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.

<table>
<thead>
<tr>
<th>Type</th>
<th>Intensity</th>
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</thead>
<tbody>
<tr>
<td>Light Rain</td>
<td>&lt; 2.5mm/h</td>
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<tr>
<td>Medium Rain</td>
<td>2.5mm/h to 7.5mm/h</td>
</tr>
<tr>
<td>Heavy Rain</td>
<td>&gt;7.5mm/h</td>
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**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.
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
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 raingage, the rain is fed into a float chamber containing a light, hallow float.

- The vertical movement of the float, as the level of water rises, is transmitted by a suitable mechanism into 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:

\[ N = (C_V T \varepsilon)^2 \]

\[ C_V = \frac{\sigma_{m-1} \cdot 100}{P} \]

\[ \sigma_{m-1} = \sqrt{\frac{\sigma_1^m (P_i - P_{\text{avg}})^2}{m - 1}} \]

- \( N = \) Optimal number of station
- \( \varepsilon = \) Allowable degree of error in the estimate of mean rainfall
- \( \sigma_{m-1} = \) Standard deviation
- \( P_{\text{avg}} = \) Average precipitation
- \( P_i = \) Average precipitation
Indian Standard Recommendation

- One station per 520 km$^2$ – in plains.
- One station per 260-390 km$^2$ – in regions of average elevation of 1000 m.
- One station per 130 km$^2$ – in predominantly hilly areas with heavy rainfall.

WMO Recommended Precipitation Network Density

- One station per 600 to 900 km$^2$ – in flat regions of temperate, Mediterranean and tropical zone.
- One station per 100 to 250 km$^2$ – in mountainous regions of temperate, Mediterranean and tropical zone.
- One station per 25 km$^2$ – in small mountainous land with irregular precipitation.
- One station per 1500 to 10,000 km$^2$ – arid and polar zones.