Chapter 24: Interception

Introduction

In the hydrological cycle, not all precipitation directly reaches the ground surface. A portion of it is intercepted by vegetation, buildings, and other surface features, temporarily held before it either evaporates or eventually reaches the ground. This process is known as **interception**. Interception plays a crucial role in determining the amount of rainfall that contributes to surface runoff, infiltration, and groundwater recharge. Understanding interception is essential for accurate hydrological modeling, watershed management, irrigation planning, and flood forecasting.

24.1 Definition of Interception

Interception is the process by which precipitation is caught and held by foliage, branches, trunks of vegetation, and man-made structures. This captured water may:

- Evaporate directly back to the atmosphere (interception loss),
- Drip to the ground (throughfall),
- Flow down plant stems or trunks to the ground (stemflow).

Interception is especially significant in forested and vegetated areas where a substantial portion of rainfall may never reach the soil surface.

24.2 Components of Interception

Interception includes the following major components:

1. Interception Loss

The portion of precipitation that is retained on leaves, stems, and branches and is lost through evaporation before reaching the ground.

2. Throughfall

The portion of precipitation that directly reaches the ground through gaps in vegetation or drips from the canopy after storage capacity is exceeded.

3. Stemflow

The portion of precipitation that flows down the stems and trunks of vegetation and reaches the ground near the plant base.

24.3 Factors Affecting Interception

Several factors influence the amount of interception loss. These include:

1. Type and Density of Vegetation

- Broadleaf trees intercept more water than conifers due to their wider leaves.
- Dense forest canopies have higher interception than sparse grasslands or croplands.

2. Storm Characteristics

- **Rainfall Intensity**: Light, steady rain results in more interception than heavy, short bursts, as the canopy may reach saturation quickly in the latter.
- **Rainfall Duration**: Longer events may saturate the canopy, decreasing interception loss after a point.

3. Meteorological Conditions

- **Temperature** and **wind speed** influence evaporation rates.
- **Relative humidity** affects how quickly intercepted water evaporates.

4. Seasonal Variation

- In deciduous forests, interception is higher during the growing season than in winter when trees are bare.

5. Canopy Storage Capacity

- Each plant type has a maximum amount of water it can hold before dripping begins. This is termed the **canopy storage capacity**.

24.4 Interception in Different Land Covers

1. Forests

- Interception can account for **10%–40%** of total annual precipitation.
- Evergreen forests usually show higher year-round interception.

2. Agricultural Crops

- Interception is generally lower, typically **5%–15%**, but varies with crop type and growth stage.

3. Grasslands

- Less interception due to shorter and sparse canopy. Values may range around **5%–10%**.

4. Urban Areas

- Man-made structures can intercept rainfall but often lead to immediate runoff due to impervious surfaces.

24.5 Measurement of Interception

Interception is not measured directly; instead, it is inferred using indirect methods:

1. Gross Precipitation (Pg)

Measured by standard rain gauges in open areas away from obstructions.

2. Throughfall (Tf)

Measured by placing collectors beneath vegetation to quantify how much rain reaches the ground.

3. Stemflow (Sf)

Captured by fitting collars or spiral tubes around tree trunks to channel water into measuring containers.

The **interception loss (I)** is calculated as:

$$I = Pg - (Tf + Sf)$$

24.6 Estimation Methods

1. Empirical Methods

Empirical equations based on field observations, such as:

$$I = P \times C$$

Where:

- I = Interception loss
- P = Precipitation
- C = Interception coefficient (depends on vegetation type)

Typical C values:

- Dense forest: 0.15 – 0.35
- Crops: 0.05 – 0.15
- Grass: 0.03 – 0.10

2. Simulation Models

- **Gash Model**: Widely used for estimating interception in forest canopies, considering rainfall intensity and canopy storage.
- **Rutter Model**: Physically based model accounting for canopy storage, evaporation, and drainage.

24.7 Importance of Interception in Hydrology

1. Reduces Surface Runoff

Interception delays and reduces the amount of rainfall reaching the ground, reducing peak runoff during storm events.

2. Enhances Evapotranspiration

Contributes to the **evapotranspiration** component of the water budget, especially in forest ecosystems.

3. Modifies Soil Moisture Input

By reducing net precipitation input to the soil, interception impacts **soil moisture**, **infiltration**, and **groundwater recharge**.

4. Influences Design of Hydraulic Structures

Accurate estimation of interception is necessary for planning **reservoir capacity**, **drainage systems**, and **flood control structures**.

24.8 Interception Loss in Water Budgeting

In water resource planning and watershed hydrology, interception is included in the **precipitation budget** as:

$$P = I + Tf + Sf$$

And eventually affects the equation:

$$P = I + ET + R + \Delta S$$

Where:

- P = Precipitation
- I = Interception loss
- ET = Evapotranspiration
- R = Runoff
- ΔS = Change in storage

24.9 Role in Urban and Rural Water Management

- **In Urban Areas**: Green infrastructure such as green roofs and tree canopies enhance interception, reducing stormwater runoff and urban flooding.
- **In Rural Areas**: Vegetative cover management (e.g., agroforestry) can optimize interception to prevent soil erosion and improve groundwater recharge.

24.10 Interception in Climate Change Context

- Climate change affects **rainfall patterns**, **vegetation cover**, and **evaporation rates**, all of which influence interception.
- Forest degradation and urbanization can significantly alter interception dynamics, making it crucial to reassess interception losses in hydrologic models.