THE WATER CYCLE

Holston River Soil and Water Conservation District

AUDREY ROOT

The Water Cycle

I. Water Basics

Water is arguably the most important substance on Earth.

It has made life on Earth possible by possessing unique qualities on an atomic scale.

Water is deemed the **universal solvent** because it dissolves more substances than any other liquid.

Water's **pH** is perfectly neutral at 7, so it is neither acidic nor basic.

Water has a high **specific heat**, a measure of how easily a substance's temperature changes. Water is resistant to temperature change.

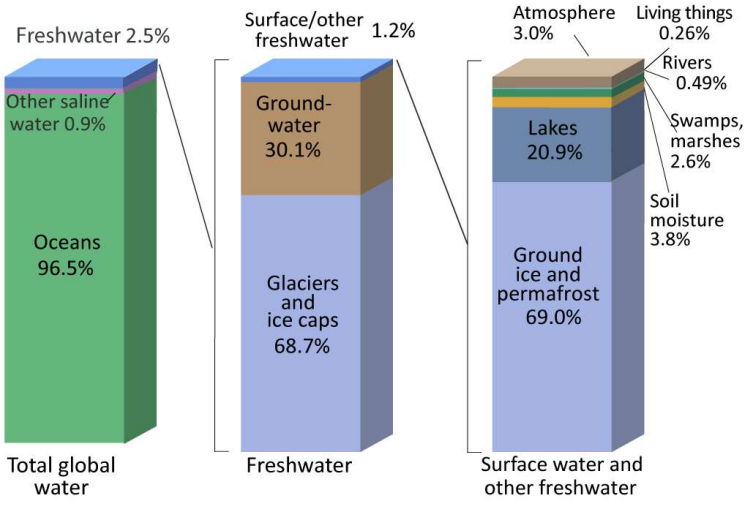
Water can exist in all three **phases of matter** on Earth at natural temperatures: gaseous water vapor, liquid water, and solid ice.

It is **cohesive**, meaning that water molecules stick to each other.

It is **adhesive**, meaning that water molecules stick to other substances.

The "stickiness" of water is important to **surface tension**, water's tendency to form drops and stick together instead of spreading out, and **capillary action**, water's ability to travel through a tube or pore. You can see capillary action in a beaker by looking at the **meniscus** (the little "U" shaped water line). The water is sticking to the sides of tube and pulling up surrounding water molecules.

Where is Earth's Water?



Source: Igor Shiklomanov's chapter "World fresh water resources" in Peter H. Gleick (editor), 1993, Water in Crisis: A Guide to the World's Fresh Water Resources. (Numbers are rounded).

On the global scale, water affects the weather, defines landscapes, and can create deep canyons or erase mountains by simply flowing over the land.

71% of the Earth is covered by water.

96.5% is found as salt water in the oceans.

1.74% is stuck as ice, found in glaciers and ice caps.

Only 0.5% of all water on earth is accessible as liquid freshwater.

Other water is found in the atmosphere, in the soil, and in organisms.

Essentially all water that exists today has been around since Earth's beginning.

Virginia's area is 42,775 square miles. **7.7%** of the area is covered in water.

II. The Water Cycle

If no new water is being created, how have we been able to use it for hydration, sanitation, farming, and energy without running out of water?

The answer is the **water cycle**: the cycling of water through Earth's system.

Water goes on a journey through the atmosphere, on land, and even below the ground.

Understanding the principle of the water cycle is simple. Water is in constant motion.

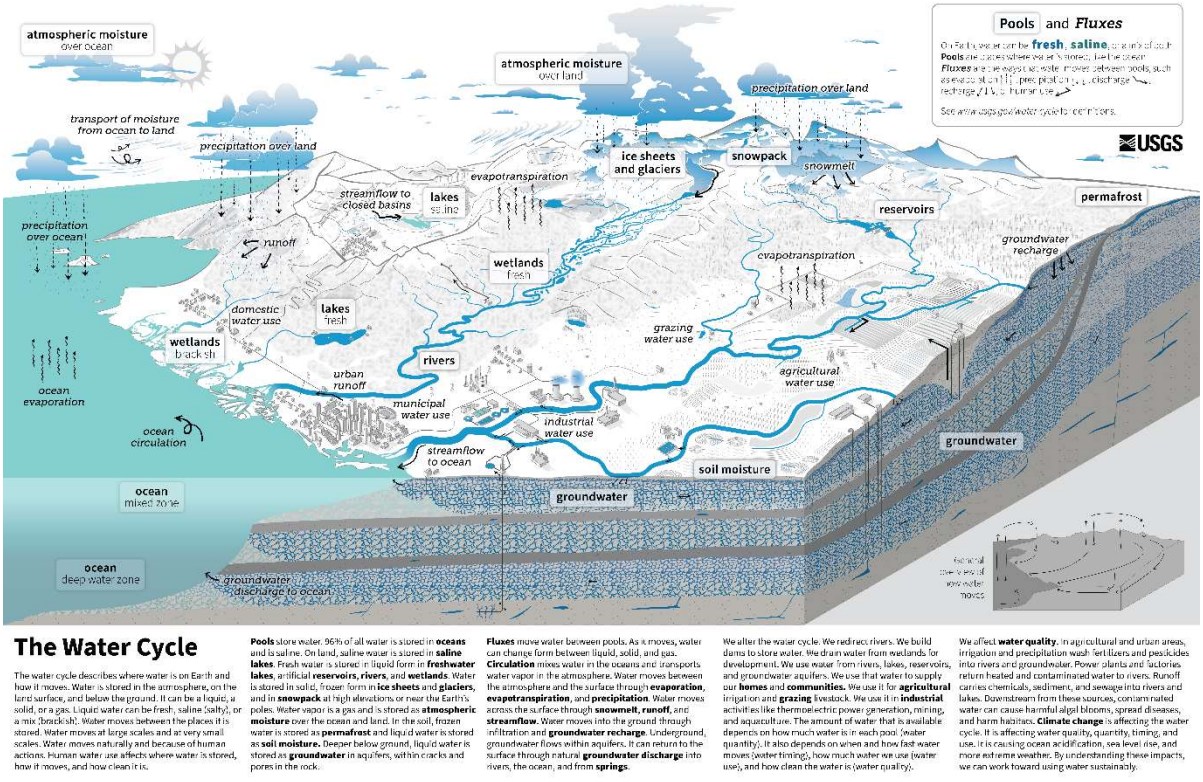
The water cycle consists of **pools** and **fluxes**.

A **pool** stores water. A simple example would be the North Fork Holston River.

A **flux** moves water: processes like evaporation.

You might confuse pools and fluxes in the water cycle. Remember that a pool is a place. A flux is a process. In diagrams, fluxes are usually represented by arrows.

There are countless pools and fluxes that make up the water cycle. Some are more important and common than others, but all play a role in the Earth's system and impact our lives.



The Water Cycle

The water cycle describes where water is on Earth and how it moves. Water is stored in the atmosphere, on the land surface, and below the ground. It can be a liquid, a solid, or a gas. Liquid water can be fresh, saline (salty), or a mix (brackish). Water moves between the places it is stored. Water moves at large scales and at very small scales. Water moves naturally and because of human actions. Human water use affects where water is stored, how it moves, and how clean it is.

Pools store water. 96% of all water is stored in **oceans** and is saline. On land, saline water is stored in **saline lakes**. Fresh water is stored in liquid form in **freshwater lakes**, artificial **reservoirs**, **rivers**, and **wetlands**. Water is stored in solid, frozen form in **ice sheets** and **glaciers**, and in **snowpack** at high elevations or near the Earth's poles. Water vapor is a gas and is stored as **atmospheric moisture** over the ocean and land. In the soil, frozen water is stored as **permafrost** and liquid water is stored as **soil moisture.** Deeper below ground, liquid water is stored as **groundwater** in aquifers, within cracks and pores in the rock.

Fluxes move water between pools. As it moves, water can change form between liquid, solid, and gas. **Circulation** mixes water in the oceans and transports water vapor in the atmosphere. Water moves between the atmosphere and the surface through **evaporation, evapotranspiration**, and **precipitation**. Water moves across the surface through **snowmelt, runoff**, and **streamflow**. Water moves into the ground through infiltration and **groundwater recharge**. Underground, groundwater flows within aquifers. It can return to the surface through natural **groundwater discharge** into rivers, the ocean, and from **springs**.

We alter the water cycle. We redirect rivers. We build dams to store water. We drain water from wetlands for development. We use water from rivers, lakes, reservoirs, and groundwater aquifers. We use that water to supply our **homes** and **communities.** We use it for **agricultural** irrigation and **grazing** livestock. We use it in **industrial** activities like thermoelectric power generation, mining, and aquaculture. The amount of water that is available depends on how much water is in each pool (water quantity). It also depends on when and how fast water moves (water timing), how much water we use (water use), and how clean the water is (water quality).

We affect **water quality**. In agricultural and urban areas, irrigation and precipitation wash fertilizers and pesticides into rivers and groundwater. Power plants and factories return heated and contaminated water to rivers. Runoff carries chemicals, sediment, and sewage into rivers and lakes. Downstream from these sources, contaminated water can cause harmful algal blooms, spread diseases, and harm habitats. **Climate change** is affecting the water cycle. It is affecting water quality, quantity, timing, and use. It is causing ocean acidification, sea level rise, and more extreme weather. By understanding these impacts, we can work toward using water sustainably.

To be able to zoom in to the diagram, visit https://labs.waterdata.usgs.gov/visualizations/water-cycle/index.html#/

Pools of water probably make you think of a swimming pool or oceans, rivers, and lakes. Pools also include:

Wetlands: areas where water saturates the soil

Groundwater: fresh water below the surface

Water in organisms: all organisms need water to live and we store a lot in our bodies.

Your body is 60% water!

Fluxes are processes that move water between pools. It can be the movement of liquid water from a river into the ocean or involves a change in phase. The three basic fluxes that drive the water cycle are evaporation, condensation, and precipitation.

Evaporation: liquid water turning into water vapor

When you heat up water on the stove and steam forms, that is evaporation.

In nature, heat energy from the sun causes water to turn into water vapor and rise into the atmosphere.

Condensation: water vapor turning into liquid water

When you leave a glass of ice water out, the water droplets on the outside are droplets that formed from water vapor in the air

Evaporated water reaches a point in the atmosphere where it gets really cold. This causes the water vapor to condense and form clouds or sometimes fog.

Precipitation: liquid water falling from clouds as liquid water **(rain)** or ice **(snow or hail)** or a mixture **(sleet)**

When clouds get too heavy and filled with condensation, it falls from the sky as precipitation and enters a pool back on the ground.

Eventually, the water will evaporate again and the cycle continues.

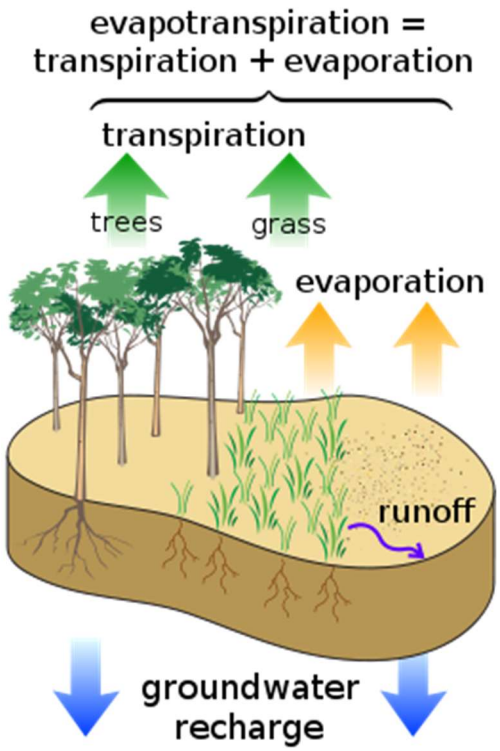
These basic processes are easy to understand and are all things that you have witnessed. You have watched a puddle dry up on a hot day (evaporation). You can look at clouds in the sky (condensation). And I bet you have gotten all wet during a rainstorm (precipitation).

Some fluxes are less obvious. In fact, there are way too many to put all in this little guide.

Where and how water falls as precipitation has a huge impact on its next step in the water cycle. Rain falling into a body of water will simply circulate with that body of water, but what happens when it falls on land?

Often times, it travels over the land as **runoff**. It picks up soil and whatever else is there, even harmful pollutants. You have seen runoff when stormwater flows into a gutter.

If conditions are right, water will **infiltrate** the soil and become part of the **soil moisture** pool or **groundwater recharge**.



Some of this water is used by plants. Plants need water just like humans. They "drink" water from the ground and bring it up to their leaves. Leaves "breathe" like humans! When a plant breathes in, they take in carbon dioxide. When they breathe out, they release oxygen and water vapor. This water vapor enters the atmosphere and can become clouds. The water cycle continues! We call the flux of plants releasing water vapor **evapotranspiration**.

Humans use a lot water. It is integral to our life as a source for hydration and to grow our food, but we also use it for hydroelectric power, in manufacturing, and so much more. While it is so important for society, humans have not treated this precious resource with respect.

To learn about threats that face the Earth's water supply, visit https://www.epa.gov/environmental-topics/water-topics.

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