INVISIBLE WATER

SUBJECTS:
Art, Earth Science, Math

TIME:
50 minutes

MATERIALS:
a large display relief map of the world
a 12-inch diameter globe (one showing the ocean bottom is best)
a five or ten gallon aquarium
writing materials
calculators
measuring cup
one quart container for every three students

OBJECTIVES

The student will do the following:

1. Define groundwater, aquifer, and hydrologic cycle or water cycle.
2. Describe the amount and distribution of groundwater on planet Earth.
3. Make inferences about the importance of responsible use of groundwater.
4. Calculate water volumes using the statistical information provided.

BACKGROUND INFORMATION

The Earth has been called the water planet. Between two-thirds and three-fourths of the Earth's surface is water, which is visible in rivers, ponds, lakes, icecaps, and clouds. The Earth's invisible source of water (groundwater) is more difficult to see and understand, yet all these forms of water are part of the interrelated flow of water that we call the water cycle or hydrologic cycle.

Water, a renewable natural resource, is continuously being renewed through the hydrologic or water cycle. The hydrologic cycle is powered by the sun's energy and gravity. In this circulation process, water is constantly in motion, cycling through sky, earth, and oceans.

When precipitation (snow, sleet, rain, or hail) falls on the Earth's surface, several things may occur. When precipitation builds up on the soil surface, surface runoff occurs. Surface water moves by overland flow into stream, ponds, lakes, or other bodies of water. When precipitation falls on a porous soil surface, some of the water will seep into the ground through infiltration. Some water clings to soil particles and is drawn into the roots of growing plants; it is then transported to leaves, where it is lost to the atmosphere as vapor in the transpiration process.

Some of the water that enters the soil moves either laterally or vertically through the soil. Lateral movement of water through the soil is called throughflow or interflow. Vertical or downward movement of water through the soil is called percolation. The percolating water eventually enters the zone of saturation, where all spaces between the rocks and soil particles are filled with water. The water filling all the spaces between the rocks and soil particles in the saturated zone is known as groundwater.

Groundwater is stored in two geologic regions: aquitards or aquifers. If water cannot move through the particles of the geologic region, the region is called an aquitard. If water can move through or permeate through the material of the geologic region, the region is called an aquifer.

Aquitards and aquifers vary in their depth, thickness, and even where they occur. An aquifer that is bounded on the top and bottom by aquitards is known as a confined aquifer. Generally, unconfined aquifers are overlaid by permeable layers and are usually found near the land surface.

Groundwater flows through the rocks and layers of earth until it discharges in springs, streams as baseflow, and oceans. The sun warms up the water surface, changing water into vapor, a process known as evaporation.

Each of the segments of the water cycle shares a portion of the total amount of the water on planet Earth. Fresh water is not evenly distributed throughout the world. Some people take fresh, clean water for granted, while others treasure every drop. Yet, simple calculations demonstrate the fact that the amount of water is limited. Scientists believe that all the water that we will ever have is on the Earth right now. Whatever amount is available for human and animal consumption depends on how the quality is maintained. We, as human beings, have the responsibility to conserve water and use it wisely while protecting its quality.

The purpose of this activity is for students to understand how fragile and important water is as a natural resource.

Terms

aquifer: an underground layer of unconsolidated (porous) rock or soil that holds (is saturated with) usable amounts of water.

aquitard: an underground layer of consolidated (nonporous) rock or impermeable soil through which water cannot move.

baseflow: groundwater contribution to a stream.

confined aquifer: an aquifer that is sandwiched between two layers of impermeable materials and is under great pressure.

evaporation: conversion of a liquid to the vapor state by the addition of heat.

groundwater supply: the amount of fresh water stored beneath the Earth's surface.

infiltration: when precipitation falls on a porous soil surface and some of the water seeps into the ground.

interflow: significant lateral movement of water through the soil.

overland flow: when precipitation moves quickly over the surface of the land into a stream channel or other body of water.

percolation: downward movement of water through the soil.

precipitation: any or all of the forms of water particles, whether liquid or solid, that fall from the atmosphere and reach the ground.

surface runoff: when precipitation builds up on the soil surface and water moves by over land flow into a stream channel or other body of water.

throughflow: significant lateral movement of water through the soil.

transpiration: the passage of water from plants and animals directly into the air in the form of a vapor.

unconfined aquifer: an aquifer overlaid by permeable layers, generally found near the Earth's surface.

water cycle: the cyclical process of water's movement from the atmosphere, its inflow and temporary storage on and in land, and its outflow to the oceans. The cycle consists of three principal phases: precipitation, runoff in surface waters or groundwater, and evaporation and / or transpiration in the air.

zone of saturation: that region below the surface in which all voids are filled with liquid.

ADVANCE PREPARATION

A. Have students make a panel mural of the water or hydrologic cycle, emphasizing the location of groundwater.

B. Make transparencies of the hydrologic or water cycle and the relative percentages of water on Earth.

C. Make a student facts sheet showing the percentages of water locations on Earth.

PROCEDURE

I. Setting the stage

A. Introduce the unit with a film on groundwater or groundwater resources.

B. Have students read and identify the terms used in the background information.

II. Activity

A. Using a relief map of the Earth and the transparency of relative percentages of water on Earth, begin the discussion by pointing out that groundwater is less than 1% of the total amount of water on the Earth. Relate this fact to the percentage of ocean water that is between two-thirds and three-fourths of the surface of the Earth.

B. Discuss the relative percentages.

C. Provide students with a facts sheet. Have the students calculate the estimated amount of fresh water potentially available for human use:

Groundwater	0.62%
Freshwater lakes	0.009%
Rivers	0.0001%
Icecaps/glaciers	2.0%
	2.6291%

D. While discussing the relative percentages of freshwater, emphasize that the usable percentage of existing fresh water is reduced by pollution and contamination, the fact that all groundwater is not available, and the fact that water from icecaps is not readily available.

E. Ask the students to discuss the following:

1. The amount of water used by humans daily for drinking, food preparation, bathing, laundry, and recreation.

2. That other life forms (plant and animal) need fresh, clean water as well as saline (salt) water.

F. Have the students assume that five gallons (or 1280 tablespoons) represents all the water on Earth. Have the students calculate the volume of all the quantities on the water percentage list. Ask the students to consider the following:

1. Remind students hat for multiplication, all the decimal places must be shifted two places to the left so 97.2% becomes 0.972 prior to multiplication:

Example: 0.972 X 1280 tablespoons = 1244.16 tablespoons

VOLUME OF WATER ON THE WATER PERCENTAGE LIST

5 gallons		1280.00	
Oceans		1244.16	
Icecaps/glaciers		26.24	
Groundwater		7.93	
Freshwater lakes		0.11	
Inland seas/salt lakes		0.1	
Atmosphere		0.0128	
Rivers		0.0012	
	approx.	1280.0000	Tablespoons

2. Once the values are obtained, ask the students to calculate the total volume of all water other than ocean water. (It is approximately 34 tablespoons.)

3. Explain to the students that the volume of water on the water percentage list will be used in the science class.

G. SCIENCE CLASS:

1. Have students make a data table using the volume of water on the water percentage list that was completed earlier in mathematics, being sure to show the total volume of water other than saline water.

2. Once the values are placed on the data table, divide the students into teams of three. Have the gopher for each team place 34 tablespoons of water in a container and take it to the team's workstation.

3. Ask students to remove the amount of water representing all freshwater lakes (approximately 0.11 tablespoon).

4. Ask students to remove the amount of water representing all the rivers (approximately 0.001 tablespoon, which is less than a drop).

5. Ask students to remove the amount of water representing all groundwater (approximately 7.9 tablespoons).

6. Have the students discuss the following:

a. The fragile nature of the freshwaters (especially groundwater), wetlands, and oceans of our planet.

b. The vast number of species (both plant and animal) that are dependent on clean, usable groundwater for survival.

c. How fresh water is replenished by the water cycle (Example: by evaporation from the snows and inland rainfall that recharges streams and aquifers).

III. Follow-Up

A. Present the film Groundwater. Have students draw and label typical soil profiles.

IV. Extensions

A. Have students find our where the local drinking water supply is obtained by calling the city or county water supply department. Research the number of wells in the area: Hown many are there? How deep is the average well? What are the most common minerals and compounds in the water? Does composition vary with locale?

RESOURCES

Aquatic Project Wild, Western Regional Environmental Education Council, 1987. Obtain from Aquatic WILD, PO Box 18060, Boulder, CO 80308-8060 (phone: 303- 444-2390).

Coble, Rice, Walla, Murry, et al. Earth Science, Prentice Hall, Englewood Cliffs, NJ; Needham, MA, 1994.

Groundwater video. Obtain through the Water Environment Federation, 601 Wythe Street, Alexandria, VA 22314-1994 (phone: 703-684-2400, FAX: 703-684-2492, or http://www.wef.org).