Engineering Hydrology (ECIV 4323)

Lecture 01

Instructors:

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Introduction

- Hydrology is the science of water:

- It is the **study of the hydrologic cycle**; occurrence, distribution, movement, physical and chemical properties of waters of the earth and their environmental relationships.
Hydrologic Cycle

- Precipitation on land
- Surface Runoff
- Infiltration
- Soil Moisture
- Subsurface flow
- Groundwater flow
- Groundwater outflow
- Subsurface flow
- Evaporation from land
- Evaporation and Evapotranspiration
- Moisture over land
- Evaporation from Ocean
- Surface outflow
- Precipitation on Ocean
Hydrologic Cycle Processes

Processes
- Precipitation
- Evaporation
- Infiltration
- Surface Runoff
- Groundwater Recharge (Percolation)
- Baseflow

System
Water Budget

Catchment or Watershed?

Catchment or drainage basin or river basin or watershed is defined as:

The area drained by a stream or a system of connecting streams such that the surface runoff originating in this area leaves the area in concentrated flow through a single outlet.
Water budget equation

System Concept

Hydrologic analysis for various applications and models begins with the system concept.

\[ I - Q = \Delta S/\Delta t \]  
(change in storage with respect to time)

I = inflow volume per unit time
Q = outflow per unit time
Typical Water Budget System Components

\[ P - R - G - E - T = \Delta S \]

- \( P \) = precipitation
- \( E \) = evaporation
- \( T \) = transpiration
- \( R \) = Surface runoff
- \( G \) = net groundwater flow
- \( \Delta S \) = change in storage
Example

A small catchment of area 150 ha received a rainfall of 10.5 cm in 90 minutes due to a storm. At the outlet of the catchment, the stream draining the catchment was dry before the storm and experienced a runoff lasting for 10 hours with an average discharge value of 2.0 m³/sec. the stream was again dry after the runoff event.
1. What is the amount of water which was not available to runoff due to combined effect of infiltration, evaporation and transpiration.
What is the ration of runoff to precipitation?
Solution

-The water budget equation for the catchment in a time $\Delta t$ is

$$P - R - G - E - T = \Delta S$$

-Take $\Delta t$ = Duration of Runoff = 10 hours
Rainfall occurred in 90 minutes and the rest (8.5 hours) the precipitation was zero.

- $\Delta S = 0$

-1. $G+E+T =$ water not available to runoff = Losses = $L$

-Hence
$P-R = L$

- $P =$ Precipitation = $150 \times 100 \times 100 \times 10.5/100 = 157,500$ m$^3$
  $R =$ Runoff volume = $2.0 \times 10 \times 60 \times 60 = 72,000$ m$^3$

$L = 157,000 - 72,000 = 85,500$ m$^3 =$ Water not available to runoff.

-2. Runoff/rainfall = $72,000/157,500 = 0.457$
1.4. World Water Balance

- Oceans: 96.5 % of total
- Fresh: 2.5 % of total

  - Groundwater: 30.1 % of fresh water
  - Polar Ice: 68.6 % of fresh water
  - Lakes & Rivers: 0.266 % of fresh water
Global Water Balance

• Global Average Precipitation:
  Ocean (70.8 %) and Land (29.2%)

  \[ 127 \text{ cm} \times 0.708 + 80 \text{ cm} \times 0.292 = 113.2 \text{ cm/yr} \]

• Global Average Evaporation:

  \[ 140 \text{ cm} \times 0.708 + 48.4 \text{ cm} \times 0.292 = 113.2 \text{ cm/yr} \]
1.6. Application in Engineering

Application of hydrosciences for planning, design and operation of various water related facilities.

- design rainfall events, stream flows, time histories for optimization, operation and continuous simulation.

- hydraulic structures, water supply, wastewater treatment and disposal, irrigation, urban drainage, reservoirs and spillways, floodplain analysis and delineation, erosion and sediment control, (etc).
1.7. Source of Data

The data normally required:
- Weather records (temperature, humidity, wind velocity)
- Precipitation data
- Stream-flow records
- Evaporation and transpiration data
- Infiltration characteristics of the area
- Groundwater characteristics
- Physical and geological characteristics
Assignments for Chapter 1

Solve the following problems:

- 1.3
- 1.5