- Geology: Deccan basalt
- Soil type: Red to reddish brown silty soils and black clayey soils (alfisols &vertisols)
- Average rainfall: 500mm
- Climate: semiarid
- Crops: Jowar, ground nut and orchards
- Area covered under DPAP

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Watershed approach may be different for the two areas

Kolwan valley

- More rainfall therefore more runoff… need to impound runoff.
- Structures may be constructed in such a way that it should sustain at high intensity rainfall conditions.
- Alternative source for water like springs can be considered

Purandhar

- Less rainfall therefore all water needs to be harvested using trenches etc.
- Limited structures could be constructed considering recharge and discharge areas.
- Proper water management should be done involving community participation

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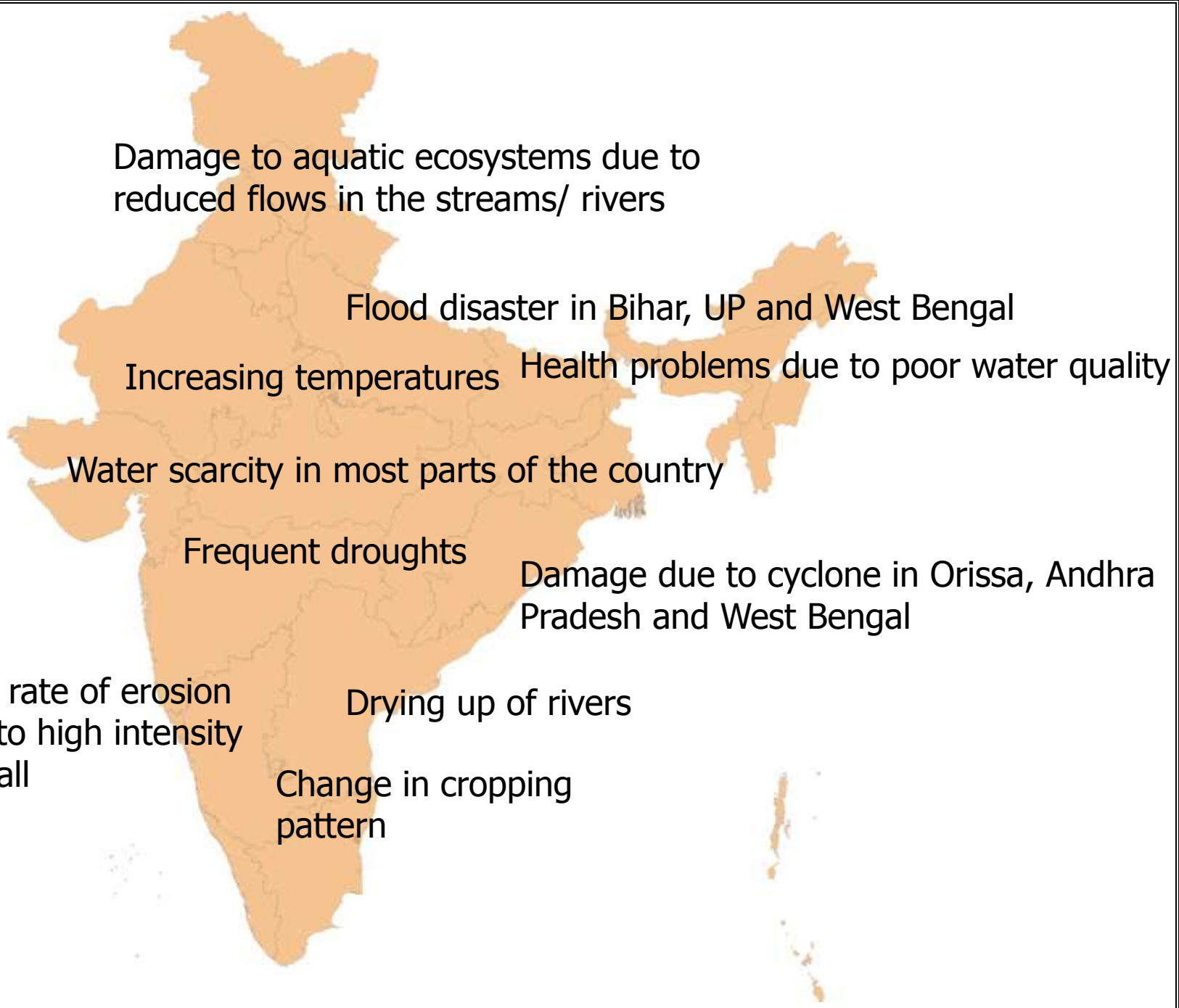
Different methods of water management required for different areas

Breaching of earthen check dam due to heavy rainfall

Adequate water storage through earthen check dam in Purandhar


Damage to aquatic ecosystems due to reduced flows in the streams/ rivers
Flood disaster in Bihar, UP and West Bengal
Health problems due to poor water quality
Increasing temperatures
Water scarcity in most parts of the country
Frequent droughts
Damage due to cyclone in Orissa, Andhra Pradesh and West Bengal
High rate of erosion due to high intensity rainfall
Drying up of rivers
Change in cropping pattern

Watershed approach for different climatic zones of India

	Mountainous region	Subtropical wet & dry	Semi arid	Arid region
Rainfall	More than 1000 mm up to 3500 mm	Around 1000 mm	Less than 500 mm	Less than 200 mm.
Watershed structures	controlling soil erosion & runoff. Spring development , Protection of recharge areas	Water harvesting, Identification of recharge & discharge areas Water management , Water budgeting	Water management, Protection of recharge areas Groundwater regulation, Community participation	GW management , GW regulation, WS structures at appropriate location, Water budgeting





Thank you!