Water Quality...Potential Sources of Pollution

GRADE SCHOOL EDITION

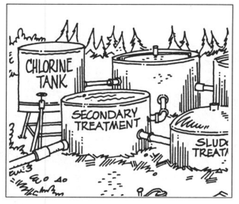
What is water quality? To most students, water quality may suggest only "clean" water for drinking, swimming, and fishing. But to the farmer or manufacturer, water quality may have an entirely different meaning. One of the most important issues concerning the quality of water is how that water will be used. Water that is perfectly fine for irrigation might not be suitable for drinking or swimming.

The quality of water can change as it flows over the land surface as rivers, streams, lakes, or ponds (surface water), or under the land surface (ground water). Because surface and ground waters are interconnected in some areas, changes in the quality of surface water can affect the quality of the area's ground water, and vice versa. These changes in water quality may be due to natural factors or human activities.

As rock minerals come in contact with water, some dissolve and become part of the surface- or ground-water system. Other natural materials, such as soil or organic matter, become suspended in the water and move from one place to another. The effects of human activities on water may result from land disturbances, which increase the amount of rock minerals, soils, or organic matter available to be transported by and dissolved in water, or from the addition of human-made pollutants. When water is degraded to a point that affects its use for a particular purpose, it has become polluted.

Water pollution originates from two very different sources: point sources and nonpoint sources. This poster depicts human activities associated with point sources (labeled in yellow) and nonpoint sources (labeled in red). Also displayed is the movement of pollutants from their sources to surface and ground waters. The stream flowing from the mountains on the left-hand side of the poster represents clean water not affected by human activities. The river on the left-hand side of the poster receives pollutants from point sources (wastewater-treatment plant, storm drain, and factory). The quantities of pollutants entering this river are reduced as a result of pollution-control measures. The river on the right-hand side of the poster receives pollutants from many nonpoint sources (suburban lawn, parking lot, construction site, landfill, logging area, septic tank, and agricultural field). This river receives large amounts of pollution because there are no pollution controls. The bottom part of the poster displays the movement of water between streams and the underlying aquifer.

The poster is folded into 8.5" x 11" panels; the front and back sides can easily be photocopied.

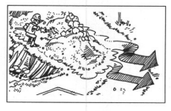


Point-Source Pollution

Pollution contributed to water from a discrete source, such as a pipe, ditch, tunnel, or well, are referred to as point sources. Generally, pollution from point sources are controlled to some degree by treatment technology. Municipal wastewater-treatment plants are one of the most common examples of treatment of point sources. While a municipal wastewater-treatment plant might receive water from many sources, it discharges into a water body at a single point.

Nonpoint-Source Pollution

Nonpoint source means that the pollution comes from a broad area, such as a large field that has been covered with fertilizer or pesticides. Excessive application of fertilizer or pesticides on agricultural lands or on lawns and gardens can create nonpoint sources. People who use fertilizers and pesticides must read labels to ensure that they are applying the materials properly.

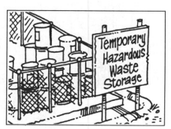


A land-surface disturbance caused by humans, such as construction or logging, can create nonpoint sources of pollution. Pollution can occur when an increase in erosion caused by land disturbances produces large quantities of sediment, which is washed into rivers, streams, and lakes. Contamination can be reduced by preventing sediment from reaching waters through the implementation of erosion-control structures and the by planting and maintenance of soil-holding vegetation.

Disposal of garbage and trash at community landfills has the potential for polluting surface and ground water. Recycling of waste products such as oil, grease, plastics, paper, and aluminum reduces the potential for pollution from landfills. Many automobile products, such as gasoline and brake fluid, and household chemicals like cleaning solutions and turpentine, should not be placed in landfills but taken to special collection areas.

Oil and grease from automobiles, sand, gravel, salt, and other potential pollutants accumulate on parking lots and streets. Because very little water infiltrates into asphalt and concrete, the nonpoint-source pollutants that accumulate on them can be washed into surface waters during large storms. Prevention of this type of nonpoint pollution requires collection and treatment prior to discharge into surface waters.

Hazardous Materials



Hazardous wastes produced as byproducts of manufacturing can affect water resources. Proper handling, storage, and disposal of hazardous materials is critical to the prevention of their entry into surface and ground water. This requires moving these materials to a safe storage location. What can individuals do to stop hazardous-waste pollution? One method is to stop dumping oil, cleaning liquids, or unknown substances on the ground or down the drain.

ACTIVITY

Dispersion of Nonpoint Pollutants

Introduction

One of the difficult problems associated with the control of nonpoint sources of pollution is the identification of the source. Different soil types and the properties of underground rock formations affect how water pollutants travel. Pollutants can behave differently once they come in contact with soil. Biological processes can alter pollutants and their behavior. Many factors affect the physical, chemical, and biological makeup of water pollution.

Objective

Students will become aware of the difficulty in determining the source of pollution.

Materials -- Each group will need:

1. One coffee filter (15-20 cm in diameter);
2. One piece of aluminum foil 30 cm x 30 cm;
3. Water to wet filters;
4. Eye dropper; and
5. One paper plate approximately 25 cm in diameter for each group.

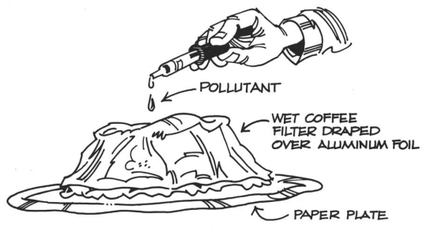
Teacher needs: one container each of red, yellow, and blue food dyes.

Teacher Preparation

1. Prepare a mixture of one part each of the three food dyes and one part water in large enough quantity that each group of students can receive five drops of the resulting mixture. Do not tell the students what the mixture is.
2. Provide each group with one filter, one paper plate, and a piece of aluminum foil.

Procedure

1. Divide students into groups of two. Have group members write their names on the coffee filter with a pencil. Then each group should place an 'X' and a 'Y' somewhere on the filter paper to represent imaginary wells.
2. Loosely crumple a piece of aluminum foil and place it in the middle of the paper plate.
3. Wet the coffee filter with water and drape it over the crumpled aluminum foil. The coffee filter represents soil on land surface. The aluminum foil represents bedrock on which the soil sits.
4. The instructor should place five drops of the food dye solution on the coffee filter. This solution represents pollution.



5. After 20 minutes, have the students examine the coffee filter. As a group, have the students observe, take notes, and make a diagram of the movement of the pollution using the 'X' and 'Y' markings as a reference.
6. Leave the coffee filter overnight and examine it again the next day.
7. Have the students answer the following questions:
   a. Describe what happened to the "pollution."
   b. What color of pollutant traveled the farthest from the point of contamination?
   c. Did any of the pollutants reach both imaginary wells?
   d. Did any of the pollutants travel uphill (against gravity)?
   e. What additional changes occurred when you compare the filter paper to the diagram you made on the first day?

Discussion

Have the students examine other group's coffee filters. How are they alike and how are they different?

1. Are pollutant paths relatively easy to predict?

Answer: No.

2. What are some factors that determine the direction and rates of movement of pollutants?

Answer: Soil types, rock types, shape of rock formation, and type of pollutants.

This activity was adapted from "Water Wisdom," published by the Massachusetts Water Resources Authority.

ACTIVITY

How Substances are Measured in Water

Introduction

Substances in water often occur in parts per million, parts per billion, or even parts per trillion. Water-quality laboratories can measure concentrations of substances at these levels, but what do these small concentrations mean? Developing an understanding of extremely large and small numbers is difficult. The following activity is designed to help students have an understanding of these extremely small concentrations.

Objective

Students will be able to visualize extremely small concentrations of a material.

Materials -- Each group will need:

1. One eye dropper;
2. Six small, clear plastic cups (the smaller the better); and
3. One 472-mL clear plastic cup filled 3/4 full of water.

Teacher needs: One bottle of food coloring.

Teacher Preparation

1. This activity is designed for students in groups of three. However, if sufficient materials are not available, this activity can be done as a demonstration.
2. For each group, place one drop of food coloring in one of the small, clear plastic cups and fill the 472-mL cup 3/4 full of water.

Procedure

1. Prior to conducting the activity, solicit responses from the students to the following questions:
   a. What is the largest number of things you can clearly visualize in your mind?
   b. Can you visualize a group of 1,000 people? Are you able to differentiate between 800 or 1,200 people from the 1,000?
2. Hand out one eye dropper; five small, clear plastic cups; one small clear plastic cup containing a drop of food coloring; and one 472-mL clear plastic cup filled 3/4 full of water to each group.
3. Explain that food coloring is usually a 10% solution; that is, 1 part (by volume) of food coloring dye is dissolved in 10 parts (by volume) of solution. For example, 1 mL of dye dissolved in 9 mL of water makes a total of 10 mL of 10% solution.
4. Using the eye dropper, have one member from each group add 9 drops of water to the small cup containing the food coloring. Stir well. What is the concentration of the food coloring? This is 1 drop of the 10% food coloring in 10 drops of the new solution. Thus, the concentration is one-tenth of the original or 1 part in 100 (10 x 10) parts of solution.
5. Use the eye dropper to transfer one drop of the 1 part in 100 solution to a third small plastic cup. Add 9 drops of water to this solution. Stir well. The concentration has again been changed by a factor of ten. The new concentration is one-tenth of 1 part per 100 or 1 part in 1,000 (10 x 100) parts of solution.
6. Transfer one drop of the 1 part in 1,000 parts of solution into the next small plastic cup. Add 9 drops of water. Stir well. The new concentration is one part in 10,000 parts of solution.
7. Continue to dilute 1 drop of each solution by adding water as before to obtain 1 part in 100,000 and then 1 part in 1,000,000. Your final solution is one part per million.

Interpretive Questions

1. In which cup do you first observe no visual evidence that food coloring is present?

Possible Answer: This generally occurs in the final container, or one part per million.

2. Since you cannot see any evidence of color present in the cup, how do you know there is food coloring in the cup?

Possible Answer: The students placed it there.

3. Can you think of an experiment that you could do to prove there is food coloring present in each cup?

Possible Answers: 1) Compare each cup with a cup containing only water. 2) Place several drops of the water from each of the cups on a piece of filter paper and let it dry.

This activity was adapted from "Science Demonstration Projects in Drinking Water (Grades K-12)," published by the U.S. Environmental Protection Agency.

ORDERING INFORMATION

Single copies of the first four posters in the series (see Poster Series panel) and a limited supply of the "Water Quality" poster (color for grades 3-5 and 6-8 or black and white) can be obtained at no cost from the U.S. Geological Survey by writing to the following address:

U.S. Geological Survey
Box 25286
Denver Federal Center
Denver, CO 80225
Telephone: (303) 236-7477

In your letter, please identify the poster title and grade level desired.

Also, the poster entitled "Water: The Resource That Gets Used & Used & Used for Everything!" has been translated into Spanish. A limited supply of color or black-and-white copies can be obtained at no cost from the U.S. Geological Survey at the above address.

Poster Series

This poster is the fifth in a series of water-resources education posters developed through the Water Resources Education Initiative. The Water Resources Education Initiative is a cooperative effort between public and private education interests. Partners in the program include the U.S. Geological Survey and the U.S. Fish and Wildlife Service of the U.S. Department of the Interior, the U.S. Environmental Protection Agency, the U.S. Army Corps of Engineers, the Nebraska Groundwater Foundation, and the National Science Teachers Association.

The other completed posters in the series are entitled "Water: The Resource That Gets Used & Used & Used for Everything!", "How Do We Treat Our Wastewater?", "Wetlands: Water, Wildlife, Plants & People!", and "Ground Water: The Hidden Resource!" The posters in the series are designed to be joined to create a wall mural. A schematic of the wall mural including the topics for the completed and planned posters is displayed on this panel. The light-shaded spaces indicate the completed posters. The dark-shaded space is this poster.

BIODIVERSITY	**WATERSHEDS**	**ACID RAIN or HAZARDOUS MATERIAL**
WETLANDS	**WATER USE**	**WASTEWATER TREATMENT**
OCEANS or NAVIGATION	**GROUND WATER**	WATER QUALITY

Water-resources topics of all completed posters are drawn in a cartoon format by the same cartoonist. Posters are available in color or black and white. The reverse sides of the color posters contain educational activities: one version for children in grades 3-5 and the other with activities for children in grades 6-8. The black-and-white posters are intended for coloring by children in grades K-5.

DEFINITIONS

Aquifer - An underground body of porous sand, gravel, or fractured rock filled with water and capable of supplying useful quantities of water to a well or spring.
Erosion - Process whereby materials of the Earth's crust are loosened, dissolved, or worn away and moved, usually by water or wind.
Ground Water - Water in the saturated zone beneath the Earth's surface.
Nonpoint Source of Pollution - Pollution from a broad area such as areas of fertilizer and pesticide application, rather than from point sources.
Point Source of Pollution - Pollution originating from a discrete source, such as the outflow from a pipe, ditch, tunnel, or well.
Sediment - Particles derived from rock or organic materials that have been transported by water or wind.
Surface Water - Water that is on the Earth's surface, such as rivers, streams, lakes, and reservoirs.
Unconfined Aquifer - An aquifer whose upper water surface (water table) is at atmospheric pressure and is free to rise and fall.
Water Pollution - Presence of any substance in water or addition of any substance to water that restricts the use of water.
Water Table - The top of the water surface in the saturated area of an aquifer.

ACKNOWLEDGMENTS

The following individuals contributed to the development of this poster:

Project Chief, Principal Author, and Layout: Stephen Vandas, U.S. Geological Survey, Denver, Colorado
Artwork: Frank Farrar, Frank Farrar Graphics, Denver, Colorado, under contract to the National Science Teachers Association

U.S. DEPARTMENT OF THE INTERIOR

As the Nation's principal conservation agency, the U.S. Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This responsibility includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people. The Department also has a major responsibility for Native American reservation communities and for people who live in island territories under United States administration.

MIDDLE SCHOOL