Module # 3

Precipitation

* Precipitation is the discharge of water (in liquid or Solid form) out of atmosphere.
* The principal form of precipitation is rain and Snow and to a lesser extend is hail, sleet etc.
* Precipitation is derived from atmospheric water.
* Other factors such as wind, temperature, atmospheric pressure and local landscape can influence precipitation.

Uses of Precipitation Data:-

* Run off Estimation Analysis.
* Amount of Infiltration.
* Ground water Analysis.
* Water Balance Studies of Catchments.
* Flood Analysis for Design of hydraulic Structures.
* Real-time Flood Forecasting.
* Low Flow studies.
* Water logging and Salanity.
* Environmental Effects of water Resources Projects

Condensation, Freezing & Deposition

Water is available on the earth in three forms vapor; liquid and Solid.

The process of water moving from one form to another is called a phase or state change.

In the atmosphere, three processes act to create water droplets or ice crystals, they are:

Condensation → water moving from a vapor to a liquid state.

Freezing → water moving from a liquid to a Solid State

Deposition → water moving from a vapor to a Solid State.

For a phase change to occur "heat energy" must be added or removed from water molecules.

Types of Precipitation:-

There are different types of precipitation.

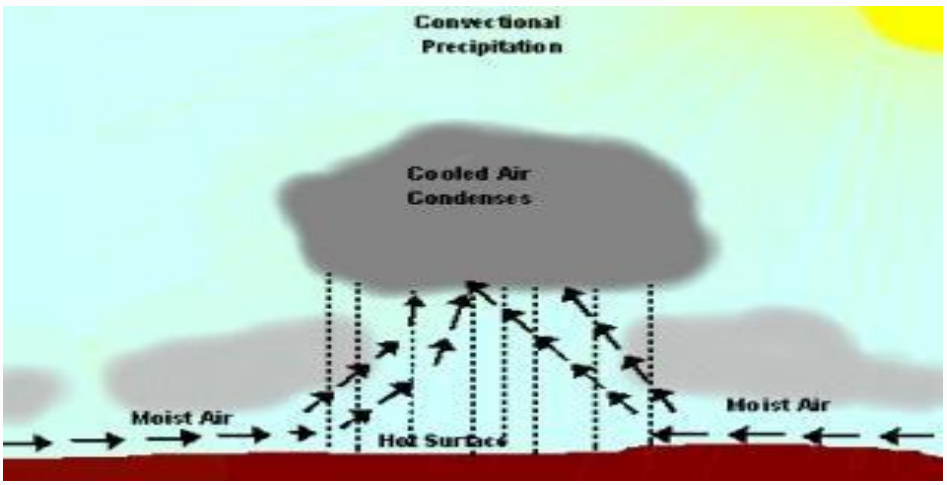
(1) Convectional precipitation.
(2) Orographic precipitation.
(3) Cyclonic precipitation.

(1) – Convectional precipitation:-

Convectional precipitation results from the heating of the earth's Surface. The warm ground heats the air over it. As the air warms, the air molecules begin to move further apart.

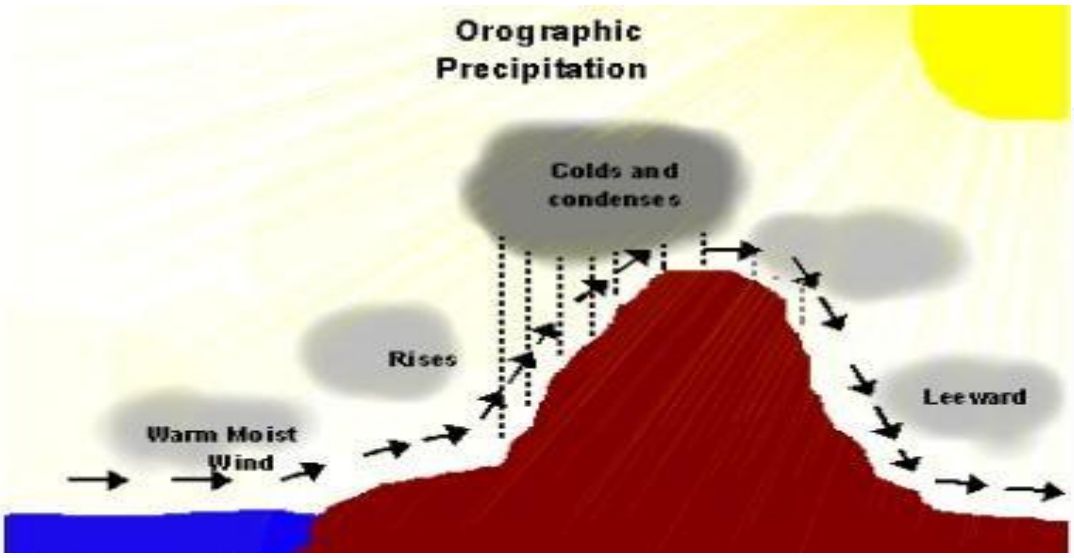
With increased distance b/w molecules the molecules are less densly packed. Thus the air becomes lighter and rises rapidly into the atmosphere. As the air rises, it cools - water vapour in the air condenses into clouds and precipitation.

Generally this kind of Precipitation occurs in tropics, where on a hot day, the ground surface gets heated unequally, causing the warmer air to lift up.



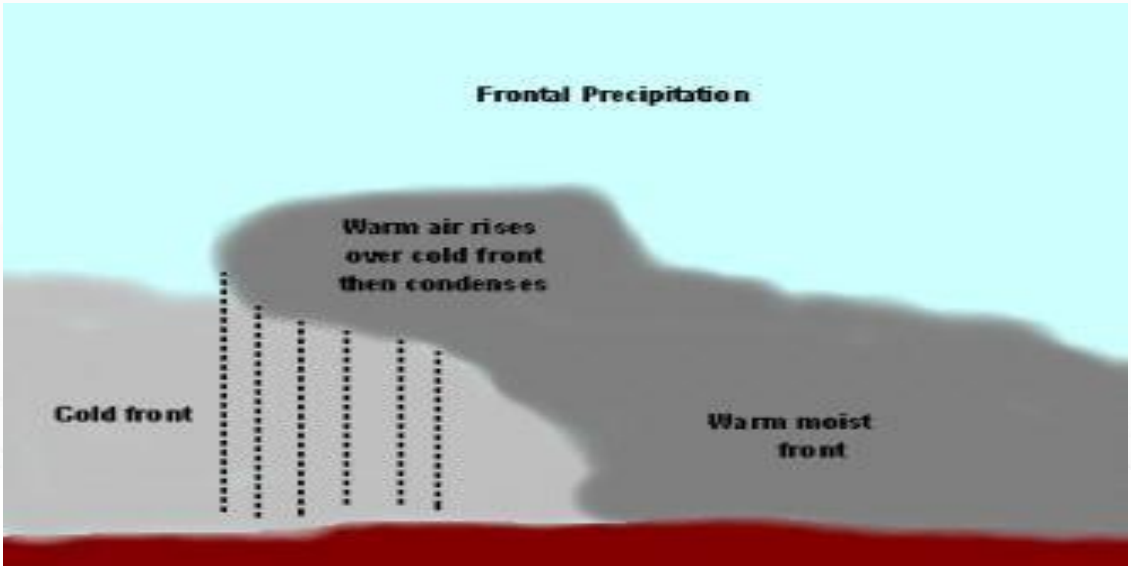
(2)- Orographic precipitation:-

Orographic precipitation results when warm moist air moving across the occean is forced to rise by large mountains. As the air rises it cools - (A higher elevation results in cooler temperatures).



Cold air cannot hold as much moisture as warm air. As air cools, the water vapour in the air condeses and water droplets are form. Clouds forms and precipitation (rain or snow) occurs on the wind ward side of the mountain. The air is now dry and rises over top the mountain. As the air moves back down the mountain, it collects moisture from the ground via evaporation. This side of the mountain is called leeward side. It receives very little precipitation.

(3) Cyclonic precipitation:-



Cyclonic or frontal precipitation results when the leading edge of a warm, moist air mass (warm front) meets a cool and dry air mass (cold front). The molecules in the cold air are more tightly packed together (more dense) and thus, the cold air is heavier than the warm air.
The warmer air mass is forced up over the cool, air. As it rises, the warm air cools, the water vapour in the air condenses, and clouds and precipitation results.
This precipitation is common in Atlantic Canada. This type of system is called Frontal precipitation because the moisture tends to occur along the front of the air mass.

Mechanism Producing Precipitation:-

Three mechanisms are needed for formation of precipitation -

(i) — Lifting and Cooling:- lifting of air mass to higher altitudes causes cooling of air.

(ii) — Condensation:- Conversion of water vapour into liquid droplets and ice crystals. Condensation nuclei are required.

(iii) – Growth of Droplets and Ice crystals :-

Growth of droplets is required if the liquid water present in a cloud is to reach ground against the lifting mechanism of air.

Forms of Precipitation:-

(1) Drizzle :-

Drizzle Consists of tiny liquid droplets usually with diameters between 0.1 and 0.5 mm and its intensity is less than 0.01 mm per hour.

(2) Rain :- Rain Consists of liquid water drops mostly larger than 0.5 mm in diameter. The upper size of water drop is generally 6.25 mm as drops greater than this tend to breakup as they fall through the air.

- Light Rain : Rate of fall upto 3mm/hr
- Moderate Rain : Rate of fall from 3–10mm/hr
- Heavy Rain : Rate of fall over 10 mm/hr

(3) Sleet :- Sleet consist of transparent, solid grains of ice formed by the freezing of raindrops falling through a layer of Subfreezing air near the earth's surface.

(4) Snow:-

Snow occurs when precipitation falls from the Clouds as flaky solids or ice crystals.

It is caused when air temperature is so cold that the vapor changes directly to ice. During a snow storm, the temperature in the clouds is very cold which freezes the rain into ice crystals. It is so cold at ground level so precipitation is frozen solid in the clouds and stays frozen by the cold surface.

The diameter of Snow flacks vary from 100mm to 500mm.

(5) Hail:-

Hail is lumps of ice or hail stones, produced in convection clouds. Hail stones may be spherical, conical, or irregular shape and range from about 5 to over 125 mm in diameter.

Note:- Of all the forms of precipitation, rain (major part) and Snow (minor part) make the greatest Contribution to our water Supply. Other forms of precipitation are all very Small and generally ignored in the design of most of the hydrological works.

Measurement of Precipitation:-

Precipitation was probably the first hydrological phenomenon to have been recorded by man. There is evidance that rainfall records were kept in India in the 4th Century B.C.

All forms of precipitation are essentially measured on the basis of the vertical depth of water that would accumulate on a level surface if the precipitation is retained where it fell.

Precipitation is usually measured in millimeters and tenths of millimeters.

One millimeter of precipitation represents the quantity of water needed to cover the land with a 1mm layer of water, taking into account that nothing is lost through drainage, evaporation, or absorption.

The temporal variation may be defined as hourly, daily, monthly, seasonal, variations and annual variation (Long term variation of precipitation).

Instrument used to collect and measure the precipitation is called "rain gauge".

Measurement Units:-

(i) **Amount of Precipitation:-**

It is measure as total depth of rainfall over an area in one day. (mm or inch)

(ii) **Intensity of Precipitation**

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

Importance of Measurement of Rainfall:-

(a) **Agriculture:-** What to plant in certain areas, where and when to plant, when to harvest

(b) **Horiculture:-** how and when to irrigate.

(c) **Engineers:-** to design structures for runoff control (eg storm-water drains, bridges etc

(d) **Scientists:-** Hydrological Modeling of Catchments.

Instruments for measuring precipitation include rain guages and snow guages and various types are manufactored according to the purpose at hand.

Instrument used to Collect and measure the precipitation is called rain guage. and the location at which rain guage is located is called guaging station.

Rain guage:-

Rain guage is type of instrument used by meteorologists and hydrologists to measure rainfall rate in Certain period of time. Rain guages are also known as udometer, pluviometer and ombrometer.

Types of Rain Guages:-

There are two types of rainguages:

(1) Non recording type rain guage.
(2) Recording type rain guage.

(1) Non- Recording type Rain Guage:-

Non-recording type rain guage is most Common type of rain gauge used by meterological department.

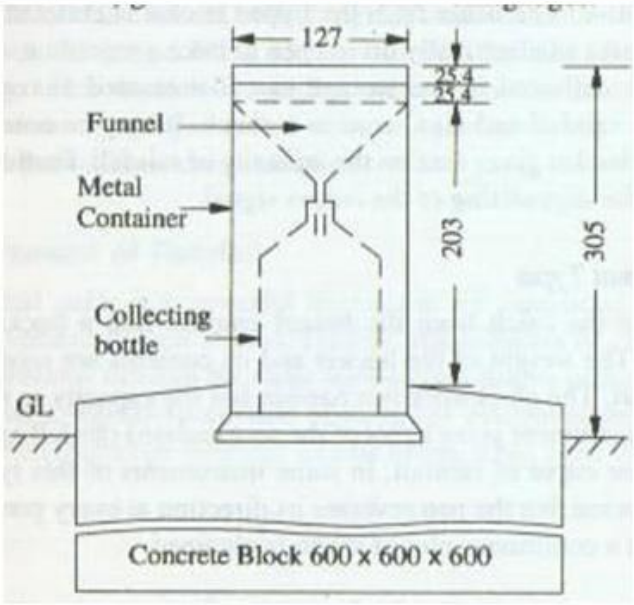
These rain gauges just collect the rain water but donot record the quantity of rainfall - The most extensively used non-recording rain guage is Symon's gauge.

It consists of cylindrical vessel 127mm in diameter with a base enlarged to 210mm diameter.

Circular collecting area of 12.7 cm diameter connected to a funnel. The collect is set in a horizontal plane at a height of 30.5cm above ground level.

The funnel discharges the rainfall catch into a recieving vessel. The funnel and collecting vessel (bottle) are housed in a metallic container.

Rainfall is measured in mm or cm of water depth.



It is a rain gauge which does not provide the distribution of amount of precipitation in a day. It simply gives the amount of precipitation after 24 hours. (daily precipitation) They are known as non-recording because they donot record the rain but collect the rain.

(2) Recording Rain Gauges:-

Recording rain gauges give a permanent automatic record of rainfall. It has a mechanical arrangement by which the total amount of rainfall since the start of record gets automatically recorded on a graph paper.

It produces a plot of Commulative rainfall rainguages since they record Cummulative rainfall.

The recording types raingatges are given as:

(a) Weighing bucket type:-

Weighing bucket type rain guage is most common self recording rain guage. It consists of a reciever bucket supported by a spring or lever balance or some other weighing mechanism.

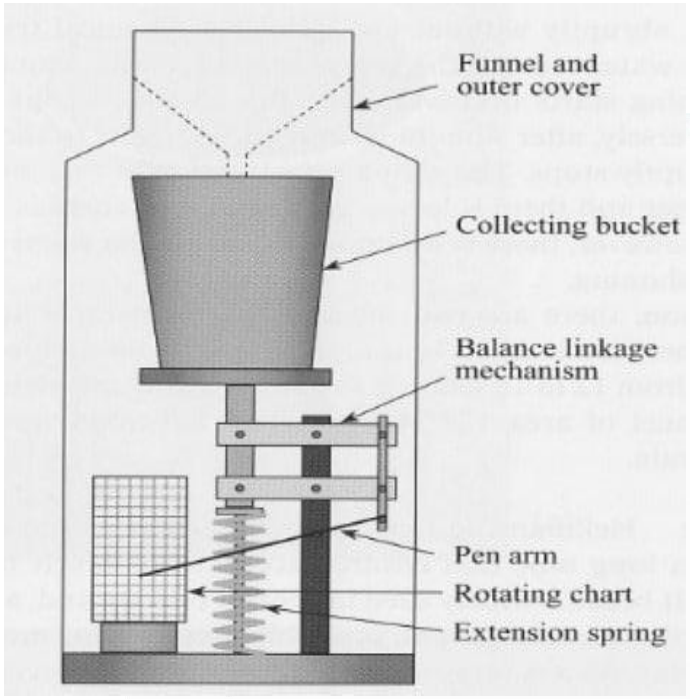
The movement of bucket due to its increasing weight is transmitted to a pen which traces record or some marking on a clock driven chart.

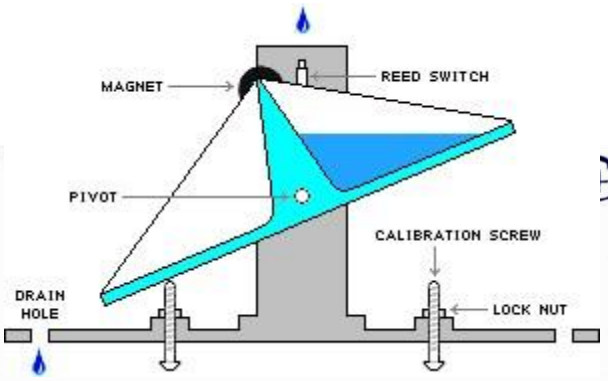
Weighing bucket type rain guage instrument gives a plot of the accumulated increased rainfall values against the elapsed time and the curve so formed is called the mass curve.

(b) Tipping Bucket Type:-

The catch from the funnel falls onto one of a pair of small buckets. These buckets are so balanced that when 0.25mm of rainfalls into one bucket, it tips bringing the outer bucket in position. The water from the tipped bucket is collected in a can. Tipping of bucket completes an electric circuit causing the movement of pen to mark on clock driven recieving drum which carries a recorded sheet. These electric pulses generated are recorded at the control room far away from the rain guage.

Also water collected in the can is measured at regular intervals to check the total rainfall recorded. The record from this rainguage gives the intensity of rainfall.





(c) Floating type recording rain gauge:-

Working is similar to weighing guage bucket. Funnel recieves the rain water which is collected in rectangular Container. Float is provided at the bottom of Container. Float is raised as the water level rises in the Container. Movement of float is being recorded by a pen moving on recording drum.

When the water level in the Container rises so that float touches the top, the siphon comes into operation, and release the water, thus the water in the box is drained out.

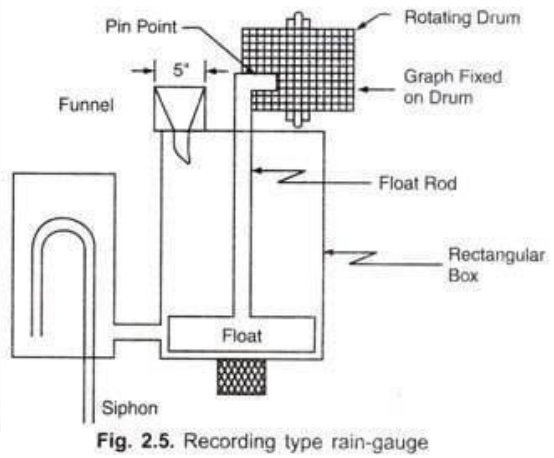


Fig. 2.5. Recording type rain-gauge