

# HYDROLOGY

GATE → (4-6) marks

IES → (6-8) marks (Prelims)

→ (10-20) marks (Conventional)

## Topics :

1. Introduction
2. Precipitation (ppt)\*\*\*
3. Abstraction from Precipitation\*\*\*
4. Surface runoff
5. Stream flow measurement
6. Hydrograph\*\*\*
7. Flood / flood routing
8. Ground water Hydrology

# 1. Introduction

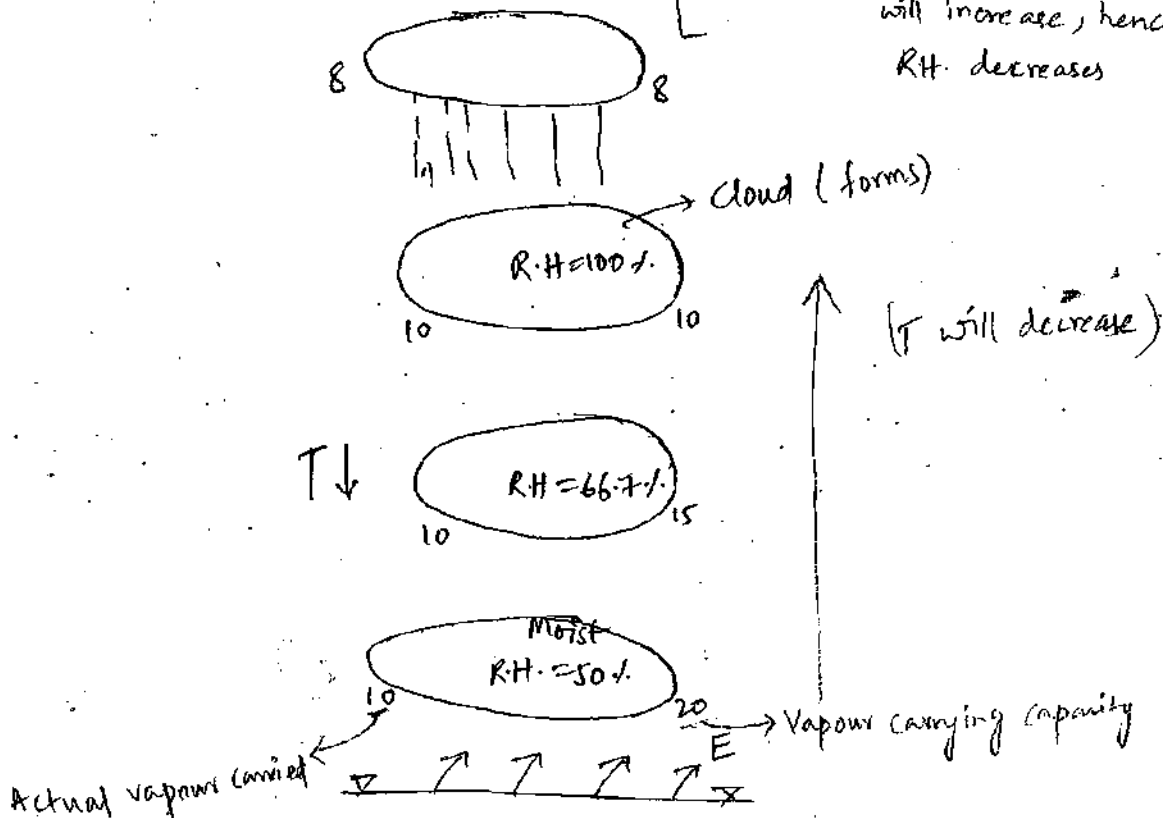
- Hydrology is an earth science involving the study of water of earth
- Hydrological cycle ;
- It is a global sun driven process in which water is transported from Oceans to the Atmosphere then to the land and then back to the sea.
- It is a continuous process with no definite starting point.
- A convenient starting point to describe the cycle is taken as Oceans.
- Extent :- 1 km below the earth surface to 15 km above the earth surface.
- Relative Humidity :- (R.H.)

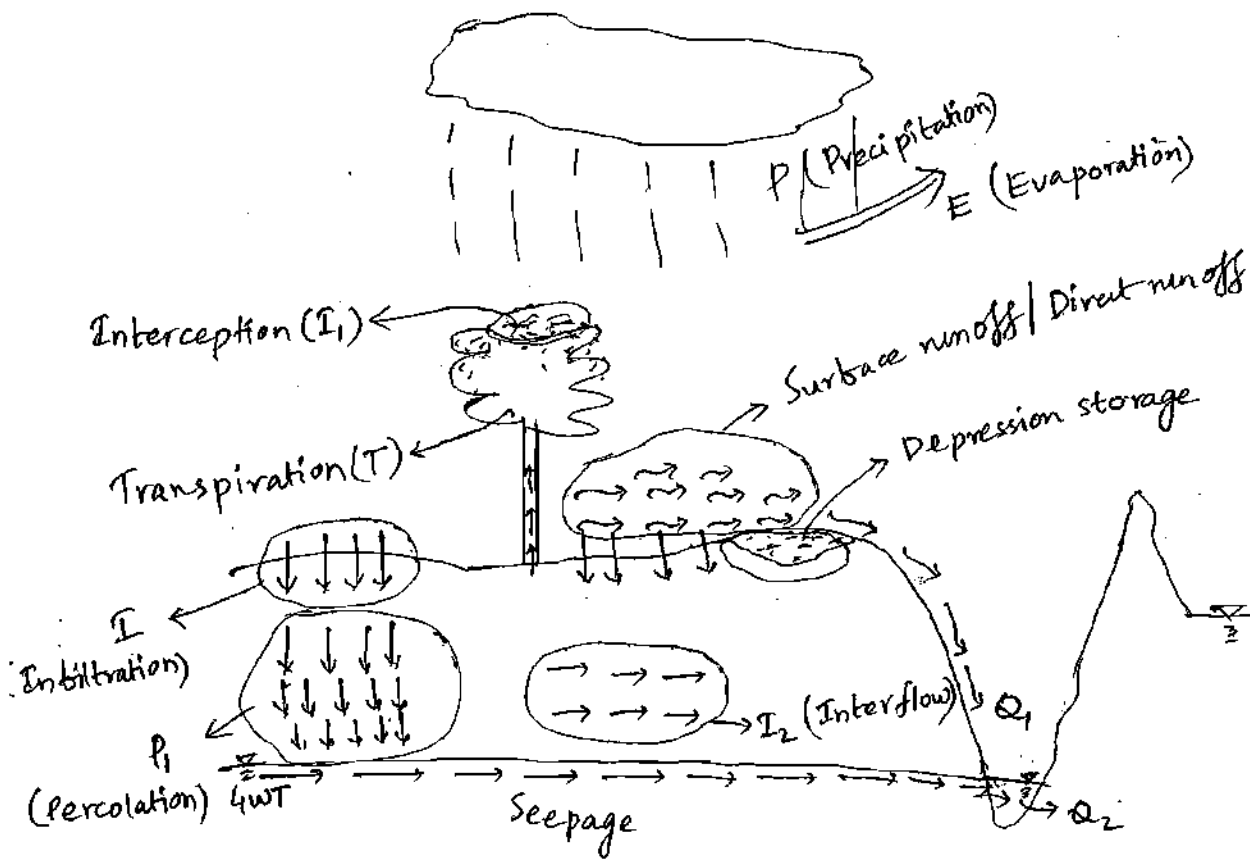
$$R.H = \frac{\text{Actual Vapour carried}}{\text{Vapour Carrying Capacity}}$$

→ with Increase in temp. R.H decreases & vice-versa.

i.e,  $T \downarrow = R.H \uparrow$

→ if  $T \uparrow \rightarrow$  Gases will expand and Vapour carrying Capacity will increase, hence by R.H. decreases





→ due to solar radiation falling on ocean surface water evaporates and mixes with the dry air above making it moist.

→ Moist air being lighter than dry air rises and in the process cools down there by increasing its R.H.

→ Relative Humidity (R.H) subsequently reaches 100% (full saturation).

Any further rise in elevation of moist air causes condensation followed by precipitation.

Some important definition :-

• Evaporation :- (E)

→ change of water from liquid to gaseous state

• Precipitation :- (P)

→ The deposition of water on Earth surface as rain, snow, Hail etc.

↳ (falling of ice while raining)

3. Interception :- ( $I_1$ )

→ short term retention of rain water by vegetation, roof tops, pavements etc.

4. Infiltration :- ( $I$ )

→ movement of water into the soil at the surface

5. Percolation :- ( $P_1$ )

→ movement of water from one soil zone to a lower soil zone.

6. Transpiration :- ( $T$ )

→ It is the water absorbed from the ground and evaporated into atmosphere through leaves.

7. Interflow :- ( $I_2$ )

→ It is the ground water flowing horizontally above the ground water table.

→ It is also known as "Subsurface flow".

8. Depression storage :- ( $D.S$ )

→ rain water accumulated in small depressions and ditches above the surface

9. Surface Runoff :- ( $S.R$ )

→ It is the part of rain which reaches the stream immediately after the rain fall flowing over the surface.

→ It is also sometimes called "Direct Runoff (D.R)", "effective rainfall" or "rainfall excess".

→ Actually D.R. is slightly more than S.R. but for all practical calculations they are taken as same.

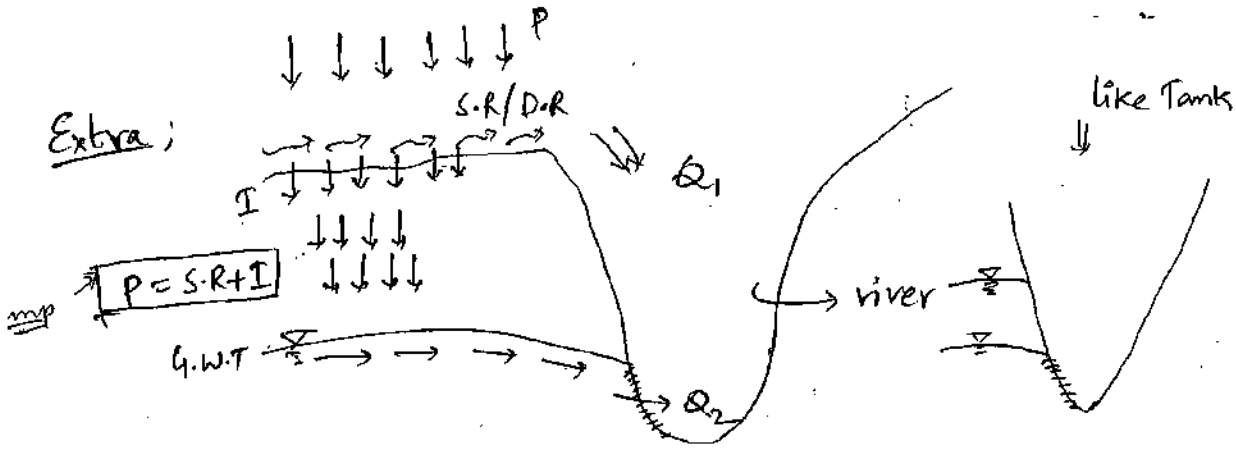
10.  $Q_2$  :-

→ It is the discharge obtained in the stream due to ground water table through seepage. It is known as "Base flow", "Dry weather flow" or

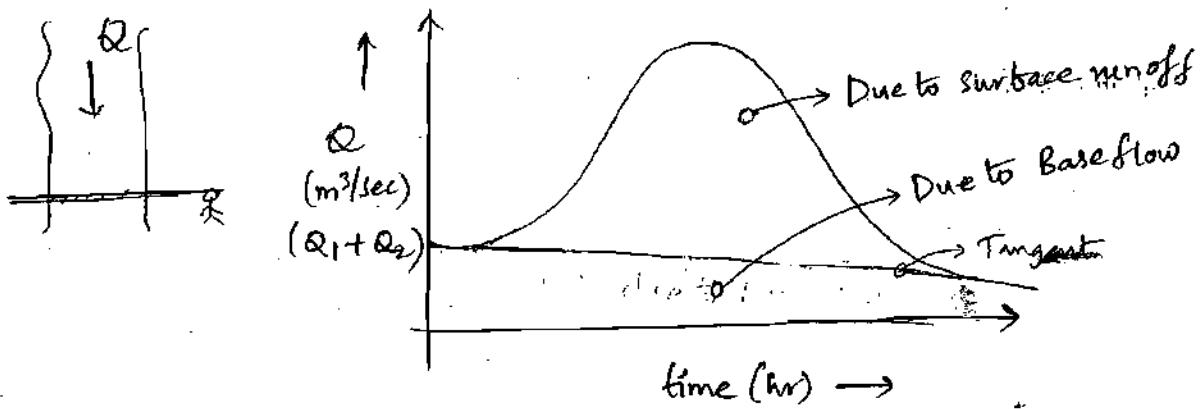
"Effluent seepage".

1.  $Q_1$  :-

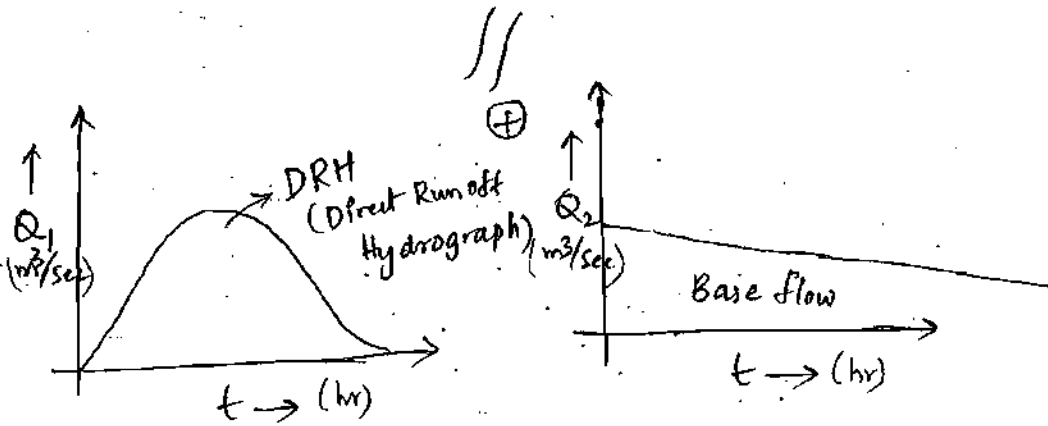
→ It is the discharge obtained in the stream due to S.R or D.R



→ Hydrograph :-



\* flood hydrograph (or) hydrograph



hydrograph ;

It is the plot of discharge against time (i.e,  $Q$  vs  $t$ ).

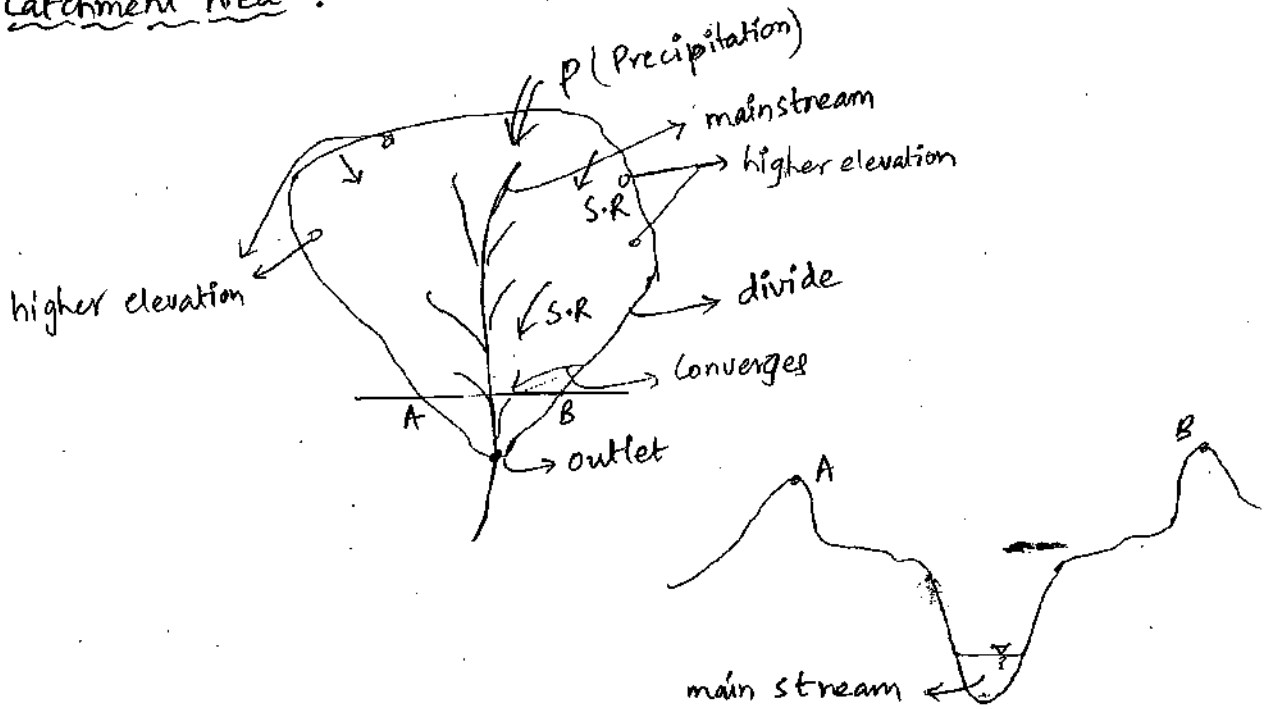
→ Area of Hydrograph gives volume of water,

Hence,  $\text{Area of DRH} = \text{Vol. of S.R. / D.R. / effective rainfall / rainfall excess}$

→ Evaporation from oceans contributes to 40% of atmospheric moisture,

→ In oceans about 9% more water evaporates than falls back as precipitation

→ Catchment Area :-  $\left[ \begin{array}{l} \text{over the oceans there is more evaporation than precipitation} \\ \text{on land it is more precipitation} \end{array} \right]$



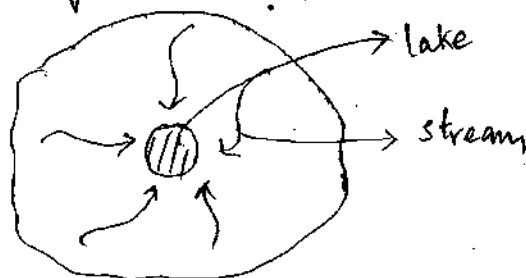
→ Catchment Area is a area of land where surface water from rain and melting snow converges to a single point known as "Catchment outlet".

Where the water joins another water bodies like lake, river (or) ocean

→ Catchment Area is also known as "water shed", "river Basin" (or) "Basin".

→ Closed Catchment :-

→ All water converges to a single point inside the Basin



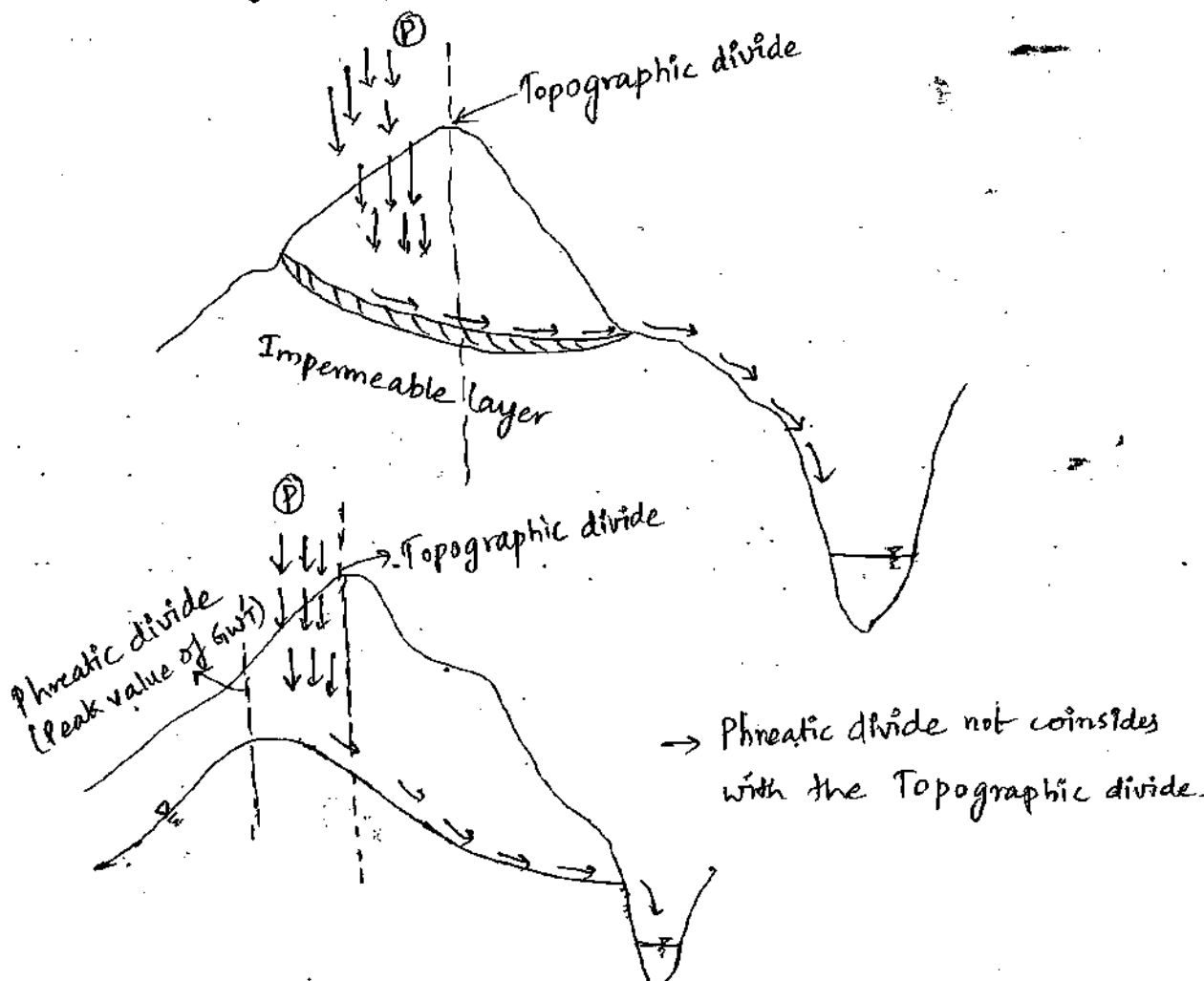
→ Each catchment is separately Topographically from adjacent catchment by geographical barrier such as Ridge (elevated land), Hills or Mountains.

→ The line which divides the surface runoff between two adjacent catchments is called "Topographic divide, Water shed divide, water divide, or Divide".

→ The Divide follows the Ridge line crossing the main stream only at the outlet.

→ Catchment leakage :-

→ when runoff at the outlet of one catchment contains contribution from precipitation falling on adjacent catchment through subsurface runoff catchment leakage is said to occur.



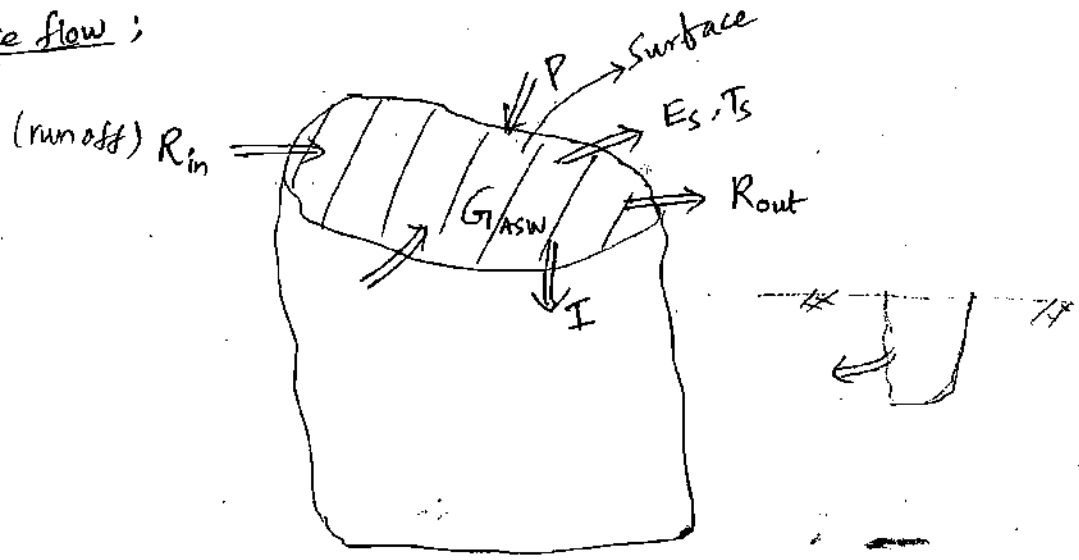
⇒ Hydrological Budget or Water Budget :- [the balance between water gains and losses in certain basin]

→ It is based on "Law of Conservation of Mass"

→ It states that,

$$\text{Mass Inflow} - \text{Mass outflow} = \text{Change in storage}$$

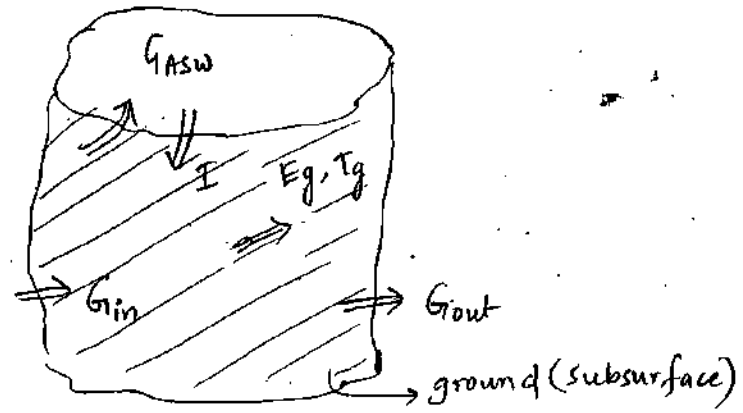
for surface flow ;



$G_{ASW}$  → Ground water. Appearing as surface water

$$(P + R_{in} + G_{ASW}) - (R_{out} + I + E_s + T_s) = \Delta S_{surface}$$

for Ground flow ;



$$(I + G_{in}) - (G_{ASW} + G_{out} + E_g + T_g) = \Delta S_{ground}$$



adding above two equations we have,

$$(P + R_{in} + G_{in}) - (R_{out} + G_{out} + E_s + E_g + T_s + T_g) = \Delta S_{total}$$

$$P - (R_{out} - R_{in}) - (E_s + E_g) - (T_s + T_g) - (G_{out} - G_{in}) = \Delta S$$

$$\rightarrow \boxed{P - R - E - T - G = S}$$

Where,  $P \rightarrow$  Total precipitation

$R \rightarrow$  Net Runoff out

$E \rightarrow$  Total Evaporation

$T \rightarrow$  Total Transpiration

$G \rightarrow$  Net ground water outflow

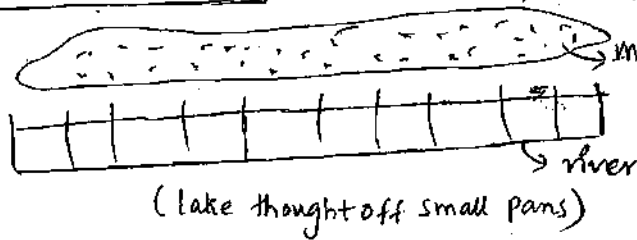
$S \rightarrow$  change in storage (final - initial)

$\rightarrow$  Imp Points

i) Precipitation as rainfall is expressed in terms of depth of rainfall over the horizontal projection of the Area.

$$\boxed{\text{Depth of rainfall} = \frac{\text{Volume of rain}}{\text{Area}}}$$

i)



$$\boxed{\text{Lake evaporation} = \text{Pan evaporation} \times \text{Pan coefficient} (\leq 1)}$$

$\rightarrow$  Pertinent to the realization of hydrological cycle ;

i) Latitudinal difference in solar heating of the earth surface

ii) Inclination of the Earth's axis

iii) Uneven distribution of land and water.

iv) Coriolis effect.

$\rightarrow$  Chemical symbol for Ice (as per UNESCO) is H<sub>2</sub>O