

What is hydrology?

The study of water
More particularly: the study of the circulation of atmospheric* and terrestrial *fresh* water

* specifically, as it hits or leaves the surface

Science and technology

- Science aims to understand things
 - hydrological science seeks to understand the hydrological cycle
- Technology aims to *do things*
 - hydrological technology involves the application of mathematical procedures to practical problems involving water

Hydrological science

• "The business of hydrology is to solve the water balance equation"

Dooge (1987)

 "Hydrologists are now being forced to consider the atmosphere and the land surface as an interactive coupled system, a perspective which draws us closer to the geophysicist's viewpoint of global scale processes" Eagleson (1986)

Hydrology as technology

- For example, develop equations to predict the magnitude of the mean annual flood:
 - Qbar = 0.203 AREA0.94 SOIL1.23 RSMD1.03

Global water reservoirs and fluxes

- About 97% occurs as saline water.
- More than 50% of remaining fresh water is "locked up" as ice sheets and glaciers.
- Mobile fresh water represents only about 0.3%.

	Valuer (km ³ × 10 ⁴)	Percentage of total	Range of values in recent blansture (km ² × 10 ⁴)
Reservoir			
Ocean	1 350 000.0	97 403	1.32-1.37 × 10 ^e
Atmosphere	13.0	0.000.94	10.5-14.0
Land	35 977.8	2.598	1000 1400
Rivers	1.7	0.00012	1.0-2.1
Freshweter lakes	100.0	0.007.2	30.0-150.0
Inland seas, saling	105.0	0.007.6	85.4-125.0
Soil water	70.0	0.0051	16.5-150.0
Groundwater	8 200.0	0.592	7.0-330.0 × 10
loe caps/glaciers	27 500.0	1.984	16 5-29 2 × 10 ²
Biota	1.1	0.000 08	10-500
Annual flux			
Evaporation	496.0		445 0-517 0
Ocean	425.0		383.0-505.0
Land	71.0		63.0-73.0
Precipitation	495.0		446 D-577 D
Ocean	385.0		320.0-458.0
Land	111.0		89 O-119 O
Runoff to oceans	41.5		33 5-47.0
Rivers	27.0		27.0.45.0
Groundwater	12.0		0.0-12.0
Glacial meltwater	2.5		17-45









The hydrological cycle

 In the terrestrial part of the cycle, not all of the precipitation reaches the ground, but is intercepted by vegetation and buildings to be re-evaporated.



The hydrological cycle

- Precipitation reaching the ground follows one of three routes:
 - Route 1: it remains as surface storage and is re-evaporated.



The hydrological cycle

• Route 2: it flows over the surface into streams and lakes

- It may then re-evaporate, seep to the groundwater or flow into the sea.
- Route 3: it infiltrates into the ground as soil moisture
- It may then evaporate, move by throughflow to streams, or move by downward percolation to the groundwater.

The hydrological cycle

- The cycle implies a smooth sequential movement, but it can be short-circuited:
 - Precipitation may be evaporated back to the atmosphere.
 - Precipitation may fall on a lake and re-evaporate without touching the land surface.
 - It may move to the groundwater storage zone and be "locked up".
 - The cycle is also modified by human activity.

The hydrological cycle

- Water movement within the cycle is irregular and many phases of the cycle are spasmodic.
 - Rainfall is often spasmodic.
 - Streamflow and Evaporation may also be spasmodic.

The hydrological cycle

- The cycle permits the relationship between the components to be expressed, but has limited practical value when concerned with water movement in a specific area.
- Hydrological studies in drainage basins have taken a systems approach to many practical aspects.









The hydrological system • The most important human modifications relate to:

- 1. Large-scale modification of channel flow and storage by means of surface changes which affect surface runoff and the incidence and magnitude of flooding.
 e.g. afforestation, deforestation, urbanization
- 2. The development of irrigation and land drainage, modifying soil moisture characteristics, infiltration, runoff etc.
- 3. Large-scale abstraction of groundwater and surface water for domestic and industrial uses.

Hydrological continunity

• Continuity of mass and energy:

$$\frac{ds}{dt} = P_t - E_t - Q_t$$

ds/dt = change in storage over time P_t = precipitation E_t = evaporation Q_t = runoff

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ff to oceans 41.5 33.5-47.0	Ocean					
	Land			99.0-119.0		
	Runoff to oceans					
	Rivers	27.0		27.0-45.0		
	Groundwater Glacial meltwater					







The global water balance

- Attempts have been made to quantify the amounts of water following the main routes within the hydrological cycle.
 - It is possible to approximately calculate the global annual water balance (or hydrological balance budget):

$$P = E + R \pm S$$

P = Precipitation

- *E* = Evaporation *R* = Surface Runoff
- S = Gains or Losses due to Changes in Storage

The global water balance

- The global water balance is largely a theoretical concept.
 - It is more realistic to calculate the water balance of a location or region.
 - These will differ greatly from the global water balance due to the influence of local factors (e.g. precipitation, temperature, vegetation, soils, relief, rock type).

The water balance in a tropical rainforest

- Well distributed, high annual precipitation (>2000 mm).
- Balanced by large-scale evaporation and transpiration (due to large biomass and high temperatures), and by runoff.



The water balance in a sub-tropical hot desert

- Annual precipitation <250 mm.
- Balanced dominantly by large-scale evaporation.
- Minimal runoff (except for ephemeral flows).



The water balance in a highlatitude region

- Annual precipitation generally low (<300mm).
- Balanced mainly by runoff from spring and summer melting.
- Reduced evaporation due to low temperatures and sparse vegetation.









The seasonal water balance of a region

- In seasonal climates, evaporation and transpiration may greatly exceed precipitation during the dry season, with the result that runoff becomes less significant.
 - Results in a water deficit.
- The opposite occurs in the wet season leading to a moisture excess.
 - Results in a water surplus.

