HYDROCLIMATIC DATA - VISUALISATION

HYDRO-CLIMATIC VARIABLES

Hydro-climatic variables are those that relate to both the hydrological cycle and the climate system. They include:

1. **Precipitation**
2. Temperature
3. Humidity
4. **Evaporation**
5. Soil moisture
6. **Runoff**
7. **Streamflow**
8. Snowpack
9. Groundwater levels
10. Evapotranspiration
11. Wind speed and direction
12. Solar radiation
13. Atmospheric pressure
14. Frost occurrence
15. Storm intensity and frequency
16. Flood events
17. Drought indices
18. Ice cover dynamics (for regions with cold climates)
19. Vegetation dynamics (related to water availability)
20. Water temperature

PRECIPITATION

- Precipitation denotes all forms of water that reach the earth from the atmosphere
  - Rainfall
  - Snowfall
  - Hail (Hail is when chunks of ice fall from the sky)
  - Frost
  - Dew

Hail

Rainfall

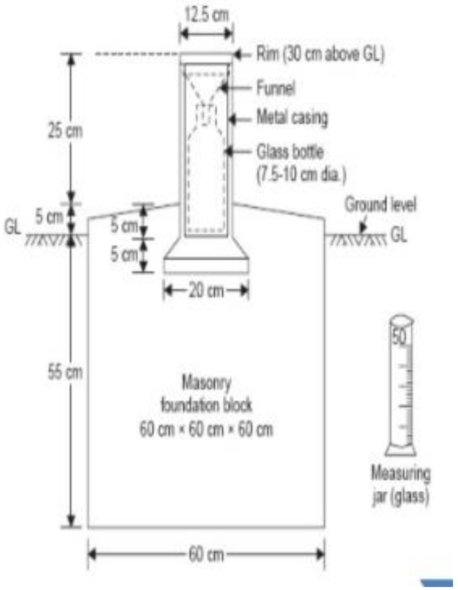
Snowfall

Frost

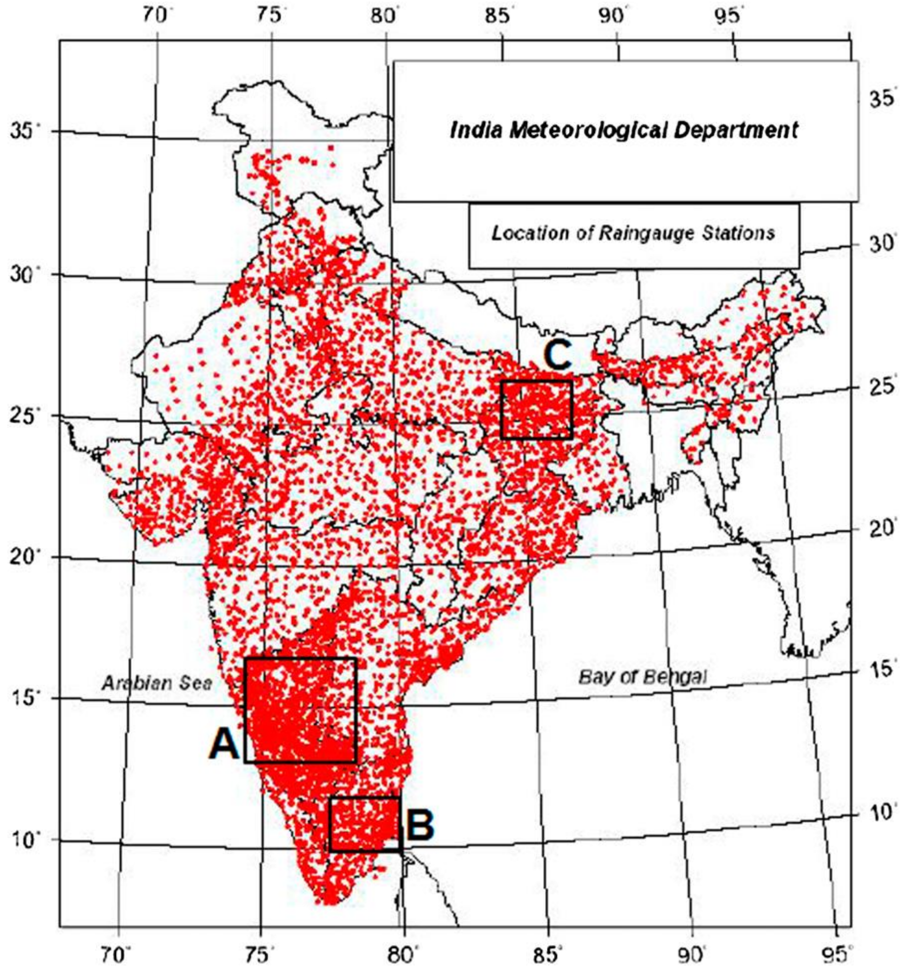
Dew

RAIN GAUGES

Symon’s gauge



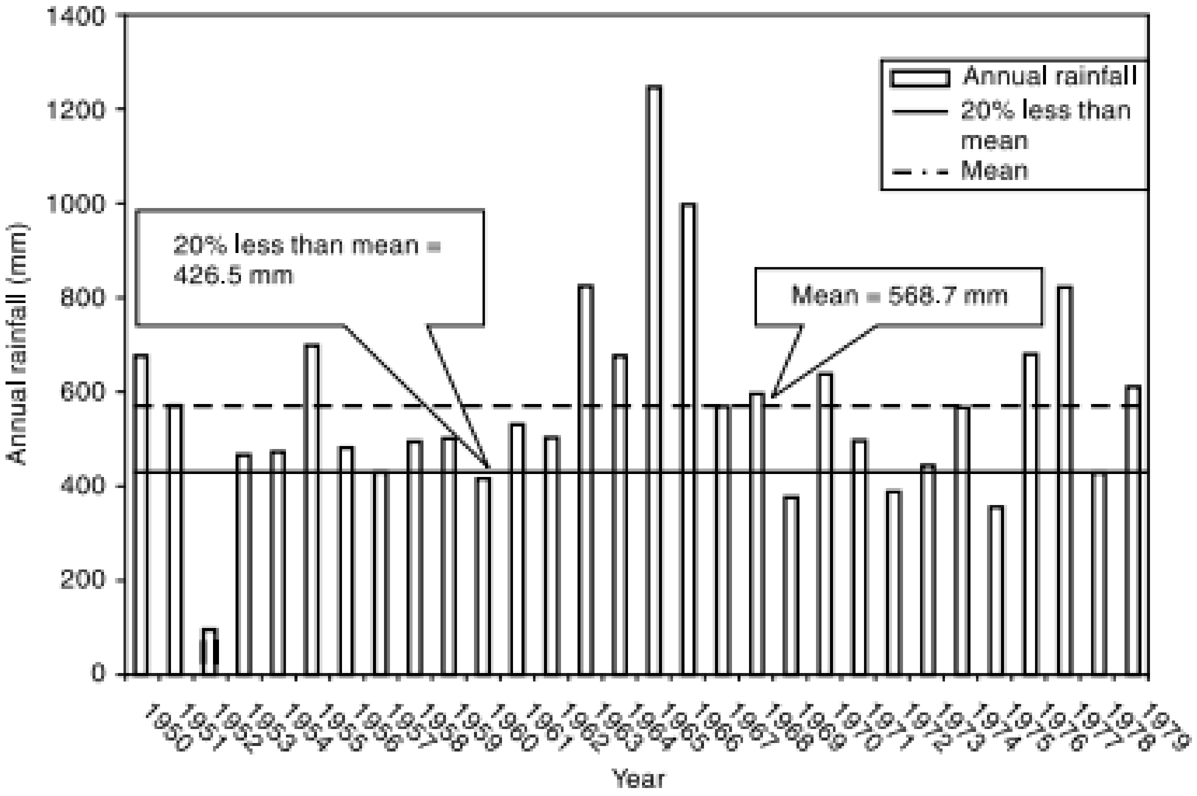
- Rainfall is measured everyday at 8.30 AM and is recorded as the rainfall of that day
- Receiving bottle normally can hold up to 10 cm, in case of heavy rainfall, measurement must be done more frequently and entered.
- Total rainfall of a particular day: sum of past 24 hrs
- Rain gauges can be used to measure the snowfall. The funnel and receiving bottle are removed and snow is allowed to collect in the outer metal container. The melted snow and the resulting depth is measured.



Location of IMD rain gauges used for the preparation of the gridded dataset (Rajeevan and Bhate 2009). Boxes A, B, and C are the subregions having dense networks of rain gauges

1. Annual Rainfall Visualisation

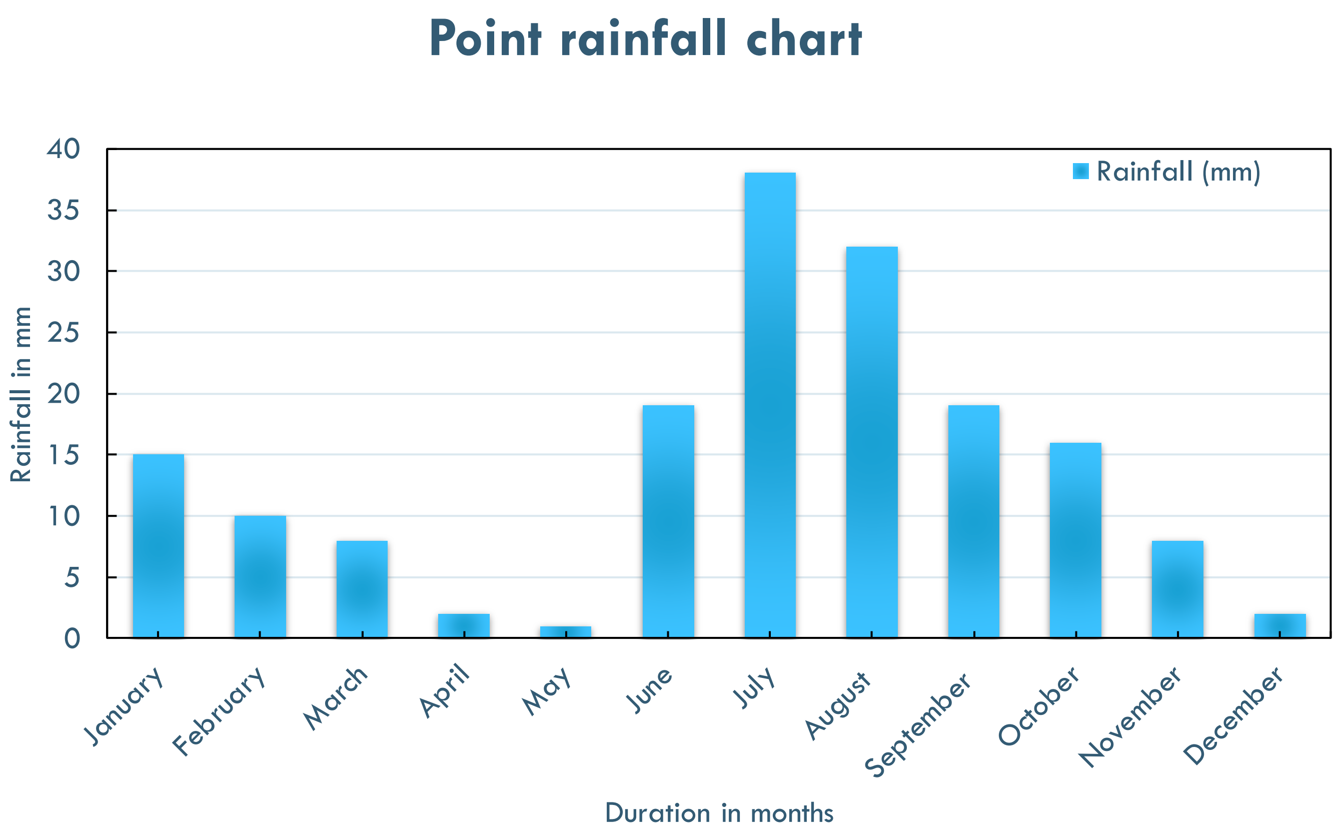
- Point rainfall, also known as station rainfall refers to the rainfall data of the station.
- Graphically these data are represented as plot of magnitude vs chronological time in the form of bar diagram.
- Based on requirement, data can be plotted as daily, weekly, monthly, seasonal or annual values for various periods.



Bar Chart of Annual Rainfall at Station *M*

1) Represent the tabulated monthly rainfall data using the point rainfall or station rainfall method

Rainfall (mm)	Month
15	January
10	February
8	March
2	April
1	May
19	June
38	July
32	August
19	September
16	October
8	November
2	December



More on RAINFALL DATA:

Intensity of rainfall: it is defined as the rate at which rainfall occurs, and is expressed as cm/h or mm/h. for non-automatic rain gauges the intensity is given by

$$I = \frac{P}{t}$$

Where i = intensity of rainfall, P = rainfall amount, t = duration of rainfall

Type	Intensity
Light Rain	Trace to 2.5 mm/h
Moderate Rain	2.5 mm/h to 7.5 mm/h
Heavy Rain	> 7.5 mm/h

2. Mass curve technique

- A mass curve of rainfall is a plot of the accumulated precipitation against time, plotted in chronological order.
- Mass curves of rainfall are very useful in extracting information on the duration and magnitude of a storm.
- And the intensity of the storm at various time intervals can be obtained by the slope of the curve.

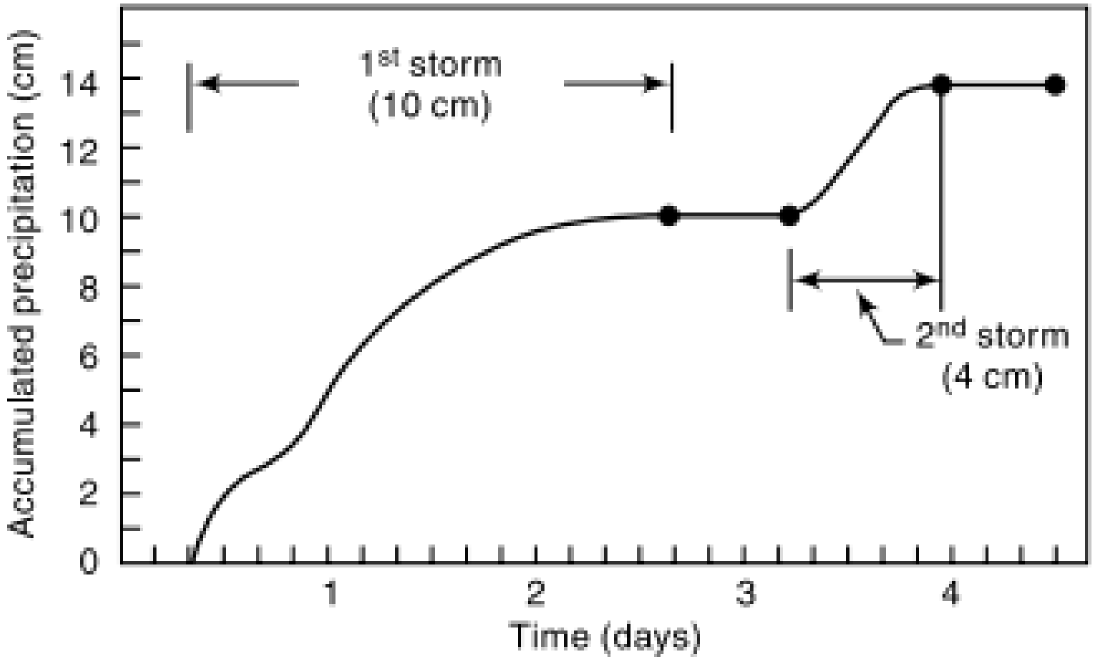
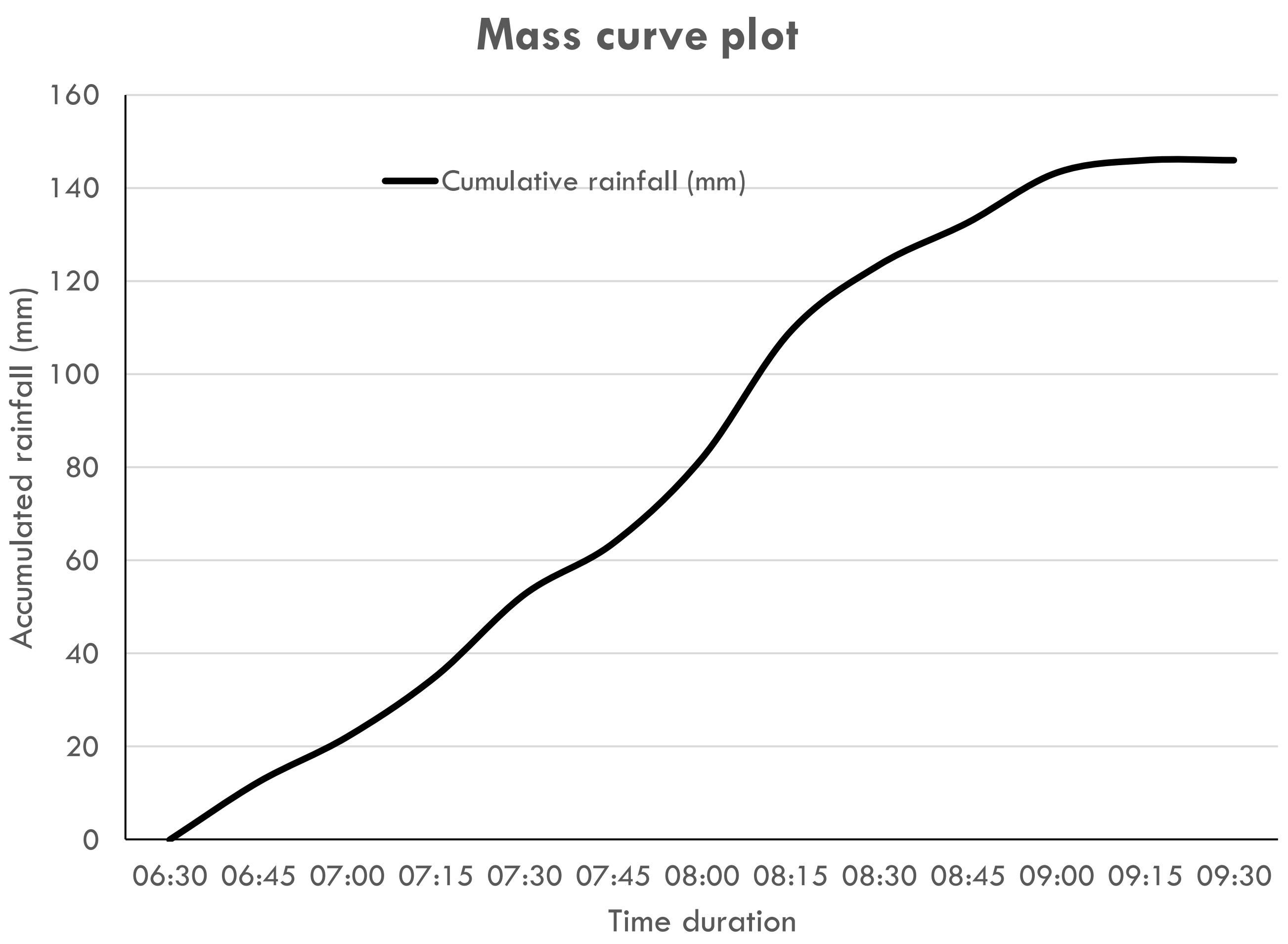


Fig. 2.9 Mass Curve of Rainfall

Time	Rainfall (mm)	Cumulative Rainfall (mm)
06:30	0	
06:45	12.4	12.4
07:00	14	26.4
07:15	13.2	39.6
07:30	15	54.6
07:45	12.3	66.9
08:00	11.3	78.2
08:15	10.3	88.5
08:30	9.5	98
08:45	9.9	107.9
09:00	12.3	120.2
09:15	11.4	131.6
09:30	13.4	145

Q1) THE CUMULATIVE RAINFALL DATA FOR A STORM STARTED AT 6:30 HOURS; THE RECORDINGS OF A SELF-RECORDING RAIN GAUGE AT 15-MINUTE INTERVALS ARE 0, 12.4, 22.1, 35.1, 52.7, 63.7, 81.9, 109.2, 123.5, 132.6, 143.3, 146 AND 146. DRAW A MASS CURVE FOR THE RECORDED DATA.

Time	Cumulative rainfall (mm)
06:30	0
06:45	12.4
07:00	22.1
07:15	35.1
07:30	52.7
07:45	63.7
08:00	81.9
08:15	109.2
08:30	123.5
08:45	132.6
09:00	143.3
09:15	146
09:30	146



The slope of the mass curve will give the intensity of the storm (Rainfall Intensity) at various time intervals.

3. Hyetograph technique

- A hyetograph is a plot of the intensity of rainfall against the time interval.
- It is derived from the mass curve and is usually represented as a bar chart
- The area under a hyetograph represents the total precipitation received in the period.
- It is a very convenient way of representing the characteristics of a storm and is particularly important in the development of designing storms to predict extreme floods.

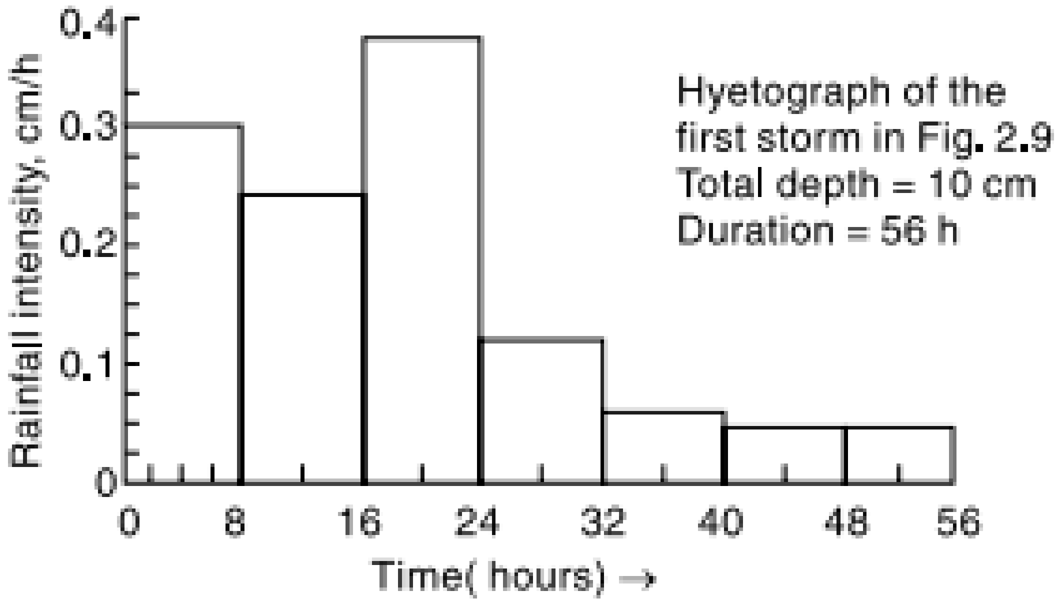
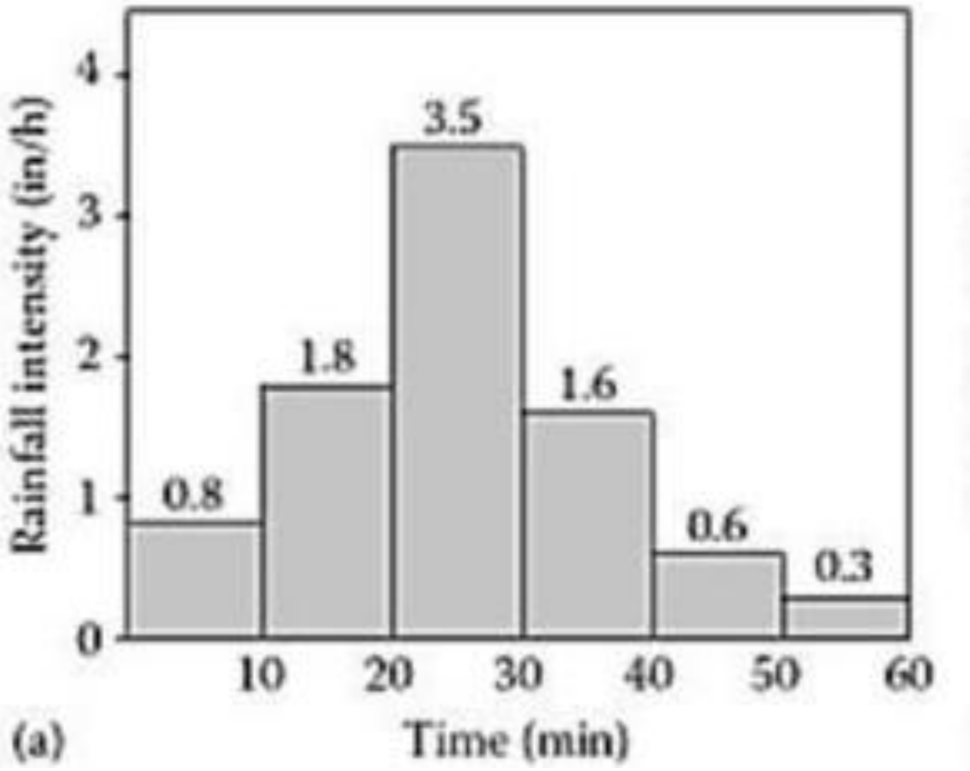


Fig. 2.10 Hyetograph of a Storm

3. Hyetograph technique



Example of a rainfall hyetograph

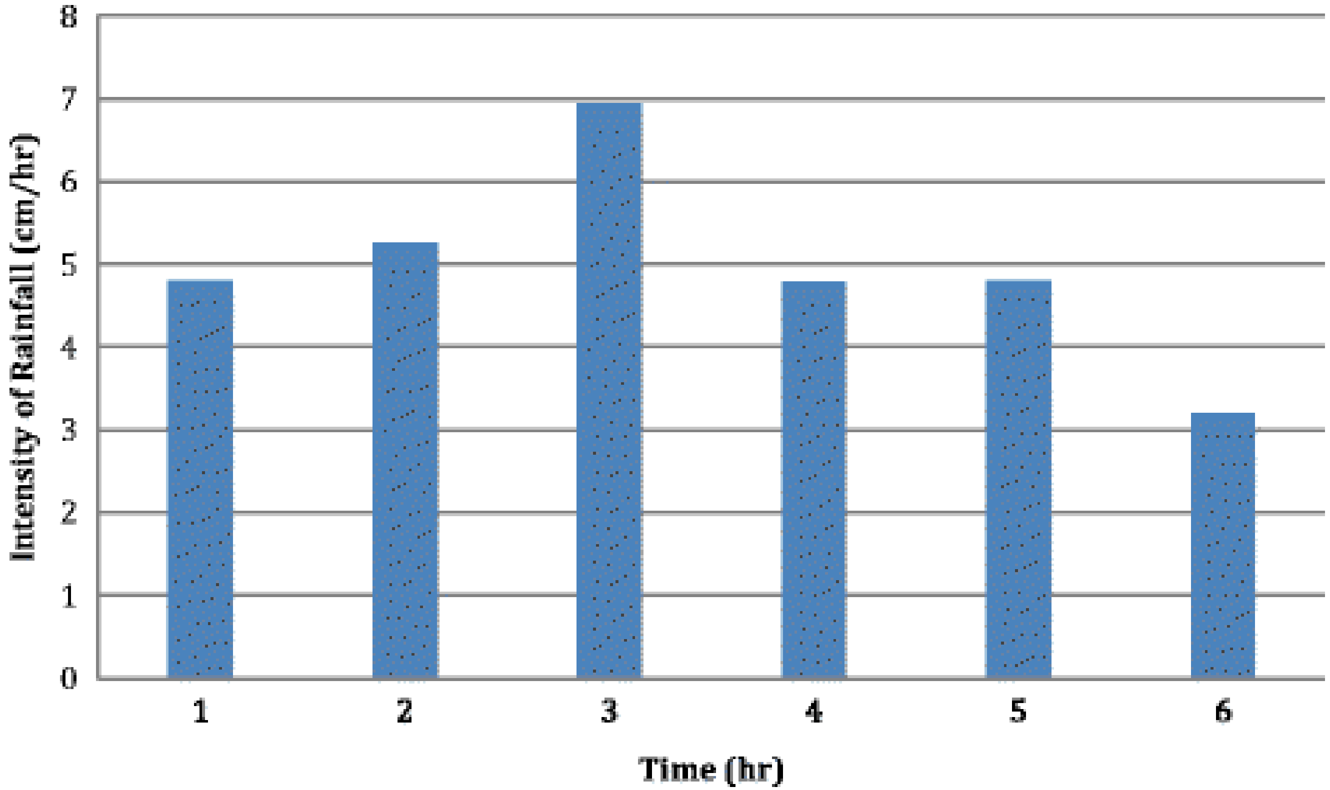


Fig: Six-hour storm rainfall hyetograph for Ahmedabad, India

Source: https://doi.org/10.1007/s11269-016-1552-y

Q2) THE ORDINATES (IN MM) OF A RAINFALL MASS CURVE FOR A STORM, WHICH COMMENCED AT 06: 30 HOURS, RECORDED BY SELF-RECORDING RAIN GAUGE AT 15-MINUTE INTERVALS ARE AS UNDER: 0, 12.4, 22.1, 35.1, 52.7, 63.7, 81.9, 109.2, 123.5, 132.6, 143.3, 146 AND 146. CONSTRUCT THE HYETOGRAPH OF THIS STORM FOR A UNIFORM INTERVAL OF 15 MINUTES.

Given data is tabulated :

Time	Cumulative rainfall (mm)
06:30	0
06:45	12.4
07:00	22.1
07:15	35.1
07:30	52.7
07:45	63.7
08:00	81.9
08:15	109.2
08:30	123.5
08:45	132.6
09:00	143.3
09:15	146
09:30	146

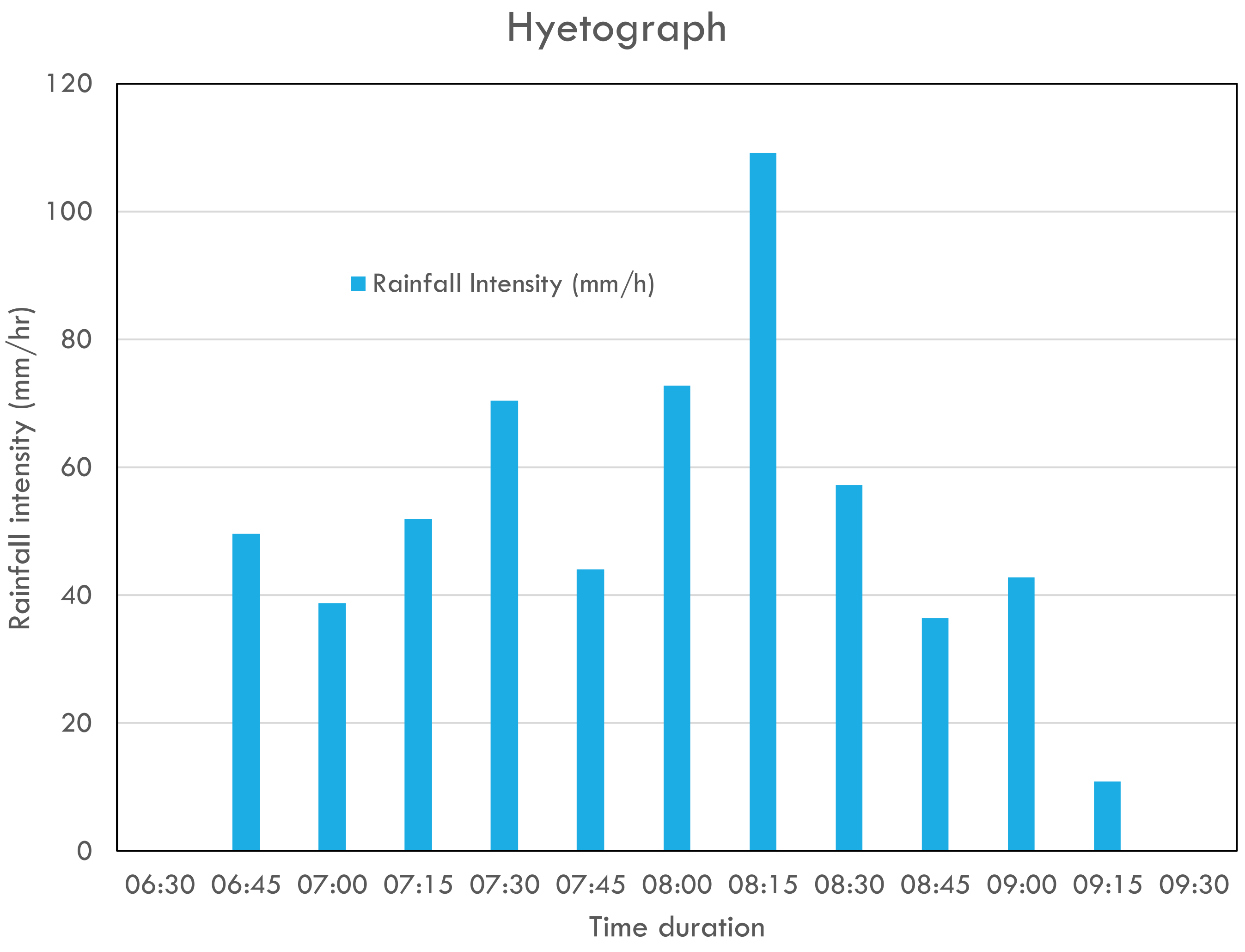
Q2) ANSWER

Time	Cumulative rainfall (mm)	Rainfall in successive 15 mits interval (mm)	Rainfall Intensity (mm/h)
06:30	0	-	-
06:45	12.4	(0-12.4) = 12.4	(12.4/0.25) =49.6
07:00	22.1	(22.1- 12.4) = 9.7	(9.7/0.25) = 38.8
07:15	35.1	(35.1-22.1) = 13.0	52.0
07:30	52.7	17.6	70.4
07:45	63.7	11.0	44.0
08:00	81.9	18.2	72.8
08:15	109.2	27.3	109.2
08:30	123.5	14.3	57.2
08:45	132.6	9.1	36.4
09:00	143.3	10.7	42.8
09:15	146	2.7	10.8
09:30	146	0.0	0

15 minutes = 0.25 hours)

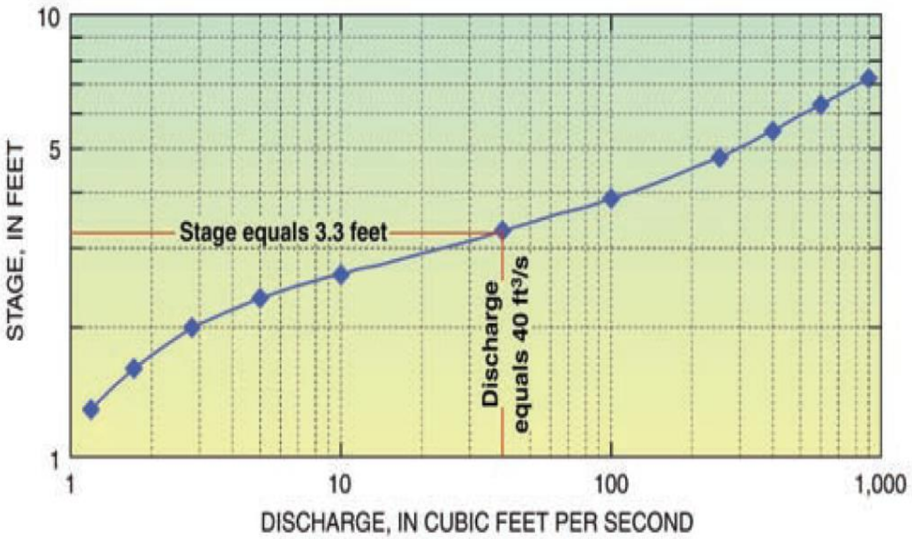
Q2) ANSWER

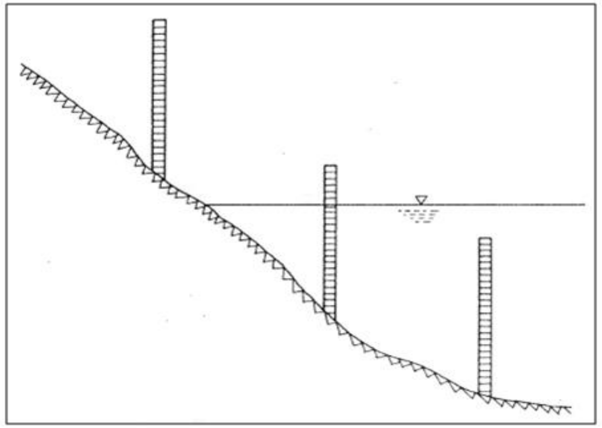
Time	Rainfall Intensity (mm/h)
06:30	-
06:45	49.6
07:00	38.8
07:15	52.0
07:30	70.4
07:45	44.0
08:00	72.8
08:15	109.2
08:30	57.2
08:45	36.4
09:00	42.8
09:15	10.8
09:30	0



STREAMFLOW/RUNOFF

- The first step in calculating streamflow involves measuring stage, which is the height of the water surface at a particular point in a stream or river. Stage is sometimes known as gauge height.
- Stream flow is measured in units of discharge (m^3/s)
- discharge is estimated by using the previously determined stage-discharge relationship ()





The **discharge** of a stream is the product of its velocity **(V** - length of travel per unit of time such as feet/second) times depth of the water (**D** - unit of length) times width (**W of the water** - units of length). (Make sure all three lengths are expressed in the same unit.)

Discharge = V x D x W

MORE ON STREAMFLOW

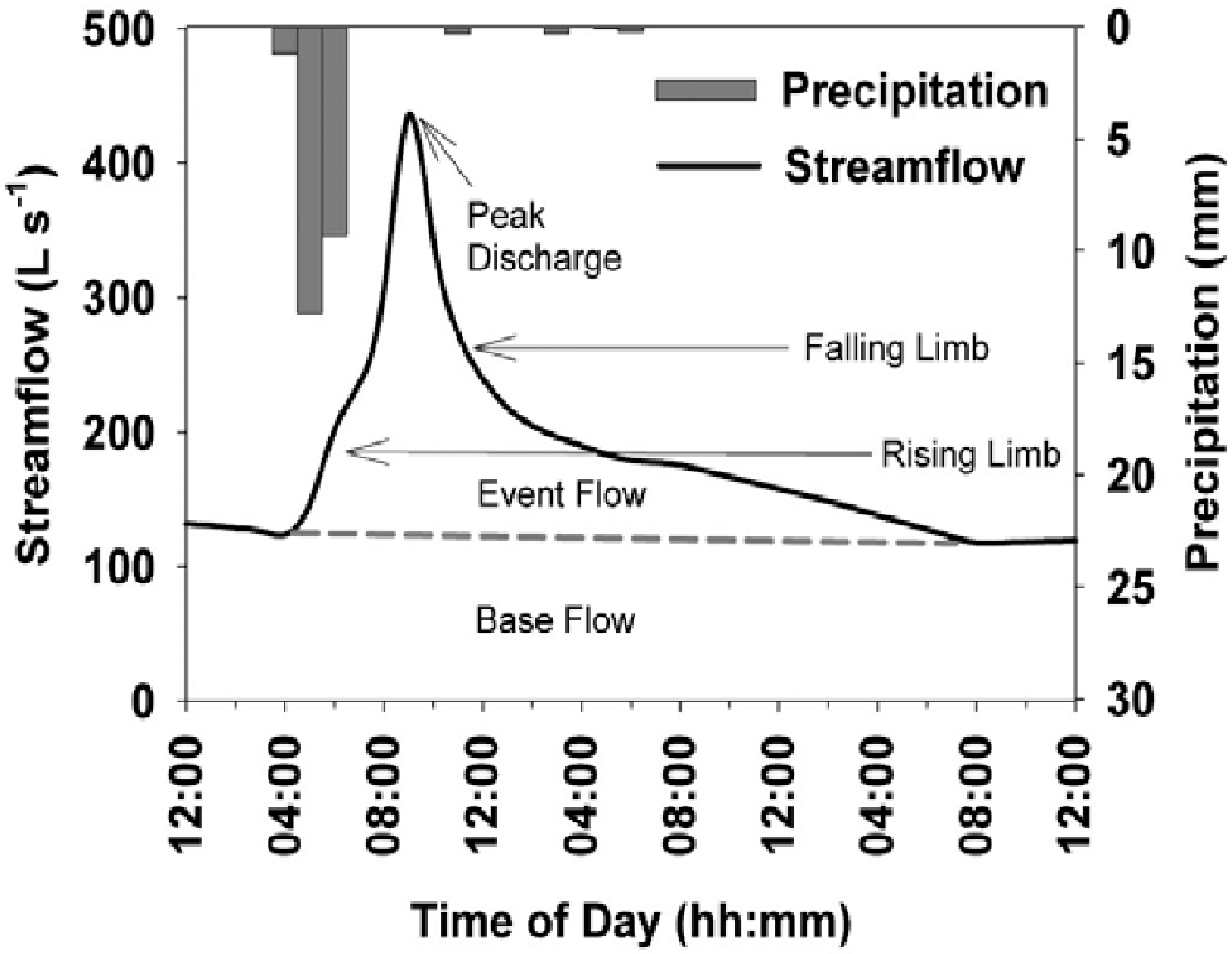
The stage-discharge relation depends on the shape, size, slope, and roughness of the channel at each gage and is different for every stream gage.

A rating curve often changes after a flood when the physical force of high-water movement can change the dimensions of the streambed or stream channel.

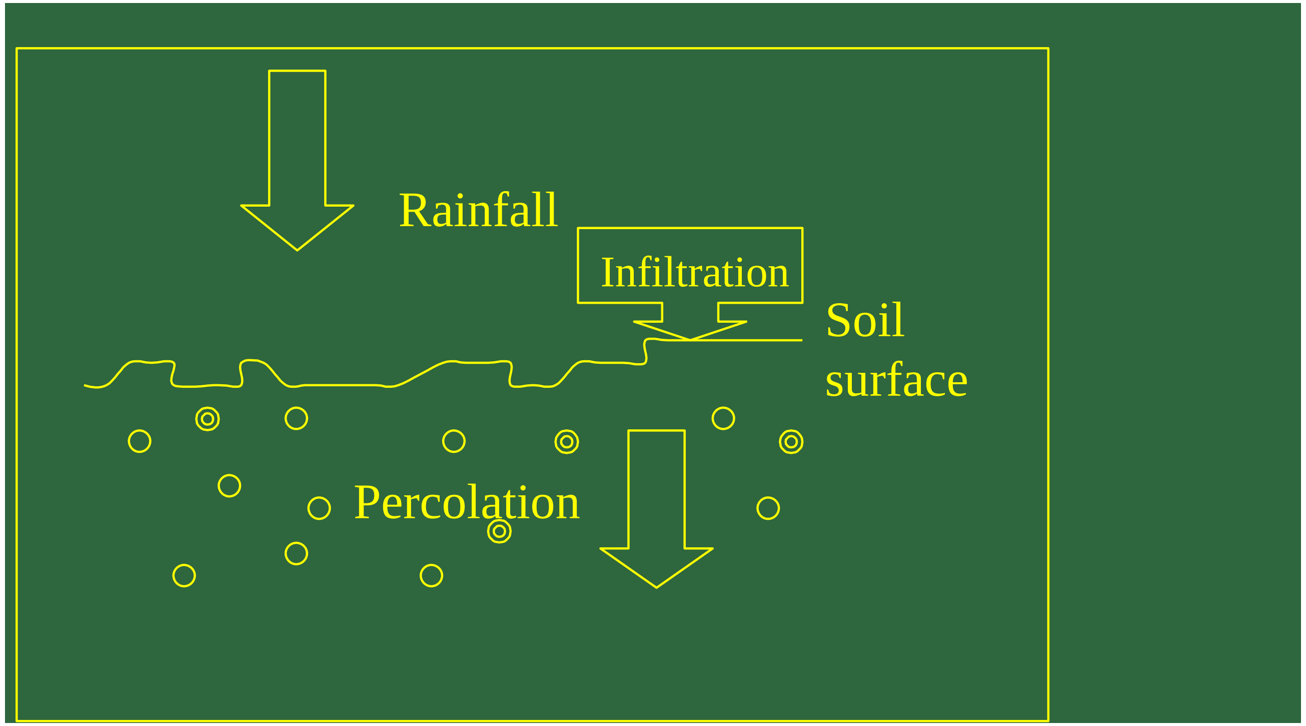
To keep the rating curve accurate and up-to-date, hydrologic technicians visit each stream gage about once every 6 weeks to measure the flow directly and also measure high flows when they happen.

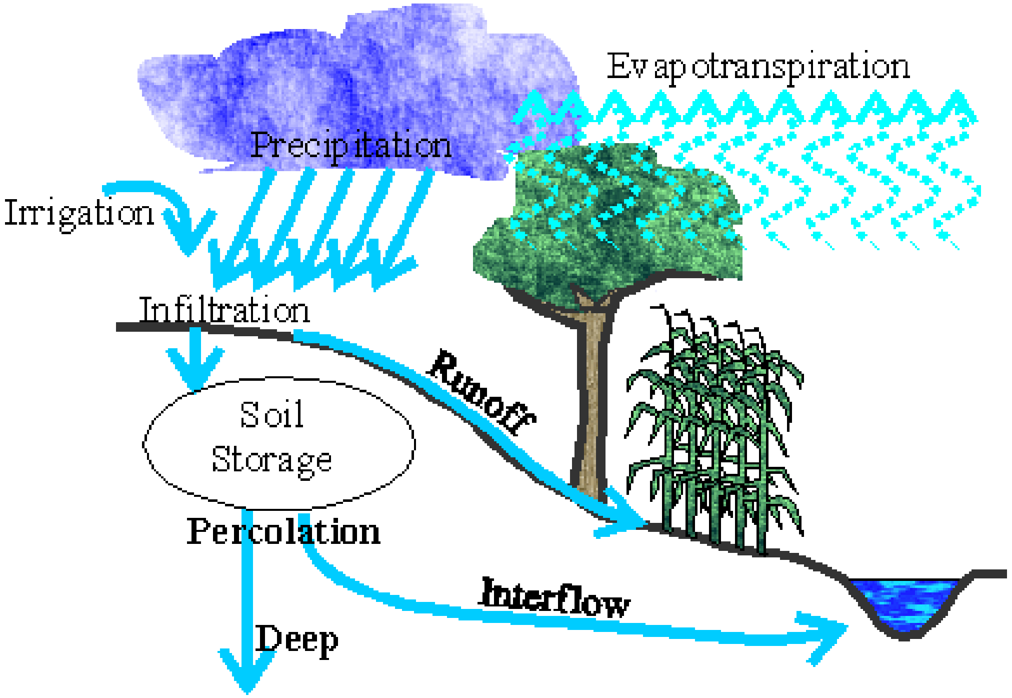
Hydrograph

- A hydrograph is a graph showing the rate of flow (discharge) versus time past a specific point in a river, channel, or conduit carrying flow
- Visual representations of water flow over time.
- **Plotting:** Graph discharge (y-axis) against time (x-axis)
- **Importance:** Aid in understanding river behavior, flood prediction, and water resource management.



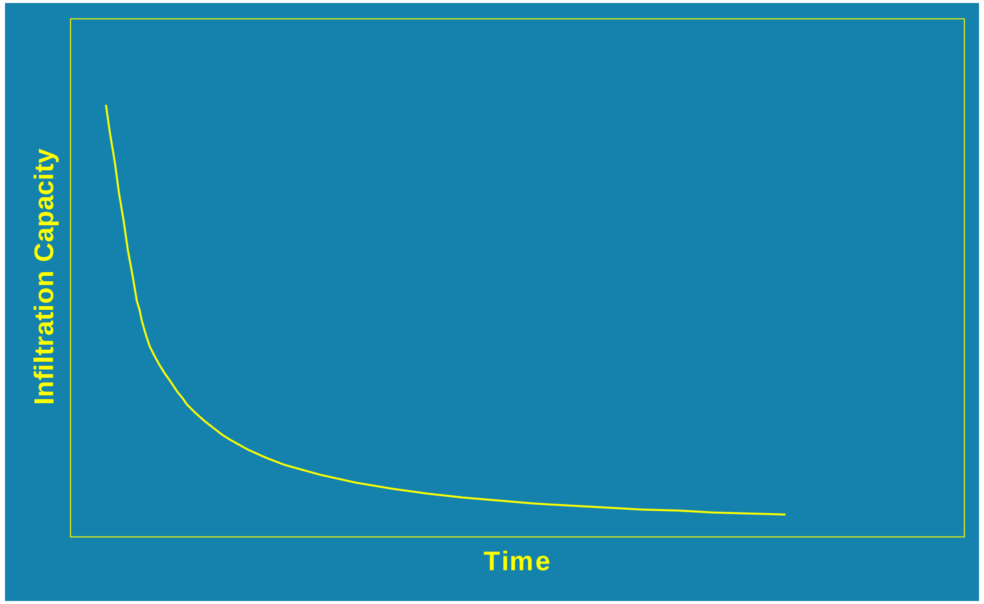
INFILTRATION





INFILTROMETERS

- ✓ Volume of water added during different time intervals will be noted
- ✓ A plot of infiltration capacity vs time can be obtained
- ✓ Experiment will be continued till a uniform rate of infiltration is obtained (take 2-3 hrs)



PAN EVAPORIMETERS

- From open water bodies will be measured.
- Evaporation of water from small pans filled with water is measured
- Assumption: evaporation from lake and pan are closely related
- Measurement must take account of evaporation losses and also gains due to rainfall

Fig. 5.1 U.S. Weather Bureau class A land pan.