WATER, WATER EVERYWHERE

People and the Planet
Lessons for a Sustainable Future

INTRODUCTION

Water is absolutely essential for life. Although 70 percent of the Earth's surface is covered with water, only a tiny fraction of that is available for human use. 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 run-off from agriculture, factories, pollutants that we dump into our sinks at home, and trash that enters watersheds and makes its way to the ocean. 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.

MATERIALS

- 6 clear containers (2 large containers; 4 smaller containers)
- Container labels
- Water
- 1,000 ml graduated cylinder
- Salt
- Sand or soil
- Blue food coloring
- Calculators (optional)
- Markers
- Water Distribution Grid (provided)

PART 1: WATER DISTRIBUTION PROCEDURE

1. Before class, gather and prepare materials:
   a. Fill one large container 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 divide into the other containers.

CONCEPT

Although water covers roughly three quarters 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:

- Recognize factors of a shared natural resource, such as availability and distribution.
- Estimate the amount of water resources they use and compare that figure to actual use.
- Identify the amount of water used by common human activities and distinguish between direct and indirect use of water.

SUBJECTS

Science (Earth and environmental), social studies, math

SKILLS

Observation, estimating, critical thinking, basic calculation

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 (2 heaping tablespoons) of salt.

2. Display the Water Distribution table and set up the containers in front of the class. Distribute markers and a copy of the Water Distribution Grid to each student.

Water Distribution

	Percentage	Metric
Total Water	100.0%	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. Prompt students with the following questions and record answers on the board:

a. What are some ways we use water?
Answers may include: drinking, cooking, bathing, washing clothes or dishes, growing crops, and generating electricity.

b. Where can we find water on the planet? Group answers into the five categories listed below as you record them on the board:
Oceans
Frozen
Deep groundwater
Other
Accessible fresh water

c. Look at the list of ways we use water. Where do we get the water for all these uses?
Answer: By far, most of the water we use is fresh water found in lakes, streams, rivers, reservoirs, etc. A smaller fraction comes from deep groundwater. An even smaller fraction comes from the other categories.

4. 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. Also explain that their grid of 100 squares (10x10) represents all of the water in the world and as you divide the water, they will fill in the corresponding percentage of squares. They should use a different color for each location of water.

5. 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 salt to the "oceans" container to match the salinity ratio of the water sample with the salinity of the oceans.
- Instruct students to color in 97.1 percent (97.1 squares) of their Water Distribution Grid.

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.
   - Students should color in 2.2 percent of their Grid.

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.
   - Students should color in 0.3 percent of their Grid.

d. Pour 1 ml into the "other" container. Explain that this 0.1 percent is water we don't have access to and it is found in clouds, saltwater lakes, etc.
   - Students should color in 0.1 percent of their Grid.

e. Pour the remaining 3 ml into the "accessible fresh water" container. This 0.3 percent water is freshwater that is easily accessed and drinkable (after filtration).
   - Students should color in 0.3 percent of their Grid.

6. Review students' 10x10 Grids and go over the Discussion Questions as a class.

DISCUSSION QUESTIONS

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

Students should indicate that 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.

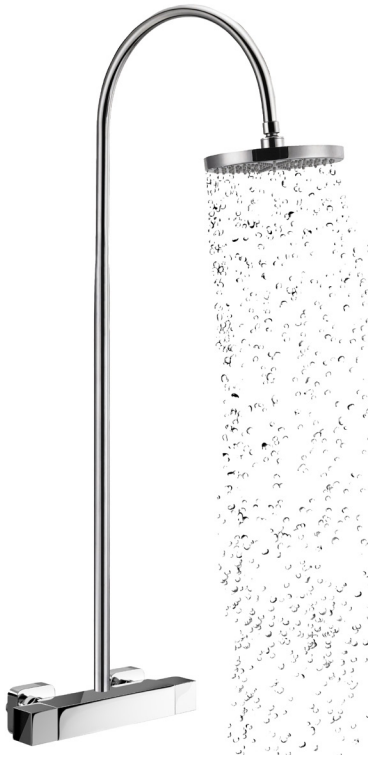
PART 2: STUDENT WATER AUDIT PROCEDURE

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 they use water on a day-to-day basis. Record the answers 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
Low-flow faucet	1.5 per minute
Standard faucet	2 per minute
Ultra-low-flow toilet	1 per flush
Standard toilet	1.5 per flush
Standard shower head	2.5 per minute
Low-flow shower head	2 per minute
Tub bathing	36 per bath
Cooking a meal	5-7 per meal
Water efficient dishwasher	6 per cycle
Older, non-efficient dishwasher	16 per cycle
Front-loading washing machine	12.5 per load
Top-loading washing machine	20 per load

Sources: United States Geological Survey, United States Environmental Protection Agency, Energy Star Database

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

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

8. 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.

9. 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

10. 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 that they indirectly use water?

11. Go over Discussion Questions as a class.

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.

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 in your community, visit the Environmental Protection Agency's website on Groundwater and Drinking Water at www.epa.gov/ground-water-and-drinking-water.

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. Students investigate "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 or two of these products.

2. Students read their home water meters daily 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 during that week. Did they see a change in the meter reading?

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, 1987, 1992, 1998, 2002, 2006).

WATER, WATER EVERYWHERE

WATER DISTRIBUTION GRID