Surface Water System

We are now talking about water that is present on earth's surface.

* Water is stored

or

* Water is flowing

Surface water interacts throughout with the

→ Atmospheric water system

→ Sub-surface water system

Recall the definition of Watershed (or Catchment)

→ The area of land on surface of earth that allows draining of water into a stream inside it.

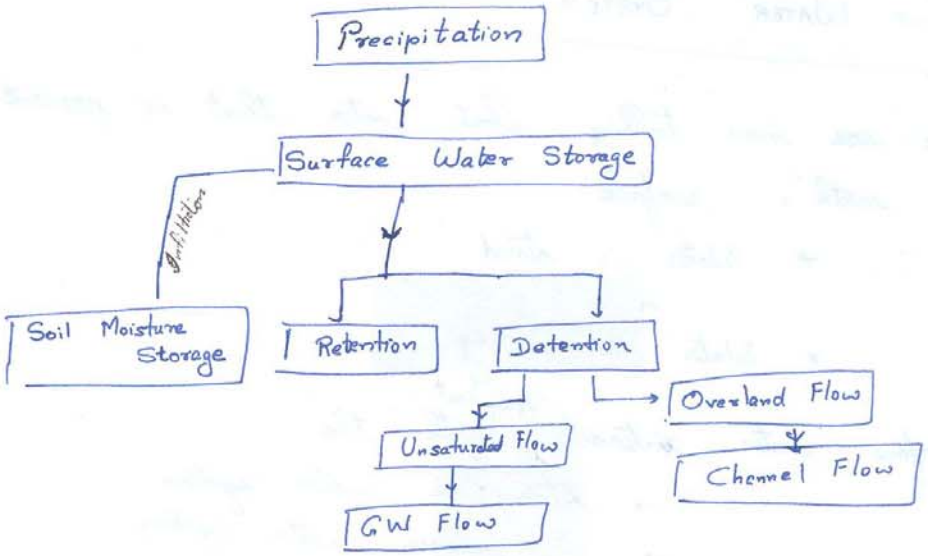
→ The watershed has boundaries.

Q What are the main processes in surface water system

→ Storage } → In various features

→ Flow

As you know precipitation is the main source of input to surface water system



As water precipitates

→ Initially surface water storage activates.

→ Due to infiltration soil moisture storage also begins.

→ There are retention and detention storages.

→ Retention is storage held for a long period of time and may get depleted by evaporation.

→ Detention – short term storage depleted by flow away from storage location.

Hortonian Overland Flow

→ For a soil of infiltration capacity f if rainfall of intensity i occurs:

If $i < f$: → All rain is absorbed into soil

If $i > f$: → Then surface runoff occurs at a rate $(i - f)$

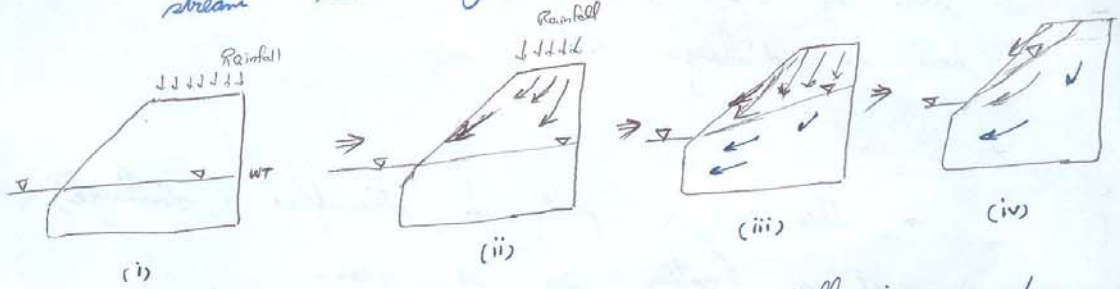
$(i - f)$ → Rainfall Excess.

~~Food~~ → Initially surface runoff formed as sheet flow.
→ As depth increases during flow downwards — sheet flow discharges to stream (or channel).

Hortonian overland flow applicable to
→ Impervious surfaces in urban areas
→ Natural surfaces with low infiltration capacity

Subsurface Flow to Streams

* Hortonian method not satisfactorily applicable on vegetated surfaces.
* Most of the time infiltration capacity > rainfall intensity.
* Naturally, you may think that than all water is infiltrated and goes to groundwater aquifers.
* That is not the case, whatever water is infiltrated - a major portion may flow through subsurface along ~~the~~ as per the terrain gradient into the stream near by.



* The water table in the mound gradually increases due to precipitation (and infiltration).

* However the infiltrated water subsequently reaches the stream contributing a flow to the stream.

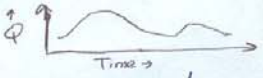
Saturation overland flow

In a hill valley or bottom of a slope
→ the subsurface flow is saturated (or gets saturated). Therefore at those regions whatever precipitation is there will go as surface runoff.
→ This is saturation overland flow.

Q: Can you interpret the difference between Hortonian overland flow and Saturation overland flow.

Streamflow Hydrograph

→ It is a graph or a table showing flow rate as a function of time at a given location on the stream.

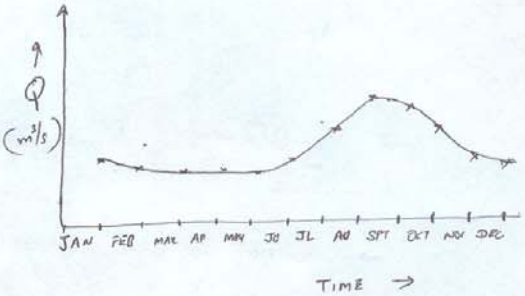


→ You can have various types of hydrographs based on the interval of time considered as well as discharge (Q).

* Annual Hydrograph
  → This is a plot of streamflow (discharge) at a location in a year.
  → It gives the variations in discharges in a year and you can easily interpret

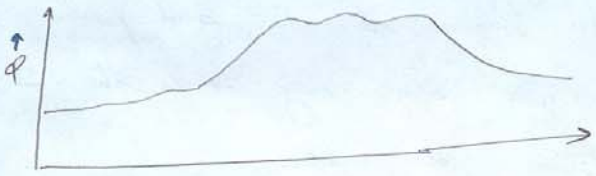
the seasonal effects.

→ The annual hydrograph can also give the yearly balance of precipitation, evaporation, and streamflow in a watershed.

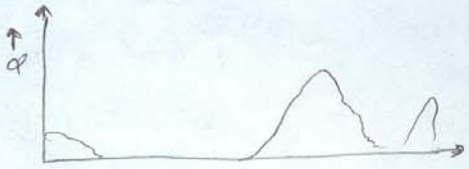


→ Total volume of flow in annual hydrograph = Basin Yield.

In India you may have seen some rivers that have water always and some having water only during monsoons. That is, you have perennial and seasonal rains.



(PERENNIAL)



(SEASONAL)

→ From the annual hydrographs above, you can see higher discharge spikes during monsoon. In non-monsoonal periods there is more or less constant discharge in perennial streams.

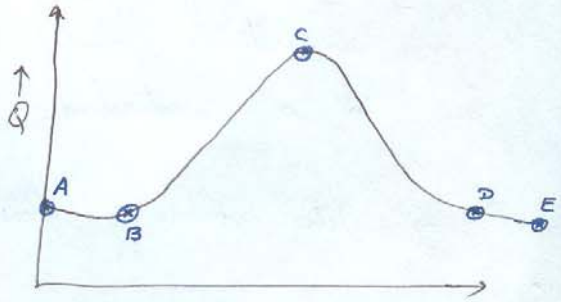
→ The first case is discharge due to rain storms. The second situation describes baseflow.

→ In India you have Ganges, Brahmaputra, Yamuna, etc. as perennial rivers.

Krishna, Cauvery, etc. are seasonal or ephemeral streams. That is, they don't have enough Baseflow.

* Storm Hydrograph

→ This is a graph of discharge versus time in a basin due to an individual storm.



→ This graph has four components.

* Before the rainfall storm there is Baseflow gradually decreasing (AB)
* The discharge due to this particular storm (direct runoff) begins at B and peaks at C (BC), and you can say ends at D.
* Baseflow continues at DE.

→ As a hydrologist, you may be interested to know how the streamflow is affected by a particular storm.

* That is you would like to separate the Baseflow from the streamflow and find the direct runoff.

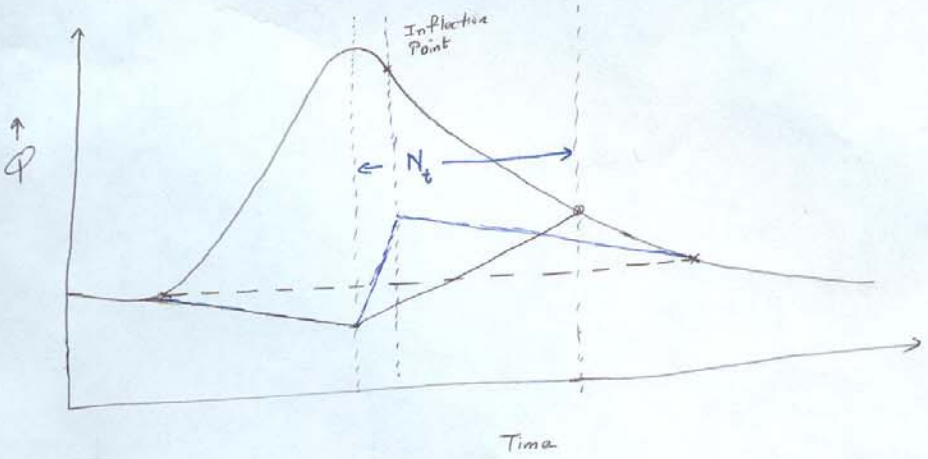
Q: So how will you separate the Baseflow so you could compute direct runoff

There are various methods and still new methods are formulated (or evolved) based on extensive research.

As you have seen if you compute the area under streamflow hydrograph you will get volume of streamflow at that location.

Some crude methods to separate Baseflow are:

* Straight - line method
* Fixed Base length method
* Variable slope method



→ The straight - line method — draw a horizontal line from point of beginning of surface runoff to the point where it intersects the receding hydrograph curve.

→ In fixed base method, surface runoff assumed to end at a fixed time N_t after the peak. The baseflow shown as drawn in the figure. That is the same slope is maintained upto peak for baseflow and connect to time N_t from peak.

→ In variable slope method, - Baseflow extrapolated to point of peak discharge. Then from the time where baseflow ceases is extrapolated backwards with same slope to the time of point of inflection.