Science Lesson Plan: Watersheds and Land Use

Main Aim:

- To understand the relationship between land use and water quality.

Subsidiary Aim:

- To understand what watersheds are.
- To understand how different land uses within a watershed may affect the quality of the water moving within that watershed.
- To learn what indicates good and bad water quality.

Performance Indicators

- Knowing: Student understands movement of pollutants in the environment.
- Doing: Student asks peers, teachers, community members, etc., questions to learn more.
- Being: Student identifies sources of pollution in their community, in classroom discussion, or at home.
- Learning to learn: Students discuss the lesson in small groups.

Assumed Knowledge

It is assumed that students have an understanding of the water cycle and basic human-environment relationships resulting from agriculture, mining, and industry practices.

Materials

- Watershed model
- Spray bottle
- Water
- Napkins
- Food coloring
- Laminated pages
- Dry erase markers
- Magnifying glass

Anticipated Problems/Solutions

Reluctance to participate: This can be addressed by splitting students into smaller groups for initial discussions.

Students express disinterest: To ensure student engagement, the material will be prepared to include local examples and relevant community information. The activity will also be used to increase student interest.

https://extension.usu.edu/waterquality/files-ou/Lesson-Plans/Water-pollution-LPs/watershed-detectives.pdf

Watersheds and Water Quality Introduction

A **watershed** , which can also be can also be called a drainage basin or catchment, is an area of land over which creeks, streams, rivers, and other bodies of water converge to a single water source. Watersheds can vary greatly in size, and numerous watersheds can be nested together to form one large one. The Magdalena River Basin in Colombia is the largest in the country, spanning over 270,000 square kilometers, and contributing a significant amount to the economy. Watersheds may also be as small as an inland lake. The land surface is also considered part of the watershed. Rain and melted snow travel over land surface carrying with it debris, soil, and contaminants.

The natural conditions of a watershed, such as its elevation, annual precipitation and temperature, native geology and plant ecosystems all play a role in determining the quality of water leaving that watershed. Human activity can have a heavy influence on these conditions, which then affect the water quality.

Ask: What do you think of when you hear 'water quality'? What is something that could indicate bad water quality? What is something that can indicate good water quality? Allow students to discuss in for 5 minutes.

Water quality describes how healthy a body of water is. This is important information to have when deciding whether water is safe to use, and it determines if fish and other important wildlife can survive in it. The health of a stream can be measured with parameters like pH, temperature, dissolved oxygen, presence of heavy metals, and turbidity, but observable factors are also very telling of the water condition. These factors include the clarity, color, odor, presence of plants, aquatic animals, and macroinvertebrates. A healthy stream is evidenced by an abundant diversity of plants, animals, and macroinvertebrates, as well as chemical levels within ranges set by scientists.

Example of discoloration due to mine drainage in Andes, Antioquia, Colombia

Ask: Where does pollution come from? How can pollution spread to bodies of water? Allow students to discuss for 5 minutes.

Watersheds are directly tied to water quality. The water that flows through these areas can pick up pollutants along the way, which collect in the larger body of water these streams and rivers flow into. In areas with a lot of human activity, this can mean high levels of water pollution. These sources of pollution are categorized into two groups: point-source and non-point source pollution. **Point-source pollution** originates in a single place, while **non-point source pollution** comes from a wide area. Some examples of point-source pollution are discharge pipes, factory emissions, and ships. Examples of non-point source pollution are contaminants that come from neighborhoods, cities, roads, ranches, and farms.

https://oceanservice.noaa.gov/facts/watershed.html

https://www.nationalgeographic.org/encyclopedia/point-source-and-nonpoint-sources-pollution/#:~:text=Point%2Dsource%20pollution%20is%20easy,many%20places%2C%20all%20at%20once.

Activities

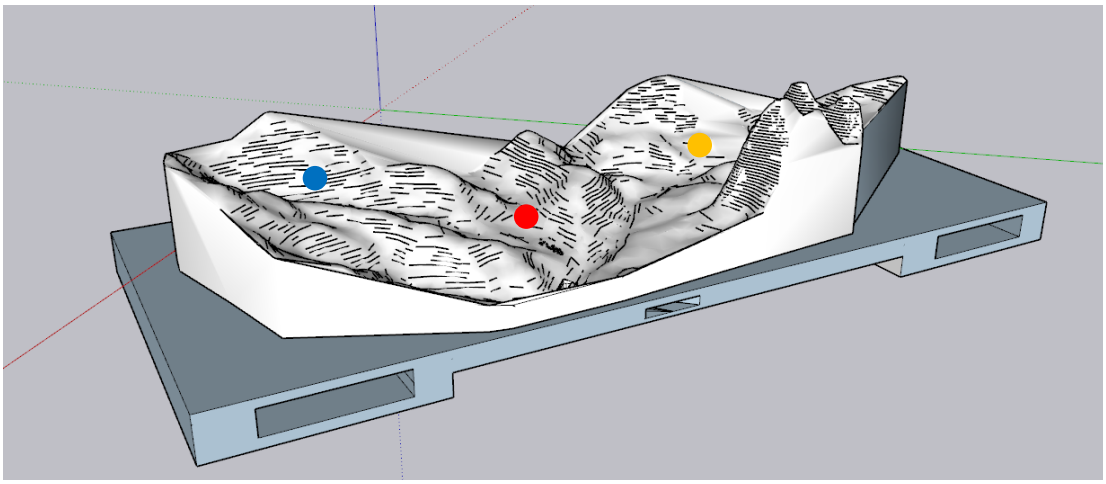
Part 1: The Watershed

The watershed model will be used to demonstrate point source and non-point sources of pollution. Regional examples of point-source pollution may be wastewater discharge pipes or textile factory discharge pipes. Non-point source pollution may come from ranching and agriculture operations such as coffee plantations or mining waste that is deposited in multiple locations, on land and in water.

Procedure:

1. Ask students where they think water would travel over the watershed model. After some discussion, point out the route the water is expected to take. Mist water over the model to demonstrate its path.
2. Choose three locations for the food coloring and add some drops to the model. The yellow food coloring will represent industry waste, blue will represent agricultural runoff, and red will represent residential area waste, like household trash.
3. Make sure the collection tray is placed under the water runoff opening.
4. Using a spray bottle, spray water in a mist across the model until the water starts to run. Use a small amount of water to simulate a light rain, and larger amounts of water to simulate heavy storms.
5. Show students how the different pollutants come together to pollute the main water source.

Ask: What kind of pollutants can the water pick up along the way? Can you think of anything in your community that may end up in the water? Would it be point-source or non-point source pollution? Discuss as a class for 5-10 minutes.



Example food coloring placement

Activities

Part 2: The Water Quality

This activity is optional and may be left out or completed on a different day if there are time constraints. This portion of the activity will involve using observable and measurable parameters to determine the quality of water. These include odor, color, presence of vegetation, aquatic life, macroinvertebrates, and pH. Students will learn that water that is highly colored or turbid may not be able to sustain vegetation and aquatic life due to inability of light to penetrate. Particles which impact the turbidity, or clarity, of water include algae, organic matter, minerals, artificial chemicals, and sediment stirred up from the bottom of a stream or lake. These particles may also cause odor which can be used to determine water quality if they exist in harmful concentrations.

Students may be able to find a variety of macro-invertebrates in the water which can be more closely observed using a magnifying glass. These are small insects and larvae that live in water that are observable to the human eye. These can tell a lot about the pollution levels in the water, depending on their tolerants of toxins. Very sensitive macro-invertebrates will exist in ecosystems with healthy water quality, while tolerant ones can exist where water is polluted. The provided key should be used to identify these. Observations of abundant and varied forms of life are indicators that the water quality is healthy enough to support a thriving ecosystem. If only few plants and animals are found, this may indicate that only tolerant ones can withstand the environment, and the water quality is poor. Finally, pH is measured to determine how acidic or alkaline water is. This parameter indicates chemical changes in water, which can be brought on by the presence of pollutants or poor oxygen availability in the water to support fish and other organisms. A point system and key has been provided to help students classify different observations with relation to quality of the water.

Procedure:

1. If a site visit is not possible, samples of water may be collected to complete this activity. The instructor should make sure to get samples from the bottom of the water body to collect enough organic matter and macroinvertebrates. Let the samples sit so particles can settle to the bottom before the activity begins.
2. Provide each student or group of students laminated tables and observation keys. Allow them to fill the table out according to their observations of the water.
3. For pH testing, ensure the probes are being handled carefully and correctly.
4. Once the students have completed their observations, discuss the results as a class.

https://www.usgs.gov/special-topic/water-science-school/science/water-color?qt-science_center_objects=0#qt-science_center_objects

https://extension.usu.edu/waterquality/learnaboutsurfacewater/propertiesofwater/aquaticmacros

https://www.usgs.gov/special-topic/water-science-school/science/ph-and-water?qt-science_center_objects=0#qt-science_center_objects

https://www.fondriest.com/environmental-measurements/parameters/water-quality/ph/

Water Quality Scoring

Directions: Observe the body of water and record observations. Use the provided keys to make inferences about each parameter and assign point values to develop an overall idea of the water quality by adding them together. Once everyone has recorded their observations, compare your results with other classmates.

Parameter	Observation	What does it mean?	Points
Clarity			
Odor			
Macro-invertebrates			
Wildlife			
Vegetation			
pH			

Total Points:

0-6: Poor Water Quality

7-12: Fair Water Quality

13-18: Good Water Quality

19-24: Excellent Water Quality

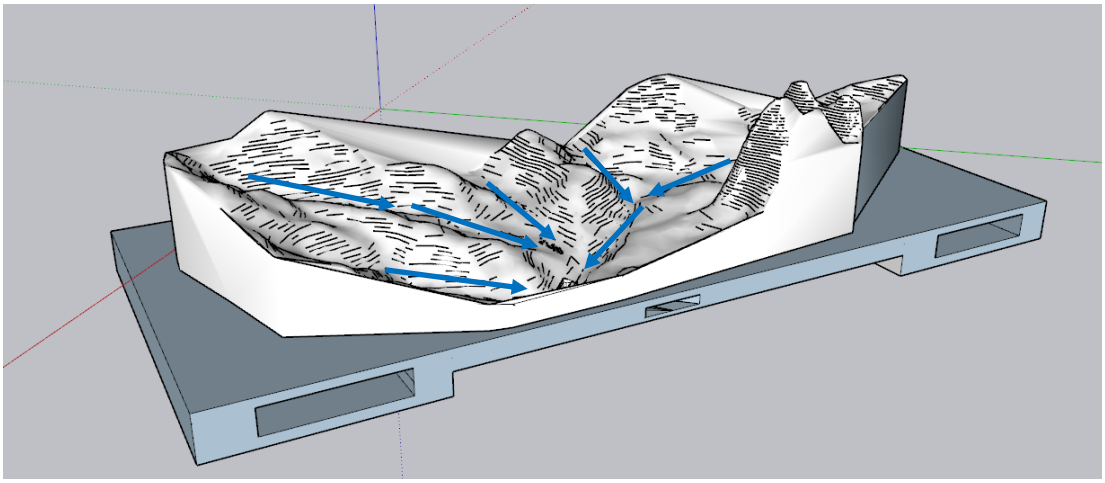
What is your final impression of the water?

_____

_____

Additional Instructor Guidance

During the watershed activity, the instructor should point out the path of the water to help students determine sources of pollution. The water is expected to flow along the course of the existing river, as well as along the other paths shown in the diagram below. It should be noted by the instructor that during rainfall events, the water will flow though the residential area of Santa Rita, which is also shown on the model.



The pH probes used during the water quality activity should be well cared for to ensure they can be reused multiple times. Some guidelines to follow are:

- Clean the electrode with distilled water before and after each use.
- Take care not to damage the glass probe during use.
- Gently wipe the probe with a clean, soft cloth when you're done, then cap it.
- After replacing the battery, make sure to recalibrate the meter.

The kit includes materials to calibrate the meter. The procedure is as follows:

- Turn on the pH meter
- Dissolve each buffer solution in 250 ml of distilled water
- Immerse the electrode into the pH 6.86 solution.(under the temperature of 25ºC
- Press the “CAL”(calibration) button for 5 seconds and release. The display screen will start flashing “6.86.”
- Wait it until the display screen stops flashing.
- Rinse the electrode with distilled water and dry it.
- Repeat the above steps with 4.01 pH buffer powder and 9.18 pH buffer powder.