MODULE 2 – Weather and Precipitation

Precipitation

When the water/moisture in the clouds/atmosphere gets too heavy, the water / moisture falls back to the earth. This is called ***precipitation.***

Forms of Precipitation	
Rain	Water drop size (0.5 - 6) mm
Snow	Ice crystals combine to form flakes having average density of 0.01 g/cm^3
Drizzle	Water droplets size less than 0.5mm and intensity less than 1mm/h
Glaze/Freezing Rain	Water drops freeze to form ice coating called glaze or freezing rain
Sleet	Precipitation of snow and rain simultaneously
Hail	Lumps of ice of size more than 8mm

Precipitation: Rainfall

- Rainfall is classified into:
  - *Light rain* – if intensity is trace to 2.5 mm/h
  - *Moderate rain* – if intensity is 2.5 mm/hr to 7.5 mm/hr
  - *Heavy rain* – above 7.5 mm/hr

- **Measurement Units:**

***Amount of precipitation/rain* (mm or inch)**

- It is measure as total depth of rainfall over an area in one day.

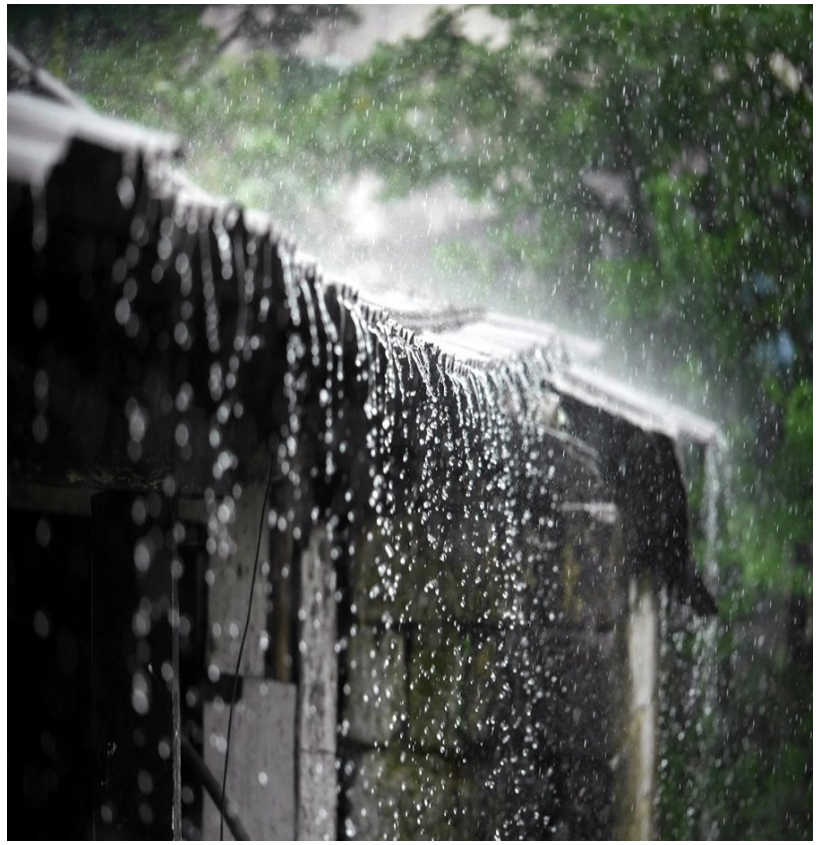
***Intensity of precipitation/rain* (mm/hr or inch/hr)**

- It is the amount of precipitation at a place per unit time (rain rate). It is expressed as mm/hr or inch/hr

Measurement of Precipitation

Why do we need to measure rainfall?

- ***Agriculture*** – what to plant in certain areas, where and when to plant, when to harvest
- ***Horticulture/viticulture*** - how and when to irrigate
- ***Engineers*** - to design structures for runoff control i.e. storm-water drains, bridges etc.
- ***Scientists*** - hydrological modelling of catchments



Types of Formation of Precipitation:

Types of Rainfall:

There are three main causes of rainfall. These are:

1. **Convectional Rainfall**: The rainfall results when a heated air expands, rises and in the process condenses to form drops of rain. Convectional rainfall is more common in the **Humid Tropical Regions** that receive much of the sun's energy. It usually occurs in the **afternoons** after surface air has been heated.

2. **Orographic (Relief) Rainfall:** The rainfall results from uplift of air above some highland. Mountain ranges force air blowing over them to rise, cool and then condense to fall as rain. The side of the mountain that faces the wind and receives the rainfall is the **Windward side**. The opposite side that receives dry winds is the **Leeward side.**

3. **Frontal (Cyclonic) rainfall**: This type of rainfall occurs along the zone of contact between a warm and cool air mass. When two large air masses of different temperature meet, the warmer and hence lighter air is lifted above the cooler air. The warm air then rises, cools and condenses to form rain. The boundary that separates the cold air and the warm air is called a **Front.**

Mechanism of Formation of Precipitation

Precipitation occurs when local air becomes saturated with water vapor, and can no longer maintain the level of water vapor in gaseous form. This occurs when less dense moist air cools, usually when an air mass rises through the atmosphere. However, an air mass can also cool without a change in altitude (e.g. through radiative cooling, or ground contact with cold terrain). There are three distinct types of precipitations.

1. Convectional
2. Cyclonic
3. Orographic

Mechanism of cooling:

Evaporative cooling is a cooling of the air due to latent heat absorption of water molecules. When water evaporates, the evaporation process requires taking heat from the environment in order for the evaporation to occur. With the removal of heat from the air, the air cools. The amount of water that is able to evaporate into a volume of air impacts the cooling. Evaporative cooling can occur until the relative humidity reaches 100% (saturated air). Thus, initially dry and warm air will produce the greatest amount of evaporate cooling when this air is saturated through the evaporation process. This is because dry air can evaporate a greater amount of moisture as compared to less dry air when both are initially at the same temperature and warm air can evaporate a greater amount of moisture as compared to cold air.

When air rises, it moves from a zone of dense air on the surface to areas of less dense air in the atmosphere. The rising air thus has less weight above it and the lower pressure allows the air to expand and cool down. The decrease in air temperature that result from expansion of rising air is called **Adiabatic Cooling**.

Mechanism of Condensation:

Clouds are formed by the condensation of water vapor onto nuclei in a rising mass of moist air. This produces droplets with sizes of the order of several microns. To precipitate, such droplets have to grow to millimeter sizes, either by coagulating together or by freezing and capturing the water evaporating from super-cooled droplets.

Mechanism of Droplet Growth:

According to the microstructure of the cloud is divided into: water clouds, cloud **droplets** are small water **droplets**, they rely mainly on collision with each other continue condensation and increases to the **rain**; ice clouds (composed by small ice crystals): composed of tiny ice crystals. **Clouds** form when the invisible water vapor in the air condenses into visible water **droplets** or ice crystals. For this to happen, the parcel of air must be saturated, i.e. unable to hold all the water it contains in vapor form, so it starts to condense into a liquid or solid form.

Mechanism of Accumulation of Moisture:

- water undergoes huge expansion during evaporation: 1 g of water equals 1 ml volume in liquid form and 42 l as vapor (at 25^{o}C)
- gravity concentrates the atmospheric gases near the surface, the pressure drops to 1/e (= 37%) at about 8 km elevation

  ----P/Po = exp(-h/8000m)

  ----90% of water vapor content is confined to the lower 6 km
- *absolute humidity* (or *water vapor mixing ratio*): mass of vapor per unit volume of air, in g m^{-3}

  ----at 30^{o}C, air has a svp of 42.43 hPa (hPa = mbar) and can contain up to 30 g m^{-3}, at 0^{o}C svp is only 4.5 g m^{-3}