

TEACHER'S GUIDE

Gray, Green, Blue: Water Security and YOU!

Subject Area: Science, Natural Resources

Grade Levels: 9TH-12TH

This teacher's guide gives an overview of the four lessons associated with the Gray, Green, Blue: Water Security and YOU! series. Background information, essential questions, standards, objectives, vocabulary, materials, and additional resources can be found in this guide. Instructions for each activity and answer keys are included for Part 1, 2, 3, and 4 below.

Essential Questions:

- Part I: Why is it important that we secure a reliable supply of water for our growing cities?
- Part II: What are sustainable solutions for water security issues?
- Part III: How can communities use water funds to protect water at the source?
- Part IV: What is the role of individuals in supporting increased water security?

Purpose and Overview:

Part 1: Water Security

People, businesses and industries, recreation, waste removal, transport, nature, and even lawn care all require water. Making sure there's enough reliable, clean water for the health and livelihoods of people and natural environments is what we mean by water security, and it is one of the biggest challenges we face. In this lesson, students learn how cities secure water and what happens when there isn't enough local water to meet their needs.

Part 2: Water Management

How does your city manage water? With pipes or with streams? Cement or grass? Engineering gives us running water, sanitation and so many essential parts of modern life. But nature can also help! In this lesson, students learn how natural water management can also help with water security issues.

Part 3: Water Funds

Water issues often start upstream. The quality and quantity of the water entering cities depends on the landscapes through which the water flows. In this lesson, students learn about water funds, a creative upstream approach to ensure downstream users have enough clean water.

Part 4: Water and You

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You are lucky if you...live in a place with abundant and clean water to brush your teeth, wash your clothes and drink. But many places around the world don't have secure water. In this lesson, students learn what you and I can do to help make sure that water availability is more socially and culturally equitable, environmentally sustainable and economically beneficial.

Materials:

Videos that support this lesson plan:

- Part 1 Video: Gray, Green, Blue: Water Security - <https://youtu.be/VXT9O1LWaw8>
- Part 2 Video: Gray, Green, Blue: Water Management- <https://youtu.be/h52imOJ7hKE>
- Part 3 Video: Gray, Green, Blue: Water Funds- <https://youtu.be/UrYDF9bTkV8>
- Part 4 Video: Gray, Green, Blue: Water and You- <https://youtu.be/RGOIPI-ZKKI>

Student materials:

- Computer with Internet connection (or can be executed with one computer and interactive board in the class)
- Grouping Activity Photos: https://docs.google.com/document/d/1RoXS2T3-NH4vF9LR23bMclwNccvj1DOI_tOqvOI3xjA/edit?usp=sharing
- Jigsaw notes articles (linked below)
- Jigsaw notes handout: <https://docs.google.com/document/d/1R8CLU3gJDTZkwNtuz9Q9cYISkbE7IFVGn4eXgGunl1g/edit?usp=sharing>
- Expert notes handout: <https://docs.google.com/document/d/19zxpadiYgqBwOXyO9YeF5sflcBYOQ8eZYZWkgeNzixA/edit?usp=sharing>
- Socratic Seminar article (lined below)
- Video Discussion Questions handout: <https://docs.google.com/document/d/1ITJLr1Dsai9hRJb5Pjk6mBwpkmeBKIDYkfvhvhluKyE/edit?usp=sharing>

Standards:

Next Generation Science Standards

Disciplinary Core Ideas:

- LS2.A Interdependent Relationships in Ecosystems
- LS2.B Cycle of Matter and Energy Transfer in Ecosystems
- LS2.C Ecosystem Dynamics, Functioning, and Resilience
- ESS3.A Natural Resources
- ESS3.B Natural Hazards
- ESS3.C Human impacts on Earth Systems

Crosscutting Concepts:

- Cause and Effect
- Stability and Change
- Systems and Models

Science and Engineering Practices:

- Asking Questions/Defining Problems
- Constructing Explanations

- Arguing from Evidence
- Communicating information

Performance Expectations High School

- HS-ESS3-4 Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
- HS-LS2-7 Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

AP Environmental Science Topics

- Land and Water Use
 - Other Land Use
 - Urban Land Development
 - Land Conservation Options
 - Sustainable Land Use Strategies

Common Core English and Language Arts Standards for Science and Technical Subjects and Writing

Grades 9-12

- CCSS.ELA-LITERACY.RST.9-10.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.
- CCSS.ELA-LITERACY.RST.9-10.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics.
- CCSS.ELA-LITERACY.RST.9-10.7 Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.
- CCSS.ELA-LITERACY.RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.

Lesson Objectives:

The student will...

- Identify the components of the water cycle and a watershed
- Describe how a watershed is part of a larger system
- Define ecosystem services, water fund, water security, grey infrastructure, and watershed
- Describe how land-based degradation/extraction and climate change can influence the water cycle and water quality
- Explain the importance of protecting headwaters for water security
- Give examples of who might be stakeholders or partners interested in a water fund and water security
- Summarize what a water fund is and why it addresses water security concerns
- Compare man-made infrastructure and natural infrastructure
- Characterize the different benefits of gray and green infrastructure for water management

GRAY, GREEN, BLUE: WATER SECURITY AND YOU!

Part 1: Water Security

Essential Question: Why is it important that we secure a reliable supply of water for our growing cities?

Suggested Flow:

1. Photocopy and make class sets (or provide a link to the Google Document) of the **Photo Grouping Activity Cards**. Arrange students into groups of your choosing. Tell students that their task is to group the cards into categories of their own choice. Students must come up with the categories on their own and they may use as many categories as they like, but they will have to justify why they chose those categories and why they grouped the images the way they did. Categories may include nature, products of nature, people, people and nature, animals, resources, etc. Give students ~10 minutes to group the cards and come up with their rationale.
2. Have each group select a representative to describe its categories and rationale. You may want to write the categories on the board to keep track. After every representative has presented, have a class discussion about the categories and groupings.

Discussion prompts could include:

- What were the most difficult images to categorize and why?
 - Did everyone group the cards the same way? If not, what were the main differences?
 - What influences the way you see these images?
3. If you'd like to share descriptions of the images with students, [you can find this information here. https://docs.google.com/document/d/1RoXS2T3-NH4vF9LR23bMclwNccvj1DOI_tOqvOI3xjA/edit?usp=sharing](https://docs.google.com/document/d/1RoXS2T3-NH4vF9LR23bMclwNccvj1DOI_tOqvOI3xjA/edit?usp=sharing)
 4. You can ask students to regroup photos after sharing their descriptions and conduct a second round of discussions afterward.
 5. Explain to students that people, businesses and industries, recreation, waste removal, transport, nature, and even lawn care all require water. Making sure there's enough reliable, clean water for the health and livelihoods of people and natural environments is what we mean by **water security**, and it is one of the biggest challenges we face. Explain that in this video, they will learn how cities secure water and what happens when there isn't enough local water to meet their needs.

Show students the video "**Gray, Green, Blue: Water Security**"

[\[https://youtu.be/VXT9O1LWaw8\]](https://youtu.be/VXT9O1LWaw8) (3:59 min)

The answer key is on the next page.

Part 1: Water Security

Discussion Questions – Teacher Answer Key

Student Google Doc:

<https://docs.google.com/document/d/1ITJLr1Dsai9hRJb5Pjk6mBwpkmeBKIDYkfvhvhluKyE/edit?usp=sharing>

These questions accompany the video “**Gray, Green, Blue: Water Security**” found here:

1. What is water security? Why is it a concern?

Answer: Water security is the reliable availability of an acceptable quantity and quality of water for health, livelihoods and production, coupled with an acceptable level of water-related risks. Water insecurity is one of the greatest risks to global prosperity as it plays an integral role in our daily lives. From the food we eat, the energy that powers our planet, the ecosystems we depend on, to even the industries that provide crucial services like health, transportation, we all need water.

2. What is the difference between surface water and groundwater?

Answer: Groundwater is located underground in large aquifers and must be pumped out of the ground after drilling a deep well. Surface water starts as rain and is found in lakes, rivers and streams, which collect surface water from their watershed, or the area surrounding them that drains rainwater into them.

3. Where do rivers and lakes collect surface water from?

Answer: Their watersheds

4. What is the role of an aquifer? How do aquifers help supply water?

Answer: Aquifers contain water which can be pumped out for our use using wells. This is a limited source which has been building up for thousands of years but will eventually run out.

6. How do cities tap into water sources if they don't have enough locally?

Answer: Through interbasin transfer or moving water from one watershed to another

7. How can cities run out of water? What can we do to help them?

Answer: Cities are growing and increasing demand and climate change is creating new patterns of rainfall with more severe droughts and storms. While it is hard to change these patterns, there are practices that we can change to make sure we don't drain water supplies.

Photo Grouping Activity

Teacher Descriptions

Photos: https://docs.google.com/document/d/1RoXS2T3-NH4vF9LR23bMclwNccvj1DOI_tOqvOI3xjA/edit?usp=sharing

Photo 1: A private water truck loads water from a local well and delivers to residents of La Florida, Zone 19. Guatemala City, Guatemala.

Photo 2: Water treatment holding tanks at the water purification facility that supplies fifty percent of Sao Paulo's drinking water, Brazil.

Photo 3: Men filling up 5 gallon containers with fresh water at a water filling station in Nairobi, they will later deliver the fresh water to residents and business because Nairobi does not have reliable fresh water delivery, Kenya. The Nature Conservancy is working to protect the Upper Tana Watershed in Kenya and provide cleaner, more reliable water for Nairobi.

Photo 4: Elizabeth Gray scoops water with her hands, Potomac River Gorge, Maryland.

Photo 5: Preston Jimmerson and his daughter, Kate, take a boat ride on the Flint River, which provides clean water for thousands of Georgians. Preston is bringing innovative water-saving practices to his fields through a powerful partnership made up of the Conservancy, the USDA's Natural Resources Conservation Service and the Flint River Soil and Water Conservation District.

Photo 6: Scene along the Verde River, Arizona's only federally designated Wild and Scenic River. The Verde provides irrigation water for farmers and drinking water for nearly three million people in the metropolitan Phoenix area, in addition to the rural communities along its banks. Existing water demands have left some stretches of the river nearly dry. The Conservancy is taking an inclusive approach to reach creative solutions that include improved water management, to use modern infrastructure and technology to test concepts that can be used in other parts of the Colorado River Basin and to develop sustainable funding to implement the projects.

Photo 7: Immanuel Varpas (blue polo shirt) and Williams Hernandez (white shirt) of Plan Yaque test the waters both before they enter the sewage treatment artificial wetland and after they have passed through the wetlands, Jarabacoa, Dominican Republic. TNC has installed artificial marshes to help filter water runoff and keep water ways clear and clean.

Photo 8: A woman washes clothes in the Ayampe River in Ecuador's Manabí Province. The Ayampe River has many responsibilities beyond its ecological role. It also supports the life of the communities within its watershed. The Conservancy is working with local partners to develop a water fund to help protect this water source.

GRAY, GREEN, BLUE: WATER SECURITY AND YOU!

Part 2: Water Management

Essential Question: What are sustainable solutions for water security issues?

Suggested Flow:

1. Ask students to consider the difference between permeable and impermeable surfaces. Lead a short discussion and explain to students that permeable surfaces (also known as porous or pervious surfaces) allow water to percolate into the soil to filter out pollutants and recharge the water table. Impermeable/impervious surfaces are solid surfaces that don't allow water to penetrate, forcing it to run off.
2. Ask students to come up with examples for each (answers will vary but can include concrete, asphalt, parking lots vs. plants, mulch, gardens)
3. Tell students you will conduct a short demonstration to better understand how cities manage their water.
4. Either allow students to each carry out this demonstration in small groups, on their own, or alternatively, you can conduct it and have students watching. If you choose to have students conduct it on their own, you can provide the demonstration directions handout:
5. Students can also **observe the difference between permeable and impermeable surfaces with a simple outdoor demonstration**. Choose a slope on your school or neighborhood where an impermeable surface, such as a walkway or parking lot, runs beside a permeable surface, such as an open, grassy area. Measure a distance of several meters or yards for each surface, then use buckets to pour several gallons of water from the top of the slope down each surface simultaneously. Have students time how long it takes for all the water to flow down each surface. They will see how an impermeable surface allows water to flow quickly and unfiltered into the watershed, while a permeable surface of soil and vegetation not only slows the water flow but also absorbs and filters much of the water. In fact, all the water may be absorbed by the soil before it reaches the end of your measured distance.
6. Following the demonstration lead a discussion.
7. **Discussion:** What is the impact of impermeable surfaces on the environment? Explain that urban and suburban sites typically contain large expanses of impermeable surface, causing a host of problems. Ask students to consider the problems this might cause.

Possible answers:

- Pollution of surface water: When stormwater runs off impermeable surfaces, it picks up pollutants as it flows into storm drains. The contaminated water can flow directly into rivers, lakes, wetlands and oceans which would hurt both people's health & the environment.
- Flooding of surface water and erosion of stream banks: During periods of heavy rainfall, large amounts of impermeable surfaces generate large

amounts of runoff. This sudden influx of runoff into rivers can cause flash flooding and erosion.

- Water shortages: Because impermeable surfaces send rainwater into storm drains rather than allow it to flow down to our aquifers, groundwater may be used faster than it is replenished

8. Show students the video “**Gray, Green, Blue: Water Management**”

[\[https://youtu.be/h52imOJ7hKE\]](https://youtu.be/h52imOJ7hKE) (4:31 min)

9. Instruct students to complete the Discussion Questions student handout. Lead a discussion following the video.

The answer key is on the next page.

Part 2: Water Management

Discussion Questions – Teacher Answer Key

Student Google Doc:

<https://docs.google.com/document/d/1ITJLr1Dsai9hRJb5Pjk6mBwpkmeBKIDYkfvhvhluKyE/edit?usp=sharing>

These questions accompany the video “**Gray, Green, Blue: Water Management**” found here:

1. What is gray infrastructure and how does it contribute to water management in cities?
Answer: Gray infrastructure refers to the man-made engineering creations that we see in cities. In the case of our water management systems, pipes and concrete are used to get water to and from residents and businesses. We call this gray infrastructure because of all the concrete involved.
2. Compare gray and green infrastructure.
Answer: In the natural water cycle, rainfall and snowmelt flow through natural water courses like rivers, or trickle into the ground; and eventually evaporate, go into the aquifer, or to the sea. A lot of people are now calling the use of natural materials to restore the natural water cycle green infrastructure and it is permeable. Gray infrastructure, meanwhile, is impermeable. It has allowed us to have a constant supply of usable water, and enabled used, polluted water to be treated but all that concrete stops water from draining into the ground.
3. How can nature support water management in cities?
Answer: Natural materials, in rain gardens, green roofs, and even urban wetlands, can slow down and filter polluted runoff before it makes its way into our streams and lakes because these surfaces are permeable. A natural area absorbs and slowly releases water, while filtering and cleaning it.
4. What are additional benefits of green infrastructure in cities?
Answer: Projects like rain gardens, tree planting, and native plant gardens can be undertaken by schools and community members, so they are able to be community-driven unlike many gray infrastructure projects. Nature also creates jobs and increases property values, reduces noise pollution and heat, and helps the economy and communities, especially ones most vulnerable to the impacts of growing cities and a changing climate, by creating healthy and enjoyable urban spaces where people can connect with nature and have access to clean air and water.
5. Explain modern water management.
Answer: Modern water management is usually three separate systems: drinking water from surface reservoirs or underground aquifers, wastewater systems to take used water to be treated at a sewage treatment plant, and stormwater systems to drain lots of water very quickly.

GRAY, GREEN, BLUE: WATER SECURITY AND YOU!

Part 3: Water Funds

Essential Question: How can communities use water funds to protect water at the source?

Suggested Flow:

1. Show students the video **“Gray, Green, Blue: Water Funds”**
[\[https://youtu.be/UrYDF9bTkV8\]](https://youtu.be/UrYDF9bTkV8) (3:59 min)
2. Instruct students to complete the Discussion Questions student handout. Lead a discussion following the video.

Part 3: Water Funds

Discussion Questions – Teacher Answer Key

These questions accompany the video **“Gray, Green, Blue: Water Funds”** found here:

Student Google Doc:

<https://docs.google.com/document/d/1ITJLr1Dsai9hRJb5Pjk6mBwpkmeBKIDYkfvhvlhluKyE/edit?usp=sharing>

1. What challenges are farmers faced with upstream and how does it impact water access?
Answer: Farmers upstream such as those in the Upper Tana watershed deal with depleted land and soil as well as increasingly unpredictable rainfall as the climate changes. There are 300,000 very small farms on the steep slopes in the Upper Tana watershed. As land and soil get depleted, farmers clear forests on steeper and steeper slopes. When there are fewer trees, there are fewer roots to hold soil in place. The hillsides erode, and water supplies and the treatment plant get clogged with sediment.
2. What is a water fund?
Answer: A water fund operates with the idea that it's both less expensive and ecologically better to prevent problems at the water's source. Businesses, governments, nonprofits and residents all get together to safeguard natural resources like forests and improve agriculture in places that supply water.
3. How can water funds help people upstream and downstream?
Answer: Governments, nonprofits and residents all get together to safeguard natural resources like forests and improve agriculture in places that supply water. By helping people upstream, they protect water quality downstream, improving their own water security. Water funds also provide vital habitat and can help in the fight against climate change.

Jigsaw Activity

1. Briefly discuss student answers and then explain that they will participate in a jigsaw activity where they will read a variety of articles about water security. For more information on the jigsaw technique, check out this website <http://www.readwritethink.org/professional-development/strategy-guides/using-jigsaw-cooperative-learning-30599.html>.
2. You will need to create an “expert” group and a “jigsaw” group. The expert group could consist of students with similar reading levels, as some of the articles are at a higher reading level or might be slightly longer than others. The expert group will work together to become experts about their particular articles. In the jigsaw group, students will teach each other about the different articles. In some cases, students might be inclined to let others in the jigsaw group copy their notes from the expert group. Make sure to discourage this behavior and encourage each expert to teach others in the jigsaw group while they take notes. It might be a good idea to give each expert group a number (1, 2, 3, 4, 5, 6) according to the number of the article they read and give jigsaw groups a letter (A, B, C, D, E) so you can easily group and regroup the students. For example, expert group 1 should have students from jigsaw groups A, B, C, D, and E.
3. Have the students first go to their expert group formation. Distribute copies of the articles and the **Expert Notes Template** [<https://docs.google.com/document/d/19zxpqDIYgqBwOXyO9YeFSsflcBY0Q8eZYZWkgeNzixA/edit?usp=sharing>]. The articles and group numbers are listed below.
 1. “Wellspring of Resilience: How Do We Provide Water Security in an Uncertain World” by Nathaniel Matthews, TNC - <https://www.nature.org/en-us/what-we-do/our-insights/perspectives/providing-water-security-in-an-uncertain-world/>
 2. “Green Infrastructure for a Thirsty Region: Water Security in Latin America and the Caribbean” by Alexandre Meira Da Rosa, IDB - <https://www.nature.org/en-us/what-we-do/our-insights/perspectives/green-infrastructure-for-a-thirsty-region/>
 3. “Protecting Africa’s Troubled Waters” by Matt Brown, TNC - <https://www.nature.org/en-us/what-we-do/our-insights/perspectives/source-water-protection-in-africa/>
 4. “Better Water Security? We Sink or Swim Together” TNC- <https://www.nature.org/en-us/what-we-do/our-insights/perspectives/better-water-security-we-sink-or-swim-together/>
 5. “Nature Is Our Strongest Ally in Ensuring Global Water Security” By Giulio Boccaletti, TNC- <https://www.nature.org/en-us/what-we-do/our-insights/perspectives/nature-is-our-strongest-ally-in-ensuring-global-water-security/>
 6. “Water Funds: A Natural Solution for Water Security in Sub-Saharan Africa” By Andrea Erickson-Quiroz, TNC- <https://www.nature.org/en-us/what-we-do/our-insights/perspectives/water-funds-a-natural-solution-for-water-security-in-sub-saharan-africa/>
4. The **Expert Notes Template** contains the overarching question and focus areas listed below. Explain to the expert groups that their job is to read the articles and use evidence from the text to answer or address the questions listed. Point out that not all of the questions can be answered by their particular article. However, collectively, all of the articles have this information. Their job is to find the way that their article makes a case

for including indigenous voices in the conservation movement and then determine how to share that information with their jigsaw group. They should individually read the article and make notes, highlight text, etc. and then work with their expert group to come up with a unified set of information to take to their jigsaw groups. Emphasize that they should use EVIDENCE from the text to support their statements. **If you have concerns that this activity cannot be completed in one class period, give the article as homework so that the expert groups need only discuss how they will share with their jigsaw groups.**

Overarching Question:

How do these articles make a case for leveraging nature as a solution to water security issues?

Focus Areas (the articles don't necessarily answer all of these questions):

- What are water scarcity concerns that impact nations around the world?
- How does poorly managed land development affect water security?
- How can cities improve their water with water funds?
- What are challenges to water funds?
- How do water funds support upstream and downstream users?
- How is a future shaped by climate change a problem for traditional water infrastructure?
- Why can "Gray" infrastructure become obsolete?
- What makes nature-based solutions adaptive and resilient?
- How can investing in source-water protection and other nature-based solutions help ensure water security?
- What creates water management issues in Latin America?
- What is creating water security challenges for many African cities?

5. After expert groups have completed their notes, have the class move to their jigsaw groups to share information. Distribute the [Jigsaw Template](https://docs.google.com/document/d/1R8CLU3gJDTZkwNtuz9Q9cYISkbE7IFVGn4eXgGunl1g/edit?usp=sharing) [https://docs.google.com/document/d/1R8CLU3gJDTZkwNtuz9Q9cYISkbE7IFVGn4eXgGunl1g/edit?usp=sharing] so students can take notes. This may take about 25-30 minutes. Remind students that they must teach each other the information and not copy each other's notes. When they are done, have them return to their expert groups.
6. Back in the expert groups, have students discuss whether or not they were able to address all of the focus areas and the overarching question in their jigsaw groups. Have them determine if they have any outstanding questions about the information. Also have them discuss their observations about the information they learned. What was surprising? What do they want to know more about? Was there anything they could personally relate to?
7. After the expert groups have had some time to process the activity, lead the class in a whole group discussion reflecting on the process, the information, and the overall learning.

GRAY, GREEN, BLUE: WATER SECURITY AND YOU!

Part 4: Water and YOU

Essential Question: What is the role of individuals in supporting increased water security?

Suggested Flow:

1. Explain to students that water security is important. It is not only a global resource issue; it is also an environmental justice issue. Providing all people with reliable, safe water and sanitation services is crucial to ensure a safe and thriving world, but not all have access to these things. And in some cases, those populations that are already vulnerable are those most impacted by water security issues. Protecting water at the source with water funds, employing natural infrastructure solutions to prevent runoff, and taking individual action downstream can all go hand in hand to improve our global water security. Pose the question: what can YOU do?
2. Show students the video **“Gray, Green, Blue: Water and You”**
[\[https://youtu.be/RGOIPI-ZKKI\]](https://youtu.be/RGOIPI-ZKKI) (3:11 min)
3. Instruct students to complete the Discussion Questions student handout while watching the video. Lead a discussion using the Socratic Seminar activity below following the video.

The answer key is on the next page.

Part 4: Water and YOU

Discussion Questions – Teacher Answer Key

Student Google Doc:

<https://docs.google.com/document/d/1ITJLr1Dsai9hRjB5Pjk6mBwpkmeBKIDYkfvhvhluKyE/edit?usp=sharing>

These questions accompany the video “**Gray, Green, Blue: Water and You**” found here:

1. What is water stewardship?

Answer: making sure that water use is more socially and culturally equitable, environmentally sustainable and economically beneficial

2. What sort of things might communities with water insecurity experience?

Answer: Water being rationed, or so expensive that clean water is out of reach. Dirty water that could put their health at risk.

3. What can individuals do to be water stewards?

Answer: You can conserve water every day. Even simple things like taking shorter showers, fixing leaks & turning off the water when not in use leave more water for people in need. Even choosing organic fruits and vegetables, especially in season, can be a way to speak with your wallet for water conservation, because these practices use less water. You can do your part to keep water clean. Never pour chemicals, pharmaceuticals, oil or paint into the drain or toilets. Check with your local household hazardous waste program to properly dispose of waste and keep it out of rivers and oceans. Pick up after your dog, and dispose of the waste in the toilet or the trash. Even driving less can help - many pollutants in our waters come from car exhaust and car leaks. Plant a native tree. Or use hardy plants that require little or no watering, fertilizers or pesticides in your yard. Explore a local stream. Wade, canoe, or kayak. Find out where it starts and where it drains. Look at topographic maps to find out what influences water flow around you. Get to know what plants, animals and insects hang out there. And maybe, get involved in a stream clean-up or protection effort. Find out if your area has a water fund – or could be a good candidate for one - and get involved. You can write river associations and local government officials. Support companies that support water funds.

Socratic Seminar

Introduction:

The purpose of this activity is to extend and broaden your students' understanding of the role of communities, businesses, governments, and individuals in ensuring water security. A Socratic Seminar will serve as a forum to discuss potentially controversial issues described in an article featured in Scientific American online.

A Socratic Seminar is a way to foster active learning, inquiry, and critical thinking skills in students. The teacher's role in a Socratic Seminar is as a guide and coach. The ideal room set-up is for students to sit in a circle with the teacher as part of the circle and at the same height as the students. It's important that the teacher relinquish a little bit of control during the discussion. It's also important to accept that there may be periods of uncomfortable wait time while students think about the text and the discussion.

To begin the seminar, use an opening prompt (provided below). During the seminar, if the discussion stalls, move the discussion along using prepared prompts like those provided below. If the discussion goes off track, you can restate the opening prompt. If there are students who have not spoken during the seminar, you may ask "who hasn't had a chance to speak?" If appropriate, you might also ask students to cite evidence from the text or ask them to relate their statements to what someone else has said. It will be very helpful if during the seminar you are taking notes about the main points of discussion.

At the end of the seminar, ask students to summarize the main points that were made in the discussion. To close the seminar, debrief with students about the process and share your own observations about the experience.

With respect to grading and assessment, some teachers offer points for participation in the seminar. At the end of the seminar, you could also have students write a reflection on the process and have them detail their initial perspective about the article and then have them comment on how the discussion may have shaped their ideas.

To learn more about Socratic Seminars, check out the following resources:

- National Paideia Center website: <http://www.paideia.org/>
- NSTA article on Socratic Seminars by Jeanne Ting Chowning: http://learningcenter.nsta.org/product_detail.aspx?id=10.2505/4/tst09_076_07_36
- To see a Socratic Seminar in action in the science classroom and hear advice from a teacher, check out the videos below:
 - [Socratic Seminars: Patience and Practice by the Teaching Channel](https://www.teachingchannel.org/videos/bring-socratic-seminars-to-the-classroom)
 - Socratic Seminar in Science by Northwest Association for Biomedical Research (NWABR) <https://www.youtube.com/watch?v=9TckVI4e3Y0>

Suggested Flow:

1. Give students the article to read as homework before the Socratic Seminar or allow class time for reading to ensure that all students have read **Chapter 1 in “Beyond the Source”**. In order to participate in the seminar, they **MUST** have read the article. **Chapter 1 in “Beyond the Source** can be found here:
https://www.nature.org/content/dam/tnc/nature/en/documents/Beyond_The_Source_Full_Report_FinalV4.pdf

Consider providing the chapter with numbered lines for student use in citing evidence. It is much easier to cite evidence from the text when students can refer to a numbered paragraph.

2. Before you begin the seminar, share the purpose of the discussion and the rules with the students.
 - a. The purpose: To understand the main ideas and evidence in the text through shared discussion and to form conclusions based on evidence from the text.
 - b. The rules for students:
 - No hand raising. Focus on the speaker and wait until it’s your turn to talk.
 - Only one person can speak at a time.
 - Be courteous to each other, even when disagreeing.
 - Respond to each other by name.
 - Listen carefully.
 - Monitor your air time.
 - Reference the text to cite evidence for your statements.
 - Keep an open mind and be willing to be flexible in light of new information.
3. Read aloud the Socratic Seminar opening prompt to students:

The article you have read highlights the importance of water and how a water crisis can be tackled best with the help of nature.

Summarize the research that supports why protecting drinking water resources at their source can contribute to conserving biodiversity, mitigating climate change, building resilience to climate impacts and providing a range of health and well-being benefits.

Compare and contrast built and natural infrastructure.

Suggest possible worldwide consequences of the source water protection.

4. Remind students to use evidence from the text to support their argument.

[Optional] Water Funds Research Activity

Suggested Flow:

1. Allow students to delve deeper into water funds by learning about various water funds around the world. Provide students with a select water fund and instruct them to research the background, local context, benefits, accomplishments, major players, and future plans. Then, have students create a visual representation of their project. Options include written reports, slide presentations, or video. Have students share their research presentations with the rest of the class.
2. Provide the following list of water funds and allow students to select one for their research project or assign them. This can also be done in small groups.

Option 1: Minnesota Headwaters Fund — a \$10-million, privately-funded investment to support our work to accomplish high-impact conservation of Mississippi River watersheds in Minnesota to ensure clean water is available for people, business and nature. The fund will support conservation work in targeted watersheds in the Upper Mississippi River basin in Minnesota, including easements, stream bank and floodplain restoration, and other projects that prevent pollutants such as nitrates and sediment from entering key rivers and lakes.

Option 2: Rio Grande Water Fund, New Mexico, USA- New Mexico's Rio Grande and its tributaries supply water for wildlife and 1 million people. The health of these waterways is key to the health of Albuquerque, Santa Fe, Native American Pueblos and other communities. The Rio Grande Water Fund protects forests and water for 1 million people in northern New Mexico and boosts local economies by creating jobs and wood for products. The project is also generating a sustainable source of funding for a 20-year program to restore 600,000 acres of forest north of Albuquerque.

Option 3: Rio de Janeiro Water Fund, Brazil- The Guandu Watershed is a vital source of drinking water for 8 million people in the city of Rio de Janeiro, but deforestation by farmers and ranchers have reduced water quality and quantity. Now, through the Guandu Water Producer Project launched in November 2008, fees collected from water users will pay 121 farmers and ranchers to leave standing riparian forests on their lands. The project will help preserve and restore Brazil's Atlantic Forest for birds and primates found nowhere else in the world.

Option 4: Yampa River Water Fund is in Northwest Colorado, which plays host to one of the most crucial water sources in the state: the Yampa River. The Yampa is the last relatively free-flowing major river in the Colorado River Basin. It is central to the people and wildlife in the Yampa River Valley for everything from local agriculture to supplying water. Funds here will be used to increase the amount of water flowing in the river through water leases (define), improve agricultural irrigation infrastructure and management and restore native plants and wildlife habitat along the river.

Option 5: The Tana River supplies 95 percent of the water for Nairobi’s 4 million residents, and for another 5 million people living in the watershed. It also feeds one of the country’s most important agricultural areas and provides half of the country’s hydropower output. There are 300,000 very small farms on the steep slopes in the Upper Tana watershed. Land scarcity and declines in soil productivity drives farmers to expand cultivation into steeper and steeper slopes and riparian catchments (will need to define). Upper Tana-Nairobi Water Fund, Kenya is providing more than 25,000 farmers with the training, resources and equipment they need to help keep the river healthy, conserve water and reap the benefits of higher crop yields and more stable farms.

Vocabulary:

Drainage Basin: any area of land where precipitation collects and drains off into a common outlet, such as into a river, bay, or other body of water.

Gray infrastructure: Gray infrastructure refers to structures such as dams, seawalls, roads, pipes or water treatment plants.

Watershed: an area of land that drains rainwater or snow into one location such as a stream, lake or wetland.

Water Cycle: The water cycle shows the continuous movement of water within the Earth and atmosphere. Liquid water evaporates into water vapor, condenses to form clouds, and precipitates back to earth in the form of rain and snow. Water in different phases moves through the atmosphere (transportation). Liquid water flows across land (runoff), into the ground (infiltration and percolation), and through the ground (groundwater). Groundwater moves into plants (plant uptake) and evaporates from plants into the atmosphere (transpiration). Solid ice and snow can turn directly into gas (sublimation). The opposite can also take place when water vapor becomes solid (deposition).

Water fund: a collaborative program that enables downstream users, like businesses, to invest in helping upstream users protect and restore vital lands and water sources—improving water quality for millions of people.

Water security: the capacity of a population to safeguard sustainable access to adequate quantities of and acceptable quality water for sustaining livelihoods, human well-being, and socio-economic development, for ensuring protection against water-borne pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability (United Nations)

Extension Activities and Additional Resources

Related Nature Lab Resources: The following lesson plans and videos can be used to supplement the series.



[Water: The Source of Life](#)

As water travels across our planet, it shapes our environment, connects all living things, and is critical for survival. This video follows the journey of water to find out how one city, Bogotá, Colombia, gets water from its source in Chingaza National Park and the surrounding páramo ecosystem. The video is accompanied by two lesson plans: In **Biomimicry: Water Security Inspired by Nature** students use the plants of the páramo as models for an engineering challenge. **Finding Your Flow: A Toolkit for Watershed Engagement** provides online resources for understanding watersheds, connecting to local watershed resources, engaging in watershed activities in the classroom, and identifying opportunities for watershed activism. It also includes a list of suggested projects that can make use of the resources.



[How Natural Areas Filter Water](#)

Nature works to filter water and to release water over time, thereby reducing the amount of artificial treatment needed to filter water and helping to prevent flooding. In this lesson, students learn about the importance of water quality for human health and agriculture. They relate their own consumption activities to the water supply and brainstorm various threats to the water supply. By contrasting natural filters with impervious (paved) areas, students compare the impact of development on the ability of nature to provide clean freshwater

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