Learn, Protect, and Promote Water!

Grade Level

6 - 8

Purpose

In this lesson students learn about water sources, water pollution, and water protection. Students participate in an activity where they demonstrate the water cycle and see the potential for our water supply to become contaminated. Grades 6-8

Estimated Time

30 - 45 minutes

Materials Needed

Activity 1: Groundwater Recharge, Pollution, and Protection

- Water Pollution Scenario Cards (https://cdn.agclassroom.org/media/uploads/2016/08/10/Scenario_Cards.pdf)
- Mini Posters (https://cdn.agclassroom.org/media/uploads/2016/08/10/MiniPosters.pdf)

Activity 2: Water Savers

- Lore Story https://cdn.agclassroom.org/media/uploads/CR1242/Water_Savers_lore_story.pdf, 1 copy per class or student group*
- Villian (https://cdn.agclassroom.org/media/uploads/CR1242/Updated_Water_Savers_Villian_Descriptions.pdf) and Hero (https://cdn.agclassroom.org/media/uploads/CR1242/Updated_Water_Savers_Hero_Descriptions.pdf) descriptions, digital copy to project or 1 printed copy for each group*
- Game board and pieces, 1 per group of 2-5 students:
    - Water Savers Rule Sheet and Game Instructions (https://cdn.agclassroom.org/media/uploads/CR1242/Updated-Water_Savers!_Rule_Sheet.pdf)*
    - Game Board (https://cdn.agclassroom.org/media/uploads/CR1242/Water_Savers_Game_Board.pdf) (Recommended printing on 11" x 17" paper)*

    - Game Cards (https://cdn.agclassroom.org/media/uploads/CR1242/Updated-Water_Savers!_Cards.pdf) (Print on cardstock and cut out)*
    - Hero Cards (https://cdn.agclassroom.org/media/uploads/CR1242/Heroes_.pdf) (Print front and back on cardstock and cut them out. Be sure to let the printer know the weight of the cardstock, otherwise they will not print front and back correctly)*
    - Villain Cards (https://cdn.agclassroom.org/media/uploads/CR1242/Water_Savers_Villains.pdf)(Print front and back on cardstock and cut them out. Be sure to let the printer know the weight of the cardstock, otherwise they will not print front and back correctly)*
    - Pollution Track (https://cdn.agclassroom.org/media/uploads/CR1242/Water_Savers_Pollution_Track.pdf) (Optional)
- Environmental Action Plan (https://cdn.agclassroom.org/media/uploads/CR1242/Updated-_Responsible_Environmental_Action.pdf), (Optional) 1 copy per student group

*These items are available in the Water Savers Game (https://agclassroomstore.com/water-savers-game/), which can be purchased from agclassroomstore.com.

Vocabulary

best management practices: methods that can improve efficiency, optimize resources, and prevent or help reduce pollution

evaporation: the changing of a liquid into a gas

groundwater: precipitation that has infiltrated through soil, rock, and gravel in the ground

hydrologic cycle: a sequence of conditions where water moves through the atmosphere through precipitation, evaporation, and transpiration

non point source: nutrient pollution that results from runoff and enters surface, ground water, and the oceans from widespread and distant activities

point source pollution: nutrient pollution that comes from a specific source that can be identified such as a factory or a wastewater treatment plant

precipitation: moisture in the form of rain, snow, sleet, or hail that falls to the ground

transpiration: the process by which plants release water vapor back into the atmosphere through their stomata

water table: the level in the ground which is saturated with water

Did You Know?

- Agriculture accounts for approximately 80% of the United States' consumptive water use.[1]
- Although agriculture accounts for a large portion of our water supply, large-scale farming could not provide food for the world's large populations without the irrigation of crop fields.[2]
- Irrigation has been around for as long as humans have been cultivating plants.[2]

Background Agricultural Connections

The **hydrologic cycle**, more commonly known as the water cycle, is a process where water is continually moving around the earth through precipitation, evaporation, and transpiration.

Precipitation is water in any form that falls from the sky. **Evaporation** is when water changes from a liquid to a gas after being heated by the sun. **Transpiration** is when water changes from a liquid to a gas after being absorbed through plant roots and then entering the atmosphere through the leaves.

Groundwater is water found underground in the cracks and spaces in soil and rock. Precipitation can help to increase groundwater levels if the precipitation is able to infiltrate deep enough through soil, rock, and gravel in the ground. Groundwater reaches aquifers, which is the saturated zone of the soil, rock, and gravel in the ground. Wells are drilled into aquifers to access water. The top of the aquifer, where the saturated zone meets the unsaturated zone, is called the **water table**.

Groundwater aquifers also serve to supply water to streams and other surface water. If not for groundwater, streams would dry up during the driest part of summer when it may not rain for weeks. In urban areas, groundwater recharge is reduced due to pavement, roofs, and other impervious surfaces.

On Earth, only 1 percent of water can be used for drinking. Additionally, groundwater is used for industry, mining, and agricultural purposes.

Water Pollution

Water can become contaminated by both **point source pollution**, which is pollution from a specific and identifiable source, and **non point source pollution**, which is pollution from a less identifiable source, often spread over several areas, and can be mobilized by rainfall or snowmelt.

Point source pollution examples include:

- Factory waste from a pipe
- Discharge from manufacturing plant
- Waste water treatment facility outfall

Non-point source pollution examples include:

- Fertilizer in garden
- Dog waste in yard
- Motor oil residue on roads

In addition to other pollutants, pesticides, if not used appropriately, can contaminate both surface water and groundwater. The contamination can be effected by the weather, environment, soil conditions, and human activities. For example, sandy soil has larger soil particles and is more prone to pesticide leaching, which occurs when a pesticide moves through the soil to reach groundwater. Certain characteristics that make a pesticide more prone to leaching include:

- High solubility, meaning the pesticide can easily move in water
- Low adsorption, meaning the pesticide does not easily bind to the soil particles
- Persistent, meaning the pesticide does not easily break down in the environment

Point source pollution examples from pesticides include:

- Improper disposal of pesticide containers and pesticides, such as dumping excess pesticides down storm sewers and other locations.
- Pesticide use in vulnerable areas such as sandy soil, sinkholes, and shallow groundwater.
- Pesticides spills at mixing, loading, and equipment clean-up sites.
- Pesticide use around wells or other known water sources.
- Back-siphoning of pesticides into water sources.
- Any way that pesticides are not mixed, used, stored, and disposed of according to label directions.

Non-point source pollution from pesticides includes pesticides moving from large areas into water or groundwater, like what might occur after a rainfall, such as if pesticides are applied to fields and lawns prior to rainfall.

Water Protection

Best management practices (BMPs) are methods that can improve efficiency, optimize resources, and can prevent or help reduce pollution. If applying pesticides, BMPs should be used, which promote environmental stewardship and help prevent pesticide contamination of water. Best management practices with pesticides around water include:

- Determine need to use pesticide products and perform spot treatments when possible.

- Apply pesticides according to the label directions.
- Identify vulnerable areas such as sandy soil, sinkholes, wells, and shallow groundwater.
- Secure storage areas to prevent unintentional chemical exposure.
- Ensure chemicals are tightly closed and monitor for tears to prevent spills or leaks.
- Maintain a 100 foot buffer zone around wells, streams, rivers, and other known water sources when mixing, loading, and applying pesticides.
- Avoid back-siphoning of pesticides.
- Incorporate pesticides into the soil to reduce runoff.
- Have buffer strips to catch sediment and help slow runoff movement.
- Monitor weather to properly time pesticide applications.
- Regularly calibrate equipment.
- Handle pesticides and equipment safely.
- Seek assistance with any questions from Extension Educators and Department of Agriculture affiliates.

Other best management practices to help prevent water contamination include:

- Reduce or eliminate fertilizer use.
- Prevent chemicals from leaking.
- Pick up trash and animal waste.
- Be aware of oil residues from vehicles.

Engage

1. As a class, or in smaller groups have students take turns sharing a response to the questions listed below. Each student should think of a response that has not already been shared. If everyone in the group answers, continue for a second round of sharing. Once students begin running out of responses, see if each group as a team can think of even more responses.
    - How do I use water in my daily life?
    - Who or what needs water?
        - Tip: As students begin running out of ideas, give prompts such as, "Do farmers need water to produce our food? Is water necessary to process our food (clean, cook, and package it after it leaves the farm) and to keep restaurants clean and safe from foodborne illness? etc."
        - Optional Adaptation: Another way to facilitate this activity is to have students write down responses as a group in a certain amount of time, such as sixty seconds. Have students share and compare responses. For a friendly competition, see which group comes up with the most unique responses

2. Discuss and summarize the information found in the Background Agricultural Connections portion of the lesson. Inform students that they will be learning about the importance of water and how we can protect our water supply.

Explore and Explain

Activity 1: Groundwater Recharge, Pollution, and Protection

Preparation:

1. Print and cut the Water Pollution Scenario Cards (https://cdn.agclassroom.org/media/uploads/2016/08/10/Scenario_Cards.pdf).
2. Print the Mini Posters (https://cdn.agclassroom.org/media/uploads/2016/08/10/MiniPosters.pdf).
3. Hang or place the "Clouds" sign at the front of the room or learning space. In the following order, display the "Plants," "Ground," and "Stream" signs several feet away from each other and several feet down from the "Clouds" sign, such as in the middle of the room. The "Aquifer" sign should be placed on the opposite end of the room or space from the "Clouds" sign, several feet down from the "Plants," "Ground," and "Stream" signs.

Activity:

1. Explain to students that groundwater is a very important resource. As a class they will soon be demonstrating the hydrologic cycle and groundwater recharge. They will serve as the "water" that moves through the hydrologic cycle and provides nutrients to plants, recharges groundwater, and supplies aquifers.
2. Explain to learners that Pennsylvania [or insert your state's statistics here] gets 41 inches of precipitation, on average. Of that precipitation, approximately 50 percent will evaporate or transpire from plants, 30 percent will go to infiltrate through the soil and recharge groundwater, and 20 percent will land on the ground and runoff into streams.
3. Ask for 20 volunteers. Assign the following number of students in respective roles: 10 students will represent evaporation and transpiration, 6 students represent groundwater recharge, and 4 students will represent runoff into a stream. Once roles are assigned, have the 20 students come to the front of the room and stand by the "Clouds" sign.
4. Teach students that approximately 50 percent of the precipitation will evaporate or transpire from plants. Have 10 students leave the "Clouds" sign, representing precipitation, and move to the "Plants" sign.
5. Teach students that 30 percent of the precipitation will infiltrate through the soil and recharge groundwater. Have 6 students leave the "Clouds" sign, representing precipitation, and move to the "Ground" sign. Have the students step over the Ground sign, representing how precipitation infiltrates into the ground. Have half (3 of the 6) of the students move and stand next to the "Aquifer" sign, demonstrating how groundwater fills aquifers. Have the other 3 move towards the "Stream" sign,

(still below the "Ground" sign,) but forming a horizontal line to replicate how the groundwater feeds surface water like the stream.

6. Next, teach students that 20 percent of the precipitation will land on the ground and runoff into streams. Have the 4 remaining students leave the "Clouds" sign, representing precipitation, and move towards the "Ground" sign. Once they reach the "Ground" sign, the students should not step over the sign, but should move horizontally across to the Stream sign, demonstrating how the precipitation becomes runoff and feeds into surface water, such as streams and lakes.
7. Now that all students have moved away from the cloud, Instruct the group of 10 students standing at the "Plants" sign to move back to the "Clouds" sign, demonstrating how water will evaporate (change from a liquid to a gas from being heated by the sun) or transpire (change from a liquid to a gas from being absorbed through plant roots and going out through leaves) as part of the hydrologic cycle.
8. Explain that groundwater recharge happens primarily in the spring and fall. In the winter, soil is often frozen. In the summer, plants are growing.
    - A Step Further: Instead of assigning students to groups, ask for volunteers and then have the students determine the numbers for evaporation and transpiration, the groundwater recharge, and the runoff into streams using the given percentages. Or, have the students represent certain inches of precipitation and allow them to determine where the water will move. Example: Each student represents 4 inches of precipitation. To replicate the movement of 40 inches of precipitation, 5 students would move to the Plants sign, 3 to the Ground sign for groundwater recharge, and 2 would be the runoff for streams.
9. Have the students remain in the same positions near the "Stream," "Groundwater," "Aquifer" and "Clouds" signs. Select an additional 4 students. These students will now be representing either a "Point Source Pollution" or a "Non point Source Pollution." Distribute one Water Pollution Scenario Card to each of the 4 students as well as the corresponding Groundwater Mini Poster.
10. Ask the 4 students to read the instructions on their scenario card and instruct the rest of the group to remain in their current position unless prompted.
    - Note: The scenario card instructions tell the student to read the instructions, perform the action when prompted by the instructor, and then share the talking points when prompted by the instructor.
11. Instruct Person #1 and Person #2 to perform the action listed on their scenario card.
12. Instruct Person #3 and Person #4 to perform the action listed on their scenario card. Once Person #3 is positioned near the "Plants" sign and Person #4 is positioned near the "Ground" sign, say “It’s Raining.” Instruct the students near the "Cloud" sign, who are serving as precipitation, to move, encouraging some to move towards the "Plants" sign and others to move towards the "Ground" sign. Person #3 and Person #4 have an additional action step on their scenario card to

move once the precipitation reaches them. Instruct the precipitation students to either stop once they have reached the signs or, take it a step further, with having the students at the "Ground" sign to either infiltrate towards the "Aquifer" sign or runoff to the "Stream" sign.

13. Ask the students about their observation of the pollution and which was point source or non point source pollution. Have Person #1, Person #2, Person #3, and Person #4 read the Talking Points on their scenario cards. Have students propose solutions to protect water sources, such as avoiding applying fertilizer or chemicals near expected rainfall events and ensuring that oil in motor vehicles is not leaking. More water protection solutions will be discussed in the next section.

Activity 2: Water Savers

1. Read the Lore Story https://cdn.agclassroom.org/media/uploads/CR1242/Water_Savers_lore_story.pdf to the students or have them read it within their game playing groups.
2. Organize the class into groups of 2-5 students. Give each student group a Water Savers game board and game pieces listed in the Materials section.
3. Review the Rule Sheet and Game Instructions (https://cdn.agclassroom.org/media/uploads/CR1242/Updated-Water_Savers!_Rule_Sheet.pdf) together as a class. If needed, see the modification options below.
4. Introduce students to the Villains (https://cdn.agclassroom.org/media/uploads/CR1242/Updated_Water_Savers_Villian_Descriptions.pdf) (environmental issues) and Heroes (https://cdn.agclassroom.org/media/uploads/CR1242/Updated_Water_Savers_Hero_Descriptions.pdf) (sustainable farming practices to help combat environmental issues) in the game.
5. Instruct students to play the game. As they play, encourage students to think about how they are defeating the Villains and how it might relate to the real world. Students should also be reminded to think about how this activity connects to big ideas.
    - You may use a timer for the game, or a pollution track (https://cdn.agclassroom.org/media/uploads/CR1242/Water_Savers_Pollution_Track.pdf).
6. Following the game, discuss any of the following questions with students. Keep track of their answers on the board.
    - What motivations did you, as the player, experience while you played the game? If you were put in your hero's shoes, do your motivators change?
    - Who were the different villains? Do you think the villains live on Earth? How might these villains represent issues in our community? Could the villains represent environmental issues and/or problems?

    - Could the heroes live on Earth? Do you think the heroes could be found in our community? Do they represent things near us? How might these heroes be examples of players?
    - Why do you think the game designers chose to represent environmental actions through the cards like they did?
7. Ask the students, "What do you already know about watersheds?" (They were mentioned in the game.)
8. After listening to the students' answers, watch the What is a Watershed? (https://www.youtube.com/watch?v=QOrVotzBNto) video.
9. Conclude by asking the students to make connections between one of the villains (environmental issues) and/or one of the heroes (sustainable farming practices) and the importance of healthy watersheds in our communities.
10. Optional: Transition to the Environmental Action Plan (https://cdn.agclassroom.org/media/uploads/CR1242/Updated-_Responsible_Environmental_Action.pdf). Give each group one copy. As a group, students work together using their knowledge gained from the game to determine ways that they could take action to help solve an environmental issue in your community. As a class, you may choose to produce an action plan to take on a water quality issue in your area.
11. The Environmental Action Sheet may be collected to help observe student ideas and to promote action.

Game Modifications:

- For younger students, remove the Crisis and Event cards or lower the number of them within the deck.
- For students with prior knowledge of environmental issues, have the students create their own crisis, Hero, or Villain
- Students can survey their neighborhood/surrounding area for farming practices that are helpful or harmful to water quality and look for areas that may have an increased the amount of nutrients.
- Encourage students to explore what goes into their water or where their water comes from (this is a good place to also include the water cycle/nitrogen cycle).
- Expand student understanding by having them design a buffer strip, or other sustainable farming practices, that will also increase biodiversity.

Elaborate

- Assign students to research specific examples and news articles that share about water contamination and the effects on the society. Allow students to share findings with a group.
- Encourage students to identify areas around their home which are near or connected to water, such as storm sewers, well heads, streams, and others. Ask students about

potential contaminants near these areas and if there are best management practices to reduce pollution.

Evaluate

After conducting these activities, review and summarize the following key concepts:

- Water cycles through the atmosphere as a liquid, solid, or gas. This is known as the water cycle.
- Water is an important natural resource. Water supply is necessary and critical to produce our food.
- Water is a limited natural resource that needs to be managed properly and protected from pollution, damage, and waste.
- The use of "Best Management Practices" helps farmers and ranchers use water more efficiently as they produce our food.

Sources

1. http://www.seametrics.com/blog/farm-water-facts/
2. http://water.usgs.gov/edu/wuir.html

Acknowledgements

Activity 1: Penn State Pesticide Education Program (https://extension.psu.edu/learn-protect-and-promote-water-lesson-plan-and-demonstration)

Activity 2: Upper Iowa University – Environmental Issues Instruction (EII) (https://uiu.edu/academics/environmental-issues-instruction-eii/); Authors: Cathryn Carney, IALF; Dylan Jacobsen, Artist; Jeff Monteith, New Hampton CSD

Recommended Companion Resources

- Agricultural Fact and Activity Sheets (https://www.miagclassroom.org/matrix/resource/160/)
- How Do You Grow a Fish Sandwich? Video (https://www.miagclassroom.org/matrix/resource/814/)
- Project WET (https://www.miagclassroom.org/matrix/resource/733/)
- Science in Your Watershed (https://www.miagclassroom.org/matrix/resource/577/)
- The Story of Bottled Water video (https://www.miagclassroom.org/matrix/resource/531/)
- The USGS Water Science School (https://www.miagclassroom.org/matrix/resource/734/)
- Using Technology to Save Water (https://www.miagclassroom.org/matrix/resource/607/)
- Water Pollution Demonstration (https://www.miagclassroom.org/matrix/resource/217/)
- Water Savers (https://www.miagclassroom.org/matrix/resource/1242/)

- Water: Sources, Use, Conservation (https://www.miagclassroom.org/matrix/resource/216/)

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Organization

Penn State Pesticide Education Program