

## For High Schools

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**SIGMA XI**  
THE SCIENTIFIC RESEARCH HONOR SOCIETY

## Teachers' Activity Guide

Article: Why We Need Water Ethics

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### ■ Content

Activity A: Stewardship of Water

Activity B: Natures Water versus Peoples Water

## Activity A:

# Stewardship of Water

## Teacher Activity Guidelines

**Teacher Background:** Our water has unique properties necessary for sustaining all forms of life. These unique properties include: polarity, an excellent solvent, high heat capacity, high heat of vaporization, cohesive and adhesive properties and is less dense as a solid than as a liquid. It is because of these properties that water is essential to living organisms. Water is an integral part of our lives with many daily uses which are often overlooked when trying to devise conservation efforts.

## Student prior knowledge

Students should be able to

- Understand the water cycle process including runoff
- Identify how natural resources are sustainable
- Describe the ethical reasoning behind water conservation
- Explain how policy making and decision affects all aspects of society: cultural, social, economic

## Vocabulary

**Sustainability** - meeting our own needs without compromising the ability of future generations to meet their own needs

**Ethical malleability** - means that we have the capacity to adopt different values

**Ethics-system of moral principles** - what is good for individuals and society

**Ethical discourse** - type of argument that attempts to establish norms

**Indigenous Communities** - peoples and nations are those which, having a historical continuity with pre-invasion and pre-colonial societies that developed on their territories

**Environmental Flows** - describe the quantity, timing, and quality of water flows required to sustain freshwater and estuarine ecosystems and the human livelihoods

**Cultural Flow** - water allocations earmarked for traditional cultural purposes

**Properties of water** - water molecules are polar, with partial positive charges on the hydrogens, a partial negative charge on the oxygen, and a bent overall structure. This is because oxygen is more electronegative, meaning that it is better than hydrogen at attracting electrons. Water is an excellent solvent

**Irrigation** - is the artificial process of applying controlled amounts of water to land to assist in production of crops

**Hypoxia** - oxygen deprivation

**Watershed** - a land area that channels rainfall and snowmelt to creeks, streams, and rivers, and eventually to outflow points such as reservoirs, bays, and the ocean

## NGSS Standard

HS-ESS2-2 Earth's Systems

Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.

HS-ESS2-5 Earth's Systems

Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.

HS-ETS1-1 Engineering Design

Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

## Lesson Objective

Students will be able to

- Create a model of a watershed.
- Model the effects of pollutants on a central water source within the model.
- Describe potential sources of water pollutants and the impact on water habitats.
- Discuss soil erosion due to runoff.

## Materials

- One can spray foam sealant/insulation
- Plastic shoe box
- Water
- Blue food coloring
- Ruler or dowel
- *Optional:* acrylic paints, foam paint brushes
- Video: [PBS Poisoned Water](#)
- [Water Pollution Causes](#) by Environmental Pollution Center
- [United States Environmental Protection Agency](#)

## Pre-Assessment

- The use of pesticides and fertilizers is carefully monitored because of the effect they can have on the environment. Describe a possible negative effect of the use of these chemicals to the environment.
- How would you devise a way to illustrate the effect of human activity on groundwater and surface in a watershed?

## Procedure

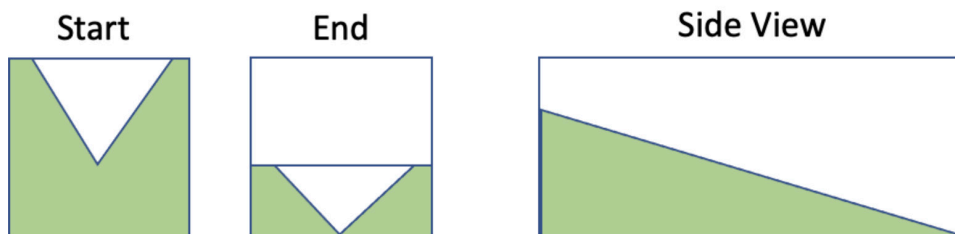
Demonstrating the natural flow of water will be established prior to the introduction of any irrigation diversions or pollutants.

## Directions

This activity will create a model of a sloping watershed inside a plastic shoe box. Starting at a narrow end of the plastic shoe box, spray the foam to about  $\frac{1}{2}$  height of the shoe box. The foam EXPANDS! Continue spraying the foam, moving side to side, keeping in mind the level of foam at the opposite end of the shoe box must be lower than the starting end. Before the foam hardens, use a ruler or dowel to make a groove that follows the contour of the foam.

Just like a real watershed, the surface of the model will not be flat. If you want to be extra creative, add model trees, houses, and cars. Use paint to color in green grass, roads, and anything else that would be on a landscape. Since the activity is to model pollutants, such as fertilizers, pesticides, and other pollutants include different environmental settings, such as farms, cities, factories, roadways, schools, natural areas, etc.

The foam will harden rather quickly, so have the ruler or dowel handy to make the groove which will represent a river or stream. Once the foam is hardened and any decorating of the landscape is done, add blue food coloring to the water. Gently pour the water at the high end of the model and observe what happens. This watershed model is reusable! Create “runoff” flows from different pollution sources. For extra fun, use different food colors for different “pollutants”.





## Discussion Questions

- What are the actions that should be taken to protect U.S. waterways from pollutants?
- Explain the effect that human activity can have on groundwater and surface water in a watershed.
- What is the water treatment process of your local water supply?
- How would changes in annual rainfall (such as droughts or excess rainfall) affect the local water table?

## Conclusion Questions

- What happens if the soil is already saturated and then you have excess water runoff?
- How does soil erosion affect the level of runoff?
- Which pollutants seemed to have the most effect on the water supply?
- In what ways did the irrigation manipulations help the water supply? In what ways did it negatively affect the water supply?

## Research Extension

- How does irrigation affect climate?
- What percentage of U.S. land is currently used for irrigation?
- What percentage of irrigation water is reusable?
- What are the consequences for increasing the percentage of land used for irrigation?

## Project Extension Option 1

Your mission is to evaluate the current water policy or Clean Water Act of 1972. Upon completion of your review, you will need to expand legislation by developing stricter requirements to curtail the entry of pollutants into U.S. waterways within the immediate future. Once completed then submit your evaluation to your local elected official.

We suggest you contact your local water treatment facility to see if there is a video or person who can come out and explain the water treatment process for your local water supply.

You may also wish to contact your local agriculture extension agency to see what percentage of land in your area is used for irrigation.

## Project Extension Option 2

After reading the article, *Moving Forward After Flint*, describe how the local water supply became contaminated and how lead piping contributed to the crisis. Develop a presentation showing a timeline of events from the start of the Flint water crisis to now. Include in the presentation the missteps of several government agencies and officials and how citizen science came into play.

## Assessment/Conclusion/CERR

**Guiding question** - Begin with a question focusing on the concept of study.

**Claim** - Answer the question with a clear statement addressing the specific inquiry.

**Evidence**- Support your claim with evidence. Data should be appropriate (relate to your point) and sufficient (fully explain your claim).

**Reasoning**- Demonstrate why your evidence supports your claim using scientific principles.

**Rebuttal**- Describe a misconception you had and use evidence and reasoning to refute the misconception.

The Mississippi River runs through the middle of the United States, emptying into the Gulf of Mexico. Along the central great plains, there is abundant farmland. Runoff from the farmlands, as well as pollution due to urbanization, is deposited into the Mississippi River which flows to the Gulf of Mexico. This deposition has created a Dead Zone in the Gulf of Mexico. The pollution from fertilizers and other pesticides in the runoff decreases the amount of oxygenated water leading to hypoxia, resulting in the death of both aquatic and marine life.

What preventative measures could have altered this outcome in the Gulf of Mexico?

**Claim:**

**Evidence:**

**Reasoning:**

**Rebuttal:**

## Activity B:

# Nature's Water versus People's Water

## Teacher Activity Guidelines

**Teacher Background:** Our water has unique properties necessary for sustaining all forms of life. These unique properties include: polarity, an excellent solvent, high heat capacity, high heat of vaporization, cohesive and adhesive properties and is less dense as a solid than as a liquid. It is because of these properties water is essential to living organisms. Since water has become such an integral part of our lives we are now dependent on it for many daily uses. Some of these daily uses are not as evident as others, and therefore are often overlooked when trying to devise conservation efforts.

Peoples' views on water and its role in their lives can vary greatly. In creating water policies we must recognize key differences water plays in nature compared to our lives. More so, the value of water can be looked at through multiple lenses.

## Student prior knowledge

- Identify how natural resources are sustainable
- Describe the ethical reasoning behind water conservation
- Explain how policy making and decision affects all aspects of society: cultural, social, economic

## NGSS Standard

### HS-ESS3-1

Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

### HS-ESS3-4

Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.



## Materials

### Diagram Discussion

Claim, Evidence, Reasoning, and Rebuttal (CERR) Template

Study the diagram:

Graphic by Barbara Aulicino; all photographs by David Groenfeldt except fourth down, left side, by Terray Sylvester/Reuters and bottom photo, right side, courtesy of Berliner-Wassertisch.

	Nature's Water		People's Water	
	How should we manage water ecosystems?	examples	How should we use water?	examples
environmental values	Maintain adequate flow for aquatic biodiversity; protect/re-store endangered species	 Fish can spawn in Australia's Yarra River using a fish ladder inside this retrofitted structure.	Return clean water to nature after using it for farming, manufacturing, or domestic purposes	 This irrigated pasture in Clovis, New Mexico, is draining an aquifer when farms should be doing more to save water, acid chemicals, minimize runoff, and enhance soil health.
economic values	Manage rivers to enhance ecosystem services, ensure water resiliency, and avoid floods	 Levees are set back from this restored floodplain on the Rhine River in Düsseldorf, Germany.	Minimize water use, and maximize reuse and recycling	 Interconnected paddy fields in Sri Lanka reuse irrigation water as it flows from one field to the next.
social values	Manage rivers to support recreation (fishing, boating, swimming) and landscape beauty	 Cities like Melbourne, Australia, are discovering the cultural benefits of a reclaimed waterfront.	Ensure universal access to safe drinking water and sanitation as a fundamental human right	 Safe, convenient water for washing and drinking is not a given, even in the United States.
cultural values	Protect culturally important water ecosystems and species.	 The Standing Rock Sioux protests against the Dakota Access Pipeline expressed spiritual as well as political and economic values.	Recognize that water has diverse cultural meanings and is enjoyed and celebrated in many ways	 Urban water fountains like this one in Paris connect us to nature and each other.
governance values	Recognize nature as a key stakeholder in water-related decisions	 The U.N. Permanent Forum on Indigenous Issues raises the profile of Indigenous philosophies of nature.	Support the values of all governance stakeholders	 Berlin citizens celebrated the return of their water supply from private to public control.

**Diagram Discussion** Think-Pair-Share

After reading and viewing the samples, what is the significance of water in that role for nature? For people?

Discuss with your group. What do you all agree on?

Summarize your conclusion for each of the values discussed.

Key Values	Summary Conclusion over Management: Nature's Water	Summary Conclusion over Use: People's Water
Environmental Values		
Economic Values		
Social Values		
Cultural Values		
Governance Values		

Your local water sources: \_\_\_\_\_

Choose a key value to highlight management and use of water in your local community. Discuss the impact of water's role in your local examples.

*Questions to consider:* Is the value you chose important to you? When looking at how water is managed and how it is used, is there a conflict between the two? Are the examples you mentioned in need of reform?

## Pre-Assessment

Describe your current understanding of water policy.

In creating water policy what factors should be considered?

## Procedure

Looking over this diagram students will compare each key value of water through management in nature to peoples' uses of water. Students will discuss the significance of water in that particular role. After discussion, students will summarize their findings for each key value. To make this discussion meaningful, students will select a key value and find local examples.

## Discussion Questions

- How is water essential to our daily lives?
- What factors should be considered when creating water policies?
- How would you describe the current global water crisis?



## Assessment/Conclusion/CERR

Guiding question - Begin with a question focusing on the concept of study.

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**Reasoning**- Demonstrate why your evidence supports your claim using scientific principles.

**Rebuttal**- Describe a misconception you had and use evidence and reasoning to refute the misconception.

In reading over the many values water holds in our community, which value stands out as the most essential for you? Be sure to use textual evidence to support your claim.

<b>Claim:</b>	<b>Evidence:</b>
<b>Reasoning:</b>	<b>Rebuttal:</b>

# AMERICAN Scientist

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## Activity B: Nature's Water versus People's Water


Article: Why We Need Water Ethics  
American Scientist 2019 September - October Issue

### Activity B:

## Nature's Water versus People's Water

### Diagram Discussion

Study the diagram below:

	Nature's Water		People's Water	
	How should we manage water ecosystems?	examples	How should we use water?	examples
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**Reasoning:**

**Rebuttal:**