ACTIVITY 10

Solutions Through Scientific Optimism

PRESENTATION

10: SOLUTIONS THROUGH SCIENTIFIC OPTIMISM

GUIDING QUESTION

How are key scientific ideas reflected in modern solutions to regional water issues?

INTRODUCTION

Over the years, many individuals and teams from different nations and cultures have contributed to fields of science such as water quality. In 2016, microbiologist Joan Rose received the Stockholm Water Prize, a prestigious global award that recognizes outstanding achievements in water-related activities. She is considered one of the world's authorities on the parasite *Cryptosporidium*. She was recognized for her research and her ability to clearly communicate her scientific findings to others, such as governmental policy makers. In 2012, the entire International Water Management Institute of Colombo, Sri Lanka, was awarded the prize for their research in improving agricultural water management, helping reduce poverty in developing countries.

The Skipton scenario was based on a 1993 outbreak of *Cryptosporidium* in Milwaukee, Wisconsin, that affected more than 400,000 people, 69 of whom died. In this activity, you will brainstorm solutions, gather information, and construct a plan for addressing water needs for a specific region by using currently available tools and techniques. You will then construct a *public service announcement* (PSA), an educational message created to raise awareness and change people's attitudes or behavior.

CONCEPTUAL TOOLS

MULTIPLE LINES OF EVIDENCE
SENSES & INSTRUMENTATION
SCIENCE AS A HUMAN ENDEAVOUR
SCIENTIFIC ADVANCEMENT
SCIENTIFIC OPTIMISM
CREDIBLE SOURCES

MATERIALS LIST

FOR EACH PAIR OF STUDENTS

- COMPUTER WITH INTERNET ACCESS

FOR EACH STUDENT

- STUDENT SHEET 10.1 “Water Solutions and Key Concepts”
- STUDENT SHEET 10.2 “Research Notes for a PSA”
- MATERIALS REQUIRED FOR PSA

PROCEDURE

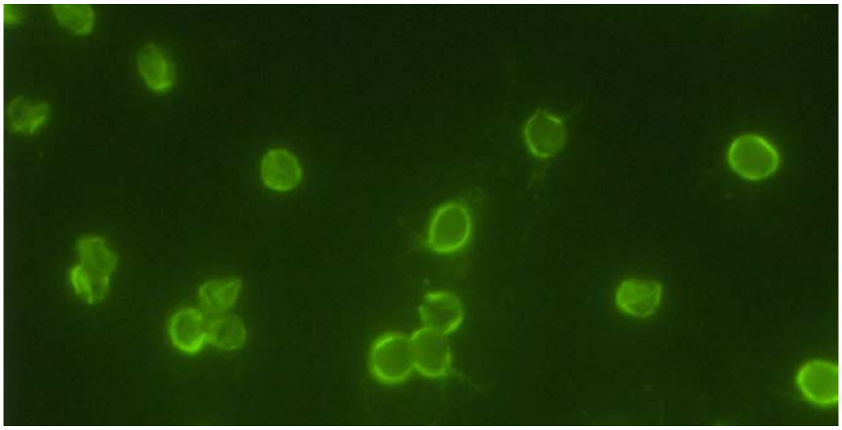
PART A: SOLVING THE FRESHWATER PROBLEM

1 As a class, brainstorm a list of the water issues raised in this unit. Add any additional issues related to water that are relevant to your local community.

2 With your group, select one of the water issues you identified. Brainstorm solutions to addressing this issue and record your responses in your science notebooks.

3 Discuss the following questions with your group:

- Do the scientific tools and technologies required to implement your solution exist today? If not, explain how you think they could be created.
- Based on your discussion, do you feel optimistic about the future of water? Explain why or why not.



One stage of *Cryptosporidium’s* life cycle can be seen under a light microscope with the use of a fluorescent dye.

PART B: CURRENTLY PROPOSED WATER SOLUTIONS

4 You learned in this unit that there are many scientific tools, techniques, and ways of thinking that can be useful for solving complicated problems. Student Sheet 10.1, "Water Solutions and Key Concepts," contains a list of some of the key concepts that you have learned. Take a moment to read through these concepts and discuss with your partner about the many places in the unit where you encountered these ideas.

5 Many people are working together to solve global water needs. Eight proposed solutions (A–H) are described here. Read a summary of one of these solutions, as directed by your teacher.

6 Discuss with your partner how your paragraph about the water solution is connected to the unit concepts listed on Student Sheet 10.1.

   a Identify and mark the concepts you think are relevant to your water solution.

   b Work with another pair of students who read the same paragraph to create a short summary of your water solution, in your own words.

   c Present your summary to the class.

   d As you listen to other group's summaries, mark which concept(s) are most relevant to the described solution.

A. WATER CONSERVATION

Water conservation is the practice of using water efficiently to reduce unnecessary water usage. Individuals can reduce water use by turning off water when brushing teeth, shaving, taking shorter showers, and using dishwashers and washing machines with full loads only. Communities can use low-water plants in public spaces and install water-efficient faucets and toilets in city buildings. The city of Cape Town, South Africa, reduced its overall water consumption even as the city's population increased over a 15-year period. They used technology to detect leaks in piping, adjust water pressure, and improve water meters. They also educated the community on how to consume less water.

Cape Town, South Africa's capital city, has focused on water conservation as it has struggled to meet the water needs of its growing population.

B. WATER STORAGE

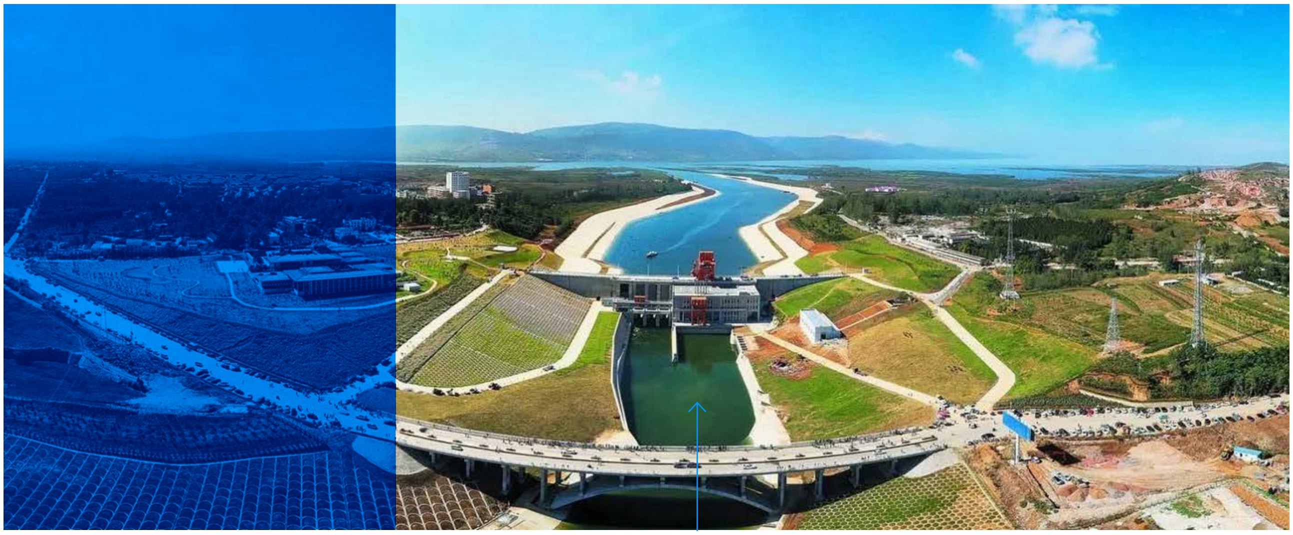
Water storage refers to holding water in a contained area for a period of time. Manufactured types of water storage range in size from rain barrels and household water tanks to city water towers, industrial holding ponds, and large dam reservoirs such as Lake Kariba. Located between Zambia and Zimbabwe in Central Africa, Lake Kariba is the largest artificial lake in the world and was formed by damming the Zambezi River. It extends for 217 kilometers (135 miles) and holds up to 180 cubic kilometers of freshwater. On a smaller scale, local people in India's Alwar district turned to traditional *johads*, earthen dams that capture rainwater and recharge reserves of groundwater under the surface. After local people built more than 3,000 johads, groundwater tables rose nearly 18 feet, and adjacent forest cover increased by a third.

Large-scale dam projects, such as the Kariba Dam, create large reservoirs for water storage.

Smaller-scale water-storage projects, such as this johad in the village of Thathawata in Rajasthan, India, can have more direct benefits for locals.

C. WATER TRANSPORTATION

Humans have been transporting water from place to place for thousands of years, with the earliest evidence coming from text describing irrigation networks in Mesopotamia during 2475–2315 B.C.E. *Water transportation* is the intentional movement of water over large distances, usually via canals or long-distance pipelines. Unless it has the assistance of gravity, water transportation requires pumping stations at regular intervals and can be very expensive due to the weight of water. China is implementing a water project that will redirect over 44 billion cubic meters of water per year from its southern rivers to its drier north. First proposed in 1952 and planned for completion in 2050, the project will link China's four main rivers—the Yangtze River, Yellow River, Huaihe River, and Haihe River—and is expected to cost about $62 billion.



Water from the Danjiangkou Reservoir (seen in the distance) will travel north via a canal system. This is one of the starting points of China's South-North water transfer project.

D. WATER RECYCLING

Water recycling (also known as water reuse or water reclamation) collects water from a variety of sources before treating it for reuse. Sources of water can include household wastewater, industrial wastewater, stormwater, and agricultural runoff. Water must then be treated to meet specific requirements for a particular reuse. For example, recycled water for crop irrigation would need to meet standards that would prevent harm to plants and soils, maintain food safety, and protect the health of farmworkers. The process of osmosis (materials passing through a membrane) was first described by French physicist Jean-Antoine Nollet in 1748. In 1959, Srinivasa Sourirajan and Sidney Loeb invented reverse osmosis, a pressure-driven membrane separation system that removes 99% of water contaminants such as dissolved solids and bacteria. Places using recycled wastewater for drinking water include Australia, Singapore, Namibia, South Africa, Kuwait, the United States, and the United Kingdom.

Recycled wastewater is treated and then used to water plants.

E. DESALINATION

Desalination is the removal of salt from saltwater and is a process that has been around for thousands of years. Greek sailors used to boil water to evaporate freshwater away from the salt and then condense the vapor into drinkable water, and Romans used clay filters to trap the salt. Today, the most common methods utilize distillation or filtration. As described in the introduction of Activity 9, new scientific desalination technology continues to be developed because desalination is both energy intensive and expensive. There are about 15,000 desalination plants around the world, with the biggest plants in the desert countries of the United Arab Emirates, Saudi Arabia, and Israel. These countries utilize solar energy and other emerging technologies to make desalination more sustainable.

Desalination plant in Ras Al Khaimah, United Arab Emirates.

F. NATURE-BASED SOLUTIONS

As cities have expanded, people have paved over wetlands and floodplains and diverted waterways such as creeks. This has resulted in less rainwater seeping into the ground to refill underground aquifers. Some cities are now investing in nature-based solutions by restoring watersheds—such as creeks, wetlands, marshes, and floodplains—that naturally absorb and filter surface water before filling underground aquifers. In 2000, Chinese landscape architect Kongjian Yu proposed "sponge cities" in which there is more green space for plants, the use of native vegetation that requires less water, green roofs that have a layer of plant material that absorbs water, and the construction of large dirt pits that capture rainwater instead of letting it wash away. Auckland, New Zealand; Nairobi, Kenya; Singapore; Mumbai, India; New York, New York; and Shanghai, China, are cities in which about 1/3 of the city is considered "spongy."

Nature-based water solutions such as restoring natural wetland habitats can help reduce flood risk while helping recharge groundwater reserves.

Adding more green spaces with native vegetation to urban areas can help reduce flood risk while helping recharge groundwater reserves.

G. RAINWATER CAPTURE

Rainwater capture is the practice of collecting and storing rain for reuse, rather than letting water run into urban storm drains or natural water bodies. Techniques to capture rainwater include permeable pavement, bioswales, and rain catchment. Permeable pavement typically involves using gravel and paving stones instead of a solid piece of concrete for driveways, sidewalks, and patios. These materials allow water to seep into the ground below, while still being strong enough to support cars and people. Bioswales are long ditches planted with vegetation, allowing more water to sink into the ground instead of running off into storm drains and creeks. Rain catchment systems can be as simple as placing a large rain barrel at the downspouts of a building's gutter system. In Mexico City, Mexico, water activist Enrique Lomnitz and others collaborated with geographer Elizabeth Tellman to identify the parts of the city that would benefit most from rain catchment. In 2019, 10,000 systems were installed.

Rainwater capturing techniques: rainwater catchment system

Rainwater capturing techniques: permeable pavement

Rainwater capturing techniques: bioswale

H. GEOLOGICAL PALEO VALLEYS

University of California, Davis, professor Graham Fogg first suggested using paleo valleys for water management almost 40 years ago. Paleo valleys are prehistoric riverbeds that formed thousands of years ago in the last ice age as rivers flowed from melting glaciers. It took Fogg and his students nearly 25 years to identify just three paleo valleys, using thousands of soil samples from wells. More recently, Stanford University geophysicist Rosemary Knight collaborated with Fogg to use specialized electromagnetic imaging cameras mounted on helicopters to study California's Central Valley. They have discovered several ancient paleo valleys that could be part of a solution to the state's water crisis. While the ancient riverbeds are currently just below the surface, they are highly permeable due to the type of sediment (layers of coarse sand and large gravel) they contain. Scientists hypothesize that if rainwater could be directed to these areas, water could flow more quickly to the underground aquifers that supply local towns and agriculture with freshwater. More research is needed to find more efficient ways of identifying more of these paleo valleys, both in California and in other places around the world.

Helicopter carrying an electromagnetic imaging camera to survey the geology in California's Central Valley.

PART C: DEVELOPING A REGIONAL SOLUTION

7 Your teacher will guide you on selecting a community or country to investigate. Research and record the following information about this region on Student Sheet 10.2, "Research Notes for a PSA":

- general geographic location
- primary source of drinking water
- most pressing water issues facing this region
- currently utilized solutions to water issues facing this region

8 Share your research with your group. Discuss similarities and differences in your region's water issues.

9 Consider what you learned from your research and in Procedure Parts A and B. Discuss with a partner what you think is the best approach to addressing your region's drinking water issues over the next few decades.

10 Develop a plan for addressing your region's drinking water issues over the next few decades by doing the following:

a identifying and listing the solutions most relevant to your region.

b prioritizing these solutions from the most to least important for your region.

c describing how these solutions will help address drinking water issues in this region.

PART D: COMMUNITY PUBLIC SERVICE ANNOUNCEMENT (PSA)

11 One commonly recognized element of addressing global water issues is education. Public service announcements (PSAs) are intended to provide useful and important information to the public; they are not selling a specific brand or service. People who create PSAs are responsible for making sure that the information is correct and helpful. This means that claims should be supported by relevant, accurate, and reliable evidence.

Create a PSA to communicate one or more aspects of your regional solution to the local community.

a Decide on your format
(video, poster, comic strip, song, etc.)

b Decide on your audience
(elementary school children, general public, etc.)

c Brainstorm ideas.

d Create your PSA, making sure that it:
- contains scientific information.
- is accurate.
- addresses other class requirements.

12 Share your PSA with your class.

BUILD UNDERSTANDING

1. Consider which characteristics of your region informed your choice of water solutions.
   - a What is one characteristic in this region that may change in the future due to climate or economic changes?
   - b If this change occurs, how would it affect your proposed solution?
   - c How could you modify your proposal to address this change?

2. You began this unit by making decisions about Skipton's water supply.
   - a Based on what you know now, would you change your decision? Why or why not?
   - b Are there other decisions you made during this unit that you would change? Explain.

3. How do you think global water issues, such as water quality and water availability, should be addressed? Support your answer with multiple lines of evidence from this unit and identify the trade-offs of your decision.

CONNECTIONS TO EVERYDAY LIFE

4. Many people think that advances in science and technology will eventually result in solutions to most global problems. Do you agree or disagree? Explain your ideas.

5. How can the concepts you learned in this unit be applied to your own life?

EXTENSION

Historically, constructing dams and levees to contain water have been one approach to addressing water scarcity. Today, new approaches—some of which are based on the traditional knowledge of local communities—are being considered. Search online to discover the most recent research and latest innovations in addressing global water issues.