

23CE506: HYDROLOGY AND WATER RESOURCES ENGINEERING

Topic: Abstractions from precipitation

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Introduction to Abstractions

- Abstractions are losses of precipitation before it becomes runoff.
- Major abstractions: evaporation, transpiration, interception, depression storage and infiltration.

Hydrological Water Balance

- $\text{Precipitation} = \text{Interception} + \text{Depression storage} + \text{Infiltration} + \text{Runoff} + \text{Evapotranspiration}$.
- Understanding losses is essential for runoff estimation.

Evaporation – Definition

- Evaporation is the process by which water changes from liquid to vapour due to solar energy.
- It occurs from water bodies, soil and vegetation surfaces.

Factors Affecting Evaporation

- Temperature
- Relative humidity
- Wind velocity
- Solar radiation
- Atmospheric pressure
- Surface area of water body

Measurement of Evaporation

- Evaporation is measured using evaporimeters.
- Common instrument: evaporation pan.
- Daily evaporation is measured as depth of water lost.

Types of Evaporimeters

- Class A pan evaporimeter
- ISI standard pan
- Colorado sunken pan
- Floating pan evaporimeter

Pan Coefficient

- Pan evaporation is converted to lake evaporation using pan coefficient.
- Lake evaporation = Pan coefficient $\times$ Pan evaporation.

Estimation of Evaporation

Methods:

- Water budget method
- Energy balance method
- Mass transfer method
- Combination methods

Reservoir Evaporation

- Reservoirs lose considerable water due to evaporation.
- Important in water resources planning.

Reduction of Reservoir Evaporation

- Reduce exposed water area
- Floating covers
- Chemical monolayers
- Wind breakers

Evapotranspiration

- Evapotranspiration is combined loss of water through evaporation and plant transpiration.

Potential and Actual ET

- PET: Evapotranspiration under unlimited water supply conditions.
- AET: Actual evapotranspiration under existing moisture conditions.

Methods of ET Estimation

- Lysimeter method
- Water balance method
- Penman method
- Blaney–Criddle method

Penman Method

- Based on energy balance and aerodynamic factors.
- Widely used for estimating potential evapotranspiration.

Blaney–Criddle Method

- Empirical method based on temperature and percentage of daylight hours.

Interception

- Rainfall captured by vegetation before reaching ground surface.
- Important components: interception loss, throughfall and stem flow.

Factors Affecting Interception

- Type of vegetation
- Density of vegetation
- Storm characteristics
- Season

Depression Storage

- Water stored in small surface depressions after rainfall.
- It is lost by infiltration and evaporation.

Infiltration – Definition

- Infiltration is the entry of water into soil through the ground surface.

Infiltration Capacity

- Maximum rate at which soil can absorb water at a given time.
- Depends on soil properties and moisture condition.

Factors Affecting Infiltration

- Soil texture
- Vegetation cover
- Rainfall intensity
- Soil moisture
- Temperature
- Land use

Measurement of Infiltration

- Simple infiltrometer
- Double ring infiltrometer
- Rainfall simulator

Double Ring Infiltrometer

- Two concentric rings are used.
- Outer ring reduces lateral spreading of water.
- Inner ring measures infiltration.

Infiltration Indices

- ϕ -index: Average infiltration rate during a storm.
- W-index: Average infiltration rate excluding initial losses.

Runoff – Definition

- Runoff is the portion of precipitation that reaches streams, rivers and other water bodies.

Types of Runoff

- Surface runoff
- Subsurface runoff (Interflow)
- Groundwater runoff

Factors Affecting Runoff

- Rainfall intensity and duration
- Catchment size and shape
- Slope
- Soil characteristics
- Vegetation
- Storage facilities

Runoff Coefficient

- Ratio of runoff volume to rainfall volume.
- Depends on catchment characteristics.

Basin Yield

- Total quantity of water available from a drainage basin during a specified period.

SCS Curve Number Method

- Used for estimating direct runoff.
- Depends on rainfall, soil group, land use and antecedent moisture condition.

Flow Duration Curve

- Shows relationship between discharge and percentage of time flow is exceeded.
- Used in water supply and hydropower studies.

Mass Curve of Runoff

- Graph of cumulative runoff volume against time.
- Slope represents discharge.

Watershed Management

- Scientific management of land and water resources within a watershed.

Watershed Conservation Measures

- Contour farming
- Check dams
- Afforestation
- Rainwater harvesting