The Hydrologic Cycle

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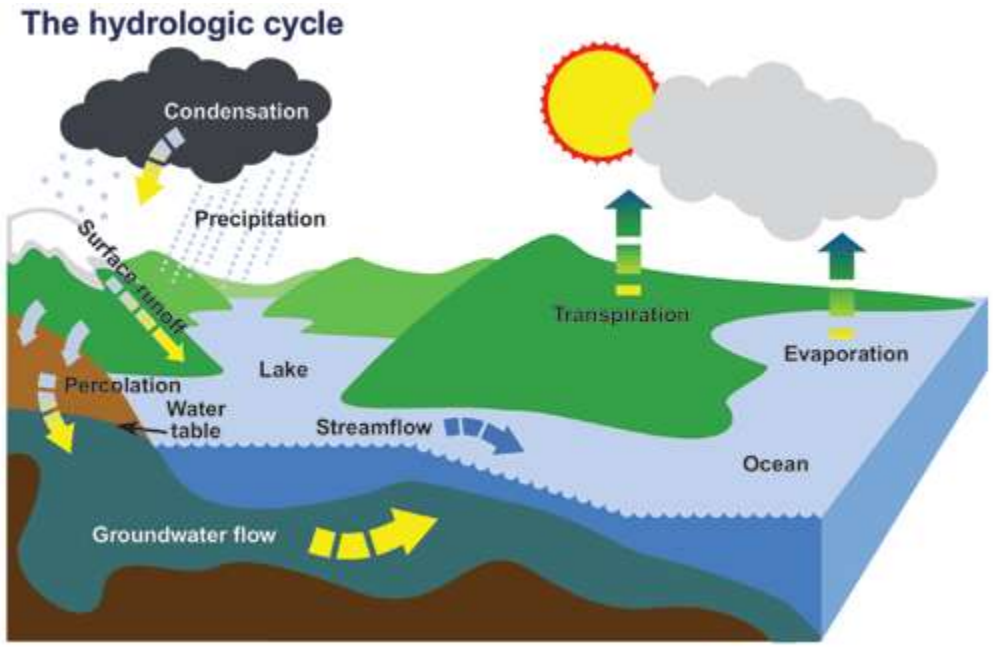
Introduction

From the beginning of time when water first appeared, it has been constant in quantity and continuously in motion. Little has been added or lost over the years. The same water molecules have been transferred time and time again from the oceans and the land surface into the atmosphere by evaporation, dropped on the land as precipitation, and transferred back to the sea by rivers and groundwater. This endless circulation is known as the "hydrologic cycle".



Evaporation

As water is heated by the sun, surface molecules become sufficiently energized to break free of the attractive force binding them together, and then evaporate and rise as invisible vapour in the atmosphere.

Transpiration

Water vapour is also emitted from plant leaves by a process called transpiration. Every day an actively growing plant **transpires** 5 to 10 times as much water as it can hold at once.

Condensation

As water vapour rises, it cools and eventually **condenses**, usually on tiny particles of dust in the air. When it condenses it becomes a liquid again or turns directly into a solid (ice, hail or snow). These water particles then collect and form clouds.

Precipitation

Precipitation in the form of rain, snow and hail comes from clouds. Clouds move around the world, propelled by air currents. For instance, when they rise over mountain ranges, they cool, becoming so saturated with water that water begins to fall as rain, snow or hail, depending on the temperature of the surrounding air.

Runoff

Excessive rain or snowmelt can produce overland flow to creeks and ditches. Runoff is visible flow of water in rivers, creeks and lakes as the water stored in the basin drains out.

Percolation

Some of the precipitation and snow melt moves downwards, **percolates** or **infiltrates** through cracks, joints and pores in soil and rocks until it reaches the water table where it becomes groundwater.

Groundwater

Subterranean water is held in cracks and pore spaces. Depending on the geology, the groundwater can flow to support streams. It can also be tapped by wells. Some groundwater is very old and may have been there for thousands of years.

Water table

The water table is the level at which water stands in a shallow well.

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The Sun-Powered Cycle

Heating of the ocean water by the sun is the key process that keeps the hydrologic cycle in motion. Water evaporates, then falls as precipitation in the form of rain, hail, snow, sleet, drizzle or fog. On its way to Earth some precipitation may evaporate or, when it falls over land, be intercepted by vegetation before reaching the ground. The cycle continues in three different ways:

- Evaporation/transpiration – On average, as much as 40 percent of precipitation in Canada is evaporated or transpired.
- Percolation into the ground – Water moves downward through cracks and pores in soil and rocks to the water table. Water can move back up by capillary action or it can move vertically or horizontally under the earth's surface until it re-enters a surface water system.
- Surface runoff – Water runs overland into nearby streams and lakes; the steeper the land and the less porous the soil, the greater the runoff. Overland flow is particularly visible in urban areas. Rivers join each other and eventually form one major river that carries all of the sub-basins' runoff into the ocean.

Although the hydrologic cycle balances what goes up with what comes down, one phase of the cycle is "frozen" in the colder regions during the winter season. During the Canadian winter, for example, most of the precipitation is simply stored as snow or ice on the ground. Later, during the spring melt, huge quantities of water are released quickly, which results in heavy spring runoff and flooding.

See also: Groundwater

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The Water-Climate Relationship

Water plays a basic role in the climate system through the hydrologic cycle, but water is intimately related to climate in other ways as well. It is obvious, from a water resource perspective, how the climate of a region to a large extent determines the water supply in that region based on the precipitation available and on the evaporation loss. Perhaps less obvious is the role of water in climate. Large water bodies, such as the oceans and the Great Lakes, have a moderating effect on the local climate because they act as a large source and sink for heat. Regions near these water bodies generally have milder winters and cooler summers than would be the case if the nearby water body did not exist.

The evaporation of water into the atmosphere requires an enormous amount of energy, which ultimately comes from the sun. The sun's heat is trapped in the earth's atmosphere by greenhouse gases, the most plentiful of which by far is water vapour. When water vapour in the atmosphere condenses to precipitation, this energy is released into the atmosphere. Fresh water can mediate climate change to some degree because it is stored on the landscape as lakes, snow covers, glaciers, wetlands and rivers, and is a store of latent energy. Thus water acts as an energy transfer and storage medium for the climate system.

The water cycle is also a key process upon which other cycles operate. For example one needs to properly understand the water cycle in order to address many of the chemical cycles in the atmosphere.