WATER, WATER EVERYWHERE

EARTH matters
Studies For Our Global Future

introduction

Water is essential for life. Although over 70 percent of the Earth's surface is covered with water, only a tiny fraction of that is available for human use. In fact, accessible **fresh water** makes up only 0.3 percent of all the Earth's water. The remainder is mostly salt water (predominately in the oceans), **groundwater** (found in the saturated soil and rock under the water table), or frozen (in glaciers and ice caps). Though water is a recyclable resource (we can, to some degree, clean and reuse it), it is not a renewable one (we will never be able to create more of it). Population growth over the past 30 years has caused demand for water to double in about half the countries in the world. Of the small percentage of water that is available to us, some becomes contaminated from human actions such as toxic run-off from agriculture and industry, and pollutants that we dump in the water supply through our sinks at home. We must be careful in the ways we use and treat water to ensure that there will be an adequate and safe supply for future generations.

Vocabulary: fresh water, groundwater

materials

Part 1

- 6 clear containers (2 large containers; 4 smaller containers)
- Container labels
- 1,000 mL graduated cylinder
- Water
- Blue food coloring
- Salt
- Tablespoon
- Sand or soil

Part 2

- Calculators (optional)

Part 1: Water Distribution

procedure

1. Before class:

    a. Fill one of the large containers with one liter (1,000 mL) of water and add four drops of blue food coloring. This represents the total amount of water in the world and is what you'll be dividing into the other containers.

concept

Although water covers roughly three-fourths of the Earth, only a small fraction is available for human consumption. As the population grows, water efficiency and conservation become more important.

objectives

Students will be able to:

- Describe the locations of global water resources and their accessibility for human use.
- Estimate their daily direct water use and compare that figure to actual use.
- Identify and graph the amount of direct water used by the class on common human activities.
- Distinguish between direct and indirect use of water.

subjects

Environmental Science (General and AP), Geography, Mathematics

skills

Observing, estimating, calculating, graphing data

method

Students observe a brief demonstration on the distribution of the world's water and then calculate how much water they use on a daily basis, both directly and indirectly.

b. Fill one small container with sand/soil and label it "deep groundwater."
c. Label the other large container "oceans" and the remaining three small containers "frozen," "other," and "accessible fresh water."
d. Measure and set aside 35 grams of salt. (Two heaping tablespoons is approximately 35 grams; 1 T = 15 g)

2. Display the Water Distribution table and set up the containers in front of the class.

Water Distribution		
	Percentage	Metric
Total Water	100.0%	1 liter or 1,000 mL
Oceans	97.1%	971 mL
Frozen	2.2%	22 mL
Deep Groundwater	0.3%	3 mL
Other	0.1%	1 mL
Accessible Fresh Water	0.3%	3 mL

3. Hold up the large container of blue water, and ask students to imagine that it represents all of the water in the world. Tell the class that you'll be dividing this water up, so that they can see how the world's water is distributed.

4. Use the graduated cylinder to measure the water and distribute it into the five containers as follows:

a. Pour 971 mL into the large "oceans" container. Tell students that 97.1 percent of all water on Earth is held in our oceans. Explain that ocean water is 3.5 percent saline. Add the 35 grams of salt to the "oceans" container to match the salinity ratio of the water sample with the salinity of the oceans.
b. Pour 22 mL into the "frozen" container. Explain that 2.2 percent of all the water on Earth is frozen in glaciers and icecaps.
c. Pour 3 mL into the "deep groundwater" container. Tell students that 0.3 percent of our water is deep within the surface of the Earth and often too deep to extract in a cost-effective manner.
d. Pour 1 mL into the "other" container. Explain that this 0.1 percent is water can't access and it is found in clouds, saltwater lakes, etc.
e. Pour the remaining 3 mL into the "accessible fresh water" container. This 0.3 percent water is freshwater that is easily accessed and not saline.

discussion questions

1. Which of the containers represents water that is readily available for humans to drink?

Only the container marked "accessible fresh water" represents readily available and drinkable water supply. The deep groundwater is also freshwater, but it is not readily available.

2. What happens to the supply of fresh water as our population continues to grow?

There are more and more people who depend on it and use it; water may become increasingly polluted with more people; water may become scarce in some areas.

3. How can we ensure that the supply of water will be sufficient to meet the needs of our growing population?

   Answers will vary. Students may suggest conservation, desalinization, stabilizing population growth, etc.

Part 2: Student Water Audit

procedure

1. Ask students whether they consider themselves "typical" water users. Ask students what they think it means to "waste water" and for examples of ways they might waste water.

2. Have students estimate and record how many gallons of water they think they personally use in an average day. Later, they will compare this with their actual calculated daily water use.

3. As a class, brainstorm different ways water is used on a day-to-day basis. Record responses on the board.

4. Display the Domestic Uses of Water table. Have students use data from the table to calculate their individual water use per day based on how much time they spend on each action. They should include their share of general family use such as washing dishes and clothes.

Domestic Uses of Water	
Activity	**Gallons of Water Used**
Faucet, low-flow	1.5 gallons per minute
Faucet, standard	2.2 gallons per minute
Leaky faucet	1 gallon per day
Toilet, newer ultra-low-flow	1 gallon per flush
Toilet, newer standard flow	1.6 gallons per flush
Toilet, old	3.5 gallons per flush
Showerhead, low-flow	2 gallons per minute
Showerhead, standard	5 gallons per minute
Tub bathing	36 gallons per bath
Dishwasher, newer efficient	6 gallons per load
Dishwasher, older non-efficient	16 gallons per load
Washing machine, top-loading	40 gallons per load
Washing machine, front-loading	25 gallons per load
Drinking water	0.1 gallons per bottle

Source: United States Environmental Protection Agency, United States Geological Survey

5. Students should compare their individual water use calculation from Step #4 with their estimated water use in Step #2. Are their calculated figures higher or lower than their estimated figures?

6. Have students construct a bar graph to illustrate how much water is used by their class for each activity.

7. As a class, determine the total water use for the class and then calculate the average amount used per person. Students can use the average to extrapolate the average use of their school, town and/or state.

8. Ask students if they can identify anywhere within their own habits or routines they waste water and how they might reduce that waste. Additionally, ask them to consider if there are any other ways they may be able to reduce the amount of water they use.

9. Ask students if the Domestic Uses of Water table includes all of the water that they use on a daily basis.
Answer: No. There are plenty of indirect uses of water on a daily basis that people don't often account for. Indirect water use is the total volume of freshwater that is used to produce the goods and services consumed – it refers to the freshwater consumption and pollution "behind" products being consumed or produced.

10. Display the Indirect Uses of Water table.

Indirect Uses of Water	
Food Item	**Gallons of Water Used**
1 lb of grain-fed beef	5,214
1 cotton t-shirt	713
1 lb rice	449
1 dozen eggs	544
1 lb corn	108
1 loaf of bread	150
1 lb apples	48
1 lb potatoes	119

Source: National Geographic

11. Have students consider their own indirect uses of water from the table. Ask them if there are any habits or household routines that they might change after considering the ways they indirectly use water?

discussion questions

1. Consider that 1.2 million gallons of water are needed to raise one calf until it is fully grown. Why do you think so much water is needed to raise a calf?

   Water is needed to grow the food and grasses that the calf consumes.

2. What are some things we can do to lower our indirect water use?

   Answers may include: purchasing and eating foods that require less water to cultivate (eating lower on the food chain), recycling items to prevent excessive use of water in manufacturing, not purchasing as many new clothes, driving less, etc.

3. Is there any evidence that the water supply we use daily is decreasing in size or is being contaminated by pollutants? How might a person go about obtaining this information?

   Answers will vary. For further information on water contamination, you may wish to consult the EPA's Resources for Local Officials and Community Members.

assessment

Students write a 4-6 sentence journal entry reflecting on the water distribution demonstration and what they learned from the discussion.

follow-up activities

1. Have students investigate various "green" household products that conserve water (such as low-flush toilets, new shower heads, timed sprinklers, etc.). Each student or group of students should then write up their findings in a brief synopsis of the costs and benefits of one of these products.

2. Ask students to read their home water meters for a week, at the same time each day, and report back to the class. They can compare these readings to their estimates of daily water use. Then have students implement some of the conservation measures discussed in class for a week and read the meter again. Did they see a change in the meter reading?

3. According to the United Nations, 2.3 billion people live in "water-stressed areas" with inadequate freshwater resources to meet their needs. The Sustainable Development Goal (SDG) #6 is "Ensure availability and sustainable management of water and sanitation for all" by 2030. Have students read about the SDG#6 targets, indicators and progress and then lead a class discussion on what measures would be necessary to meet these targets.

4. In 2020, one-fourth of the world's people lacked safely managed drinking water and nearly half lacked safely managed sanitation services. A number of international non-governmental organizations (NGOs) have been trying to address these gaps in services with on-the-ground projects in countries worldwide. Many of these NGOs suggest opportunities for school fundraisers and other service learning projects that can help them meet their goals. Have students investigate a few of these programs (e.g. H2O for Life, Charity: Water, and Water is Life), vote on an organization to support, and use the group's guidance on setting up a class, school-wide, or community fundraiser.

Part 1 adapted with permission from the National Science Foundation. Original activity appears in the National Science and Technology Week Activity Guide, 1988 by the National Science Foundation, Washington, DC.

Part 2 adapted with permission from Biological Science Curriculum Study. The original activity appears in Biological Science: An Ecological Approach (Kendall-Hunt Publishing Company)