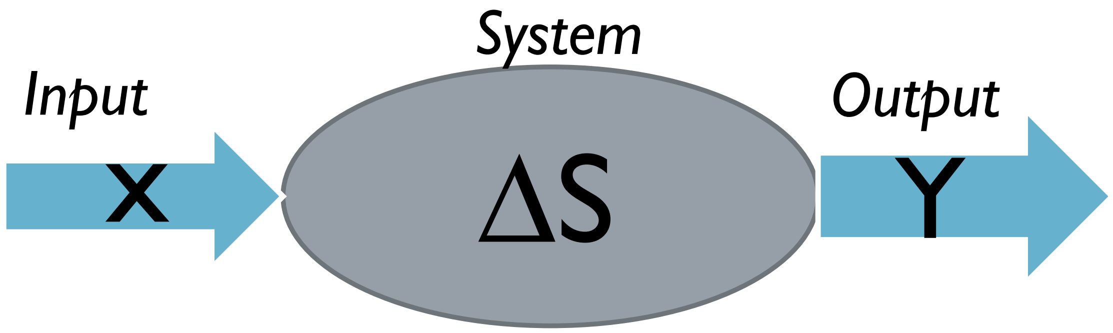
ITU
CIVIL ENGINEERING FACULTY HYDRAULICS DIVISION
HYDROLOGY

EXAMPLES – I INTRODUCTION TO HYDROLOGY AND ANALYSIS OF PRECIPITATION

INTRODUCTION

Two main equations of hydrology

- ❖ Conservation of masss
- ❖ Conservation of energy



- Precipitation
- Surface flow
- Groundwater flow

- Surface storage
- Groundwater storage
- Snow cover
- Soil moisture

- Evaporation
- Transpiration
- Surface flow
- Groundwater flow

INTRODUCTION TO HYDROLOGY AND ANALYSIS OF PRECIPITATION

1. Annual precipitation in a particular year was measured to be 70 cm over a lake with 200 km^2 surface area. The mean annual inflow and outflow discharges by the rivers to this lake is given as 1.20 m^3/s and 1.27 m^3/s, respectively. A 9 cm rise was observed in water level for that year. The leakage from the lake bottom is negligibly small. Considering given data calculate the annual evaporation depth of the lake for that particular year.

Area = 200 km^2

Precipitation = 70 cm

Inflow = 1.20 m^3/s

Outflow = 1.27 m^3/s

ΔS = +9 cm

Evaporation ?

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Precipitation = 70 cm → volume = 0.70*200*10^6 = 140*10^6 m^3

Inflow = 1.20 m^3/s → volume = 1.20*365*24*60*60 = 37.84*10^6 m^3

Outflow = 1.27 m^3/s → volume = 1.27*365*24*60*60 = 40*10^6 m^3

ΔS = +9 cm → volume = 0.09*200*10^6 = 18*10^6 m^3

X(inputs) = Precipitation + Inflow = 140*10^6 + 37.84*10^6 =177.8*10^6

Y(outputs) = Outflow + Evaporation = 40*10^6 + Evaporation

ΔS(accumulation) = 18*10^6 m^3

X-Y = ΔS

(177.8*10^6)- (40*10^6 + Evaporation) = 18*10^6 m^3

Evaporation = 119*10^6 m^3

Hevaporation = (119*10^6 $m^{3)}$ / (200*10^6) = 0.61 m

INTRODUCTION TO HYDROLOGY AND ANALYSIS OF PRECIPITATION

2. The reservoir capacity of a small dam constructed to supply water to a nearby town is $14x10^6$ m^3. At the beginning of February there is $8x10^6$ m^3 water in the reservoir. The precipitation and evaporation depths for this month are given as 120 mm and 35 mm, respectively. The inflow during February is $6.7x10^6$ m^3, and water demand of the town is $0.18x10^6$ m^3. If the surface area of the reservoir is 1.1 km^2, calculate the water volume that is to be spilled from the dam for February after the water demand of the town is supplied.

Area = 1.1 km^2

Precipitation = 120 mm

Evaporation = 35 mm

Inflow = $6.7*10^6$ m^3

Demand = $0.18*10^6$ m^3

Spill ?

INTRODUCTION TO HYDROLOGY AND ANALYSIS OF PRECIPITATION

Precipitation =120 mm → volume = 0.120*1.1*10^6 = 0.132*10^6 m^3

Evaporation = 35 mm → volume = 0.035*1.1*10^6 = 0.04*10^6 m^3

Inflow = 6.7*10^6 m^3

Demand = 0.18*10^6 m^3

X(inputs) = Precipitation + Inflow = 0.132*10^6 + 6.7*10^6 = 6.83*10^6 m^3

Y(outputs) = Evaporation + Demand = 0.04*10^6 + 0.18*10^6 = 0.22 *10^6 m^3

$X\text{-}Y = \Delta S$

(6.83*10^6)- (0.22 *10^6) = 6.61*10^6 m^3 water accumulated.

At the beginning there is 8*10^6 m^3 water in the reservoir so at the end of the month there wiil be 8*10^6 + 6.61*10^6 = 14.61*10^6 m^3

Reservoir capacity is 14*10^6 m3 therefore 0.61*10^6 m3 water should be spilled.

6. Radiation reaching the surface of earth is 45 when the radiation from the sun at the outer edge of the atmosphere is taken as 100. Long wave radiation from the earth to the atmosphere is 104, long wave from the earth directly to the space is 15. Atmosphere reflects 98 of the long wave radiation back to earth. The daily average energy coming from the sun is 680 cal/cm^2 at the outer edge of the atmosphere. Find the energy used in evaporation and annual depth of evaporation.

Hx = (45+ 98)/100

Hy = (104+15)/100

Hx - Hy= ΔH

$$\Delta H = \frac{(45+98)-(104+15)}{100} = 0.24$$

Annual energy for evaporation is 365*0.24*680 = 59570 cal/cm^2

Heat of vaporization for water is 590 cal/cm^3 then annual evaporation depth 59570/590 = 101 cm

INTRODUCTION TO HYDROLOGY AND ANALYSIS OF PRECIPITATION

6. P1 precipitation gage has recorded the reading below during a strom. Accordingly
   a) Draw the curve which shows the variation of total precipitation with respect to time.
   b) Draw the curve showing the variation of precipitation intensity time (hyetograph).

Time	02:16	02:20	02:22	02:25	02:27	02:30	02:32
Total Precipitation (mm)	0.5	3.0	8.0	13.0	18.0	23.0	25.5

INTRODUCTION TO HYDROLOGY AND ANALYSIS OF PRECIPITATION

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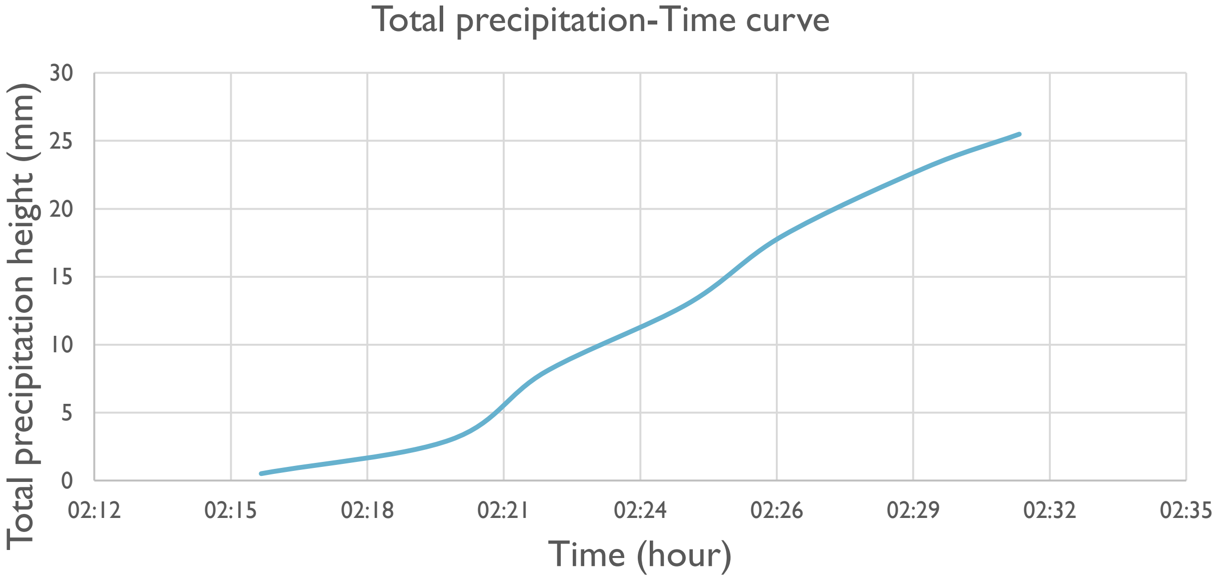

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b) Draw the curve showing the variation of precipitation intensity time (hyetograph).

t(saat)	P (mm)	Δt(dakika)	ΔP(mm)	i=ΔP/Δt (mm/saat)
02:16	0.5			
		4	2.5	37.5
02:20	3			
		2	5	150
02:22	8			
		3	5	100
02:25	13			
		2	5	150
02:27	18			
		3	5	100
02:30	23			
		2	2.5	75
02:32	25.5