Hydrology

- Hydrology is the science of water which deals with occurence, circulation & distribution of water on earth's surface and its atmosphere.

★ Hydrologic cycle :-

It is the cyclic movement of water in which water moves from one phase to the other having different residence time. in each phase.

The cycle is completed through the processes of precipitation, infiltration, Runoff, evaporation, transpiration etc.

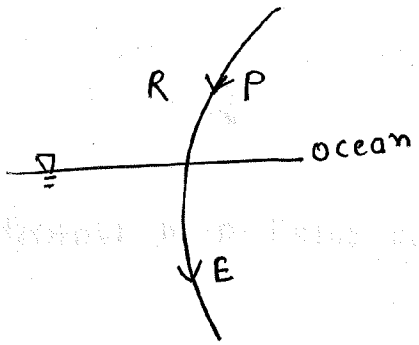
★ Residence Time :-

This is the average time taken by a water particle in crossing one particular phase of the hydrological cycle.

$$t_r \text{ (s)} = \frac{V_{Total}\ \ m^3}{q_{avg}\ \ m^3/s}$$

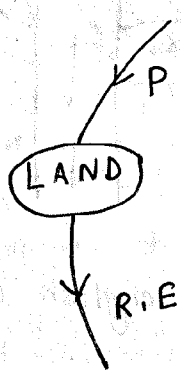
NOTE:

Input = output



$R + P = E$

$\Rightarrow$ $E > P$



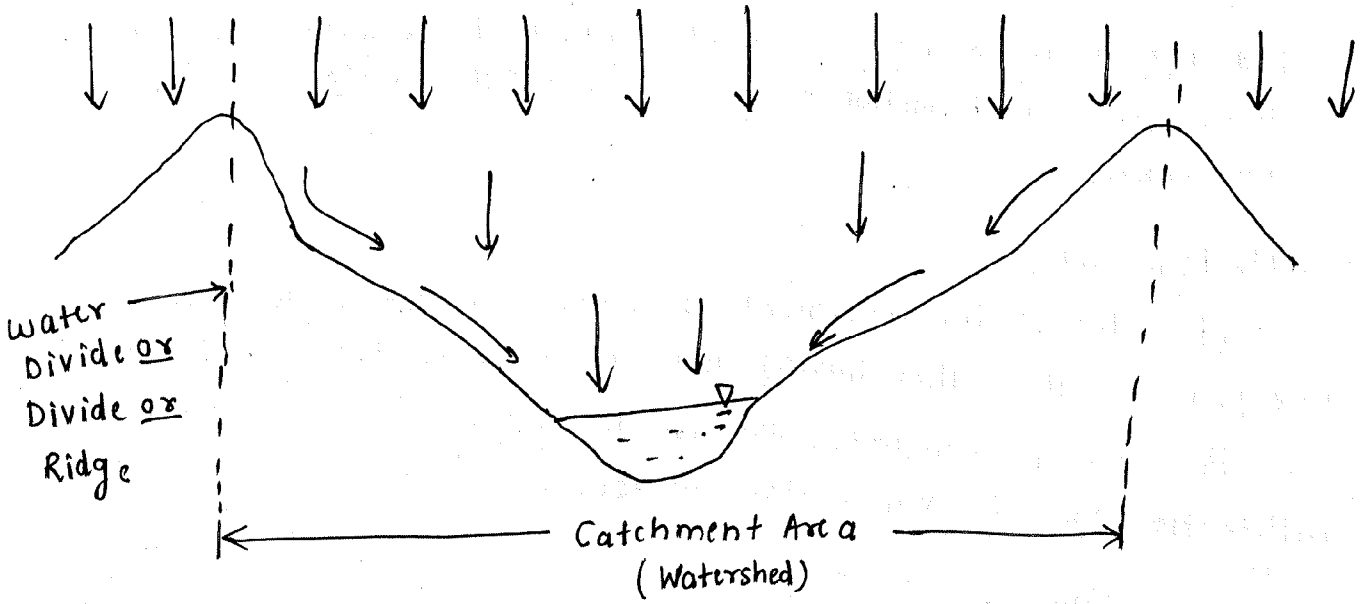
$P = R + E + T$

$\Rightarrow$ $P > E$

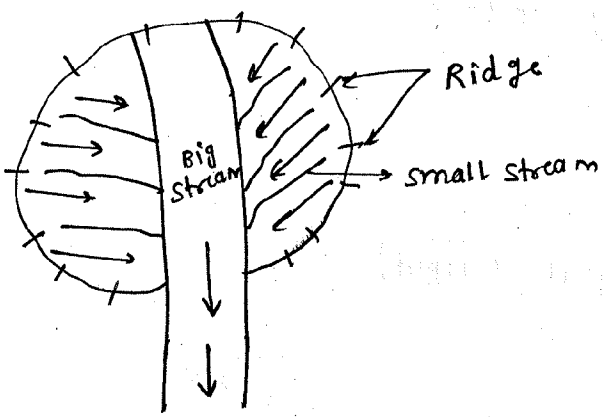
$\Rightarrow$ $P > E + T$

- In the ocean phase evaporation is greater than precipitation (approximately 9 %) whereas on the land mass precipitation is greater than evaporation. (or evapotranspiration).

★ Catchment Area :- / Basin



- Area draining into a river or stream is called catchment area of that river or stream at a particular location.
- Area bounded by a Ridge called Catchment Area.

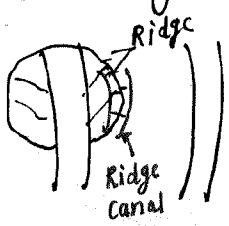


Plain Area → CA ↑
Hilly → CA ↓ (undulation)

NOTE: In American english catchment area is also called as a Watershed

★ Ridge:
It is the line which differentiate/demarked two adjacent catchment Areas.
It is also called as water Divide or Divide.

NOTE:- In British English this is also called as a Watershed.



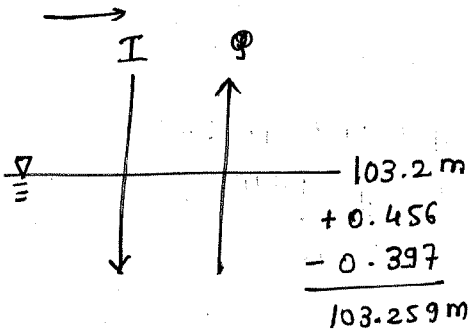
NOTE:- Sun is the source of energy which drives the Hydrological cycle.

★ Water Budget Equation:-

This is based on the law of conservation of mass and its state that difference of inflow and outflow is equal to change in storage.

Mass Inflow ~ Mass outflow = Δ Storage ~→difference

Pg. 84 Ch-2
Q 22]



$I = 6\ m^3/s + 145\ mm$

$= \frac{6 \times 30 \times 24 \times 60 \times 60}{5000 \times 10^4}\ m + 0.145\ m$

$I = 0.456\ m$

$Q = 6.5\ m^3/s + 6.1\ cm$

$= \frac{6.5 \times 30 \times 24 \times 60 \times 60}{5000 \times 10^4}\ m + 0.061\ m$

$Q = 0.397\ m$

|Mass inflow − Mass outflow| = Δ storage

0.456 − 0.397 = 0.059 m → change in storage.

I > Q → Rise in storage

103.2 + 0.456 − 0.397 or 103.2 + 0.059 = 103.259 m

★ World Water Balance :

1386 Mkm^3 ≈ 1400 Mkm^3

→ 96.5% : Ocean
→ 1% : Saline
} ⇒ 97.5%

2.5% of 1400 ⇓ 35 Mkm^3

Approx 1/3rd → 10.6 Mkm^3 liquid

Approx 2/3rd → 24.4 Mkm^3 frozen

⊙ Salinity is expressed as ppt → ‰ (parts per thousands)

NOTE:
About 3/4th of the earth's surface (Approx. 71%) is covered with water

% → ppt
↓
numbers

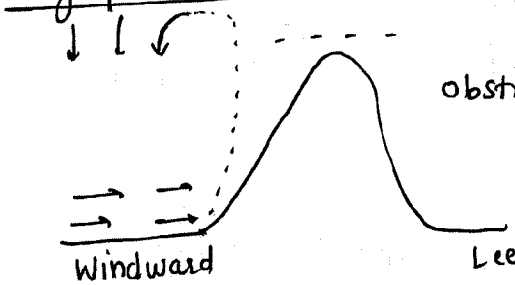
* Precipitation:

It denotes the different processes / forms by which water reaches the earth's surface.

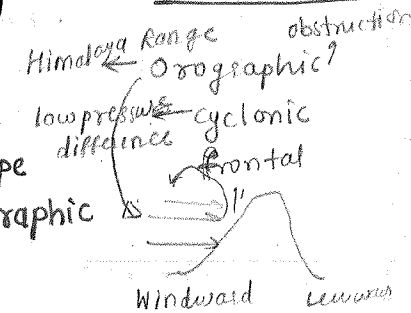
Following are the different types of precipitation.

1) Rain / Rainfall :-
- This is the most dominant form of precipitation in India.
- It denotes water droplets with size varrying from 0.5 - 6 mm

orographic Rainfall :- Himalayan Range

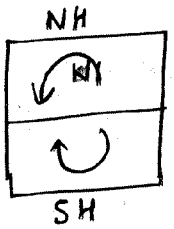


Most important type of Rainfall is orographic Rainfall.

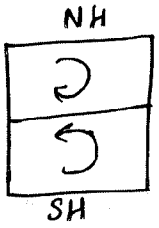


cyclonic :-
- Pressure is low
- wind speed high
- Rainfall high

Voilent weather condn



Anticyclonic :-
Pressure high
low wind velocity
No Rainfall
Mild, pleasant



frontal :-
- two air masses
- cold heavy subsides → heavy
- warm move upward → light

Ex: AC

- On the Basis of intensity Rainfall is classified as follows :-

⑤ Intensity (mm/hr) ***

0 – 2.5 ⟶ Light

2.5 – 7.5 ⟶ Medium

> 7.5 ⟶ Heavy

$V = A_{India} \times 1.2\,m$ → avg depth of rf in India

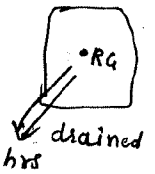
↓

$3.3\,M\,km^2 \Rightarrow 330\,Mhc$

$d = \frac{5mm}{}$

$V = A_{Delhi} \times 5mm$

$q = \frac{V}{10hrs}$



RWH ⟶ TB

NOTE:- In India Rainfall data is collected every day at 8.30 Am and if Rainfall on a particular day is more than 2.5 mm, then that day is known as a Rainy day.

2) Snow / Snowfall :-

This are ice crystals having a density of 0.1 gm/cc

ice → dense/hard

Snow → ↓ hard/dense

3) Drizzle :-

This are fine droplets of water whose size is less than 0.5 mm and intensity is less than 1 mm/hr.

4) Glaze :-

When droplets of water comes in contact with cold ground surface (at sub freezing temp.) then the droplet of water is converted into ice which is called as Glaze.

5) Sleet :-

This are frozen raindrops of transparent nature

6) Hail :-

This are lumps of ice whose size is more than 8 mm.

NOTE: As per international convention lumps of ice greater than 5 mm is called as Hail. Whereas lumps smaller than 5 mm is called as Graupel.

NOTE: Rainfall variation or Variability is least in Regions of Heavy Rainfall.

★ Average Annual Rainfall :-

The amount of Rain collected by a Raingauge in last 24 hrs is called as daily Rainfall & the amount collected in one year is called Annual Rainfall.

Average value of this annual Rainfall for a period of 35 years (or any other suitable time interval) is called as average annual Rainfall.

India's Average Annual Rainfall is approx. 120 cm.

1951-2000
Long period
Avg. (LPA)
Approx. 90cm

★ Index of Wetness:

- This is used to find variation or deviation of Rainfall for a particular year & is given as follows.

$$\text{Index of Wetness} = \frac{\text{Rainfall in a year}}{\text{Avg annual Rainfall}} \times 100$$

Ex:- If in a particular year India receives 90cm of Rainfall then Index of wetness will be $\frac{90}{120} \times 100 = 75\%$ → which implies Rainfall defficiency is 25%

- Rainfall defficiency is further categorised as follows:-

Defficiency (%)	
30 - 45	→ Large
45 - 60	→ Serious
>60	→ Disastrous

- If index of wetness is 100%, it indicates that Rainfall is normal. If it is greater than 100%, it is called as a good year. Whereas If it is less than 100%, it is called as Bad year.

NOTE: Occurence of flood or Drought (which are region specific phenomena) can not be directly corelated with the index of wetness.

ch-1
Q9 P9 78 ⇒ (d) ✓ ⇒ Land necessary for Hydrological cycle.
(b) X ⇒ Land missing ⇒ cyclic moment of water not Hydrological cycle.

Q2 (c) ⇒ ch-1

Q11 (a) z) ch-2

★ Drought:-

This is the climatic situation characterised by less availability of water. The following are the different types of Drought.

1) Metrological Drought:-

- This type of Drought is characterised by deficiency in precipitation.
- If the decrease in precipitation is more than 25% then it is called as Drought. [If it is 25-50% → Moderate Drought
  > 50% → Severe Drought.

- A particular year is called Drought year if Area affected by Drought is more than 20% of a total area of a country.

- If Drought occures in an area with the probability of 0.2 - 0.4 then that area is called as Drough prone area. $P \in (0.2-0.4)$

- If this probability is more than 0.4 then the area is called as chronically drought Prone Area.

NOTE: 33% of india's area comes under the category of either Drought prone or chronically drought prone area.

2) Hydrological Drought :-

- This type of Drought denotes below average value of stream flow, water contaiint in lake, reservoir, under ground water etc.

3) Agricultural Drought :-

- This type of Drought is characterised by deficiency of water which is available for a plants growth.
- This can be calculated by an index called as Aridity Index.

$$\text{Aridity Index} = \frac{PET - AET}{PET} \times 100$$

↓ dry

PET → Potential Evapotranspiration & it is the water consumed by plants is sufficient water is available for a plants growth.

AET → Actual Evapotranspiration & it denotes the actual water . i.e. available & consumed during the plants growth.

- On the basis of Aridity index Region is classified as follows :-

AI (%)	
0-25	→ Mild
25-50	→ Moderate
>50	→ Severe.

NOTE:- Apart from Aridity index certain other indices are also used for denoting Agricultural drought such as Palmer Index & MAI

(Moisture Availability Index).

★ Average Rainfall & Design of Raingauge Station:-

– In order to find average rainfall over an area, a proper distribution of Raingauge stations is required whose network density depends upon the following factors.

1) Magnitude of Rainfall

2) Topography of the Region :

3) Desired level of Accuracy :- Higher the accuracy more the no. of Raingauges

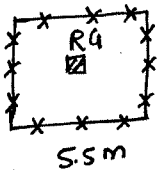
– Rainfall is expressed in terms of depth to which water would stand on an area if all the Rainwater was to be collected on ~~level~~ it

– Rainfall is measured by an instrument called as Raingauge which is also known as Pluviometer, Ombrometer, Hyetometer, & Udometer

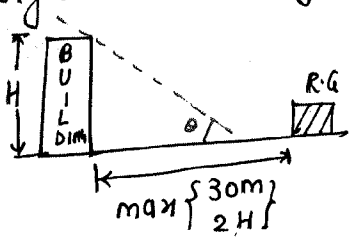
– A Raingauge Basically consist of a cylindrical vessel assembly which is open to the atmosphere in order to collect the Rainwater.

– Following are the requirements which are to be satisfied prior to installation of Raingauge.

i) Raingauge must be installed in an open fenced area of atleast 5.5m x 5.5m.



ii) Raingauge must be installed at a distance of atleast 30m or twice the height of building or obstruction.



$\tan\theta = \frac{H}{2H} = 0.5$ $\quad \theta = \tan^{-1}(0.5)$ $\quad \theta = 26.56^\circ$

↓ max angle of an inclination

iii) Raingauge must be installed on level ground surface which is free from undulations.