Hydrology

Introduction

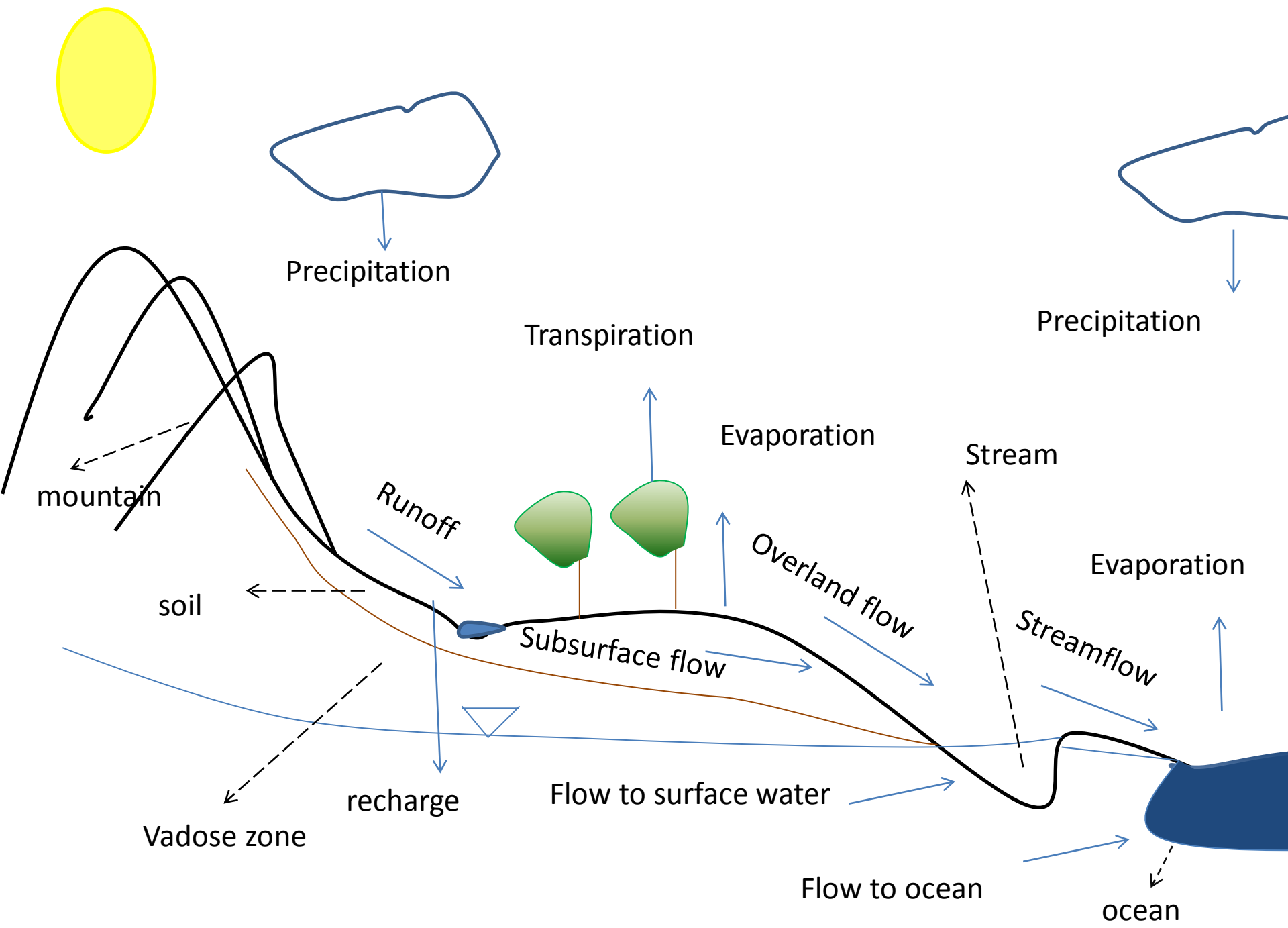
Hydrology

- Hydro → Water
- Logy → science

Hydrology → water science

Hydrology definition

- Free dictionary : “The scientific study of the properties, distribution, and **effects** of **water on the earth's surface**, in the soil and underlying rocks, and in the atmosphere.”
- Hydrology is the study of **hydrologic cycle** (Chow et al. 1988)
- Hydrology include all hydroscienes : Distribution, circulation, physical and chemical properties of the waters of the earth and **its interaction with the environment and the human and living beings** (Chow et al. 1988)


Precipitation
Precipitation
Transpiration
Evaporation
Stream
mountain
Runoff
Overland flow
Evaporation
soil
Subsurface flow
Streamflow
recharge
Flow to surface water
Vadose zone
Flow to ocean
ocean

Global water

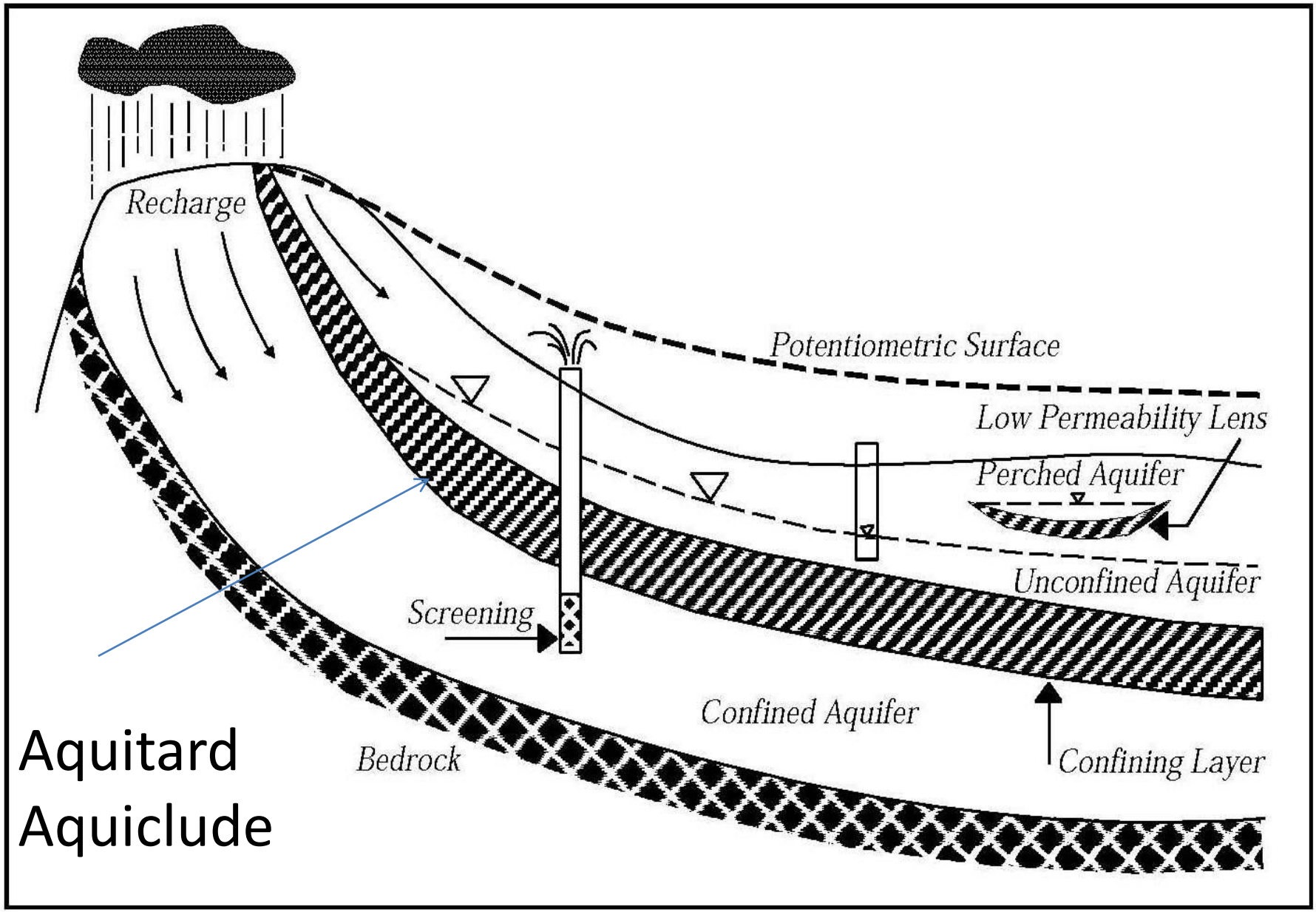
- Global water is *finite (no gain or loss)*

96.5% ➔ Oceans

1.7% ➔ Groundwater

1.7% ➔ Polar ice

0.1% ➔ Surface water and atmospheric



Aquitard

Aquiclude

What is an aquifer

An aquifer is a geologic formation that can:

1. Store water
2. Transmit significant amounts of water

Other geologic formation that store water

- Aquiclude → does not allow the movement of water → impervious → e.g. clay layer
- Aquitard → allow the movement of water but small compared to the aquifer → semi- impervious

Continuity equation

$$change\ in\ storage(\Delta)s = I(t) - Q(t)$$

Global water is finite ➔ $\Delta s = 0$

S: storage, (L^3)

I(t): Input(s) as a function of time (t), (L^3/t)

Q(t): Output(s) as a function of time (t), (L^3/t)

Global water cycle

We can recognize 7 subsystems within the global water cycle:

1. Surface water storage (water storage above surface)
2. Soil water storage
3. Vadoze zone storage
4. Groundwater storage
5. Ocean storage
6. Atmospheric storage
7. Polar ice storage

Global water cycle – Surface water (ΔS)

$$\Delta S = P_{land} + GWF_{surface} + F_{sub} - I - E_{land} - SF_{ocean}$$

P_{land} *:* precipitation over land (L^3)
I: Infiltration (L^3)
E_{land}*:* Evaporation from land (L^3)
SF_{ocean}: stream flow to ocean (L^3)
$GWF_{surface}$ *:* ground water flow to surface water (L^3)
F_{sub}*:* subsurface flow to surface water (L^3)

Global water cycle – Surface water ($\Delta Soil$)

$$\Delta Soil = I \ - T - E_{soil} - F_{sub} - DP$$

I: Infiltration (L^3)

DP: Deep percolation (L^3)

T: Transpiration (L^3)

Global water cycle – Vadoze Zone (ΔV)

$$\Delta V = DP - RG$$

RG: Recharge to the ground water (L^3)

Global water cycle – Ground water (ΔGW)

$$\Delta GW = RG - GWF_{surface} - GWF_{ocean}$$

GWF_{ocean}: ground water flow to oceans (L^3)

Global water cycle – Ocean storage (ΔO)

$$\Delta O = P_{ocean} + SF_{ocean} + GWF_{ocean} + \mathrm{M} - E_{ocean}$$

P_{ocean}: Precipitation over the oceans (L^3)

E_{ocean}: Evaporatiom from the oceans (L^3)

M: Melting of ice cap (L^3)

Global water cycle – Polar storage (ΔPolar)

$$\Delta Polar = -M - E_P$$

M: Melting of polar ice (L^3)

E_p*:* evaporation (sublimation) of polar ice (L^3).

Global water cycle – Atmospheric storage (ΔA)

$$\Delta A = E_{land} + T_{land} + E_{ocean} + E_p - P_{land} - P_{ocean}$$

➔ $\Delta A = E - P$

$$\Delta S = P_{land} + GWF_{surface} + F_{sub} - I - E_{land} - SF_{ocean}$$

$$\Delta Soil = I - T - E_{soil} - F_{sub} - DP$$

$$\Delta V = DP - RG$$

$$\Delta GW = RG - GWF_{ocean} - GWF_{surface}$$

$$\Delta O = P_{ocean} + SF_{ocean} + GWF_{ocean} + \mathrm{M} - E_{ocean}$$

$$\Delta Polar = -M - E_P$$

$$\Delta Surface + \Delta Soil + \Delta V + \Delta O + \Delta GW + \Delta Polar = P - E$$

$$\rightarrow \Delta A = E - P$$

Change in global water storage = 0