

Watershed Hydrology

Precipitation and Its Measurement

What is Precipitation ?

It denotes all the forms of water that reach the earth from the atmosphere. Precipitation occurs in many forms e.g. drizzle, rain, glaze, sleet, snow, hail, dew and frost, depending upon the causes and temperature at the time of formation.

Forms of Precipitation



Rain: Drop size is between 0.5 to 6 mm in dia.

Type	Intensity
Light Rain	< 2.5mm/h
Medium Rain	2.5mm/h to 7.5mm/h
Heavy Rain	>7.5mm/h



Drizzle: Drop size < 0.5 mm in dia. and intensity is usually < 1 mm/h.



Glaze: It is the ice coating formed when drizzle or rain freezes as it comes in contact with cold ground at around 0 °C.



Sleet: It is frozen raindrops, which likely form when raindrops are falling through the medium at subfreezing temperature.



Snow: It is a precipitation in the form of ice crystals resulting from sublimation, i.e., directly from water vapor to ice.



Hail: It is precipitation in the form of balls or lumps of ice over 5 mm dia. formed by alternate freezing and melting.



What is climate?

- Climate is **average atmospheric condition** of a place, location or region **almost constant** for a quite **long observational** time.



What is weather?

- Weather is the atmosphere condition of any place for a **short period** of the time with respect to its one or more elements (temperature, precipitation, wind, pressure, sunshine hours, humidity, cloud cover etc.).
- Measured on the scale of **hot** or **cold**, **wet** or **dry**, **calm** or **storm**, **clear** or **cloudy**.

Types of Precipitation



Frontal Precipitation



Orographic Precipitation



Convective Precipitation

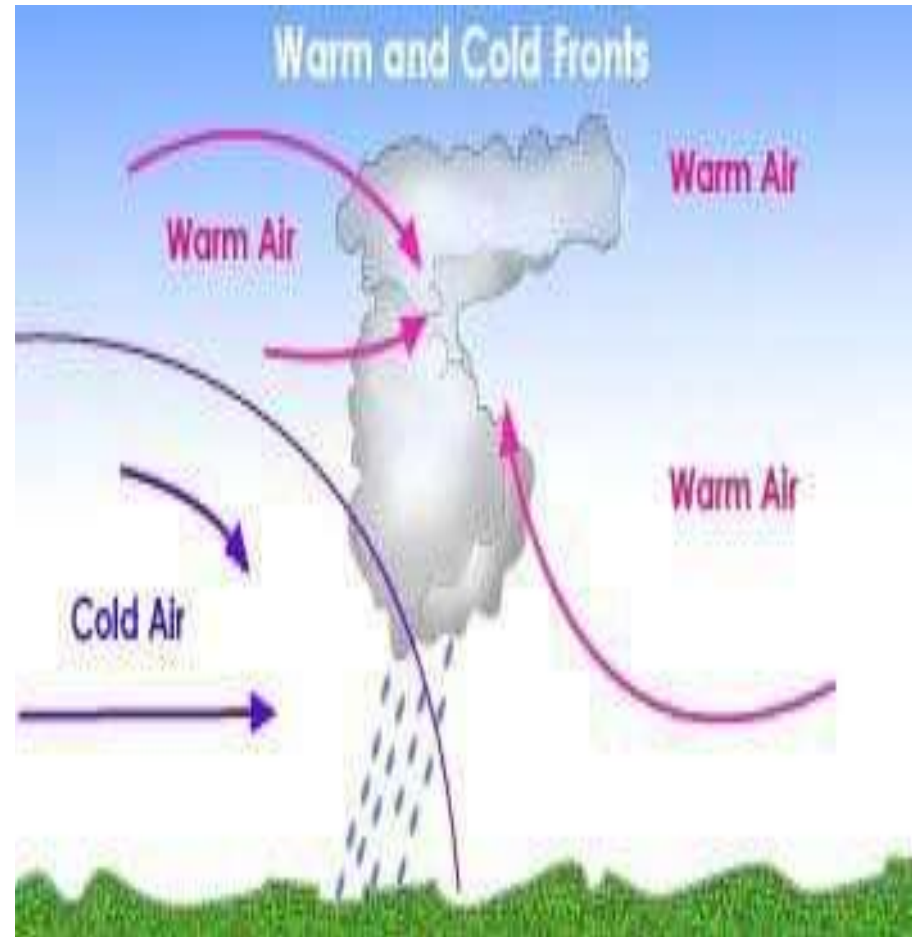
Frontal Precipitation

When a warm air mass and cold air mass meet, the warmer air mass is lifted over the colder one with the formation of a front. The ascending warmer air cools **adiabatically** with the consequent formation of clouds and precipitation.

A **front** is the interface between two distinct air masses.

Frontal precipitation is usually in **drizzle form**.

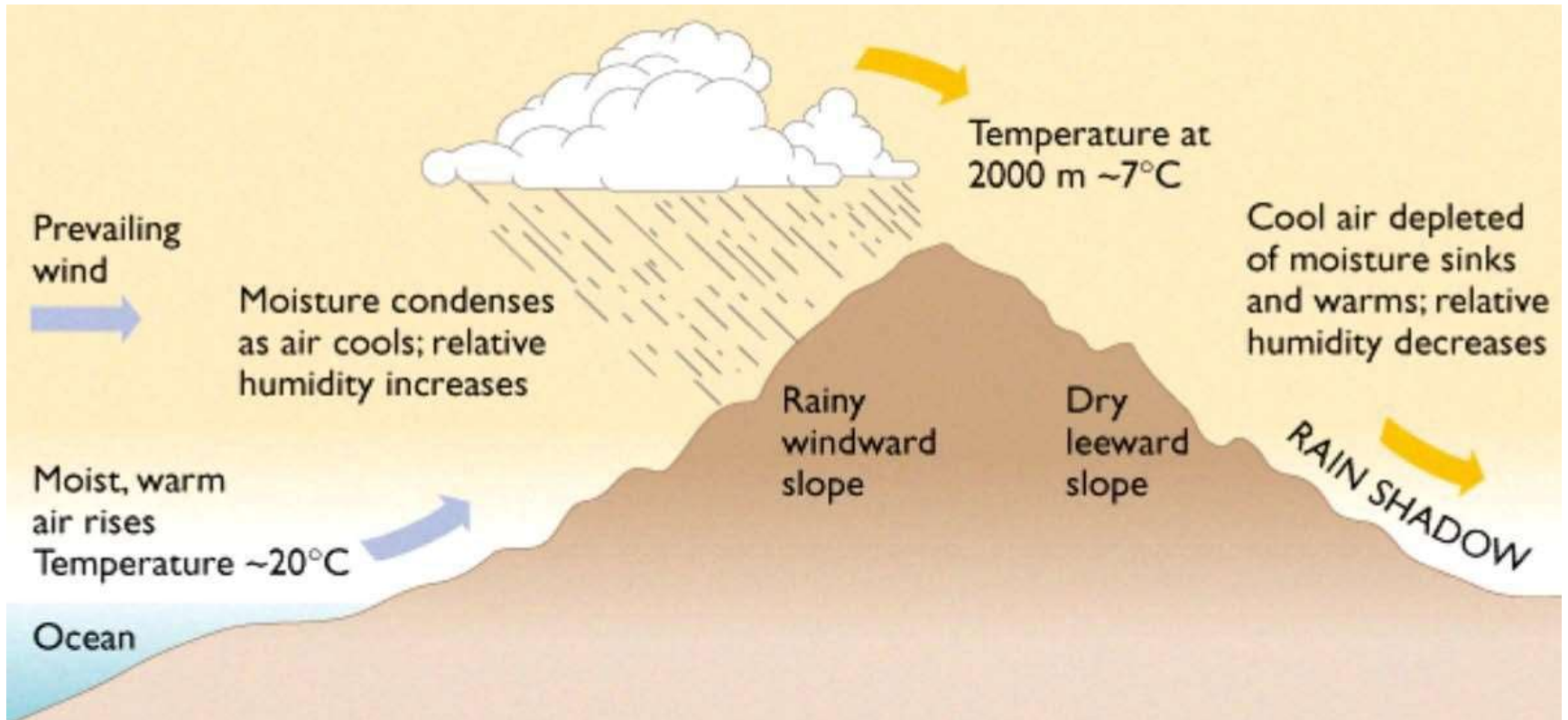
Mainly occurred in **temperate zones**.



Orographic Precipitation

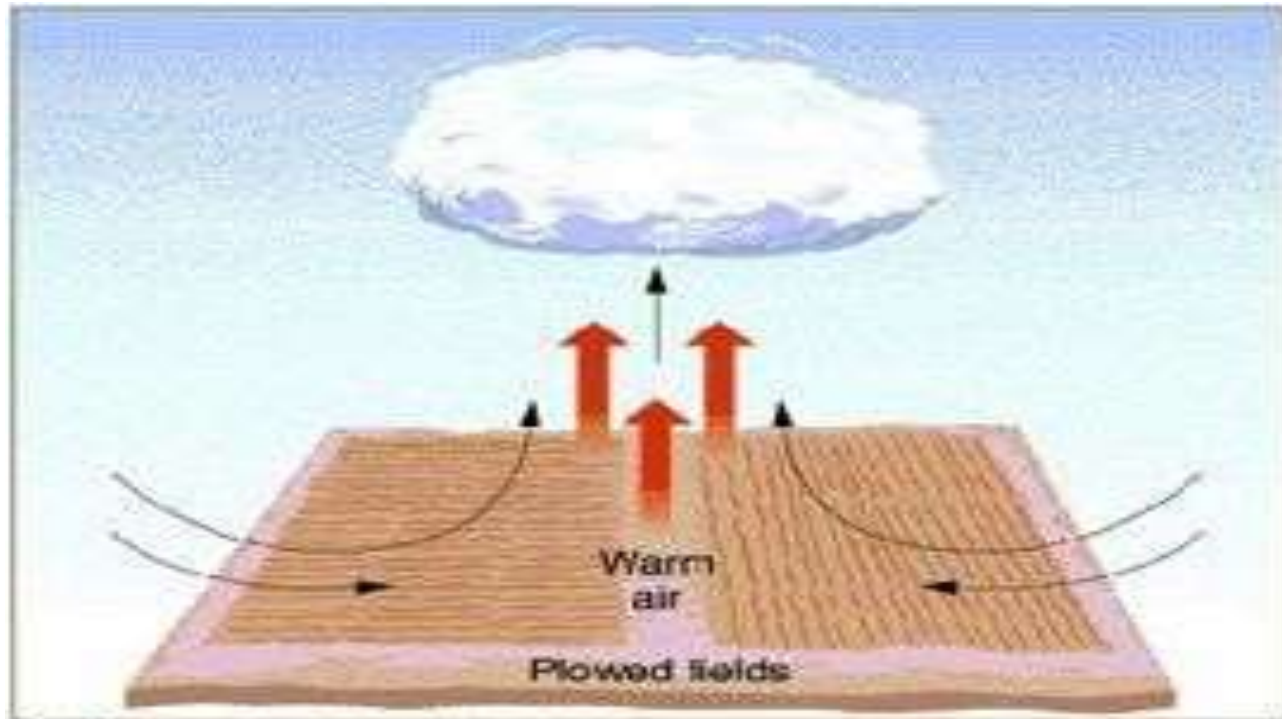
The moist air may get lifted up to higher altitudes due to presence of **mountain barriers** and consequently undergo **cooling, condensation** and **precipitation**.

Windward slopes receive more precipitation than **leeward**.



Convective Precipitation

- ☛ Lifting of air mass is done by **convection process**. The **solar energy** is the main energy source of supplying heat for development of convective currents in the air.
- ☛ Occurs in **temperate** zones at low latitudes.

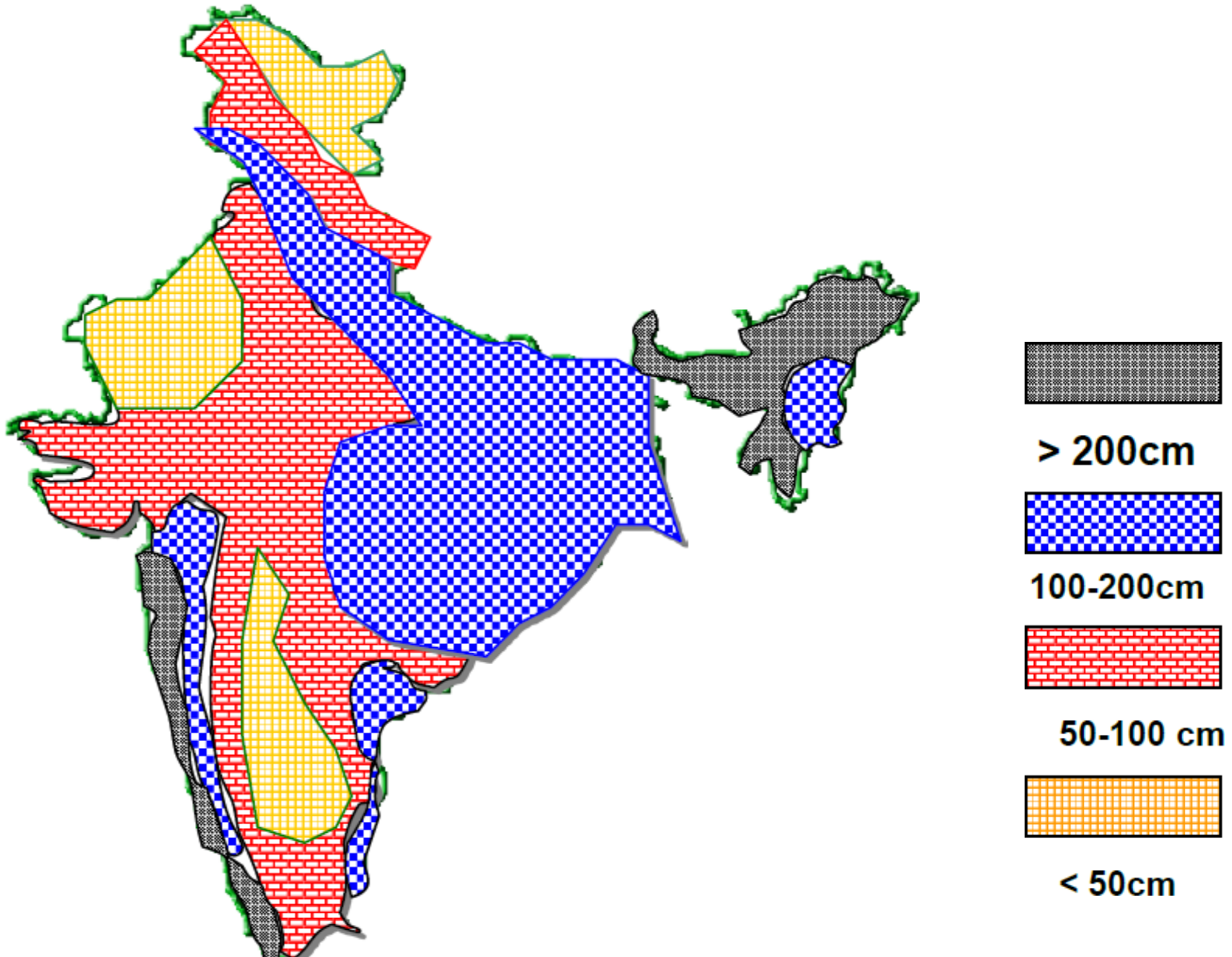


(b) Convectonal (local heating)

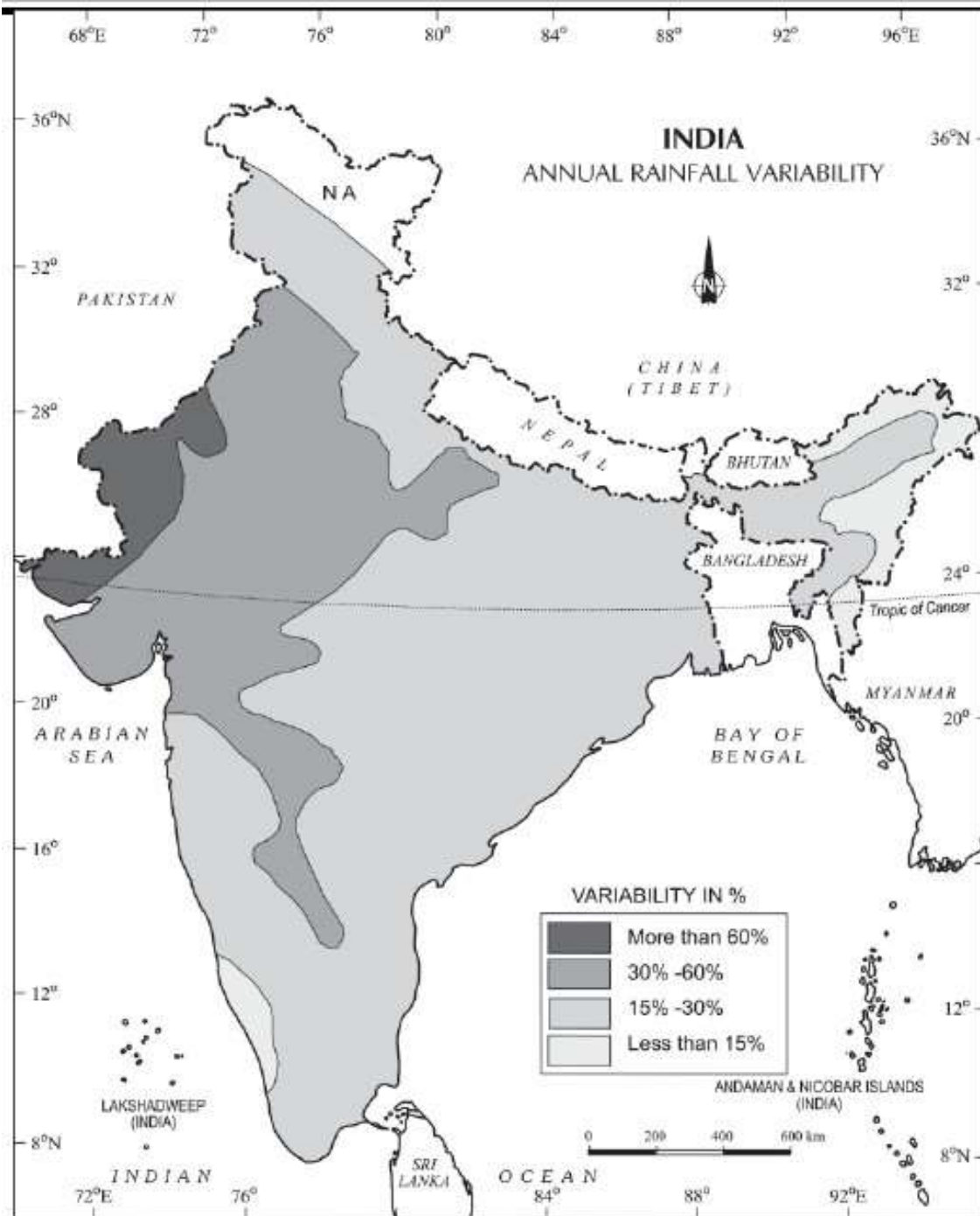
Indian Seasons

1.	Cold weather season	December - February
2.	Hot weather season	March - May
3.	South-west monsoon season	June - September
4.	Retreating monsoon season	October - November

Distribution of rainfall



Rainfall variability



Rainfall Measurement

Raingauge

- To Measure the **depth** and **intensity** of rainfall

Type of Raingauge

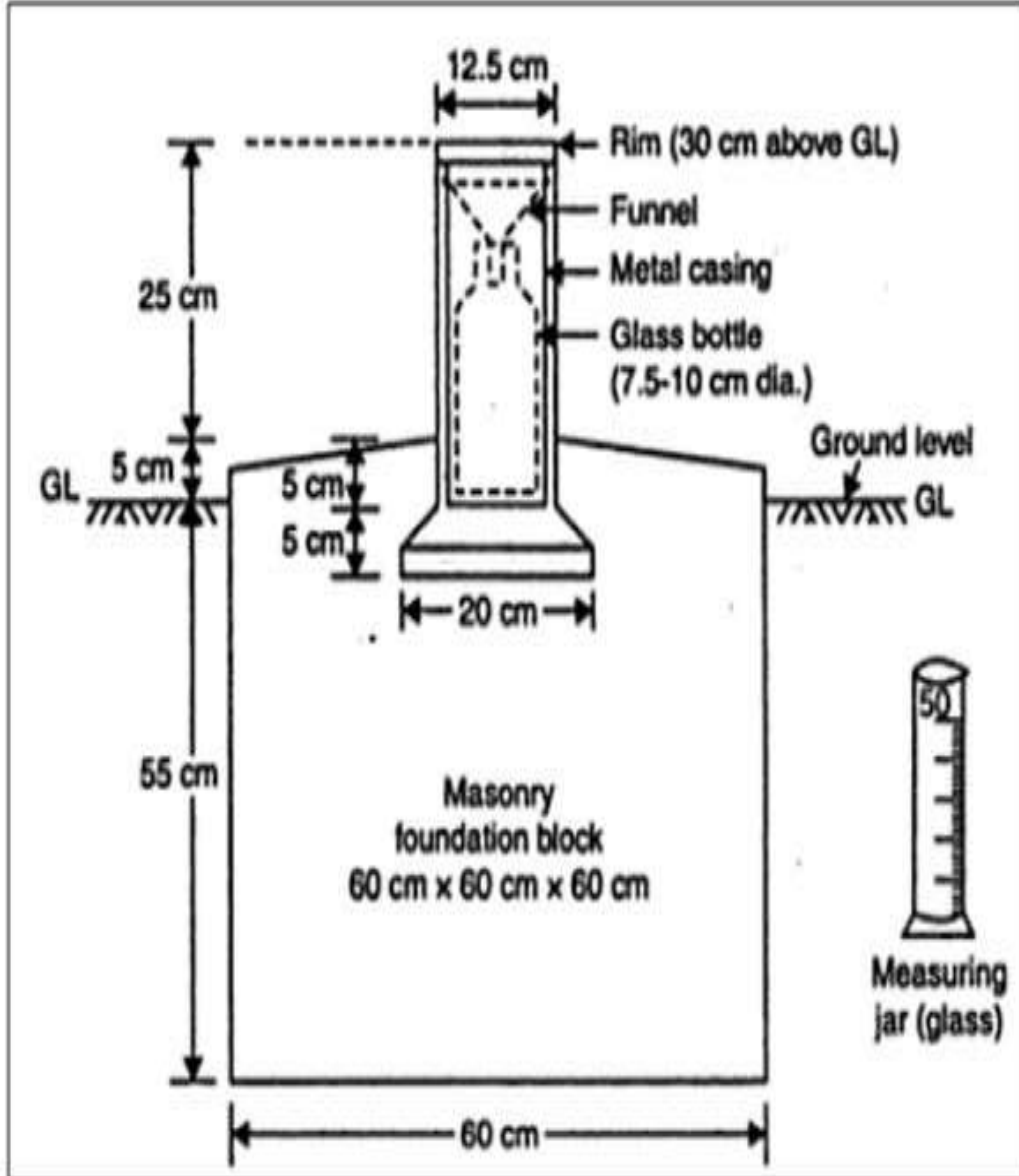
A. Non-recording

- Symon's gauge

B. Recording

- Weighing Bucket Type
- Tipping Bucket Type
- Siphon or Floating Type

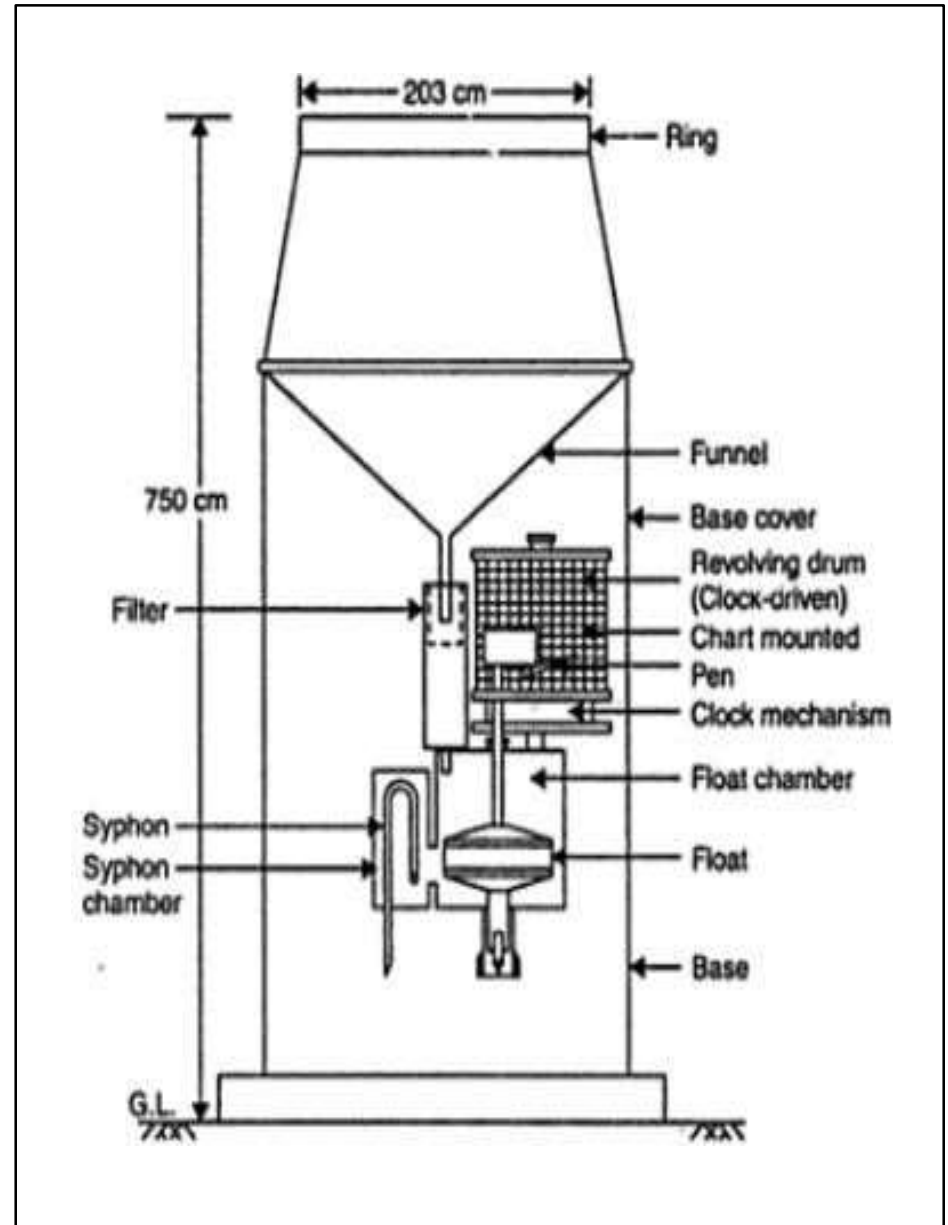
Symon's gauge



- The standard raingage, known as **Symon's gage** is recommended and installed by the **Indian Meteorological Department (IMD)**.
- This is a **vertical, cylindrical** container with top opening 127 mm in diameter.
- A funnel shaped hood is inserted to **minimize evaporation** losses. The water is funneled into an inner cylinder.

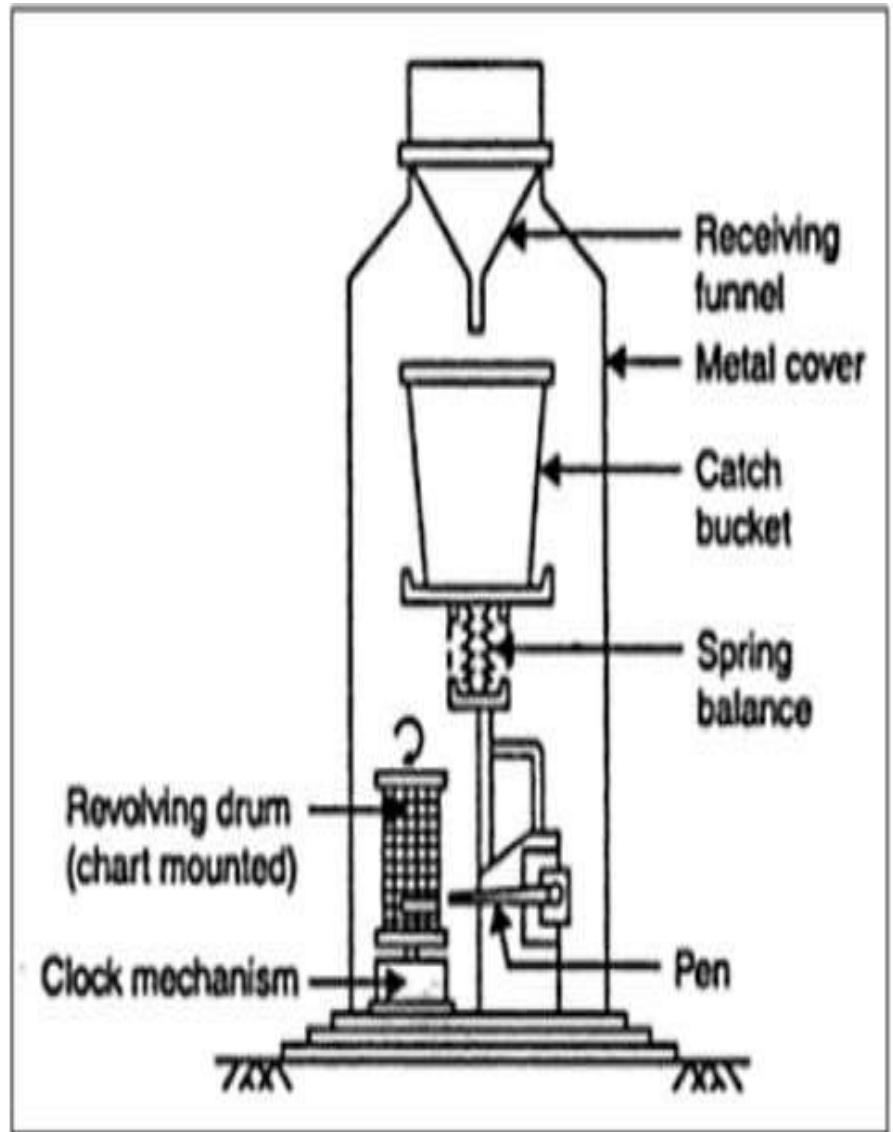
Siphon or Floating Type

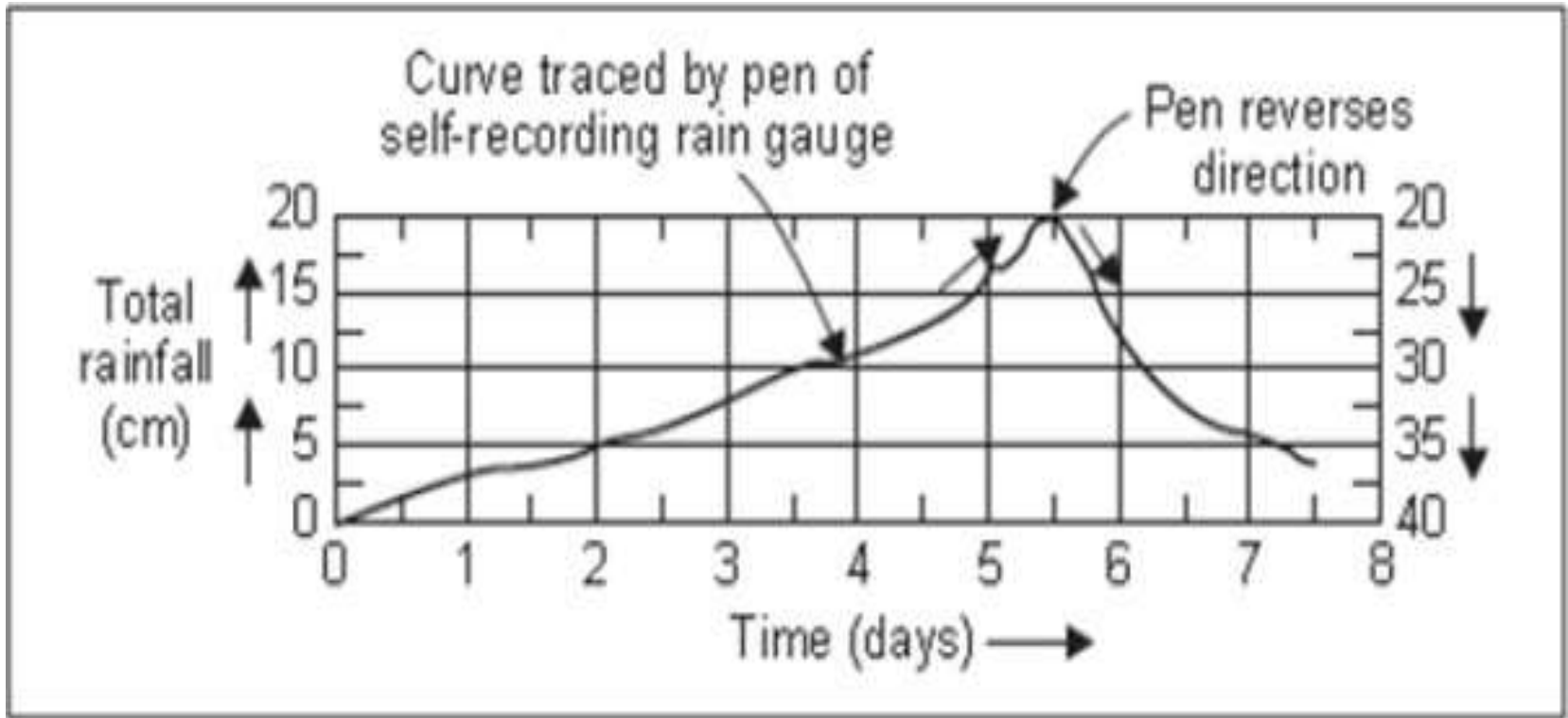
- Siphon gage, also known as the **float type** of recording rain gage, the rain is fed into a float chamber containing a light, hollow float.
- The **vertical movement** of the float, as the **level of water rises**, is transmitted by a suitable mechanism in to the movement of the pen on a revolving chart.
- Siphoning arrangement is provided for **emptying** the float chamber quickly whenever it becomes full, the pen returns to the bottom of the chart.



Weighing Bucket Type

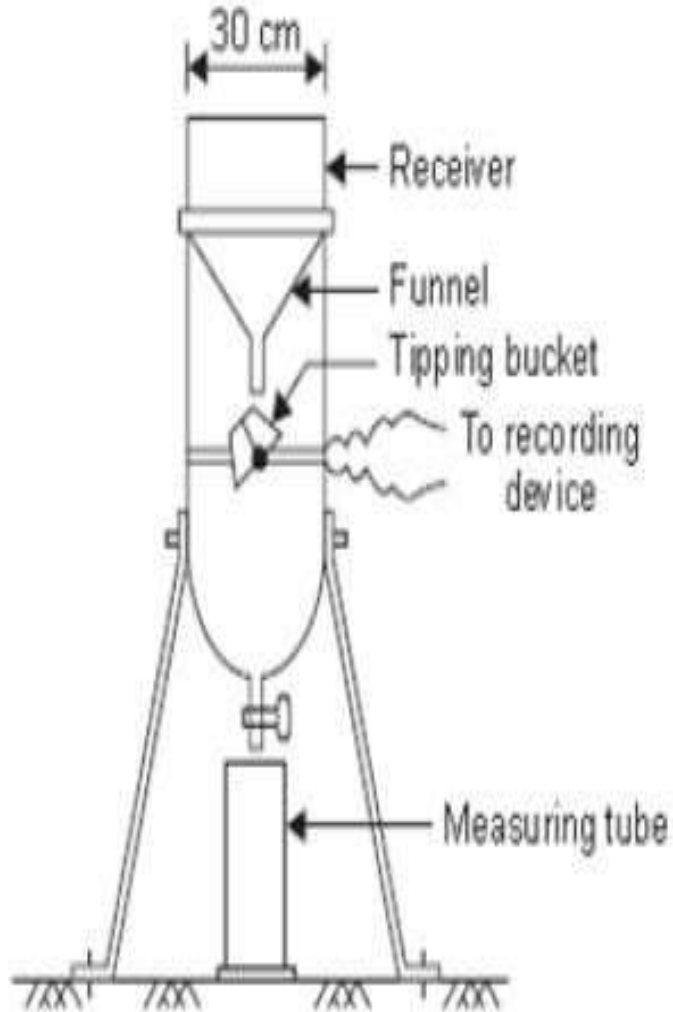
- This gage weighs the rain, which falls into a bucket set on a platform of a **spring or level balance**. The **increasing weight** of bucket and **its counts** are recorded on the chart held by a **clock driven drum**.
- The record shows the **accumulation of precipitation with time** in the shape of a **mass curve** of precipitation.
- The gage must be serviced about **once a week** when the clock is rewound and the chart is replaced.





For high rainfall, the recording mechanism reverses the direction of record immediately on reaching the upper edge of the recording chart.

Tipping Bucket Type



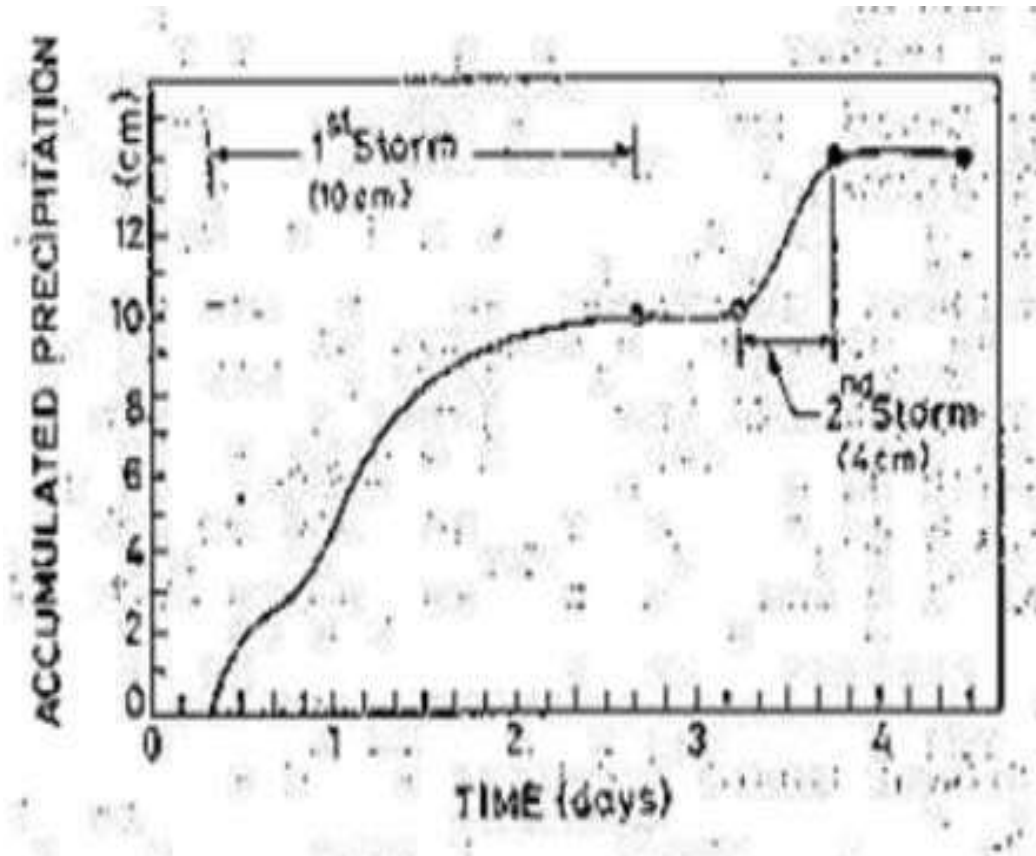
- It consists of a 30 cm diameter sharp edge receiver. At the end of the receiver a funnel is provided.
- A pair of buckets are pivoted under the funnel in such a way that when one bucket receives 0.25 mm of rainfall it tips, discharging its contents into a tank bringing the other bucket under the funnel.



Presentation of Rainfall Data

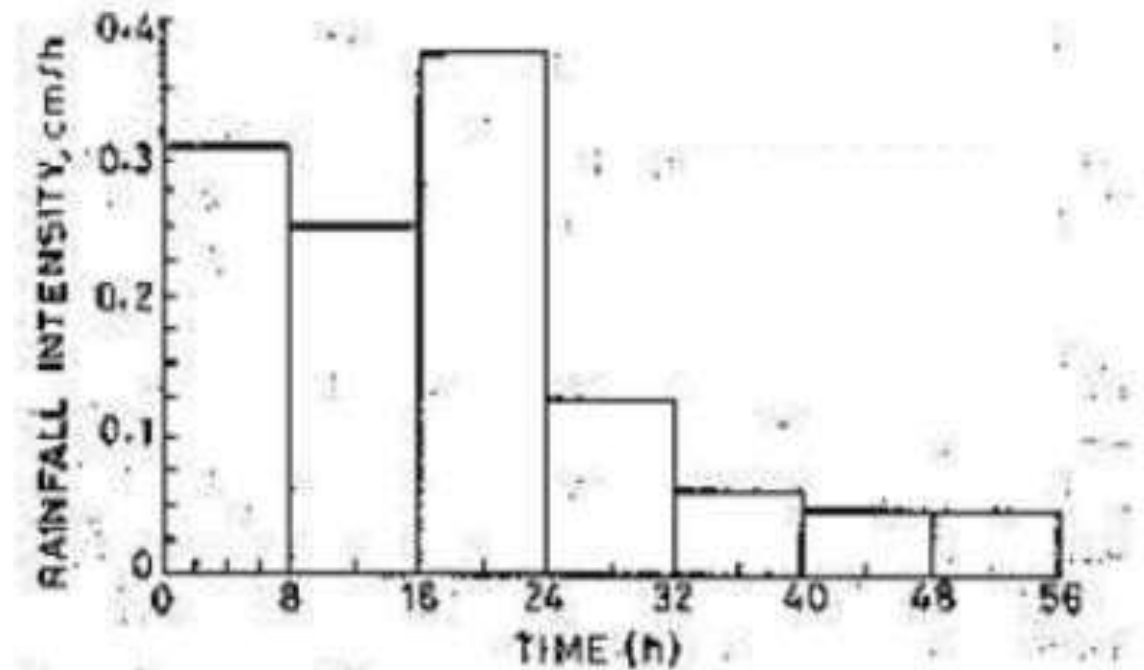
1. Mass Curve of Rainfall

- Plot of the accumulated precipitation against time, plotted in chronological order



2. Hyetograph

- Plot of the intensity of rainfall against the time



Estimation of Missing Rainfall Data

- Simple Arithmetic Method
- Normal Ratio Method

Normal Precipitation

- It is the **average** value of precipitation at a particular **date, month** or **year** over a specified **30 year period**.

Optimum Number of Raingauge

- The **optimal number** of Raingauge corresponding to an assigned of error in **estimation** of **mean areal rainfall** can be obtained as:

$$N = (C_V T \epsilon)^2$$

$$C_V = \frac{\sigma_{m-1} * 100}{P}$$

$$\sigma_{m-1} = \sqrt{\left[\frac{\sigma_1^m (P_i - P)}{m - 1} \right]}$$

N = Optimal number of station

ϵ = Allowable degree of error in the estimate of mean rainfall

σ_{m-1} = Standard deviation

P = Average precipitation

P_i = Average precipitation



Indian Standard Recommendation

- One station per 520 km² – in plains.
- One station per 260-390 km² – in regions of average elevation of 1000 m.
- One station per 130 km² – in predominantly hilly areas with heavy rainfall.



WMO Recommended Precipitation Network Density

- One station per 600 to 900 km² – in flat regions of temperate, Mediterranean and tropical zone.
- One station per 100 to 250 km² – in mountainous regions of temperate, Mediterranean and tropical zone.
- One station per 25 km² – in small mountainous land with irregular precipitation.
- One station per 1500 to 10,000 km² – arid and polar zones.

