

Origin of Water on Earth

Earth is the only planet we know that has liquid water.
Where did it come from? Comets, Volcanoes or Asteroids?

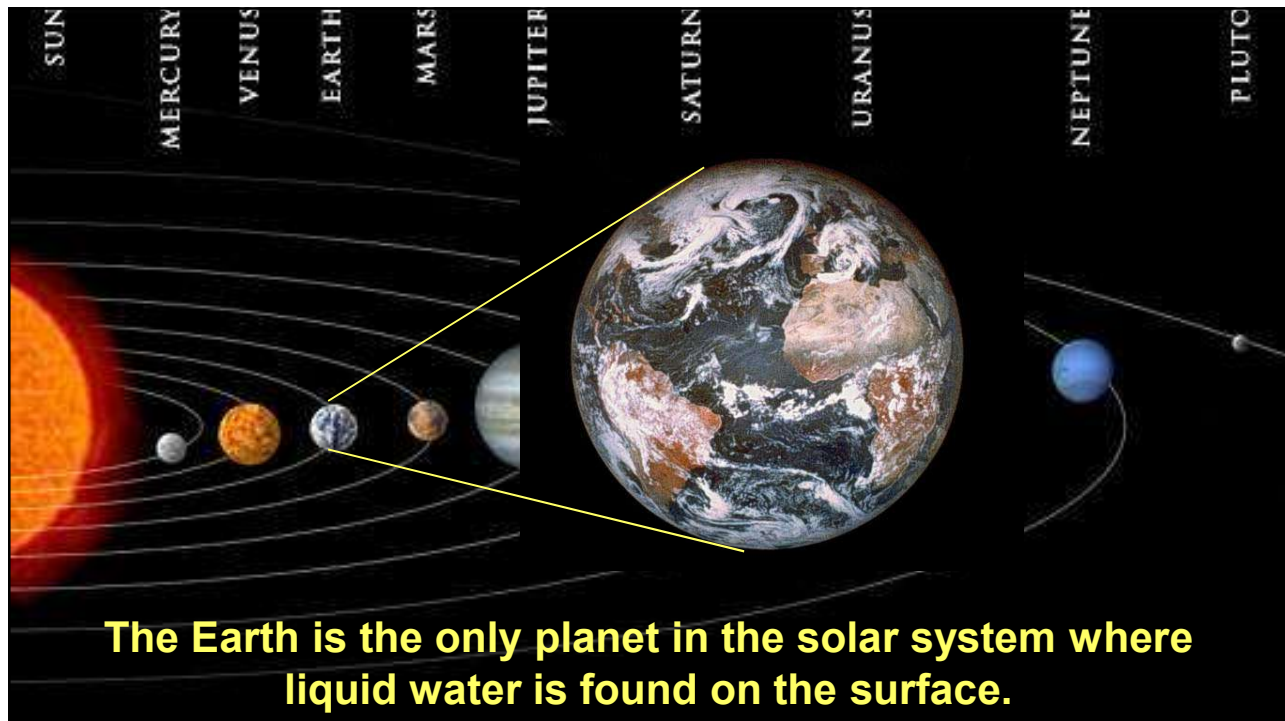
Volcanic Theory of Water

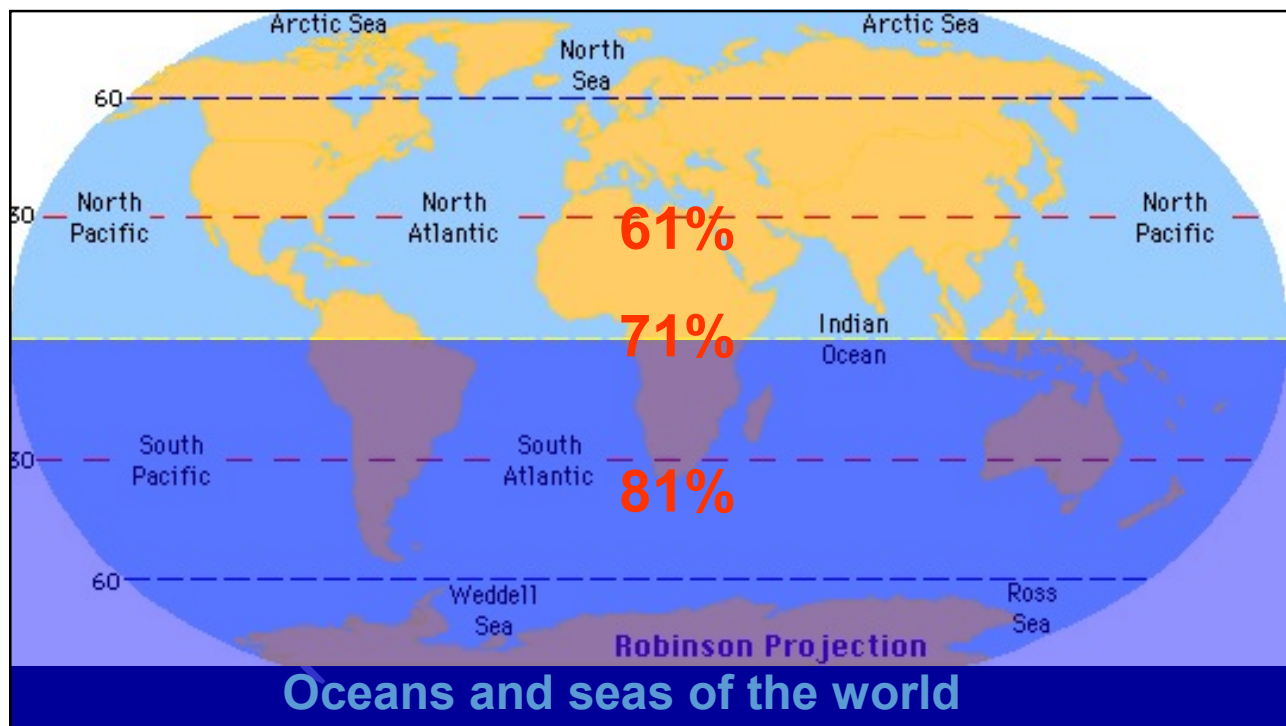
Water existed inside the rocks that made up the Earth itself.

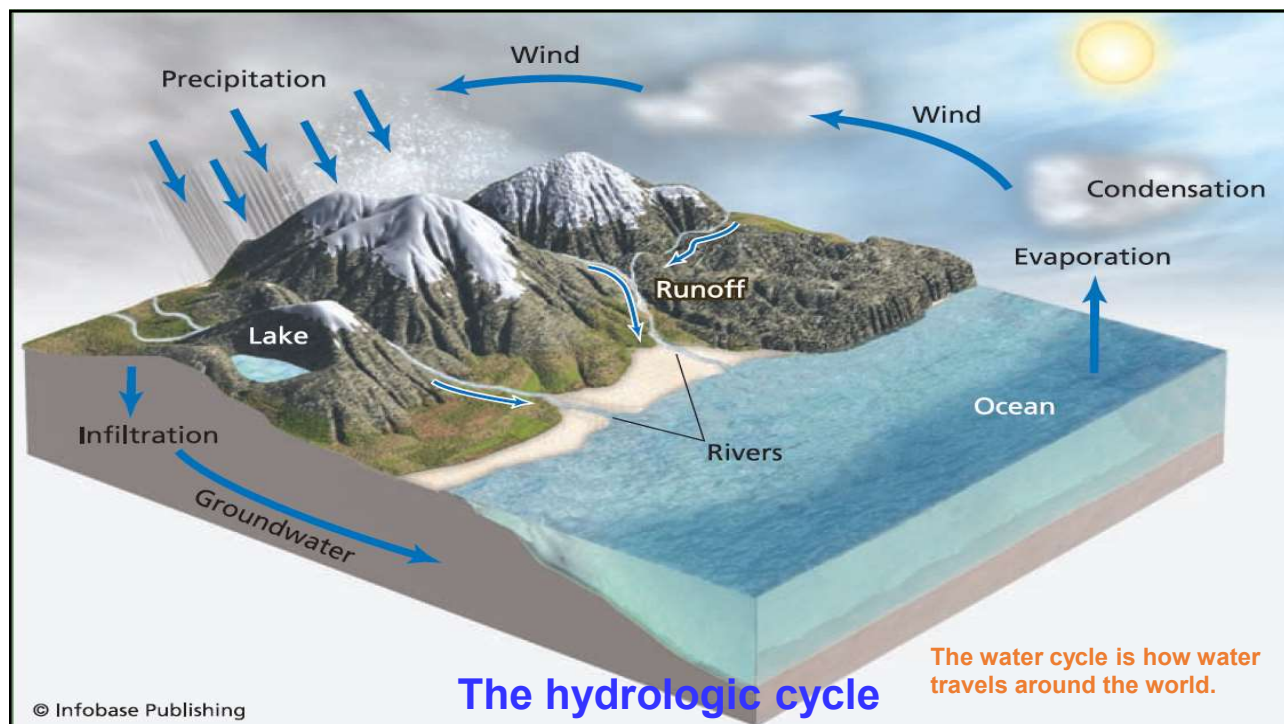
Volcanoes continually release H_2O as water vapor.



<https://earthhow.com/origin-of-water-comets-volcanoes-outgassing/>







What is Salinity?

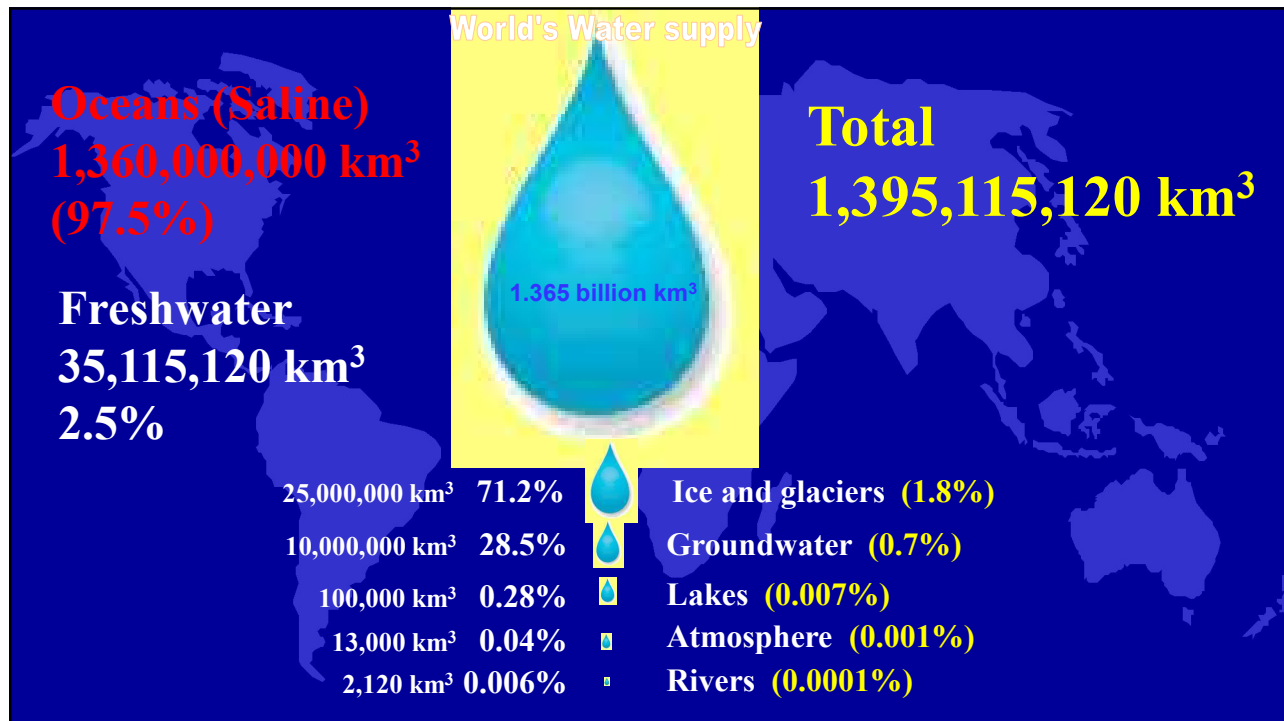
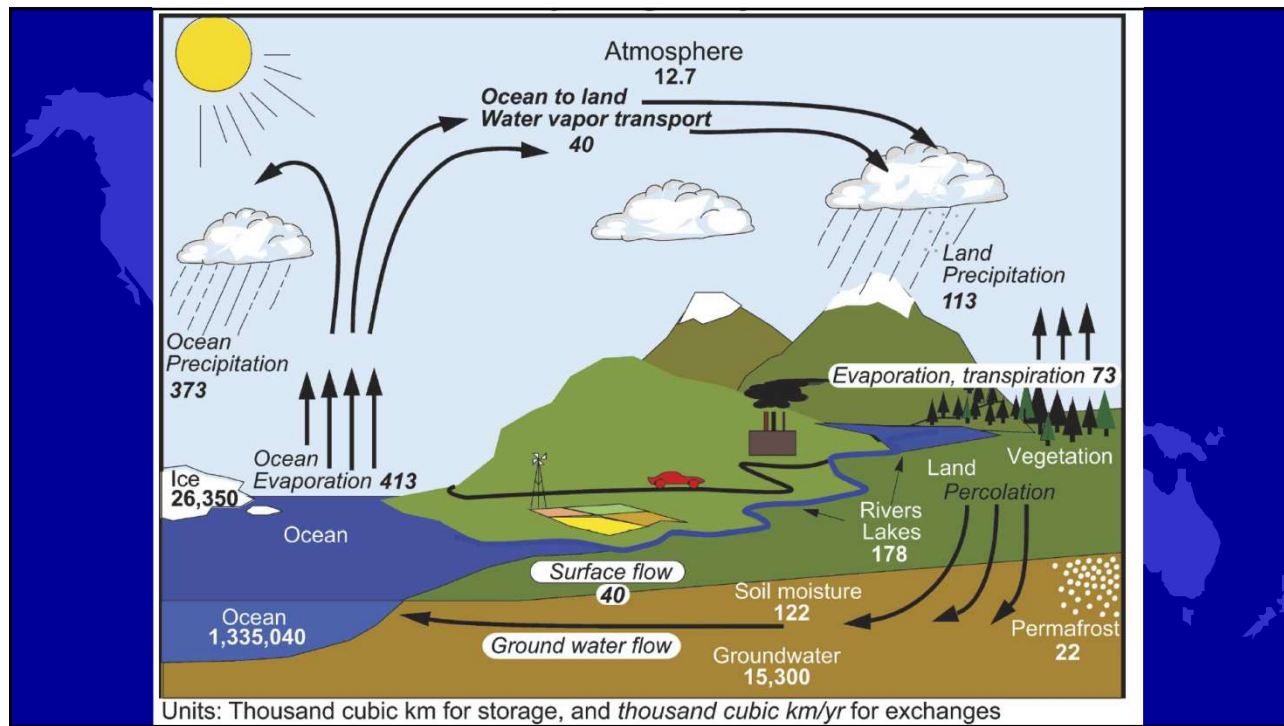
□ Salinity refers to the amount of total dissolved solids (TDS)
It is frequently measured by electrical conductivity (EC), as ions dissolved in water

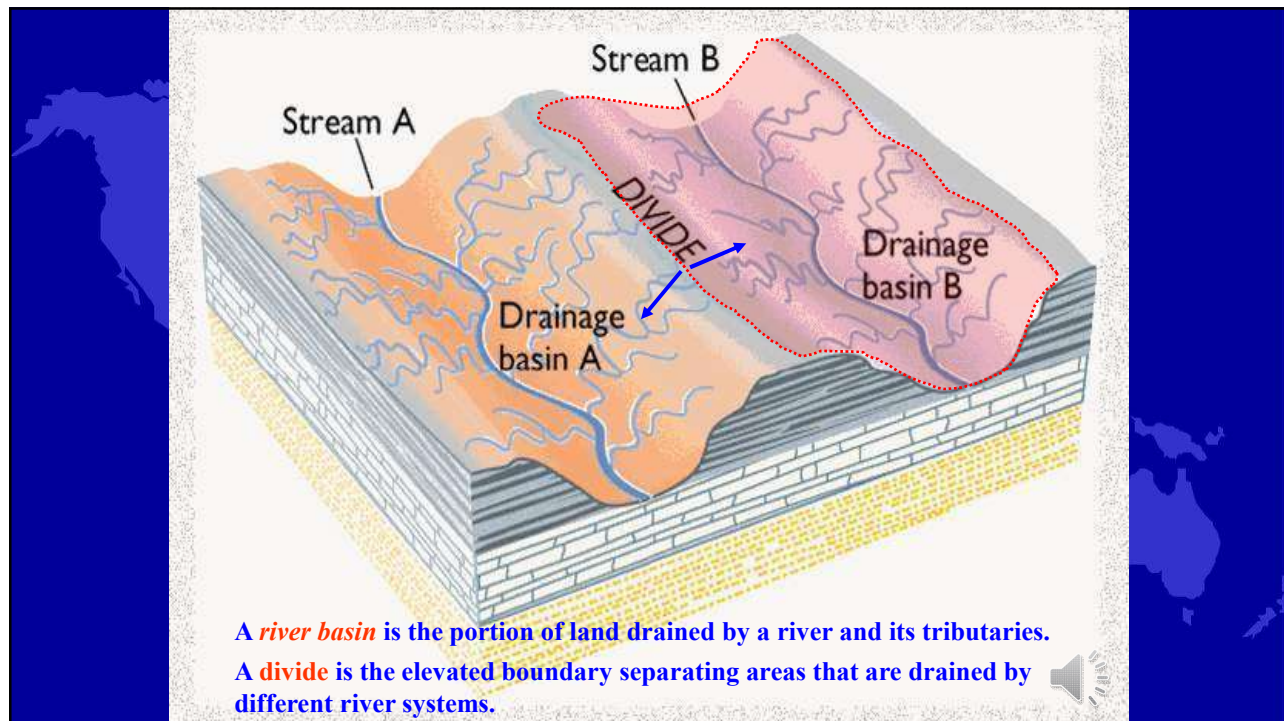
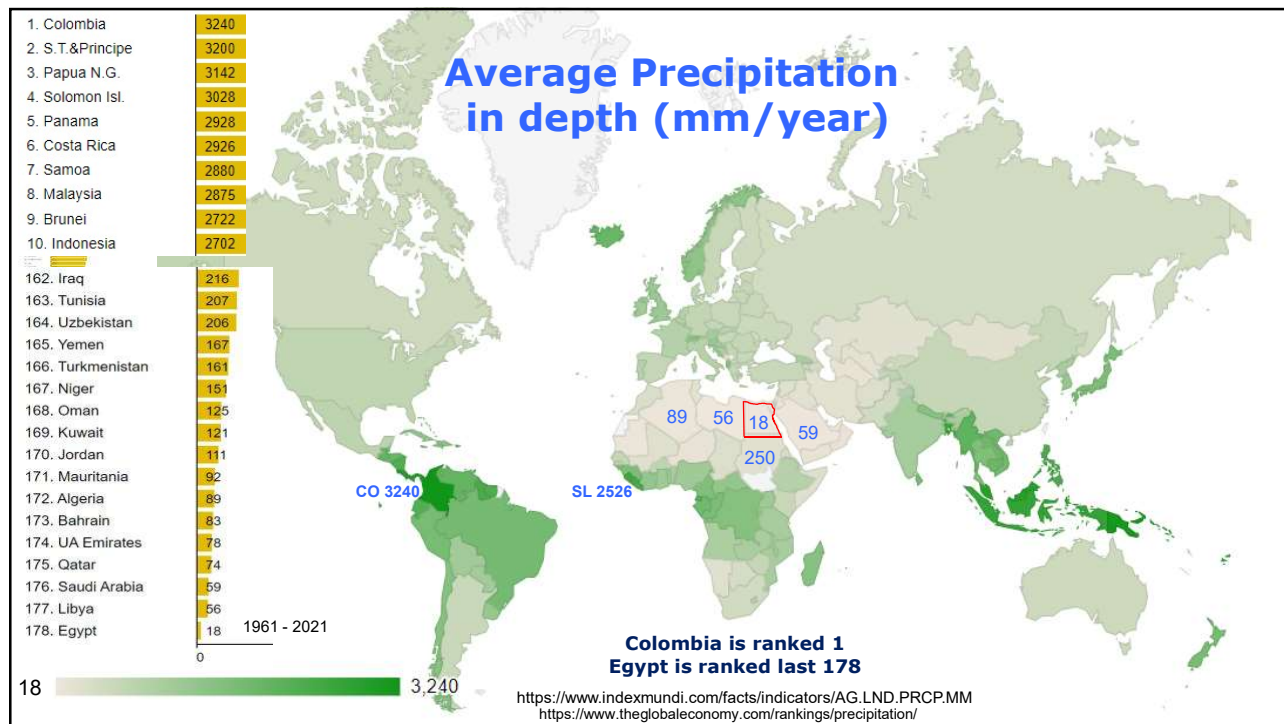
□ Waters with higher TDS concentrations will be relatively conductive.
TDS is measured in mg/l = parts per million (ppm), parts per billion (ppb), or wt%
(wt 1% = 10,000 ppm)

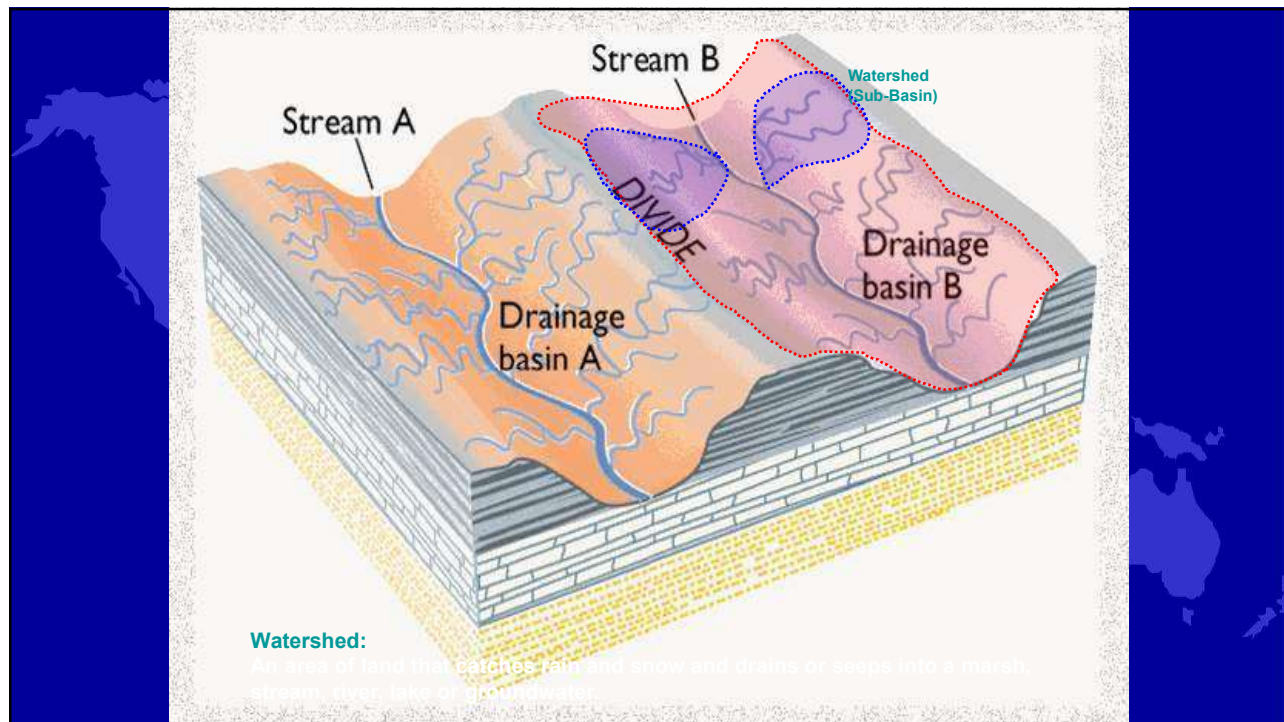
EC is measured in micro-Siemens per centimeter ($\mu\text{S}/\text{cm}$).

Parameters for saline water:

Freshwater (Drinking water)	<1,000 ppm
Slightly saline	1,000 - <3,000 ppm
Moderately saline (brackish).....	1,000 - <10,000 ppm
Highly saline water (Saline).....	10,000 - <35,000 ppm
Brine water	>35,000 ppm







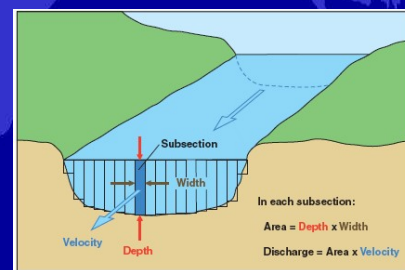
River Discharge

River discharge (Q):

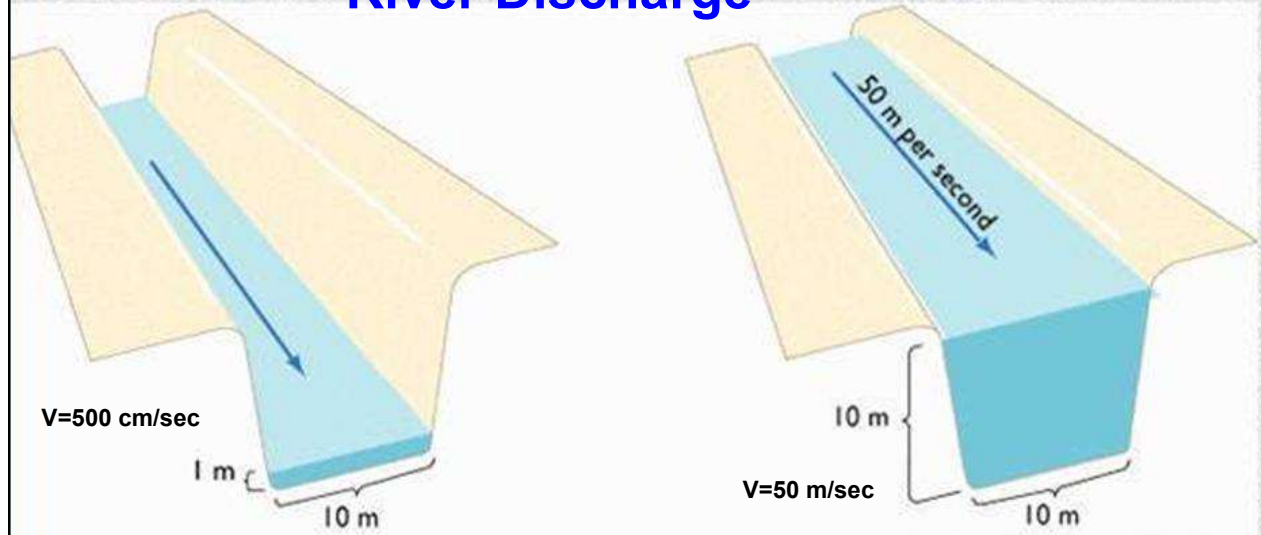
It is the volume of water moving down a stream or river per unit of time, commonly expressed in m^3/s .

$$Q = W \times D \times V$$

Q = river discharge (m^3/sec)
 W = average width (m)
 D = average depth (m)
 V = velocity of water (m/sec)

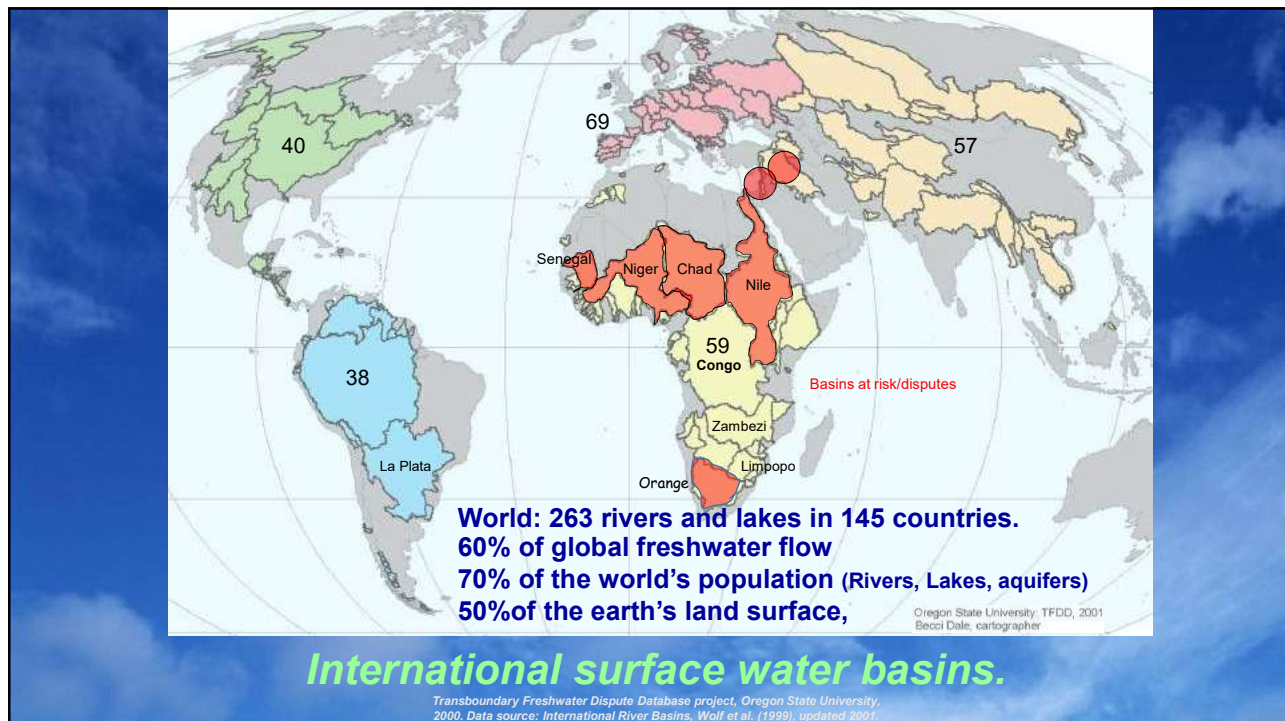


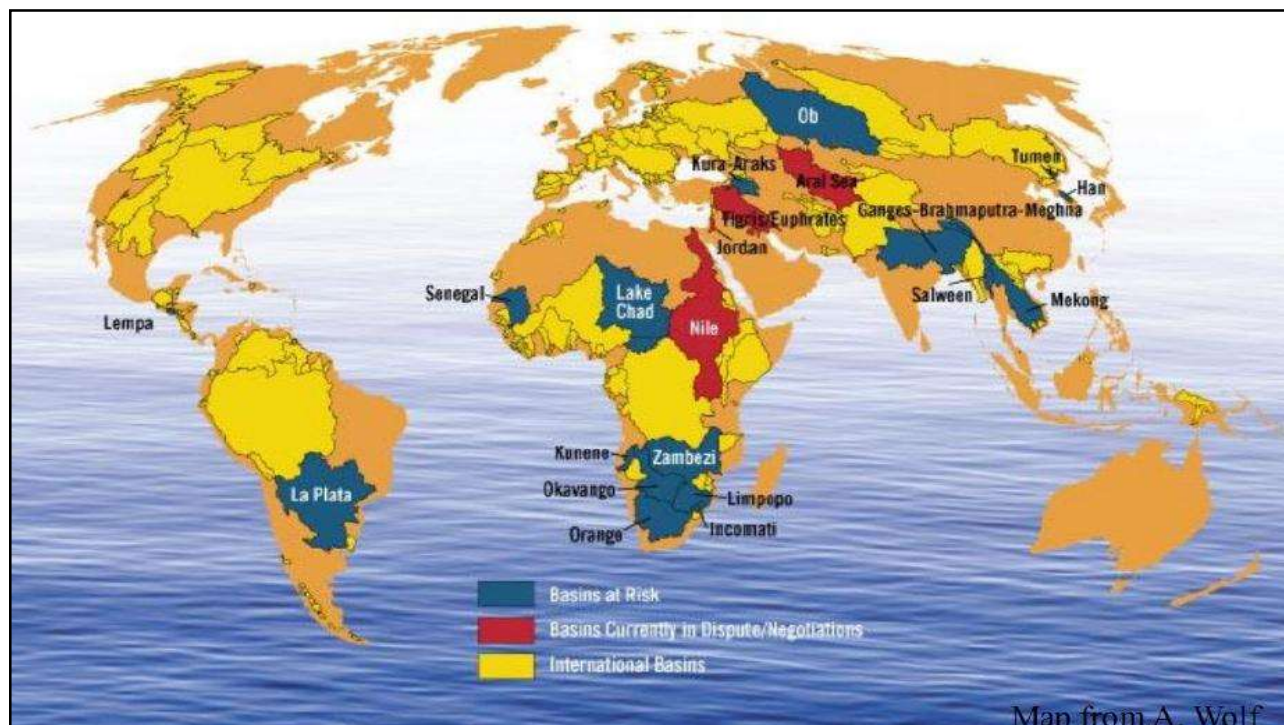
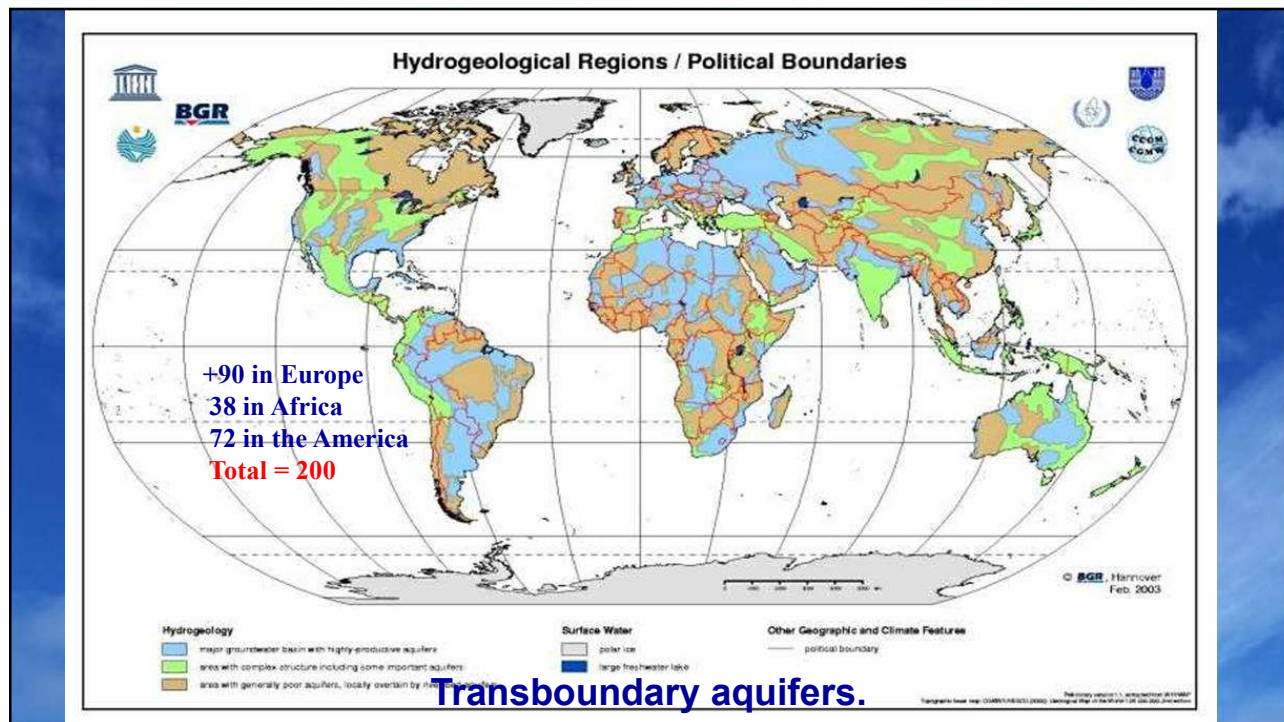
River Discharge



$$Q = W \cdot D \cdot V = 10 \cdot 1 \cdot 5/100 = 50 \text{ m}^3/\text{sec}$$

$$Q = W \cdot D \cdot V = 10 \cdot 10 \cdot 50 = 5000 \text{ m}^3/\text{sec}$$





Water disputes

- **International Waters**

International river is one which, on its journey between its source and the sea passes through the territory of two or more different states (transboundary).

- **Water disputes revolve around:**

1. Quantity
2. Quality
3. Timing
4. Sediment load

General Principles of International Water Law

Water can create peace or spark conflict

1. Obligation to Share Data.
2. Obligation to Resolve Disputes Peacefully.
3. Equitable Utilization of Water.
4. Prevention of Significant Harm
(Quantity, quality, time, load sediments)
5. Obligation to Notify and Inform.
6. Cooperative Management.

The Nile Treaties & Agreements

1. Protocol between Britain and Italy (1891)
2. Treaty between Britain and Ethiopia (1902)
3. Britain and Congo [Modifying 1894 Agreement of Brussels] (1906)
4. Agreement between Britain, Italy and Ethiopia (1906)
5. Exchange of notes between Britain and Italy (1925)
6. Nile water agreement (1929)
7. Convention between Britain and Belgium (1934)
8. Exchange of memos Egypt & Britain (on behalf of Uganda) , 1949 – 1953
9. Egypt and the Sudan Nile Agreement (1959)
10. Exchange of memoranda between Egypt and Uganda (1991)
11. Framework for General Cooperation , Egypt and Ethiopia in 1993
12. Egypt and Uganda Agreement for controlling water hyacinth (1998)
13. Nile Basin Initiative (NBI), 1999
14. Cooperative Framework Agreement of Nile Basin States (Entebbe, CFA) (2010)
15. Declaration of Principles on the Grand Ethiopian Renaissance Dam (2015)

1993 Agreement Egypt-Ethiopia

1. Both countries should not embark in any works on the Nile that could harm and affect other countries' share and benefits.
1. Importance of both countries and safekeeping and protecting the Nile Water.
2. Compliance with international laws.
3. Consultation and cooperation between both countries for utilization of the Nile water to increase water flows and to reduce losses.

Water Scarcity

Water scarcity is the lack of sufficient available water resources to meet the demands of water usage within a region.

Water scarcity involves:

water crisis, water shortage, water deficit or water stress.

Causes of Water Scarcity

1. Natural:

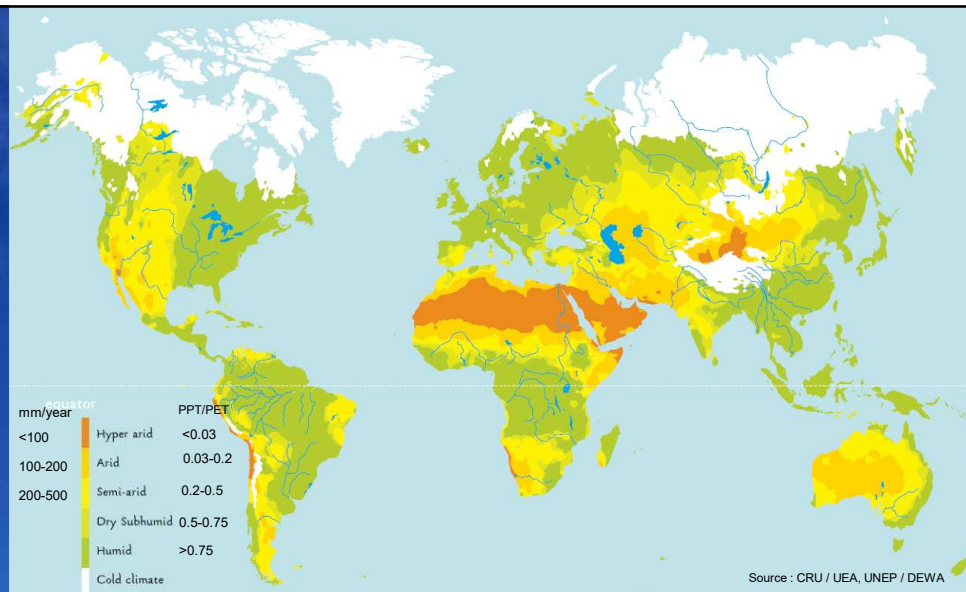
- a. Climate factors (temperature, evaporation, rainfall variability in time and space).
- b. Geologic factors (topography, rock types, fractures,...).
- c. Vegetation cover.

2. Human influences:

- a. Pollution degrade the water quality and lead to water unavailability for many uses.
- b. Population growth
- c. Poor water management.

MAJOR CLIMATIC ZONES

Climatic Zone	Annual Rainfall (mm)	Wet period (months)	Vegetation
Hyper arid (Desert)	less than 100	0-1	Little or no vegetation
Arid	100-400	1-3	Some scrubs, some grassland
Semi-arid	400-600	3-4	Scrubs & bushes, grassland
Sub-humid	600-1200	4-6	Bushes to woodland, grassland
Moist sub-humid	1200-1500	6-9	Forest and woodland
Humid	more than 1500	9-12	Tropical rain forest



World Map of Aridity Zones.

aridity is the following climatic aridity index: PPT/ETP

Water stress index (WSI)

- Annual average flow of water per head of population

e.g. Egypt:

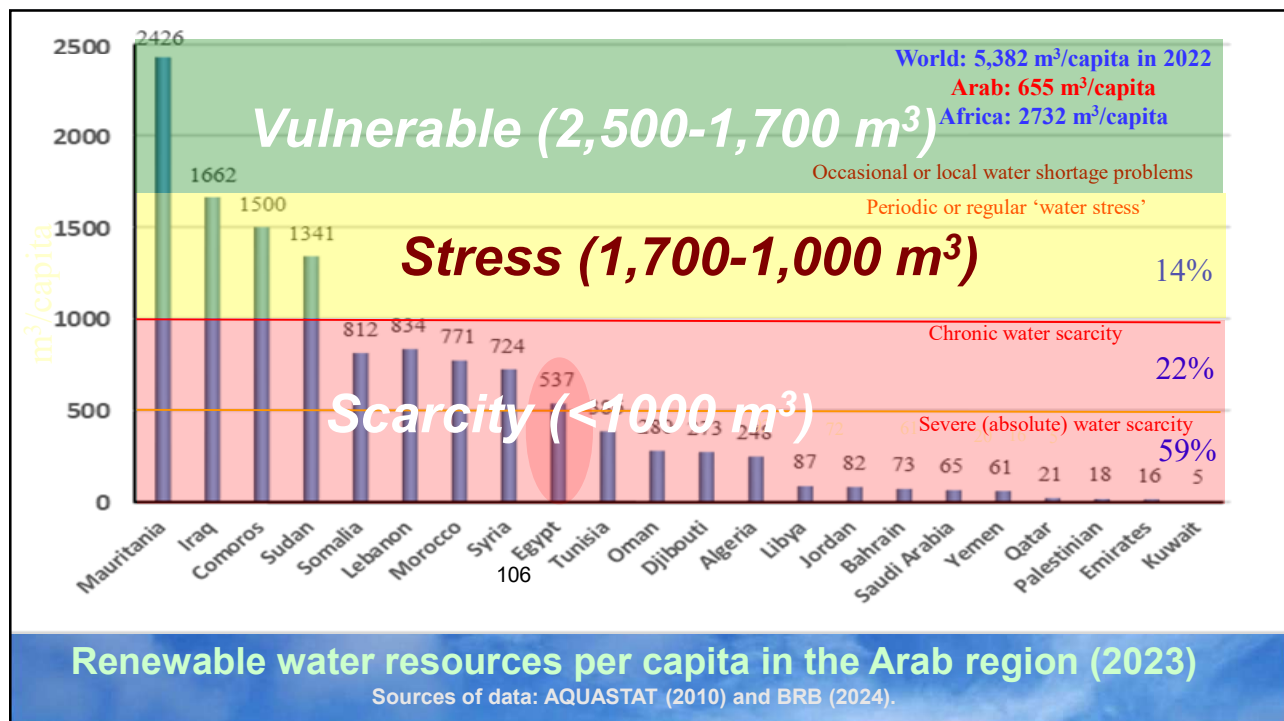
-Available Water

$$\begin{aligned} (\text{Nile } 55.5 \text{ km}^3, \text{ Rainfall} = 1.0 \text{ km}^3) &= 56.5 \text{ km}^3 \\ &= 56,500 \text{ million m}^3 \end{aligned}$$

- Population in 2024 = 106.3 million

$$\text{WSI} = \frac{\text{Annual average surface water flow}}{\text{Population}}$$

$$\text{WSI} = 56,500 \text{ million m}^3 / 106.3 \text{ million} = 532 \text{ m}^3/\text{capita}$$



Water Stress Indicator

Index (m³/capita/year)	Class
>2,500	No stress
1,700 - 2,500	Vulnerable
1,000 - 1,700	Stress
500 - 1,000	Chronic Scarcity
<500	Absolute or Severe

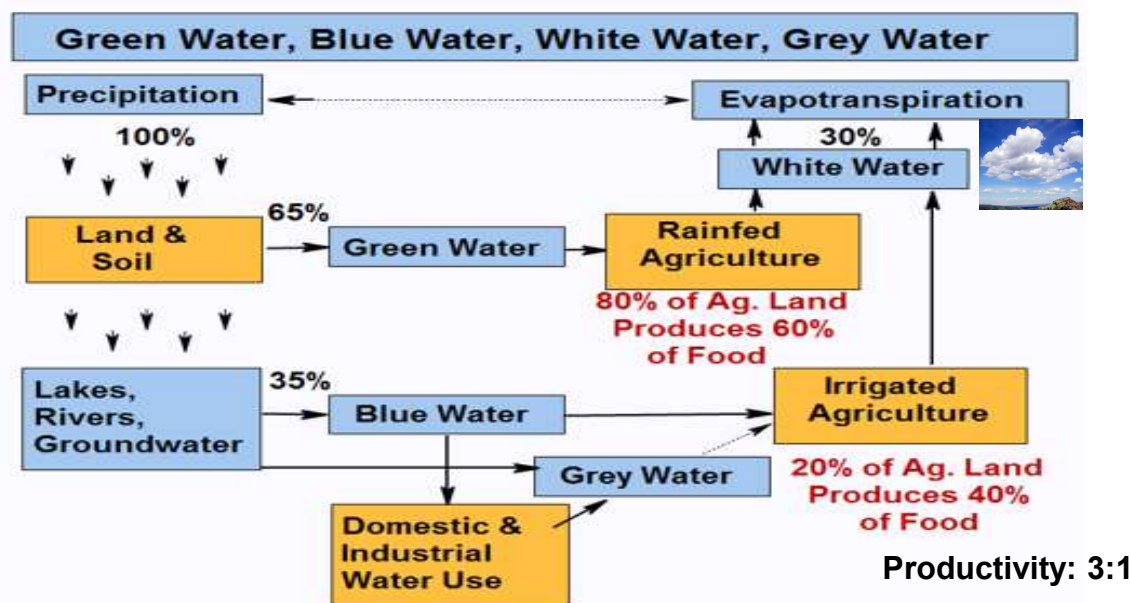
Limitations of water stress evaluation

- The indicator ignores the differences in water demand between the countries determined by the climate and culture, etc.
- It omits the seasonal water availability variations.
- The indicator disregards the water quality or water accessibility.
- It also does not take into account the non-renewable groundwater and artificial water sources such as desalination plants that increase the amount of available water.
- It ignores poor water management.

Virtual water

- Virtual water is the water 'embodied' in a product, not in real sense, but in virtual sense.
- Virtual water has also been called 'embedded water' or 'exogenous water'
- Water footprint
 - **Green water**
The water used by plants via transpiration
 - **Blue water**
The water bodies as rivers, lakes, swamps, and groundwater.
 - **Grey water**
The polluted water
 - **White water**
Water vapor (Clouds)
 - **Black water**
Sewage Water

Partitioning rainwater



Virtual water (footprint)

Product	(m ³ per Kg)
Beef meet	15
Sheep meet	10
Chicken meet	2.8
Eggs	4.7
Cheese	5.3
Milk	0.9
Cereals	1.5

Virtual Water

Product	Virtual-water (liters)
1 sheet of paper (80 g/m ²)	10
1 tomato (70 g)	13
1 slice of bread (30 g)	40
1 orange (100 g)	50
1 apple (100 g)	70
1 egg (40 g)	135
1 glass of orange juice (200 ml)	170
1 bag of potato crisps (200 g)	185
1 glass of milk (200 ml)	200
1 hamburger (150 g)	2,400
1 cotton T-shirt	2,700
1 pair of shoes (bovine leather)	8,000