Lecture 1 **04-January-2013**

CE 311 HYDROLOGY AND WATER RESOURCES ENGG.

LECTURE 1
04-JAN-2013

SYSTEMS CONCEPT FOR HYDROLOGY

We have discussed yesterday that

Hydrology → The science that treats all phases and aspects of water on earth.

In Fluid Mechanics and Hydraulics you have studied various principles governing the motion of water or fluid.

Q: Why do we require hydrology ?

You require hydrology to infer

- → Where the water comes from to a dam site
- → Design and Operations of Various Hydraulic Structures
- → Water Supply
- → Irrigation, etc.

We have seen that water exists on earth in

- → Atmosphere
- → Surface
- → Sub-surface

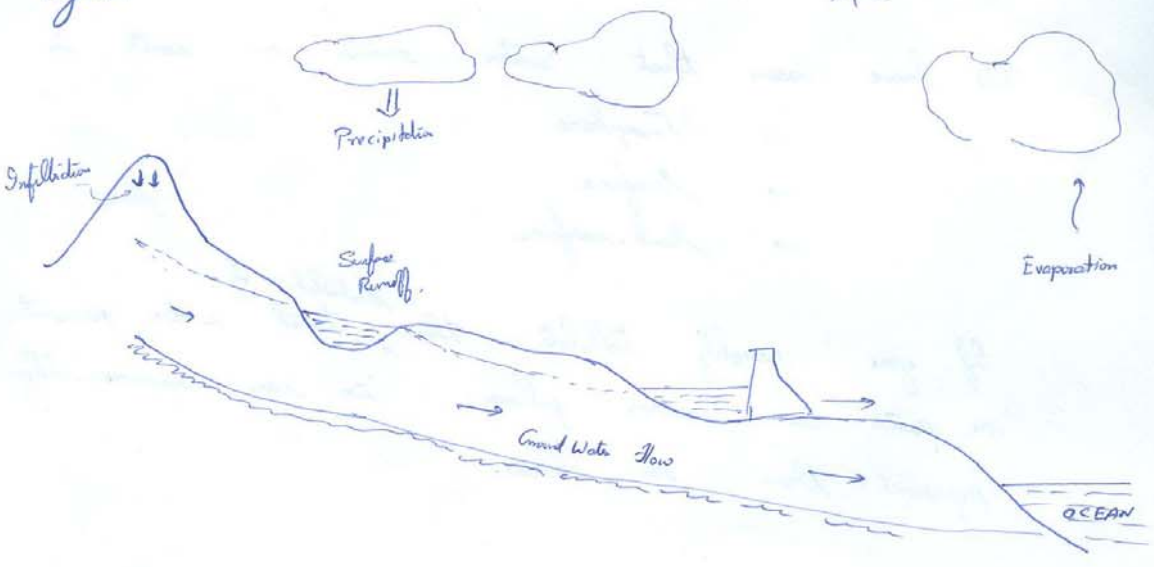
If you roughly tabulate the distribution of total water present on earth in various phases, we can approximately represent them as below.

Estimated distribution of water in Percentage (%)

1)	Oceans	96.5 %
2)	Fresh groundwater	0.76 %
	Saline GW	0.93 %
3)	Soil Moisture	0.0012 %
4)	Polar Ice	1.7 %
5)	Other ice & Snow	0.025 %
6)	Fresh Lakes	0.007 %
	Saline Lakes	0.006 %
7)	Marshes	0.0008 %
8)	Rivers	0.0002 %
9)	Biological Water	0.0001 %
10)	Atmospheric Water	0.001 %

Total volume of water ≈ 1,385,984,610 km^3

So water on earth exist on the above mentioned locations and they are inter-related using hydrologic cycle.



→ The hydrologic cycle has no beginning nor end.

→ You can see the processes of → Precipitation, Evaporation, Infiltration, Surface Runoff, Subsurface Runoff, etc. in hydrologic cycle.

→ The hydrologic cycle is complicated. It depends on
- topography, geology, vegetation, anthropogenic influences, etc.
- It may consist of many sub-cycles.

→ Therefore, with our limited knowledge it is not possible to correlate all aspects of hydrologic cycle.

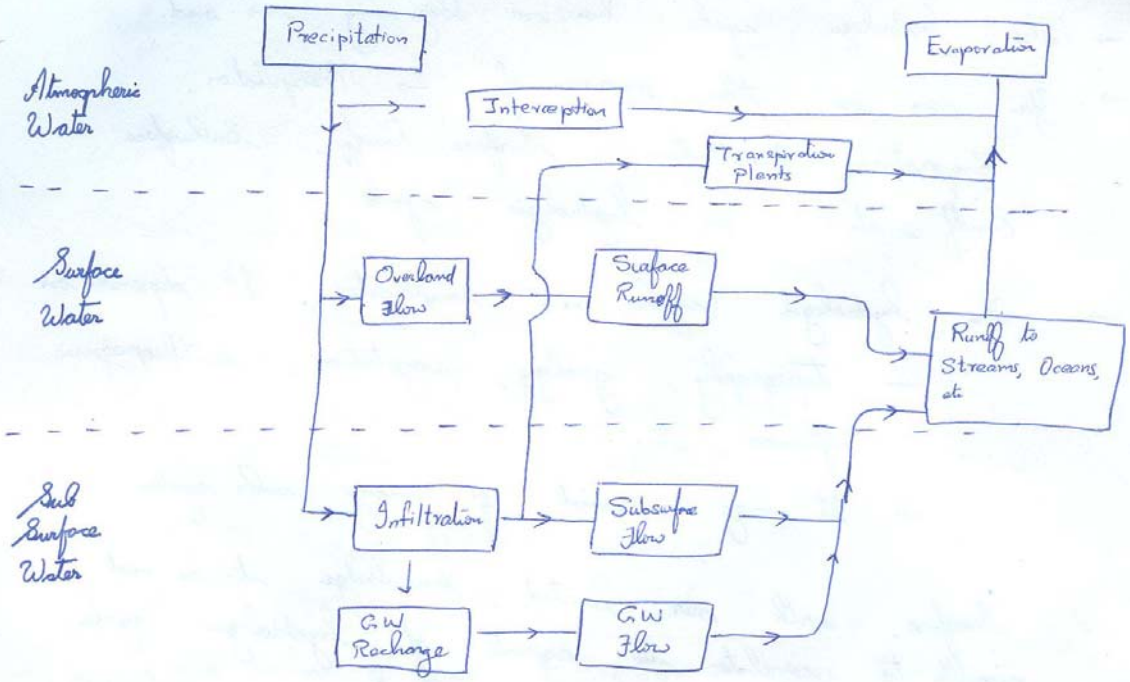
However, we can simplify the processes in hydrologic cycle using <u>systems concept</u>.

Q: <u>What is a system ?</u>

A system is a set of connected parts that form a whole.

Now the hydrologic cycle — consider as a system
It consists of parts like — precipitation, evaporation, runoff, etc.
(They can be classified as sub-systems).

One can classify the global hydrologic cycle as a system consisting of three sub-systems
(i) Atmospheric water (ii) Surface water, and
(iii) Sub-surface water



Usually for most practical problems only a few processes of hydrologic cycle are considered at a time.

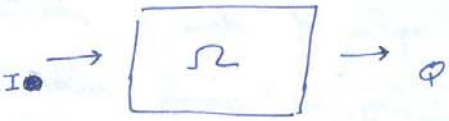
→ In fluid mechanics you might have studied control volume approach to define principles of mass, momentum, energy, etc.

→ For this you require a three dimensional reference frame with Boundaries

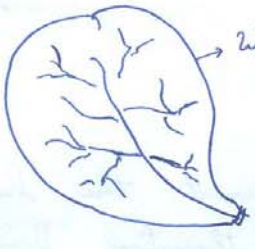
What happens inside the control volume is not that important in CV approach – how the properties transfer through the Boundaries are more important.

Therefore we can use a CV approach to define Hydrologic system

" A hydrologic system is a structure or volume in space, surrounded by a boundary that accepts water and other inputs, operates on them internally, and produces output".



You can visualise this phenomena in a watershed



- It has a geographical and geological boundary.
- Water cannot cross the water divide.

Therefore, a hydrologic system consists of

- → Structure
- → Boundary for the structure
- → Working medium

→ Our objective is using such systems concept, develop hydrological models.

The hydrological system mathematically (or symbolically) represented as

$$\Phi = \Omega I$$

Ω → Transfer function b/w input and output.

Classification of Hydrological Models

You can have

→ Physical models

→ Abstract models

Physical Models → you see in laboratories or fields (e.g replica of dam, structures, etc.)

They are usually called scale models

You can also have analog models.

Analog models use some other physical systems to correlate the hydrologic system.

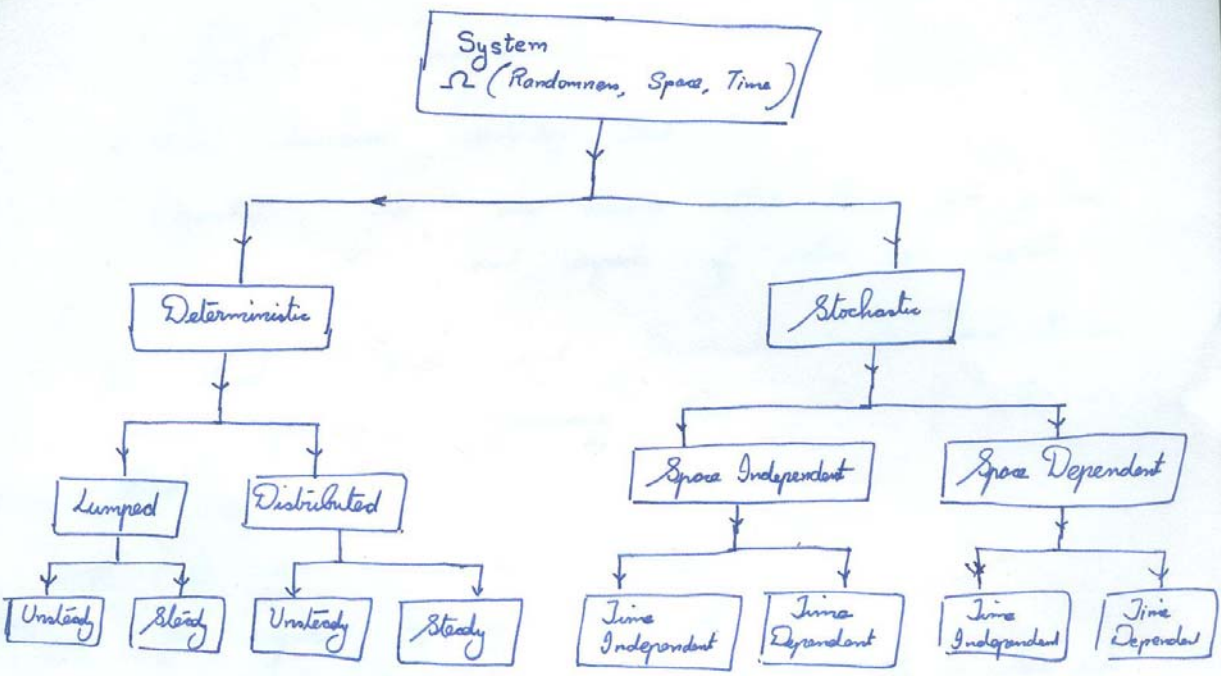
Abstract Models → Represent the hydrologic system in mathematical form.

A set of equations used to describe the linking of input and output variables.

→ These input and output variables (I and O) and the operator R may be functions of space and time.

→ They may also be probabilistic or random.

Based on these natures we can classify the abstract hydrological models in the following diagram.



→ Therefore, based on the randomness one can have deterministic or probabilistic model.

→ Similarly w.r.t space → lumped & distributed

→ w.r.t time → Steady and Unsteady

For Example

Recall the uniform flow you studied in hydraulics

You know the flow variables velocity, height, etc. does not vary w.r.t space.

∴ This is a lumped model.