NATIONAL GEOGRAPHIC

Activity*develop*

Groundwater and Surface Water

How can we keep water flowing in streams?

Overview

Students use interactive computational models to explore the underground flow of water and how it affects surface bodies of water. They predict how the water table will be affected by the placement of wells around a gaining stream. Finally, they explore the reasons the river dried up in a case study of the Santa Cruz River in Arizona.

For the complete activity with media resources, visit:
http://education.nationalgeographic.org/activity/groundwater-and-surface-water/

Directions

1. Engage students in thinking about how water moves through sediments.

Tell students that much of their water comes from groundwater and that water moves from the ground to the surface. Ask:

- *Why does water move through gravel more quickly than it moves through clay?* (Gravel is more permeable than clay.)
- *Would it be easier to get water out of sand or out of gravel?* (It would be easier to get water out of gravel because the pore spaces are larger. The water will move more quickly through larger pore spaces.)

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 can see examples of scientists' uncertainty in the forecasting of precipitation amounts. Have students go to **NOAA National Weather Service**. Ask them to input their zip codes, 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 dew point (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 dew point.)

- *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.)

  *If there is no or low likelihood of precipitation in your area, you may want to find a different location (in the United States) that has a higher likelihood of precipitation. You can look at a current weather map (radar) to find where in the United States precipitation is happening currently. Your students will then be able to see scientists' forecasts of precipitation amounts represented as a range overlaid on the bar graphs.

Tell students they will be asked questions about the certainty of their predictions and that they should think about what scientific data are 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 to Earth's fresh water supplies is a complicated process because there are many different interacting parts. Tell students that 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.)
- *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 are sharing their food supply, the rabbits will decrease because they have more predators, 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. Go to **NOAA Weather Forecast 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 Groundwater and Surface Water interactive.

Provide students with the link to the Groundwater and Surface Water interactive. Divide students into groups of two or three, with two being the ideal grouping for sharing computer workstations. Inform students they will be working through a series of pages of models with questions related to the models. 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 4 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 these questions:

- *How does the water table affect the relative amount of water in surface bodies and underground?* (When the water table is high, meaning the soil is saturated, water will move [or stay] above ground and surface bodies of water will expand. When the water table is low, water will move from the surface downward toward the ground.)
- *What are the effects on a stream of removing too much water from the ground?* (If too much

water is removed from the ground, the stream can dry up. The water table can be lowered below the level of the stream.)
- *How can humans better manage their use of limited water supplies?* (Humans can conserve water. They can use the wastewater to recharge the water supplies.)
- *Are rivers an endless supply of fresh water?* (Rivers are not an endless supply of fresh water. They can be run dry if the water table goes too low. This can happen when people withdraw too much water from the river and/or from the groundwater that supplies the river. Even though the rivers still receive precipitation, they can be depleted if the water table isn't high enough.)

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, or as a whole class activity. If using as a whole class activity, use an LCD projector or interactive whiteboard to project the activity.

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

- How does water move between groundwater and surface water when the water table is high?
- What can humans do to keep water flowing in streams?

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 how water moves between the ground and surface water bodies depending on the level of the water table
- describe the effects on a stream of withdrawing too much water

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
  - 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 D-1:**
Structure of the earth system
• **(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 B-6:**
Interactions of energy and matter

• **(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**:
Key Ideas and Details, RST.6-8.1
• **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**:
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**:
Craft and Structure, RST.11-12.4
• **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**:
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 2**:
Cause and effect: Mechanism and prediction
• **Crosscutting Concept 3**:
Scale, proportion, and quantity
• **Crosscutting Concept 4**:
Systems and system models
• **Crosscutting Concept 5**:
Energy and matter: Flows, cycles, and conservation
• **Crosscutting Concept 6**:
Structure and function
• **Crosscutting Concept 7**:
Stability and change
• **Science and Engineering Practice 1**:
Asking questions and defining problems

• **Science and Engineering Practice 2:**
Developing and using models
• **Science and Engineering Practice 3:**
Planning and carrying out investigations
• **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, Interactive whiteboard, 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 - Groundwater and Surface Water

Resources Provided: Interactives

- Groundwater and Surface Water Interactive

Background & Vocabulary

Background Information

Water moves between the groundwater and surface bodies of water. Gaining streams gain water from the groundwater. Losing streams lose their water to the groundwater. The level of the water table determines which way water will move between the groundwater and surface. Humans can alter the water table by withdrawing water from the groundwater with wells.

Prior Knowledge

[]

Recommended Prior Activities

- Availability of Fresh Water
- Groundwater Movement
- Using Fresh Water

Vocabulary

Term	Part of Speech	Definition
aquifer	*noun*	an underground layer of rock or earth which holds groundwater.
confined aquifer	*noun*	layer of water-bearing rock between two layers of less permeable rock.
conservation	*noun*	management of a natural resource to prevent exploitation, destruction, or neglect.
freshwater	*noun*	water that is not salty.
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.
permeable	*adjective*	allowing liquid and gases to pass through.
porosity	*noun*	the ratio of the volume of all the pores, or holes, in an object and the object's total mass.
porous	*adjective*	full of tiny holes, or able to be permeated by water.
precipitation	*noun*	all forms in which water falls to Earth from the atmosphere.
recharge	*verb*	to renew or restore to a previous condition.
runoff	*noun*	overflow of fluid from a farm or industrial factory.
stream	*noun*	body of flowing water.
sustainability	*noun*	use of resources in such a manner that they will never be exhausted.

Term	Part of Speech	Definition
system	*noun*	collection of items or organisms that are linked and related, functioning as a whole.
topography	*noun*	the shape of the surface features of an area.
unconfined aquifer	*noun*	layer of water-bearing rock covered by permeable rock.
water cycle	*noun*	movement of water between atmosphere, land, and ocean.
water table	*noun*	underground area where the Earth's surface is saturated with water. Also called water level.

For Further Exploration

Reference

- 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

Partner

The Concord Consortium

Funder

This material is based upon work supported by the National Science Foundation under Grant No. DRL-1220756. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

NATIONAL GEOGRAPHIC