Hydrology as a Science

Is a branch of earth science, it is the science that treats the waters of the earth, their occurrence ,circulation, and distribution, their chemical and physical properties, and their reaction with the environment, including the relation to living things.

Hydrology as a Profession

- A profession is a “calling requiring specialized knowledge, which has as its prime purpose the rendering of a public service”
- What hydrologists do:
  - ***Water use*** – water withdrawal and instream uses
  - ***Water Control*** – flood and drought mitigation
  - ***Pollution Control*** – point and nonpoint sources

Branches of Hydrology

- **Chemical Hydrology**

  Study of chemical characteristics of water
- **Water Quality**

  Chemistry of water in rivers and lakes, both of pollutants and natural solutes.
- **Eco Hydrology**

  Study of interactions of living organisms and the hydrologic cycle.
- **Hydrogeology**

  Study of the distribution and movement of groundwater in the soils and rocks of the Earth’s crust.
- **Hydrometeorology**

  Study of the transfer of water and energy between land and water body surfaces and the lower atmosphere.
- **Surface Hydrology**

  Study of hydrologic processes that operate at or near Earth's surface.
- **Drainage Basin Management**

  Covers water-storage, in the form of reservoirs, and flood-protection.

History of Hydrology

4000 BC

Along the Indus River, Pakistan, the Tigris and Euphrates in Mesopotamia, Hwang Ho in China, and the Nile in Egypt that the first hydraulic engineers created canals, levees, dams, subsurface water conduits, and wells

200 AD

The Romans constructed numerous aqueducts to bring water from distant sources into their cities and towns. Waste water was removed by complex sewage systems and released into nearby bodies of water. Some aqueducts also provided water for mining, processing, manufacturing, and agriculture.

1500

Leonardo da Vinci and Bernard Palissy independently reached an accurate representation of the hydrologic cycle

1800

Perault
Linked rainfall to flow of the river Seine
Marriotte
Combined velocity and river cross section to obtain discharge of the river Seine

Pitot
Bernoulli
Euler
Chezy
Dalton
Made progress in applications of mathematics, fluid mechanics, and hydraulics
Darcy
Worked on groundwater hydrology

1850

Poiseuille
Stokes
Manning
Reynolds
Mead
Meyer

1900

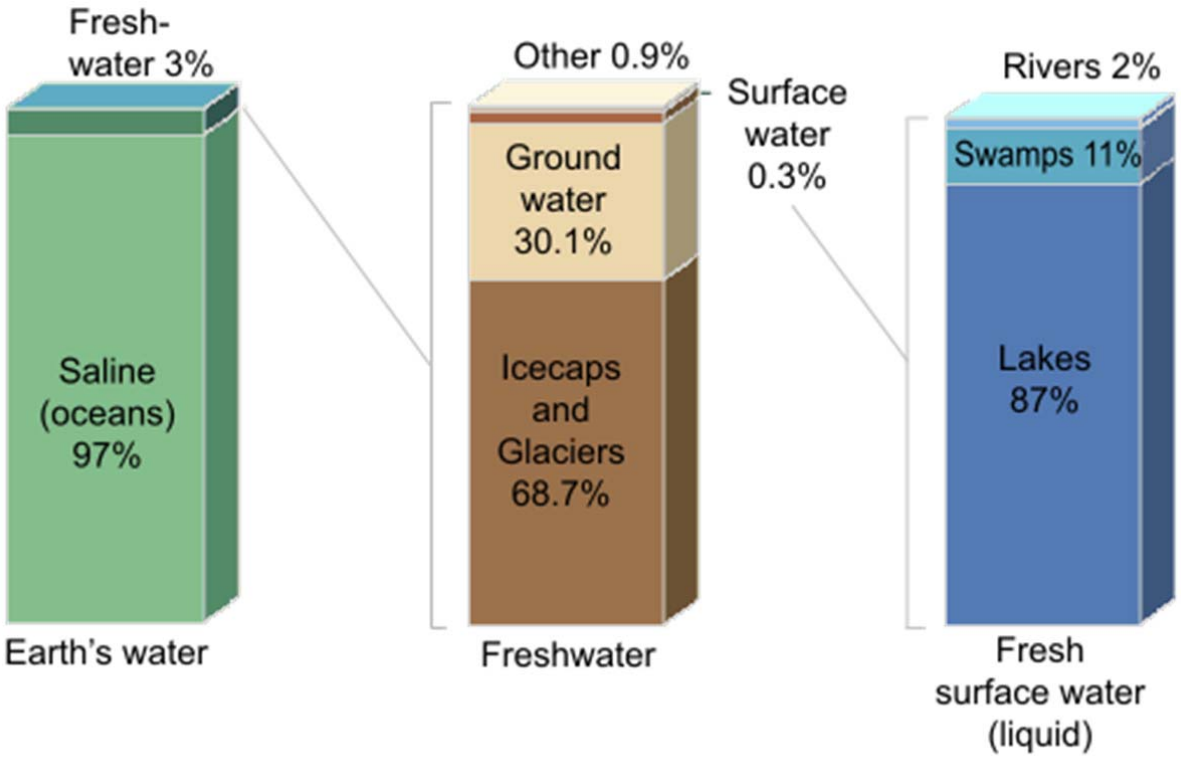
Hazen
Gumbel
Hurst
Meinzer
Hubbert
Prandtl
Chow
Thornthwaite
Penman
Horton

Worlds Water Resources

About $1.4*10^9$ km^3 of water participates in the surface and near surface hydrological cycle of the earth. The water cycled between land, sea, and air through a number of reservoirs.

97.2% of these global water resources are salt water, only 2.8% is available as fresh water, out of this 2.8%, about 2.2% is available as surface water and 0.6% as ground water. Even out of this 2.2% of surface water, 2.15% is fresh water in glaciers and icecaps and only of the order of 0.01% is available in lakes and streams, the remaining 0.04% being in other forms.

Out of 0.6 of stored ground water, only about 0.25% can be economically extracted with the present drilling technology.



Scope of Hydrology

The study of hydrology helps us to know:

1- The maximum probable flood that may occur at a given site and its frequency ; this is required for the safe design of drains, bridges and culverts, dams and reservoirs , channels and other flood control structures.

2- The water yield from a basin-its occurrence, quantity and frequency, etc.; this is necessary for the design of dams, municipal water supply, water power, river navigation, etc.

3- The ground water development for which a knowledge of the hydrology of the area , i.e. of formation soil , recharge facilities like streams and reservoirs, rainfall pattern, climate, cropping pattern, etc. are required.

4- The maximum intensity of storm and its frequency for the design of a drainage project in the area.

Hydrology data

For the analysis and design of any hydrologic project adequate data and length of records are necessary. A hydrologist is often posed with lack of adequate data. the basic hydrological data required are:

1- Climatological data.
2- Hydro-meteorological data like temperature, wind velocity, humidity, etc.
3- Precipitation records.
4- Stream-flow records.
5- Seasonal fluctuation of ground water table or piezometric heads.
6- Evaporation data.
7- Cropping pattern, crops and their consumptive use.
8- Water quality data of surface streams and ground water.
9- Geomorphologic studies of the basin like area, shape and slope of the basin,

mean and median elevation, mean temp. (as well as highest and lowest temp. recorded) and other physiographic characteristics of the basin; stream density and drainage density; tanks and reservoirs

10- Hydro meteorological characteristics of the basin:

- Depth area duration (DAD) curves for critical storms (Station equipped with self-recording rain gauges)
- Isohyetal maps-Isohyets may be drawn for long-term average, annual and precipitation for individual years and months.
- Cropping pattern –crops and their seasons.
- Daily, monthly and annual evaporation from water surfaces from the basin.
- Water balance studies of the basin.
- Chronic problems in the basin due to a fluid-menacing river or silt menacing river
- Average annual rainfall (AAR), long term precipitation, space average over the basin using isohyets and several methods.
- Soil conservation and methods of fluid control.

Hydrologic Cycle

The central focus of hydrology is the hydrologic cycle consisting the processes which occurs continuously in nature; the three important phases of the hydrological cycle are:

(1) Evaporation and evapotranspiration

(2) Precipitation

(3) Runoff.

Water evaporates from the oceans and land surfaces to become *water vapor* that is carried over the earth by atmospheric circulation .The water vapor condenses and *precipitates* on the land and oceans .the precipitated water may be *intercepted* by vegetation, become overland flow over the ground, *infiltrate* into the ground, flow through the soil as *subsurface flow*, or discharge as *surface runoff*. Evaporation from the land surface comprises evaporation directly from the soil and vegetation surfaces, and *transpiration* through plant leaves. Collectively these processes are called evapotranspiration. Infiltrated water may percolate deeper to recharge groundwater

and later become *spring flow* or seepage into streams to also become *stream flow*. The continuous processes are shown in Fig. (1 A & B).

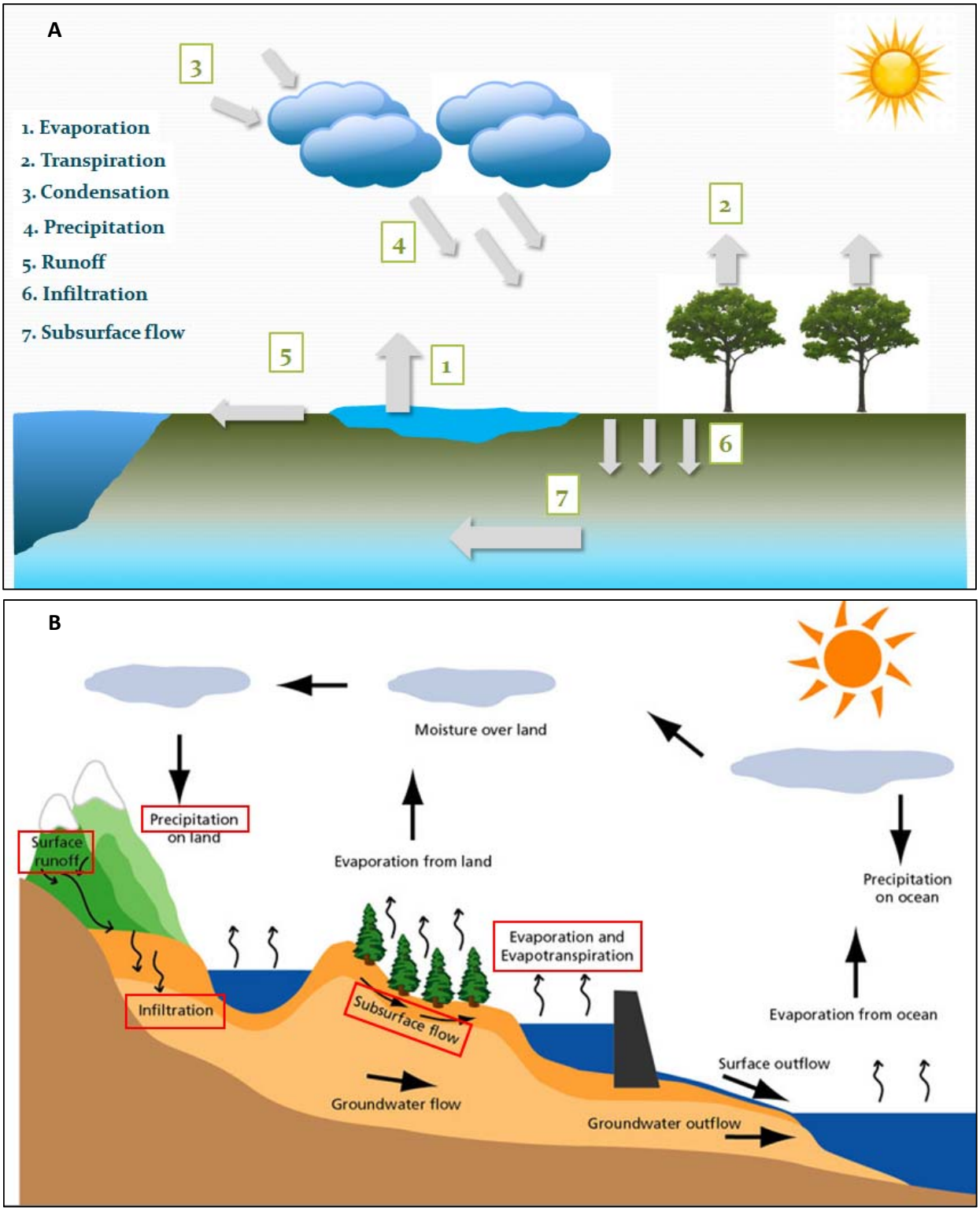


Fig. 1 A & B: The Hydrologic Cycle