Water losses

Short Notes:

Intereeption loss:
Loss of water due to surface vegetation or held by Plant leaves.

* Evaporation:

Loss of water from water surface i.e reservoirs, lakes, ponds, river channel and from soil surface when water table is very close to the soil surface, is known as Evaporation.

* Transpiration:

Water loss from plant leaves is called Transpiration

* Evapotranspiration:

Water loss from both the land surface and plants of an cropped land or irrigated land

* Infiltration:

Water which is absorbed into the ground surface.

* Watershed leakage:

~~Wat~~ Ground water movement from one basin to another or to the sea.

** Interception loss: (Short Notes)

The precipitation intercepted by
- foliage (Plants, leaves, forests)
- buildings

and returned to atmosphere (by evaporation from leaves) without reaching the ground surface is known as Interception loss.

(i) Intereption loss high is in the beginning in the beginning of storms and gradually decreases

(ii) The loss is of the order of 0.5 to 2mm per shower

(iii) Interception loss is higher for light rain & continuous rain.

(iv) Effective rain = Rainfall - Interception loss

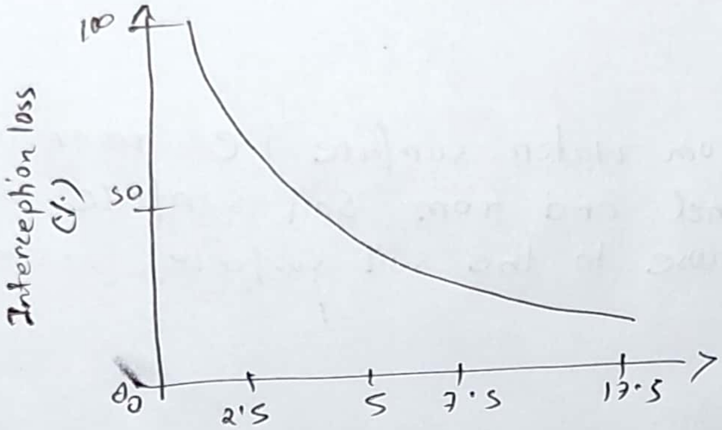


Fig. Interception loss (Horton's mean curve)

Methods of Estimating Lake evaporation:

(i) Storage Equation: $P + I \pm O_g = E + O \pm S$

(ii) Auxilary pans. Ex: Land pans, floating pans colorado sunken pans.

(iii) Evaporation formula (Dalton's law)

(iv) Humidity & wind velocity Gradients

(v) The energy budget
- too many meteorological factors
- too much instrumentation
- needs specialist approch

(vi) The water budget

(vii) Combination of aerodynamic and energy blance equations - Penman's equation.

P = Precipitation
E = Evaporation
I = Surface Inflow
O = Surface Outflow
O_g = Subsurface in/outflow
S = change in surface water storage.

Evaporation pans:

* Pan coefficient = $\frac{\text{Lake evaporation (mm)}}{\text{Pan evaporation (mm)}}$ (0.67 ~ 0.82) or 0.7

* Mean water spread of a Lake, $A_{ave} = \frac{1}{3}(A_1 + A_2 + \sqrt{A_1 A_2})$

* Infiltration loss F_P (mm) = Rainfall (R) (mm) − Runoff (R_r) (mm)

* Average Infiltration Rate, $f_{ave} = \frac{F_P}{t}$

* Yield = CAP ; C = runoff coefficient
  A = area of basin
  P = total Precipitation
  Y = yield of basin or Runoff

Ex: 3.1

Pan evaporation = 16.7 + 14.3 + . . . + 16.7 = 228.7 cm

∴ We know,

Pan coeff = $\frac{\text{Lake evaporation}}{\text{Pan evaporation}}$

⇒ Lake evaporation = 0.7 × 228.7 cm = 160.09 cm = 1.609 m

mean water spread of lake, $A_{avg} = \frac{1}{3}(A_1 + A_2 + \sqrt{A_1 A_2})$

$= \frac{1}{3}(2.8 + 2.55 + \sqrt{2.8 \times 2.55})$

$= 2.674$ km^2

$= 2.674 \times 10^6$ m^2

∴ Annual water evaporation in Volume = $A_{avg} \times E$

$= 2.674 \times 10^6 \times 1.609$

$= 4.278$ Mm^3 Ans.

Ex: 3.1(a)

Day :	1	2	3	4	5	6	7
Pan Evaporation :	14-5	6+3	12	8	0	5+4	6+3
E_p	=9	=9	12	8	7	9	9

∴ Total, $E_p = 63$ mm

We know,

$$\text{Pan coeff} = \frac{\text{Lake evap.}}{\text{Pan evap.}}$$

$$\Rightarrow 0.75 = \frac{E_L}{E_p}$$

$$\Rightarrow E_L = 0.75 \times E_p = 0.75 \times 63 = 47.25 \text{ mm}$$

∴ Volume of loss $= E_L \times A$

$$= \frac{47.25}{1000} \times 640 \times 10^4$$

$$= 0.3 \text{ Mm}^3$$

Ans.

Ex: 3.1(b)

(i) Here, Runoff $(R) = \frac{21.6 \times 10^6}{300 \times 10^6} = 0.072$ m

Rainfall $(P) = 15 \times 10^{-3} \times 6 = 90 \times 10^{-3}$ m

∴ Infiltration loss, $F_p = P - R$

$= ~~0.072 - 90 \times 10^{-3} \text{ m}~~ =$

$= 90 \times 10^{-3} - 72 \times 10^{-3} = 18 \times 10^{-3}$ m $= 18$ mm

∴ Infiltration ratio, $f_{avg} = \frac{F_p}{t} = \frac{18}{6}$ mm/hr

$= 3$ mm/hr

(ii) Yield = CAP

$\Rightarrow 21.6 \times 10^6 = C \times 300 \times 10^6 \times 90 \times 10^{-3} m$

$\therefore C = 0.8$ Ans.

Measures to Reduce Lake Evaporation:

(i) storage reservoirs with more depth, less area
- water is relatively cool in deep
- less prone to temperature gradient.

(ii) By growing tall trees - Causerina by the windward side
- acts as wind breaker

(iii) By spraying chemicals or fatty acids
- spready acetyl alcohol ($C_{16}H_{33}OH$)
- a thin film is formed of 0.015 micron
- It's a polar compound and is hydrophilic in one side & hydrophobic on other.
- This film will allow precipitation from top but wont allow molecules to escape
- Only aplicable for less velocity
- About 2.2kg $C_{16}H_{33}OH$ needed for 1ha of area.
- best for small & medium reservoir

(iv) By allowing flow of water - temp & evap reduced

(v) " removing water loving weeds & plants
- Phreatophytes

(vi) By straighliy – less surface area

(vii) By mechanical coverings – polythene

(viii) By underground reserovbi's

(ix) By surrounding with huge trees and forest.

Soil Evaporation:

The evaporation of water molecules from a wet soil immediately after rainfall on escape of water with more resistance from soil when water table lies within a 1m from surface is known as soil evaporation.

– will continue at hight rate right after rain
– reduces as surface starts drying

Evaporation Opportunity:

Ratio of soil evaporation and free water surface is called evaporation opportunity.

$$\therefore \text{Evaporation Opportunity} = \frac{\text{Average evap. from land}}{\text{Evap from area equivalent water surface}} \times 100\%$$

Transpiration:

Transpiration is the process by which water vapour escapes from the living plant leaves and enters the atmosphere.

* Transpiration Ratio: is the ratio of weight of water absorbed, conveyed through and transpired from a plant during the growing season to the weight of dry ~~body~~ matter produced

$$\therefore \text{Transpiration Ratio} = \frac{\text{weight of water transpired}}{\text{weight of dry matter produced}}$$

Evaporontranspiration:

or consumptive use is the total water lost from a cropped land by evapotranspiration from soil and transpiration by plants.

Potential evapotranspiration: — from short green vegetation
— supplied with unlimited water covering the soil.

Estimation of evaporation:

Factors affecting:

(i) Climatological factors:
- wind speed
- Humidy
- sunshine hours
- mean monthly temperature

(ii) Crop factors
- type of crop
- percentage of crop growing season

(iii) moisture level.

Infiltration:

Water entering the soil ~~entering~~ at ground surface is called Infiltration.

— replinishes soil moisture deficiency

f (cm/hr)

Deep seepage / Percolation:

After Infiltration, movement of excess water downward by the force of gravity called deep seepge.

Infiltration Capacity (f_p):

The maximum rate at which any soil is capable of absorbing water.

Horton's Equation:

The infiltration rate (f) at any time t,

$$f = f_c + (f_0 - f_c)e^{-kt}$$

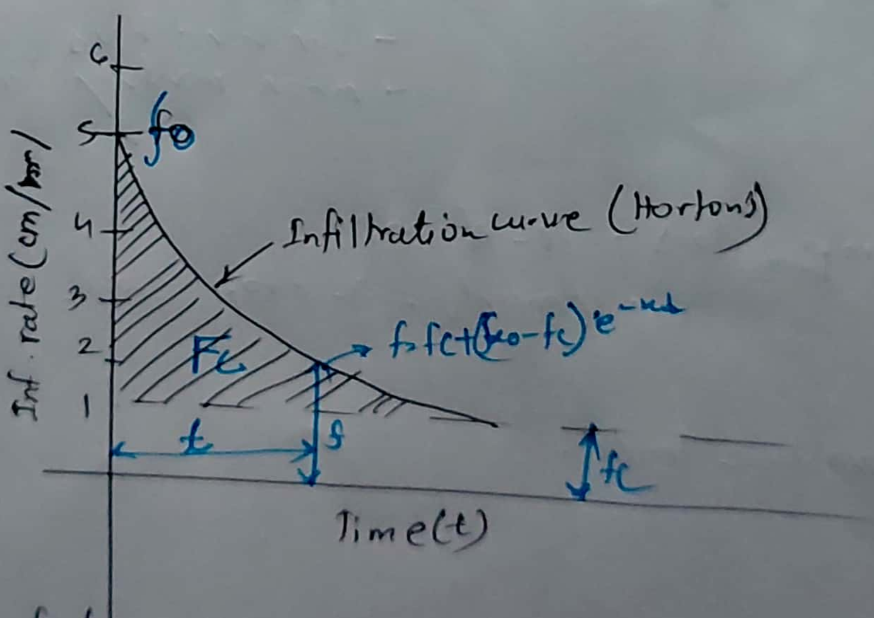
$$k = \frac{f_0 - f_c}{F_c}$$

f_c = final/ultimate rate of inf

f_0 = initial

k = Constant depends on soil & vegetation

Infiltration Curve:



When $i \geq f_p$, $f = f_p$

When $i < f_p$, $f < f_p$

Factors of infiltration:

(i) Intensity & duration of rainfall.
(ii) Weather
(iii) Soil charecteristics
(iv) vegetal cover
(v) land use
(vi) Initial soil moisture content
(vii) Entrapped air
(viii) Depth of G.W.T

Double Ring Infiltrometer:

(i) The two rings are driven into the soil by a driving plate and a hammer uniformly to a depth of 15cm.

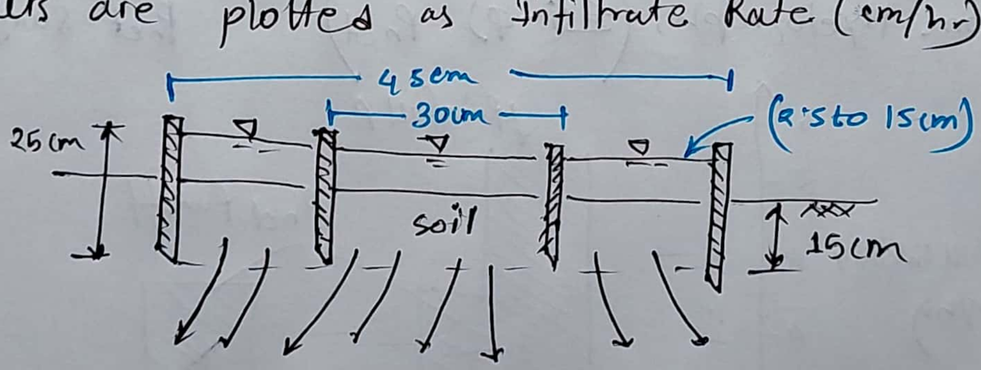
(ii) After driving, any disturbed soil is is tamped with a metal tamper.

(iii) Point gauges are placed in the centre of the rings

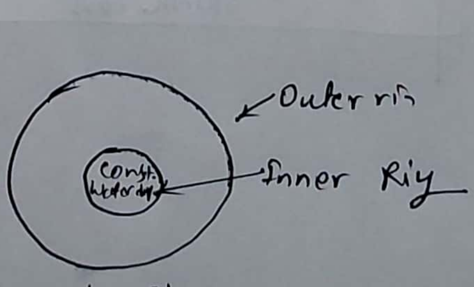
(iv) Water is poured into the rings to main a desired depth 2.5cm to 15cm

(v) Water is added at regular time intervals of 5, 10, 15, 20, 30, 45, 50 min for at least 6 hours.

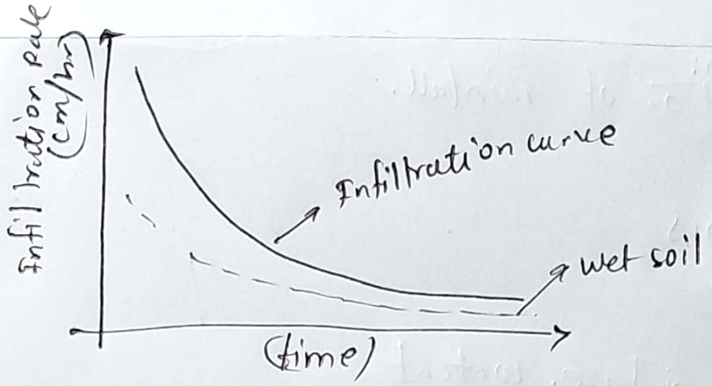
(vi) Results are plotted as Infiltrate Rate (cm/hr) to time



Section:



b. Plan



Infiltration Indices:

(i) **φ index:** Defines as the rate of rainfall above which rainfall volume = runoff volume.

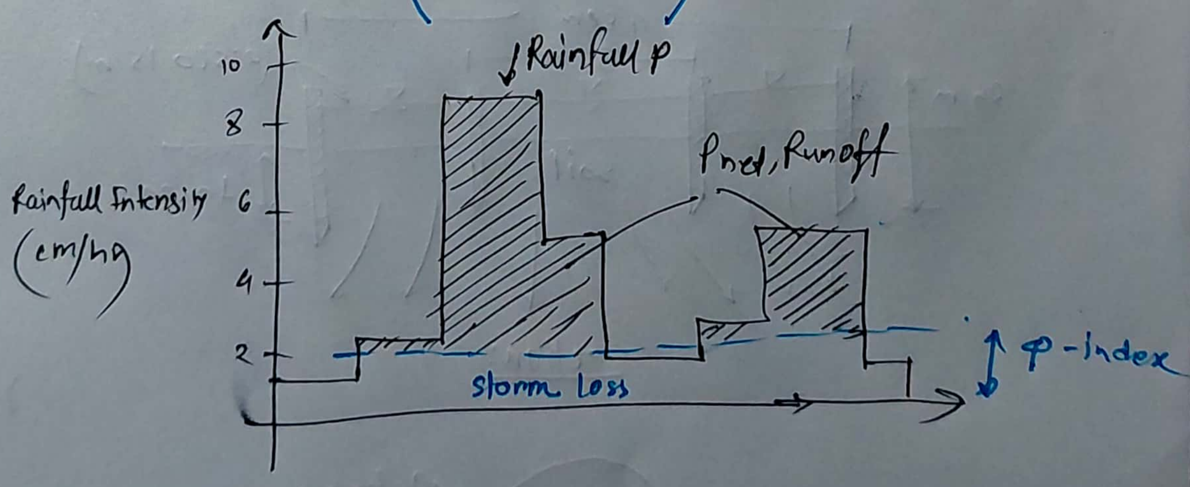
$$\varphi\text{-index} = \frac{\text{basin recharge}}{\text{duration of rainfall}}$$

→ **Hyetograph:** The bar graph showing distribution of rainfall, storm loss & rainfall excess is called Hyetograph.

— Thus φ-index divides the rainfall into net rain and storm loss

— Througout the storm $i > \varphi$

— from Hyetograph, $\left(\sum(i-\varphi) = P_{net}\right)$ P_{net} = surface Runoff



(iii) W-index:

is the average infiltration rate for which Rainfall Intensity exceeds > infiltration capacity rate

$\therefore i > f_p$

$$\therefore W\text{-index} = \frac{P - R - S}{t_R} = \frac{F_P}{t_R}$$

$$\left[F_P = P - R - S \quad ; S = 0 \quad \therefore F_P = P - R \right]$$

P = total rainfall (cm, mm)

R = Runoff (cm, mm)

* φ > W always
* তাই W এর ~~[illegible]~~ কম মান φ এর calculation এ নেয়া যাবে না