



## 4.2 The Water Cycle

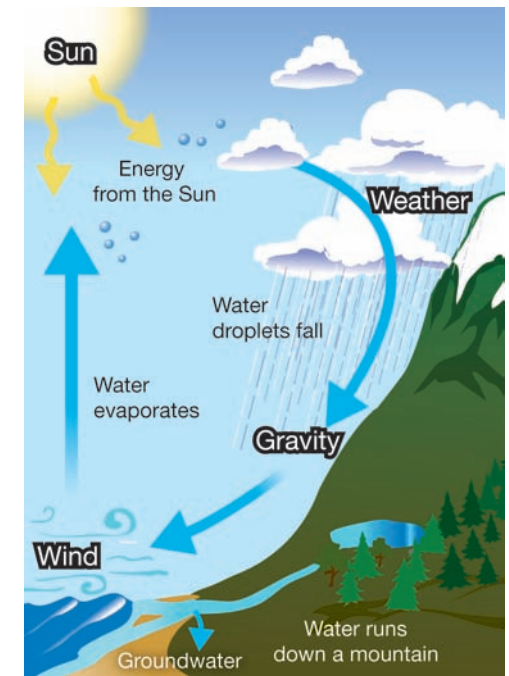
The Sun keeps water moving through the hydrosphere by providing energy. In this section, you will learn about the water cycle and where water goes so that it is available for people, animals, and plants.

### Recycling water

- Sharing water with the dinosaurs** For millions of years, only a small percentage of fresh water has been available to meet the basic needs of life on Earth. Remember that our total water supply today is the same as when the dinosaurs were around. Therefore, the water you drink was probably used by other organisms during the past millions of years. A set of processes called the **water cycle** keeps our water continuously recycled and naturally filtered. The water cycle is sometimes called the *hydrologic cycle*.
- The Sun drives the water cycle** The Sun is the source of energy that drives the water cycle. Wind, weather, and gravity are additional natural forces that keep water moving from place to place (Figure 4.7). Of course, people also play a role in transporting water on Earth.
- Wind and weather** Wind and storms provide forces that cause water to be blown or moved from one place to another. For example, wind blowing clouds moves water vapor from one place to another. Precipitation (rain or snow) is a way water moves from the sky to the ground.
- Gravity** In Chapter 2, you learned that the more mass an object has, the greater the force of gravity is on that object. Water has mass and is affected by gravity. For example, when raindrops get big enough in a rain cloud, gravity causes them to fall to the ground. Gravity also causes water to run down mountains to the coast (Figure 4.7). And gravity is the primary force that moves water from Earth's surface, through the ground, to become groundwater.

### VOCABULARY

**water cycle** - a set of processes energized by the Sun that keep water moving from place to place on Earth; also called the hydrologic cycle.



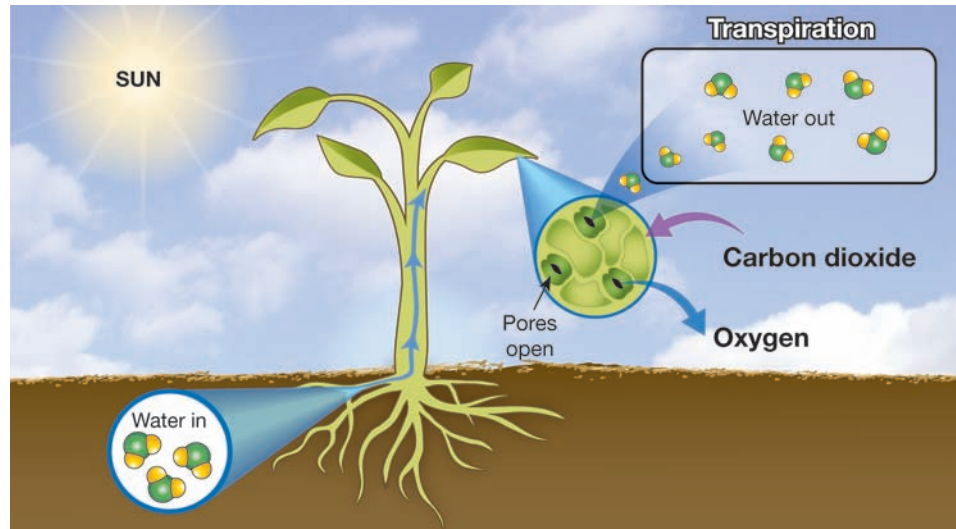
**Figure 4.7:** The Sun, wind, weather, and gravity drive the water cycle.

## Water cycle processes

**Four main processes** The four main processes of the water cycle are *evaporation*, *transpiration*, *condensation*, and *precipitation*.

**Evaporation** **Evaporation** occurs when liquid water has enough energy to leave the liquid phase and become a gas called **water vapor**. The source of this energy is heat from the Sun. The Sun warms the surfaces of mud puddles, lakes, rivers, and oceans. As a result, water obtains enough energy to evaporate and become water vapor in the atmosphere.

**Transpiration** **Transpiration** is the process in which plants lose water through tiny pores on their leaves. The pores open to gain carbon dioxide. Once the pores are open, the plants lose water, and release oxygen. The water vapor contributes to the water cycle. All living organisms benefit from the released oxygen. It's what we breathe!



## VOCABULARY

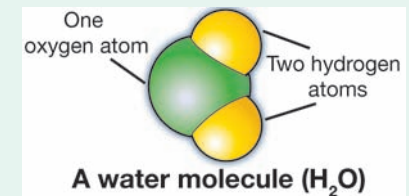
**evaporation** - the process by which a substance in its liquid phase gains energy and enters its gaseous phase; a phase of the water cycle.

**water vapor** - water in gas form.

**transpiration** - the process by which plants lose water through tiny pores on their leaves; a phase of the water cycle.

### The water molecule

You have probably heard water called "H-two-O" and written as  $H_2O$ . This way of talking about water refers to a water molecule that is made of two hydrogen atoms and one oxygen atom. In this text, we represent the water molecule like this:



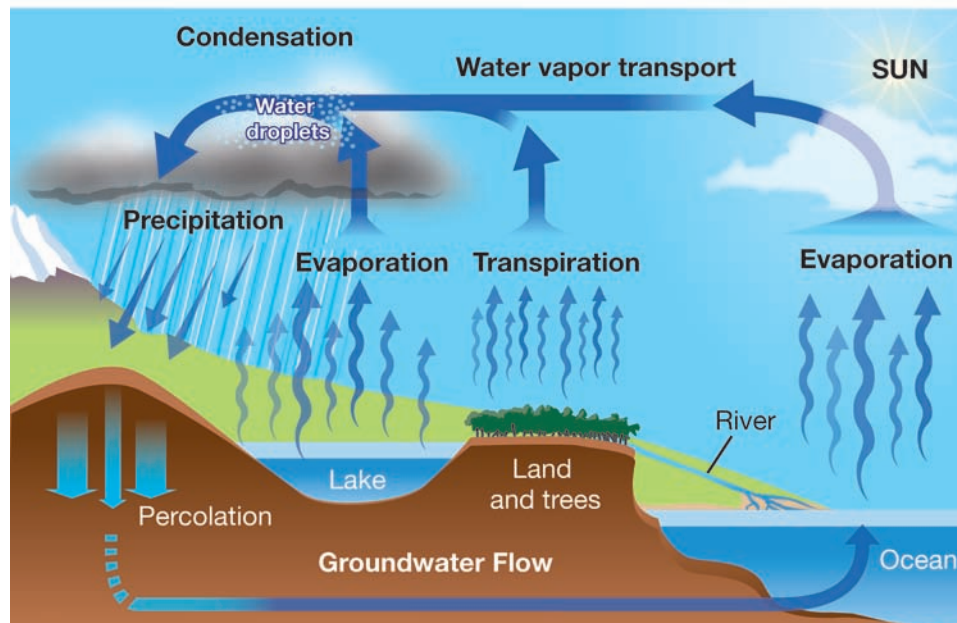


**Condensation** **Condensation** occurs when water in its gaseous phase loses energy. This tends to happen high in the atmosphere as the molecules cool down. Water molecules cool and slow down so much that they group and form droplets of liquid. When these droplets are heavy enough, they fall to Earth as rain.

**Precipitation** **Precipitation** is any form of condensed water vapor in the atmosphere falling back to Earth. This includes rain, snow, sleet, and hail.

**Following the water cycle** The diagram below illustrates the water cycle. Trace the path of water from the ocean to groundwater and back to the ocean.

**The Water Cycle**



### **VOCABULARY**

**condensation** - the process by which a substance in its gaseous phase loses energy and enters its liquid phase; a phase of the water cycle.

**precipitation** - condensed water vapor in the atmosphere falling back to Earth in the form of rain, hail, sleet, or snow; a phase of the water cycle.

### **MY JOURNAL**

Imagine you are a snowflake in an icecap on the top of a mountain. Describe what happens to you as the seasons change starting with winter. Describe your path through the water cycle. Also, describe any points along your journey where you might interact with human beings!

## How water moves in the water cycle

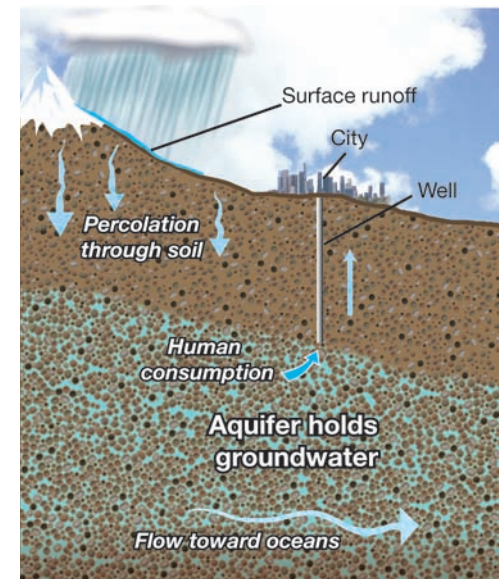
- Surface runoff** Precipitation that reaches Earth's surface often flows over the land. This water, called **surface runoff**, eventually reaches lakes, rivers, and oceans. Surface runoff dissolves and collects minerals and nutrient-rich soil as it flows. Many of the minerals and nutrients in fresh water and salt water come from surface runoff.
- Percolation** Water that flows over the land can percolate through the soil to become groundwater. **Percolation** is the process of liquid moving through a substance that is porous (has many tiny holes or "pores"). Groundwater can move through soil because the soil is porous.
- Aquifers** The destination for percolating groundwater can be an underground area of sediment and rocks called an **aquifer**. When groundwater is removed from an aquifer for human consumption, it can take 300 to 1,000 years or more to replenish the supply. Groundwater that is not collected from an aquifer will continue to flow through sediments and may eventually enter the ocean, thus continuing the water cycle.
- The importance of aquifers** Aquifers are important water sources. For example, the water obtained from the Ogallala Aquifer in the mid-western United States has made agriculture profitable in this dry region. The Ogallala is one of the largest aquifers in the world. Its underground area (450,000 km<sup>2</sup>) is in parts of South Dakota, Nebraska, Wyoming, Colorado, Kansas, Oklahoma, New Mexico, and Texas. With such a demand on its water supply, the Ogallala Aquifer is in danger of becoming depleted because the water is being used faster than it can be replenished.

### VOCABULARY

**surface runoff** - water that flows over land until it reaches lakes, rivers, and oceans.

**percolation** - the process of liquid moving through a porous substance.

**aquifer** - a underground area of sediment and rocks that is filled with groundwater.



**Figure 4.8:** Surface runoff reaches surface water locations or percolates into an aquifer. Groundwater that is not collected from the aquifer flows to oceans.

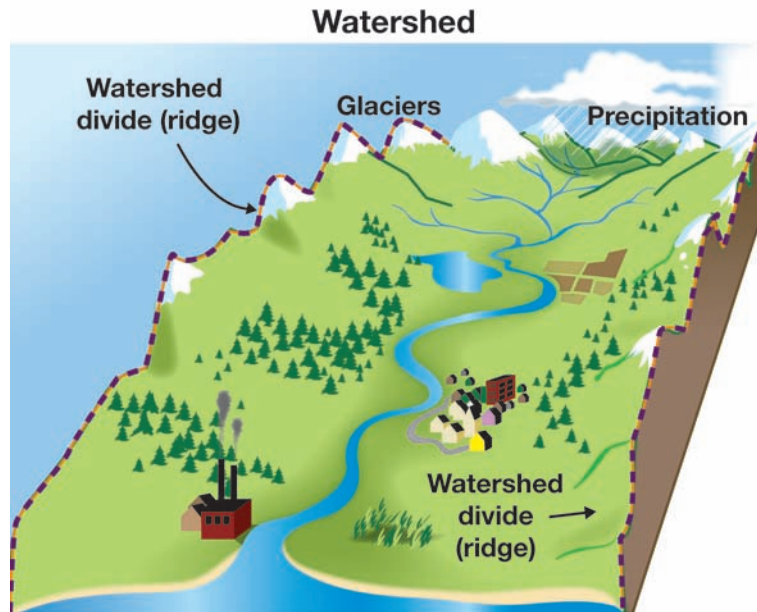


## Watersheds

**What is a watershed?** A **watershed** is an area of land that catches all precipitation and surface runoff. This water is collected in a body of water such as a river. Eventually, all this water flows to an ocean (Figure 4.9). The boundaries of a watershed are often steep mountain ridges.

**Watersheds** The water in a watershed is directly connected to the groundwater. Water collects in a place like a river, but some of the surface runoff becomes groundwater. The water that comes to many homes in the United States originates in a watershed that can be local or from another region.

**Natural resources** In addition to supplying our drinking water, watersheds also provide habitat for plants and animals, areas of natural beauty, and bodies of water for recreation. As communities grow and change, it is important to protect these natural resources.



### **VOCABULARY**

**watershed** - an area of land that catches all precipitation and surface runoff and collects it in a body of water such as a river.

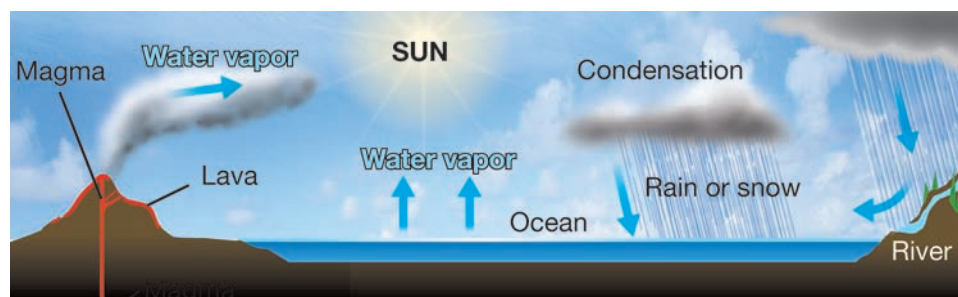
Ocean	Some sources of water
<b>Atlantic</b>	St. Lawrence River, the Great Lakes, eastern North America, South America east of the Andes, northern Europe, western-Sub-Saharan Africa, Caribbean Sea basin, Mediterranean Sea basin
<b>Pacific</b>	China, southeastern Russia, Japan, Korea, South America west of the Andes, Pacific Islands, and western North America
<b>Indian</b>	eastern coast of Africa, India, Burma, Australia, Indonesia, southeast Asia
<b>Arctic</b>	Most of Russia and Northern California
<b>Southern</b>	Antarctica

**Figure 4.9:** Some sources of water for the world's oceans. See if you can find these places on a globe!

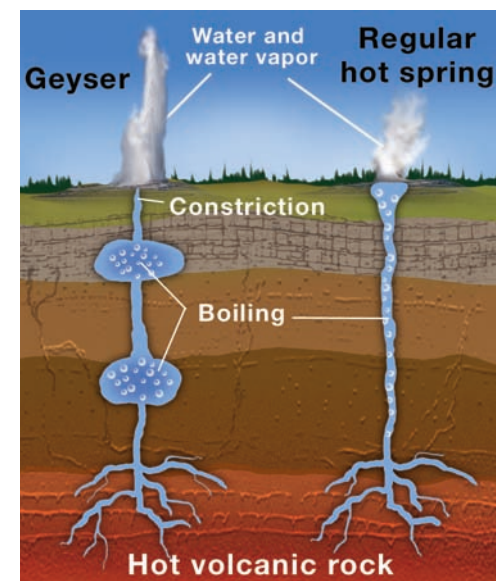
## The water cycle and volcanoes

**Water in hot rock** You may be surprised to learn that volcanoes are part of Earth's water cycle. This is because water is an ingredient in the hot, molten rock that is inside a volcano. Inside the volcano, this hot, molten rock is called *magma*. Outside the volcano, it is called *lava*. You will learn more about volcanoes in Chapter 12.

**Water vapor from eruptions** When a volcano erupts, water is released as water vapor into the atmosphere. The water vapor eventually condenses and falls as rain or another form of precipitation.



**Hot springs and geysers** Hot springs are the result of groundwater coming in contact with hot rock or magma below Earth's surface. The hot rock heats the water. A hot spring can become a geyser. A *geyser* is a hot spring with constricted passageways to the ground's surface. The constriction causes water pressure to build up so that the water eventually explodes from the ground. The water passageway is not constricted for other types of hot springs (Figure 4.10). Old Faithful in Yellowstone National Park is a geyser (Figure 4.11). Water that evaporates from geysers or hot springs—both volcanic features—becomes part of the water cycle.



**Figure 4.10:** A diagram of a geyser and a hot spring.



**Figure 4.11:** Old Faithful in Yellowstone National Park is a geyser.



## 4.2 Section Review

- List the sources of energy and forces that drive the water cycle.
- Give an example of how people participate in the water cycle.
- All the water on Earth is recycled. What does that mean about the water you drank today? Give an example of where your drinking water could have been in the past.
- What has to happen for liquid water to become water vapor?
- Plants need water but they lose water by opening pores on their leaves. Why do they open their pores?
- Which process of the water cycle is similar to water droplets forming on a bathroom mirror when you take a shower? Pick the correct answer and explain your choice.
  - condensation
  - precipitation
  - evaporation
  - transpiration
- Which of these items is porous under normal conditions?
  - a cotton shirt
  - a piece of steel
  - a raincoat
  - a plastic cup
- In which of these situations is percolation occurring?
  - A mud puddle dries
  - You pour a glass of orange juice
  - Water goes through coffee grounds to make coffee
  - Snow melts outside on a hot, sunny day
- What is the difference between an aquifer and a watershed?
- You learned that it might take 300 to 1,000 years or more to replenish any groundwater that is removed from an aquifer. Why do you think it would take so long?
- How are volcanoes part of the water cycle?

### MY JOURNAL

Research the answers to these questions for your town.

- What is the name of the watershed or aquifer that your town uses for drinking water?
- Is there a local organization that monitors the water quality of your watershed?

### STUDY SKILLS

#### Learning new words

You can learn and remember the definitions of new words by using them in a sentence.

For each of the vocabulary words in this chapter, write a sentence that uses the word correctly. You may want to make a drawing that helps you remember the new word. For example, make a drawing of the water cycle and fill in the terms you know!