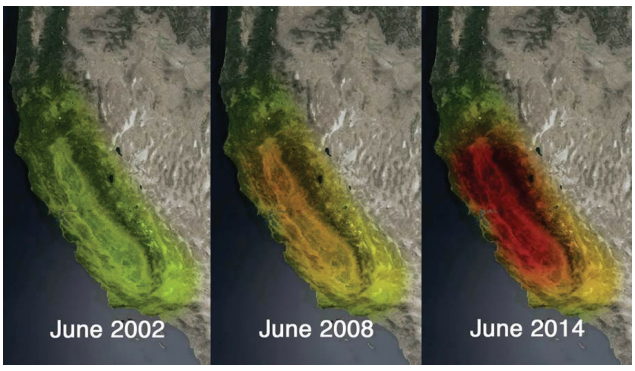
17 Enough Resources for All?

INVESTIGATION

HUMANS USE MANY natural resources. In the last activity, you learned about resources that are nonrenewable. They are limited because they form over geological time. Some examples include petroleum, metal ores such as copper, and granite. The geological processes that formed nonrenewable resources are still occurring. But it will take too long for new resources to form for them to be of use to humans in our lifetimes.

Some natural resources are **renewable**. They can be replaced as quickly as they are used by human populations. You learned about one such resource in the "Investigating Groundwater" activity. Groundwater stored in aquifers is essential to humans. Roughly 23% of freshwater used across the United States comes from groundwater. The rest comes from surface water sources. Groundwater is critical in places that lack enough surface water to meet the local population's needs. In 2010, Americans withdrew 76 billion gallons of groundwater per day. This groundwater was used for a variety of purposes, such as household water for drinking and cooking, irrigation for crops, and manufacturing.

But, even the supplies of renewable resources are not limitless. In this activity, you will explore how groundwater is used and replenished. And you will think about how the rapid growth in human population may affect access to groundwater in the future.



Groundwater levels in California have decreased over this time period, as indicated by the orange and red areas.

GUIDING QUESTION

How can monitoring natural resources help guide decisions about their use?

MATERIALS

For each group of four students

- 1 plastic cup
- 28 blue game tokens
- 2 red game tokens
- 1 set of Aquifer Inputs and Outputs Cards
- 1 Student Sheet 17.1, "Aquifer Inputs and Outputs"
- 1 Student Sheet 17.2, "Graph of Groundwater Level in Our Aquifer"

For each student

- 1 piece of graph paper
- 1 clear metric ruler

PROCEDURE

Part A: Aquifer Inputs and Outputs

1. Place 20 blue tokens in your cup. In this model, the cup represents your community aquifer, and the tokens represent the groundwater in your aquifer. Leave the extra tokens on your table.
2. Shuffle the Aquifer Inputs and Outputs Cards, and place them face down on your table.
3. With your group of four students, use the model to learn about aquifer inputs and outputs.
   a. Decide which group member will complete each part of the model.
      - Person #1: Take one Aquifer Inputs and Outputs Card from the pile, and read all of the text on the card to your group. Each card has information about something that happened that month in your aquifer.
      - Person #2: Remove or add tokens to the aquifer cup based on the directions on the Aquifer Inputs and Outputs Card.
      - Person #3: Record what happened in the aquifer as described on the card on Student Sheet 17.1, "Aquifer Inputs and Outputs." If you removed water tokens from your aquifer, record it in the Outputs column. If you added water tokens to your aquifer, record it in the Inputs column.
      - Person #4: Count the number of tokens in your aquifer after adding or removing tokens. Plot the token or "water" level on Student Sheet 17.2, "Graph of Groundwater Level in Our Aquifer."

b. If you get a card that asks you to remove more chips than you have, remove all of your chips. Plot this point on your graph as zero. Your aquifer was empty, and your community was forced to buy water from another source.

c. Your aquifer can hold only 28 tokens. If you get a card asking you to add more tokens than will fit in your aquifer model, add tokens until you have 28, and do not use the remaining tokens. Your aquifer was full, and the rest of the water stayed on the surface and didn't add to your aquifer.

4. Repeat Step 3 above until you have drawn seven cards.
5. To have enough water for everyone in your community, you will need to have at least 15 water tokens in your aquifer. Draw a horizontal line at 15 tokens on Student Sheet 17.1.
6. With your group, observe and discuss the patterns you see in your graph on Student Sheet 17.2. What patterns do you notice in the graph? How did the amount of water in the aquifer change over time? Use evidence from the graph to support your ideas.
7. Leave your graph and your aquifer model on your table. Follow your teacher's directions to observe aquifers from other groups.
8. Respond to Analysis items 1–3 in your science notebook.

Part B: Monitoring Aquifer Levels

9. On the next page are four sets of data on the depth (below Earth's surface) to aquifer water levels from four counties in the state of California over time. The map to the right shows the locations of the four counties in the state of California. Decide with your group members which group member will graph each data set.

10. Create a line graph for your data.

Depth to Groundwater Level by Year in Santa Barbara County, CA

LOCATION: SANTA BARBARA COUNTY, CA	YEAR									
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Depth To Groundwater Level (Meters Below Land Surface)	94	95	95	95	94	95	96	98	99	100

Depth to Groundwater Level by Year in Imperial County, CA

LOCATION: IMPERIAL COUNTY, CA	YEAR									
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Depth To Groundwater Level (Meters Below Land Surface)	45	44	44	43	42	42	41	40	39	37

Depth to Groundwater Level by Year in Siskiyou County, CA

LOCATION: SISKIYOU COUNTY, CA	YEAR									
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Depth To Groundwater Level (Meters Below Land Surface)	48	49	52	49	50	50	51	52	52	51

Depth to Groundwater Level by Year in Inyo County, CA

LOCATION: INYO COUNTY, CA	YEAR									
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Depth To Groundwater Level (Meters Below Land Surface)	9	9	10	10	10	10	10	10	10	10

11. What happened to the water level in the aquifer you graphed in Step 10 over time? Use information from Student Sheet 17.2 and Analysis item 1 to provide a possible explanation for the trends in your graph. Record your ideas and data to support your claim in your notebook.

    Hint: Your graph represents how far below the surface of Earth you have to go before you hit the water level in the aquifer. This means that the larger the number and the higher the point you plot, the deeper you have to dig into Earth before you reach the water level in the aquifer.

12. Take turns sharing with your group your completed graph and the possible explanation for the trends in your graph. As your group members share, listen to each explanation to make sure it fits their graph.

ANALYSIS

1. What activities from Part A increased the groundwater level in your model aquifer? What activities caused aquifer levels to decrease? Make a list of each in your notebook.
2. Which of the inputs and outputs from Part A will increase as human population continues to grow? How do you think a larger human population will impact aquifer groundwater levels?
3. In science, we use models to help us understand cause-and-effect relationships in systems, but all models have strengths and weaknesses.
   a. What are strengths of this model? Explain your reasoning.
   b. What are weaknesses of this model? Explain your reasoning.
4. A friend tells you that we don't need to consider the location of aquifers when choosing a site to store nuclear waste. Your friend explains that this is because the groundwater stored in aquifers is a renewable resource. That means the supply of it will be replenished as quickly as people use it. Explain how you would respond to your friend.

   In your explanation, be sure to

   - explain what an aquifer is and the geological processes that form aquifers.
   - describe where aquifers form and what that says about the geological processes that happened in that area.
   - describe the activities that cause groundwater levels to increase and decrease, as well as the rate at which these changes occur.
   - explain how nuclear waste stored underground can affect groundwater in aquifers.

EXTENSION

Around the world, approximately 780 million people lack access to clean drinking water, and another 2.5 billion lack access to sanitation facilities. Conduct research to discover where lack of access to drinking water and sanitation have the biggest impacts. What are the

impacts? What is already being done, and what more can be done? Visit the *SEPUP Third Edition Geological Processes* page of the SEPUP website at *www.sepuplhs.org/middle/third-edition* for links to help you begin your research.