NATIONAL GEOGRAPHIC
Activity*engage*

Availability of Fresh Water

How fresh water is available on Earth?

Overview

Students explore how water moves above and below Earth's surface by using interactive computational models. Then they examine the supply and demand issues around their local water source(s), and they meet a hydrogeologist who introduces students to some of the issues around the sustainability of fresh water sources around the world.

For the complete activity with media resources, visit:
http://education.nationalgeographic.org/activity/availability-fresh-water/

Directions

1. Engage students in thinking about how water is distributed on Earth.

Show the **Earth from Space** photograph. Tell students that most of Earth is covered with water. Show the **Diagram of Water Distribution on Earth**. (In media carousel; click the photograph images. Click the image and carousel down arrows to see the full image.) Ask:

- *How much of the water is available for us to use for things like drinking and crop irrigation—things that require fresh water?* (Less than 3% of the total water on Earth is fresh water.)
- *How does water cycle through Earth's systems?* (Water moves throughout Earth's systems through precipitation, runoff, and evaporation, among other processes.)

2. Discuss the role of uncertainty in the scientific process.

Tell students that science is a process of learning how the world works and that scientists do not know the “right” answers when they start to investigate a question. We see examples of scientists' uncertainty in the forecasting of precipitation amounts. Have students go to the NOAA National Weather Service. Ask them to input their zip codes into the "Local forecast by "City, St" or ZIP code" box in the top left (under "Home"), hit “Go”, scroll down to the bottom of the page, and click on the “Hourly Weather Graph”. This page shows the hourly weather forecast for your area. The first box shows the predicted temperature and dewpoint (along with wind chill or heat index, when applicable). The second box shows the predicted wind speed and direction. The third box shows the predicted sky cover (i.e. cloud cover), relative humidity, and chance for precipitation. The boxes below that line show whether the precipitation is likely to be rain, snow, freezing rain, or sleet. Point out the line for precipitation potential (the brown line). Ask:

- *Why is the precipitation shown as a "%"?* (Precipitation is dependent on other factors, such as relative humidity and temperature. It is more likely to precipitate when the temperature is the same as or lower than the dewpoint.)
- *If there is a likelihood of precipitation, why is the amount of rain/snow shown as ranges?* (The amount of precipitation that will fall is dependent on the amount of moisture in the atmosphere. The atmosphere is continually changing, so the amounts are guidelines for what could happen rather than perfect predictions.)

Tell students that they will be asked questions about the certainty of their predictions and that they should think about what scientific data is available as they assess their certainty with their answers. Encourage students to discuss the scientific evidence with each other to better assess their level of certainty with their predictions.

3. Introduce the concept of systems in Earth's water resources.

Tell students that forecasting what will happen in Earth's climate system is a complicated process because there are many different interacting parts. Scientists think about how one part of the system can affect other parts of the system. Give students a simple example of a system, as described in the scenario below.

On an island, there is a population of foxes and a population of rabbits. The foxes prey on the rabbits. Ask:

- *When there are a lot of rabbits, what will happen to the fox population?* (It will increase because there is an ample food supply.) Ask:
- *What happens to the fox population when they've eaten most of the rabbits?* (The foxes will die of starvation as their food supply decreases.)
- *What happens to the amount of grass when the fox population is high?* (The amount of grass will increase because there are fewer rabbits to eat the grass.)
- *If there is a drought and the grass doesn't grow well, what will happen to the populations of foxes and rabbits?* (The rabbit population will decrease because they have a lesser food supply. The fox population should also decrease as their food supply decreases.)

Humans introduce dogs to the island. The dogs compete with the foxes over the rabbit food supply. Ask: *What will happen to the populations of foxes, rabbits, and grass after the dogs are introduced?* (The foxes will decrease because they're sharing their food supply, the rabbits will decrease because they've got more predation, and the grass will do well because of the lowered impact of the smaller rabbit population.)

Tell students that simple cause-effect relationships can expand into more complex system relationships. Let students know that they will be exploring the relationship between how sediments and rock types affects groundwater movement. Encourage students to think about how human actions play a role in changes in the flow of water and in freshwater availability.

4. Introduce and discuss the use of computational models.

Introduce the concept of computational models, and give students an example of a computational model that they may have seen, such as forecasting the weather. The weather forecast provides a good example of how model input is used to predict future conditions. Project the NOAA Weather Forecast Model, which provides a good example of a computational model. Tell students that scientists used current information about the energy and moisture in the atmosphere as an input to the model, and that what they see on the weather map is the output of the model's calculations.

5. Have students launch the Availability of Fresh Water interactive.

Provide students with the link to the Availability of Fresh Water interactive. Divide students into groups of two or three, with two being the ideal grouping to allow groups to share a computer workstation. Tell students they will be working through a series of pages of models and data with related questions. Ask students to work through the activity in their groups, discussing and responding to questions as they go.

Let students know that this is Activity 1 of the **Will There Be Enough Fresh Water?** lesson.

6. Discuss the issues.

After students have completed the activity, bring the groups back together and lead a discussion focusing on the following questions. Ask:

- *When water falls on the ground, what can happen to it?* (Water that falls on the ground can run off into streams or it can be absorbed into the ground. Students may also say that water can evaporate.)
- *Why is water considered a renewable resource?* (Water is considered a renewable resource because it cycles through the ground and atmosphere.)
- *What are some ways that humans have affected the quantity and quality of water supplies around the world?* (Humans have changed the surface, which has allowed less water to infiltrate the surface. They have pulled water out of very deep aquifers in desert areas. They have inadvertently contaminated some water supplies.)

Tip
To save students' data for grading online, register your class for free at the High-Adventure Science portal page.

Tip
This activity is part of a sequence of activities in the lesson Will There Be Enough Fresh Water?. The activities work best if used **in sequence**.

Modification
This activity may be used individually or in groups of two or three students. It may also be modified for a whole-class format. If using as a whole-class activity, use an LCD projector or interactive whiteboard to project the activity. Turn embedded questions into class discussions. Uncertainty items allow for classroom debates over the evidence.

Informal Assessment
1. Check students' comprehension by asking students the following questions:

- When water falls on the ground, what can happen to it?
- Why is water considered a renewable resource?

2. Use the answer key to check students' answers on embedded assessments.

Objectives
Subjects & Disciplines
Science
- Earth science
- General science

Learning Objectives
Students will:

- describe the locations of fresh water on Earth
- explain why fresh water is considered a renewable resource
- describe how humans have affected freshwater supplies on Earth

Teaching Approach
- Learning-for-use

Teaching Methods
- Discussions
- Multimedia instruction
- Self-paced learning
- Visual instruction
- Writing

Skills Summary

This activity targets the following skills:

- 21st Century Student Outcomes
  - Information, Media, and Technology Skills
    - Information, Communications, and Technology Literacy
  - Learning and Innovation Skills
    - Critical Thinking and Problem Solving
- 21st Century Themes
  - Environmental Literacy
  - Global Awareness
- Critical Thinking Skills
  - Analyzing
  - Evaluating
  - Understanding

National Standards, Principles, and Practices

National Science Education Standards

• (5-8) Standard A-1:
Abilities necessary to do scientific inquiry
• (5-8) Standard A-2:
Understandings about scientific inquiry
• (5-8) Standard E-2:
Understandings about science and technology
• (5-8) Standard G-1:
Science as a human endeavor
• (5-8) Standard G-2:
Nature of science
• (9-12) Standard A-1:
Abilities necessary to do scientific inquiry
• (9-12) Standard A-2:
Understandings about scientific inquiry
• (9-12) Standard E-2:
Understandings about science and technology
• (9-12) Standard F-4:
Environmental quality
• (9-12) Standard G-2:
Nature of scientific knowledge

Common Core State Standards for English Language Arts & Literacy

• **Reading Standards for Literacy in Science and Technical Subjects 6-12:**
Craft and Structure, RST.9-10.4
• **Reading Standards for Literacy in Science and Technical Subjects 6-12:**
Key Ideas and Details, RST.9-10.1
• **Reading Standards for Literacy in Science and Technical Subjects 6-12:**
Key Ideas and Details, RST.9-10.3
• **Reading Standards for Literacy in Science and Technical Subjects 6-12:**
Key Ideas and Details, RST.6-8.1
• **Reading Standards for Literacy in Science and Technical Subjects 6-12:**
Key Ideas and Details, RST.6-8.3
• **Reading Standards for Literacy in Science and Technical Subjects 6-12:**
Craft and Structure, RST.6-8.4
• **Reading Standards for Literacy in Science and Technical Subjects 6-12:**
Craft and Structure, RST.11-12.4
• **Reading Standards for Literacy in Science and Technical Subjects 6-12:**
Key Ideas and Details, RST.11-12.3
• **Reading Standards for Literacy in Science and Technical Subjects 6-12:**
Key Ideas and Details, RST.11-12.1

ISTE Standards for Students (ISTE Standards*S)

• **Standard 3:**
Research and Information Fluency
• **Standard 4:**
Critical Thinking, Problem Solving, and Decision Making

Next Generation Science Standards

• **Crosscutting Concept 1:**
Patterns
• **Crosscutting Concept 2:**
Cause and effect: Mechanism and prediction
• **Crosscutting Concept 3:**
Scale, proportion, and quantity
• **Crosscutting Concept 5:**
Energy and matter: Flows, cycles, and conservation
• **Science and Engineering Practice 1:**
Asking questions and defining problems
• **Science and Engineering Practice 4:**
Analyzing and interpreting data
• **Science and Engineering Practice 5:**
Using mathematics and computational thinking
• **Science and Engineering Practice 6:**
Constructing explanations and designing solutions
• **Science and Engineering Practice 7:**

Engaging in argument from evidence
• **Science and Engineering Practice 8:**
Obtaining, evaluating, and communicating information

Preparation

What You'll Need

Required Technology

- Internet Access: Required
- Tech Setup: 1 computer per learner, 1 computer per pair, 1 computer per small group, Projector

Physical Space

- Classroom
- Computer lab
- Media Center/Library

Grouping

- Heterogeneous grouping
- Homogeneous grouping
- Large-group instruction
- Small-group instruction

Resources Provided: Websites

- NOAA National Weather Service
- NOAA Weather Forecast Model

Resources Provided: Handouts & Worksheets

- Answer Key - Availability of Fresh Water

Resources Provided: Interactives

- Availability of Fresh Water

Resources Provided: Images

- Earth From Space
- Diagram of Water Distribution on Earth

Background & Vocabulary

Background Information

Water cycles through Earth's systems. It falls on Earth's surface as precipitation. The precipitation can evaporate back into the atmosphere, it can percolate into the ground, or it can run off into surface bodies of water. The composition of the layers of rock and sediment determine whether precipitation can percolate into the groundwater.

Prior Knowledge

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Recommended Prior Activities

- None

Vocabulary

Term	Part of Speech	Definition
aquifer	*noun*	an underground layer of rock or earth which holds groundwater.
condensation	*noun*	process by which water vapor becomes liquid.
conservation	*noun*	management of a natural resource to prevent exploitation, destruction, or neglect.
evaporation	*noun*	process by which liquid water becomes water vapor.
freshwater	*adjective*	having to do with a habitat or ecosystem of a lake, river, or spring.
groundwater	*noun*	water found in an aquifer.
model, computational	*noun*	a mathematical model that requires extensive computational resources to study the behavior of a complex system by computer simulation.
precipitation	*noun*	all forms in which water falls to Earth from the atmosphere.
sustainability	*noun*	use of resources in such a manner that they will never be exhausted.
system	*noun*	collection of items or organisms that are linked and related, functioning as a whole.
transpiration	*noun*	evaporation of water from plants.
water cycle	*noun*	movement of water between atmosphere, land, and ocean.

For Further Exploration

Instructional Content

- National Geographic Education: Our Hydrosphere

Maps

- Freshwater Map

Reference

- National Geographic: Encyclopedic Entry: iceberg
- National Geographic: Freshwater Facts and Tips
- National Geographic Education: Earth's Freshwater
- National Geographic: Encyclopedic Entry: aquifer

- National Geographic: Encyclopedic Entry: watershed
- National Geographic: Encyclopedic Entry: basin
- National Geographic: Encyclopedic Entry: wetland
- National Geographic: Encyclopedic Entry: reservoir
- National Geographic: Encyclopedic Entry: river
- National Geographic: Encyclopedic Entry: lake
- National Geographic: Encyclopedic Entry: water table

Websites

- USGS: Aquifer Basics

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