INTRODUCTION:

Hydrology means the science of water. It is the science that deals with the occurrence, circulation and distribution or water of the earth and earth's atmosphere. As a branch of earth science, it is concerned with the water in streams and lakes, rainfall and snow fall, snow and ice on the land and water occurring below the earth's surface in the pores of the soil and rocks. In a general sense, hydrology is a very broad subject of an inter-disciplinary nature drawing support from allied sciences, such as meteorology, geology, statistics, chemistry, physics and fluid mechanics. The importance of hydrology in the assessment, development, utilisation and management of the water resources, of any region is being increasingly realised at all levels.

Hydrology is basically an applied science. To further emphasise the degree of applicability. The subject is sometimes classified as

1. Scientific hydrology- the study which is concerned chiefly with academic aspects.
2. Engineering or applied hydrology- a study concerned with engineering applications.

In a general sense engineering hydrology deals with

i. Estimation of water resources.
ii. The study of processes such as precipitation, runoff, evapotranspiration and their interaction and
iii. The study of problems such as floods and droughts and strategies to combat them

WORLD'S WATERRESOURCES:

The World's total water resources are estimated at 1.36×10^8M ha-m. Of these global water resources, about 97.2% is salt water mainly in oceans, and only 2.8% is available as fresh water at any time on the planet earth. Out of this 2.8% of fresh water, about 2.2% is available as surface water and 0.6% as ground water. Even out of this 2.2% of surface water, 2.15% is fresh water in glaciers and icecaps and only of the order of 0.01% is available in lakes and streams, the remaining 0.04% being in other forms. Out of 0.6% of stored ground water, only about 0.25% can be economically extracted with the present drilling technology (the remaining being at greater depths). It can be said that the ground water potential of the Ganga Basin is roughly about forty times the flow of water in the river Ganga.

The geographical area of the country (India) is 3.28 Mkm^2 and the annual runoff (from rainfall) is 167 M ha-m (or 167 × 104 Mm^3), which is approximately two-and half-times of the Mississippi-Missouri river Basin, which is almost equal in area to the whole of India. Due to limitations of terrain, non-availability of suitable storage sites, short period of occurrence of rains, etc. the surface water resources that can be utilised has been estimated as only 67 M ha-m. The total arable land in India is estimated to be 1.47 Mkm^2 which is 45% of the total geographical area against 10% for USSR and 25% for USA. India has a great potential for agriculture and water resources utilisation.

HYDROLOGY AND HYDROLOGIC CYCLE:

Hydrology is the science, which deals with the occurrence, distribution and disposal of water on the planet earth, it is the science which deals with the various phases of the hydrologic cycle. Hydrologic cycle is the water transfer cycle, which occurs continuously in nature; the three important phases of the hydrologic cycle are: (*a*) Evaporation and evapotranspiration (*b*) precipitation and (*c*) runoff and is shown in Figure 1.1. The globe has one-third land and two-thirds Ocean. Evaporation from the surfaces of ponds, lakes, reservoirs, ocean surfaces, etc. and transpiration from surface vegetation *i.e.,* from plant leaves of cropped land and forests, etc. take place. These vapours rise to the sky and are condensed at higher altitudes by condensation nuclei and form clouds, resulting in droplet growth. The clouds melt and sometimes burst resulting in precipitation of different forms like rain, snow, hail, sleet, mist, dew and frost. A part of this precipitation flows over the land called runoff and part infilters into the soil which builds up the ground water table. The surface runoff joins the streams and the water is stored in reservoirs. A portion of surface runoff and ground water flows back to the ocean again. Evaporation starts from the surfaces of lakes, reservoirs and ocean, and the cycle repeats. Of these three phases of the hydrologic cycle, namely, evaporation, precipitation and runoff, it is the ‘runoff phase’, which is important to a civil engineer since he is concerned with the storage of surface runoff in tanks and reservoirs for the purposes of irrigation, municipal water supply hydroelectric power etc.

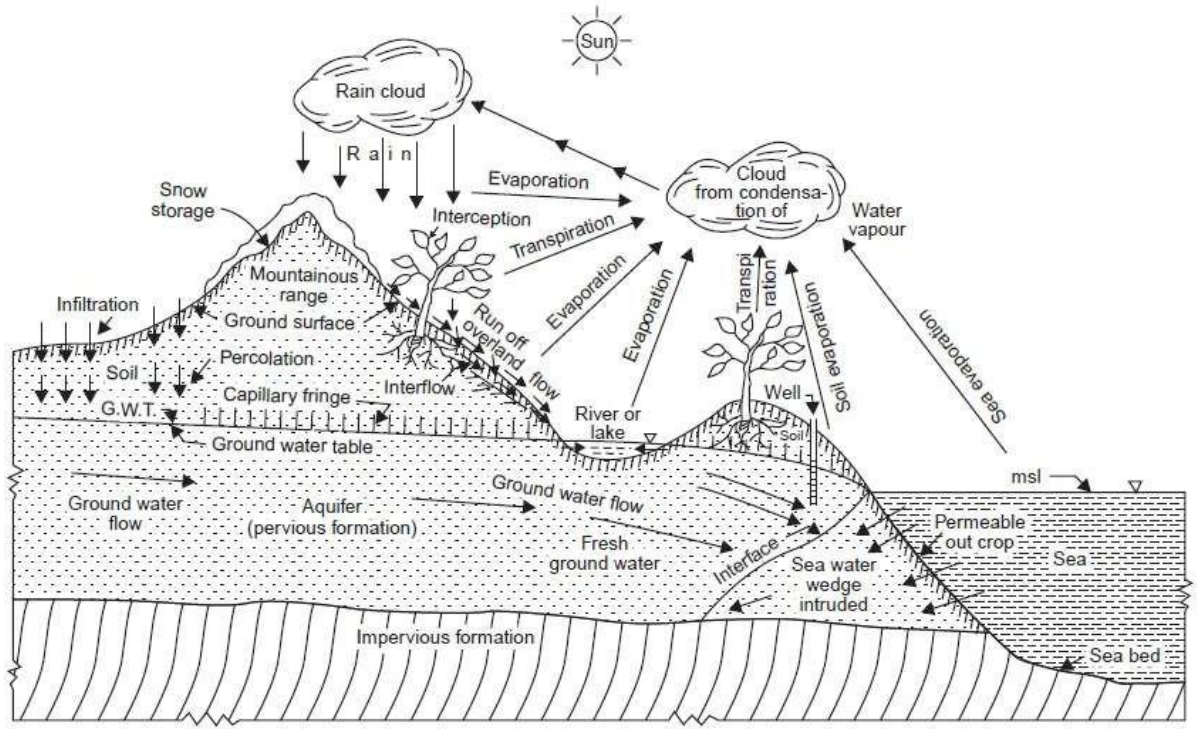

Figure 1: The Hydrologic Cycle

FORMS OF PRECIPITATION:

Drizzle	- a light steady rain in fine drops (0.5 mm) and intensity <1 mm/hr
Rain	- the condensed water vapour of the atmosphere falling in drops (>0.5 mm, maximum size-6 mm) from the clouds
Glaze	- freezing of drizzle or rain when they come in contact with cold objects
Sleet	-frozen rain drops while falling through air at subfreezing temperature.
Snow	-ice crystals resulting from sublimation (*i.e.,* water vapour condenses to ice)
Snowflakes	-ice crystals fused together.
Hail	-small lumps of ice (>5 mm in diameter) formed by alternate freezing and melting, when they are carried up and down in highly turbulent air currents.

SCOPE OF HYDROLOGY:

The study of hydrology helps us to know

i. The maximum probable flood that may occur at a given site and its frequency, this is required for the safe design of drains and culverts, dams and reservoirs, channels and other flood control structures.
ii. The water yield from a basin-its occurrence, quantity and frequency, etc, this is necessary for the design of dams, municipal water supply, water power, river navigation, etc.
iii. the ground water development for which a knowledge of the hydrogeology of the area, *i.e.,* of the formation soil, recharge facilities like streams and reservoirs, rainfall pattern, climate, cropping pattern, etc. are required.
iv. The maximum intensity of storm and its frequency for the design of a drainage project in the area.

HYDROLOGIC EQUATION:

The hydrologic equation is simply the statement of the law of conservation of matter and is given by

$$I = O + \Delta S \text{---------- Eq.1.1}$$

Where I = inflow

O = outflow

ΔS = change in storage

This equation states that during a given period, the total inflow into a given area must equal the total outflow from the area plus the change is storage. While solving this equation, the ground water is considered as an integral part of the surface water and it is the subsurface inflow and outflow that pose problems in the water balance studies of a basin.

PRECIPITATION:

The **precipitation** in the country (India) is mainly in the form of rain fall though there is appreciable snowfall at high altitudes in the Himalayan range and most of the rivers in north India are perennial since they receive snow-melt in summer (when there is no rainfall).

TYPES OF PRECIPITATION:

i. Convective precipitation: This type of precipitation is in the form of local whirling thunder storms and is typical of the tropics. The air close to the warm earth gets heated and rises due to its low density, cools adiabatically to form a cauliflower shaped cloud, which finally bursts into a thunder storm. When accompanied by destructive winds, they are called 'tornados'.

ii. Frontal precipitation: When two air masses due to contrasting temperatures and densities clash with each other, condensation and precipitation occur at the surface of contact, Figure 1.2. This surface of contact is called a 'front' or 'frontal surface'. If a cold air mass drives out a warm air mass' it is called a 'cold front' and if a warm air mass replaces the retreating cold air mass, it is called a 'warm front'. On the other hand, if the two air masses are drawn simultaneously towards a low pressure area, the front developed is stationary and is called a 'stationary front'. Cold front causes intense precipitation on comparatively small areas, while the precipitation due to warm front is less intense but is spread over a comparatively larger area.

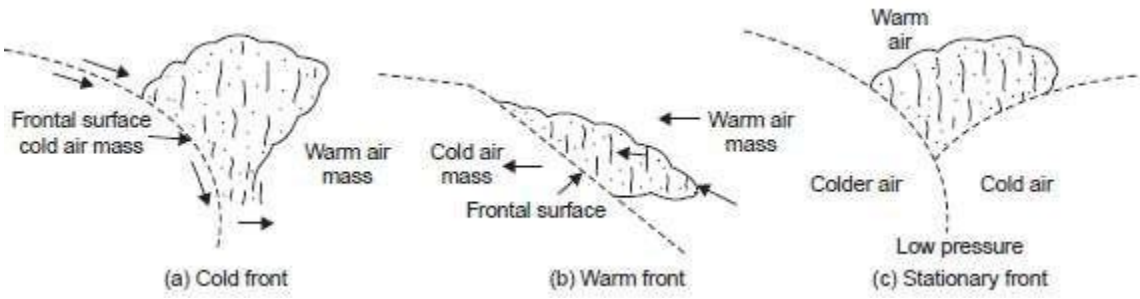

Figure 2: Frontal precipitation

iii. Orographic precipitation: The mechanical lifting of moist air over mountain barriers causes heavy precipitation on the windward side (Figure 1.3). For example

Cherrapunji in the Himalayan range and Agumbe in the western Ghats of south India get very heavy orographic precipitation of 1250 cm and 900 cm (average annual rainfall), respectively.

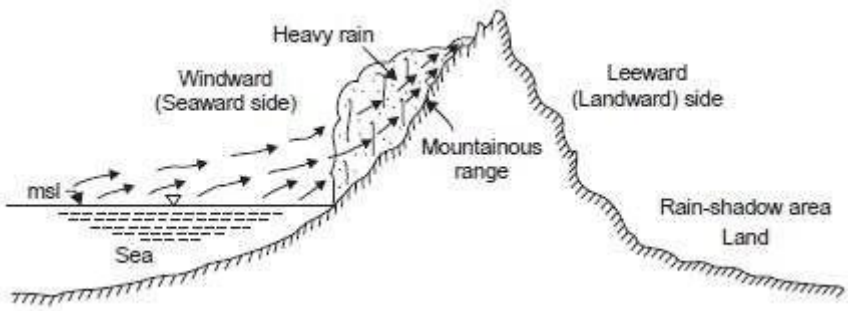

Figure 3: Orographic precipitation

iv. Cyclonic precipitation: This type of precipitation is due to lifting of moist air converging into a low pressure belt, *i.e.,* due to pressure differences created by the unequal heating of the earth's surface. Here the winds blow spirally inward counter clockwise in the northern hemisphere and clockwise in the southern hemisphere. There are two main types of cyclones- tropical cyclone (also called hurricane or typhoon) of comparatively small diameter of 300-1500 km causing high wind velocity and heavy precipitation, and the extra-tropical cyclone of large diameter up to 3000 km causing wide spread frontal type precipitation.