IT'S SEDIMENTARY, MY DEAR WATSON

OBJECTIVES

The students will do the following:

1. Determine the amount of solid material or sediment suspended in water samples.
2. Explain turbidity observations of water samples.
3. Explain ways in which sediment disturbs organisms.
4. Determine possible local nonpoint sources of sediment present in water samples.

SUBJECTS:
General Science, Earth Science, Ecology, Chemistry, Biology

TIME:
2-4 class periods

MATERIALS:
thermometers
local topographic map
filter paper
funnels
stirring rods
balances (electronic preferred)
shovel or spades (to collect soil, optional)
turbidimeter (optional)
clean, dry, wide-mouth collection bottles with lids (two per student or lab team)
beakers
large watch glasses
stick-on labels or masking tape
permanent ink markers or grease pencils
area land use maps
samples of water from local streams or lakes
data table (included)
cooler with ice (optional)
calculators (optional)
soil—preferably clay type (optional)
sun lamp or grow light (optional)
data sheet (optional; included)
graph paper
"Collecting a Water Sample" handout (included; see page 60)
"It's Sedimentary" Quiz (optional, included)

BACKGROUND INFORMATION

Heavy rains or snow melt can wash a variety of suspended materials or sediment into water bodies and make water cloudy or turbid. Turbidity is a measure of the amount of suspended material (cloudiness) in the water. Many other pollutants such as bacteria, nutrients, and harmful chemicals can attach to sediment particles and be transported with the sediment. While the process is natural, human activities can increase the rate faster than ecosystems can adjust. Improperly managed construction sites may cause a 2,000-fold increase in erosion rates and poorly managed farmland may cause a 200-fold increase, compared to rates of similar undisturbed forest lands. Sediment can interfere with aquatic life, commercial and recreational activities, and hydroelectric power generation. Sediment can decrease light transmission through the water, thus decreasing plant photosynthesis and reproduction. Also, sediment absorbs heat causing the temperature of the water to increase. A decrease in photosynthesis and/or an increase in water temperature can result in a decrease in the level of dissolved oxygen. Moreover, sediment can interfere with feeding and reproductive patterns of aquatic life. When sediment settles, it may create blankets which smother the aquatic plants and animals, and disrupt the food chain. Sediment can gradually fill lakes and streams. This can reduce flood storage capacity and hydroelectric power potential in reservoirs and cause navigation problems in rivers. The best way to solve nonpoint problems caused by sediment is to prevent or reduce soil erosion caused by human activities.

ADVANCED PREPARATION

A. Make copies of the student data table and/or other forms as needed.

B. Choose sampling sites.

1. Number and mark them on a local topographic map.

2. Assign a site to each student (or lab team) and have them collect a water sample. (NOTE: To save time, you may want to mix up some water samples in the lab which contain various amounts of sediment and assign them site numbers on a ficticious map. If you do, use a shovel or spade to collect a clay type soil. NOTE: Soils with high organic matter or peat float on water.)

C. If the students collect samples, have them complete a data table that includes date, time, site of collection, weather at time of collection, site number, description of location (including possible nonpoint sources of pollution), general observations of water sample (color, odor, appearance), and temperature of sample (data table included).

D. Instruct the students on proper water sample collection procedure.

1. Give each student or lab team a copy of the handout "Collecting a Water Sample." (See page 60.)

2. Give each student or lab team two clean, dry collection bottles.

3. Have them wait until a heavy rain is forecast and tell the students to collect their samples, preferably, just after it has rained. They can also collect them while it is raining or within 30 minutes after the rain stops. Each collection bottle should be filled completely and capped tightly. (CAUTION: Hands should be washed with antibacterial soap after the sample is collected.)

4. Have the students record site number, date, time, weather, and collector's initials at time of collection on the sample bottle.

5. Students should put their samples in a cool, dark place (such as a cooler with ice) immediately after they collect them and bring them to the class.

PROCEDURE

I. Setting the Stage

A. Explain that heavy rains can wash a variety of suspended materials into water bodies.

B. Discuss what types of land use activities are most likely to result in erosion and why.

C. Explain ways sediment can disturb aquatic ecosystems.

II. Activity

A. Make general observations of the samples. (NOTE: Shake sample first to suspend sediment.)

1. If you collected the samples, have the students make observations on the color and general appearance of their water samples and record them on the data table. (NOTE: If they collected the sample, this information should already be recorded.)

2. Distribute thermometers and have students record the room temperature. (CAUTION: Remind students to use extra caution when working with glassware and thermometers to prevent breakage. Go over lab safety procedures.)

   a. Establish a standard room temperature and have students adjust their thermometer readings to it. For example, if a student's thermometer reads one degree lower than the standard room temperature, then the student should add one degree to their temperature reading.

   b. Record the adjusted temperature on the data table.

B. Observe the effects of sediment on water temperature.

1. Have the students remove the lid from one of their two sample containers and place the uncapped samples in a sunny location so they all receive the same amount of sunlight. Be sure to include a control sample for comparison. Record the time. (NOTE: You may substitute a grow light or a sunlamp if sunny windows are not available.)

2. After about an hour, have students measure the temperature of the water sample. Explain the proper procedure for holding a thermometer. The thermometer should be suspended in the water, not touching the bottom or sides of the container. Record the time and temperature on the data table.

C. Have the students determine the percent sediment load in the water samples using the second sample collected.

1. Have them leave the lid on the collection bottle and weigh the sample. Then have them record the result in the data table. (NOTE: Make sure the outside of the bottle is clean and dry).

2. Next, have them weigh the filter paper and record this in the data table.

3. Then have them shake the sample. (NOTE: If a turbidimeter is available, use it to determine the turbidity of the water samples.)

4. Review with the students how to fold filter paper. (See the following illustration.) Then have them slowly pour the sample through the funnel lined with the filter paper into a receiving beaker. (NOTE: Students may need to gently stir the water in the funnel with a stirring rod to get the water to pass through the filter paper.)

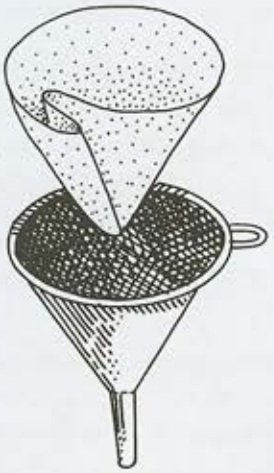
5. To make sure all of the sediment is removed from the collection bottle, have the students rinse the bottles several times with small amounts of distilled water and pour the rinse water through the filter each time.

6. Have students use a grease pencil to label a large watch glass with their initials.

7. Then have them carefully remove the filter paper from the funnel and place it unfolded, dirty-side up on the watch glass.

8. Have them set aside the watch glass with the filter paper and allow the sediment and filter paper to air dry completely.

9. Next, have them wash, dry, recap, and weigh their original collection bottle and record this weight in their data table.



10. To determine the weight of the water sample, have them subtract the weight of the bottle from that of the bottle with the water sample. Have them record the results in the data table.

11. After the filter paper (with sediment) dries, weigh it and substract the weight of the clean filter paper to get the weight of the sediment and record the result in the data table.

12. To calculate the percent sediment load, divide the weight of the sediment by the weight of the water sample and multiply by 100. Record the result in the data table.

D. Compile the class data.

1. Have the students compare the appearance of the various samples with their corresponding sediment loads and temperature readings. They may want to categorize the samples by site type, such as urban, agricultural, construction runoff, etc., or by area referring to the map and site numbers.

2. Distribute graph paper and have students plot percent sediment load versus temperature in sunlight for all the samples.

3. Fit a line to the data plotted.

E. Discuss the results.

1. Is there an apparent correlation between percent sediment load and temperature? Why or why not? (Greater sediment load, higher temperature. Sediment absorbs heat.)

2. How does sediment affect stream temperature? (More sediment absorbs more heat and causes higher stream temperature.)

3. How might temperature affect the dissolved oxygen content and aquatic life? (Higher temperature causes lower dissolved oxygen level. Organisms requiring higher DO levels will either move to a more favorable environment or perish.)

4. Which organisms are might be most affected by a temperature increase? Why? (Trout, mayflies, stoneflies, and caddisfly larvae; they require colder temperatures and higher DO to live.)

5. Have students refer to the topographic map of the sample sites and the data they collected.

   a. What are the probable sources of sediment? (Answers will vary depending on land use activities.)

   b. What other nonpoint pollutants are likely to occur in the water samples? (Answers will vary.)

   c. How could this erosion be prevented? [Apply best management practices (BMPs) associated with specific land uses.)

III. Follow-Up

A. Have students complete the quiz included and discuss the results.

B. Take the lids off the jars and allow the water samples to sit in a sunny location for about a week. Record observations daily on color, odor, algae growth, sediment, and turbidity of water on the data sheet. Some jars may begin to smell foul. Bacteria, litter, and animal waste would make a sample smell foul. Toxic chemicals would kill algae; hence the water would be clear. Fertilizers and animal wastes would foster the growth of algae. Refer to the land use map and data collected. What pollutants are the samples likely to contain that exhibit these traits? Where and what are the likely sources of these pollutants?

IV. Extension

Prepare two each of water samples with various sediment loads. Place one set of the samples in the sun, and the other set in the shade. Determine temperature differences between the different sediment loads and between those in the sun and those in the shade. Graph the results. Let sediment load be on the x-axis and temperature be on the y-axis. Connect the temperature data for the shaded samples together and those from the sunny samples together. Examine the slopes of the lines. Is there an apparent correlation between sediment load and temperature? (Yes.) Is there a gap between the lines? (Yes.) On average, how much does the lack of cover affect the temperature of the water? (Significantly.) Compare the slopes of the lines. How does the amount of cover affect the sediment load? (Answers will vary.) Is there a correlation between the three variables—cover, sediment, and temperature? (Yes.)

RESOURCE

Walesh, Stewart G., Urban Surface Water Management, Chapter 7, "Nonpoint Source Water Pollution Load Techniques," John Wiley and Sons, Inc., New York, NY, 1989, pp. 217-244.

IT'S SEDIMENTARY
DATA TABLE

Name _____ Date _____ Standard Room Temperature _____

Site # & Who Collected	Date Collected	Time	Location Description	Weather Conditions	Color and Appearance	Weight of Sample	Weight of Sediment	% of Sediment Load	Temperature in Sunlight	Turbidity Reading (Optional)

Name _____ Date _____

DATA SHEET

YOUR WATER SAMPLE

Date collected _____ Location collected _____ Sample # _____

Color and general appearance of initial sample _____

DAILY OBSERVATIONS
(color, odor, algae growth, sediment, and turbidty)

Day	Control	SAMPLE NUMBER						
		#1	#2	#3	#4	#5	#6	#7
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								

Name _____ Date _____

"IT'S SEDIMENTARY" QUIZ

True/False

1. _____Sediment is the largest contributor to nonpoint source pollution.

2. _____Poorly managed farmland may cause a 20,000-fold increase in erosion rates as compared to those of undisturbed forest land.

3. What is turbidity? _____

_____

4. Sediment (increases,decreases) light transmission in water. _____

5. What does sediment consist of? _____

6-7. A(n) (increase, decrease) in photosynthesis and a(n) (increase, decrease) in water temperature can result in a decrease in the amount of dissolved oxygen. _____

8-10. List 3 types of land use practices where mismanagement may result in sediment pollution.

(1) _____

(2) _____

(3) _____

11. Why was it important to allow the filter paper containing sediment to dry in this experiment?

_____

12-14. Use the following data to fill in the required information:

56.44 g = mass of collection bottle, lid, and water sample.
1.24 g = mass of filter paper.
2.78 g = mass of filter paper and sediment.
25.21 g = mass of collection bottle and lid.

What is the mass of sediment?_____

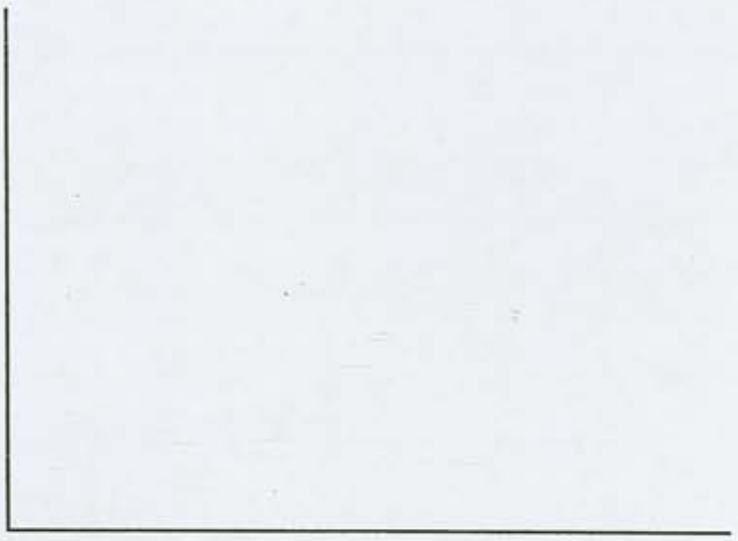
What is the mass of water sample?_____

What is the percent sediment load?_____

"IT'S SEDIMENTARY" QUIZ
(continued)

15-20. Construct and label the graph below with the following data:

% sediment load	Temperature °C
2.5	28
4.5	29
6.5	30
8.5	31
10.5	32



"IT'S SEDIMENTARY" TEACHER KEY

True/False

1. True Sediment is the largest contributor to nonpoint source pollution.

2. False Poorly managed farmland may cause a 20,000-fold increase in erosion rates as compared to those of undisturbed forest land.

3. What is turbidity? Measure of the amount of suspended material in the water (cloudiness).

4. Sediment (increases,decreases) light transmission in water. decreases

5. What does sediment consist of? Suspended materials washed or blown from land.

6-7. A(n) (increase, decrease) in photosynthesis and a(n) (increase,decrease) in water temperature can result in a decrease in the amount of dissolved oxygen. decrease, increase

8-10. List 3 types of land use practices where mismanagement may result in sediment pollution.

(1) Agricultural or Logging

(2) Urban or Mining

(3) Construction

11. Why was it important to allow the filter paper containing sediment to dry in this experiment?

So the mass measurements would be accurate.

12-14. Use the following data to fill in the required information:

56.44 g = mass of collection bottle, lid, and water sample.
1.24 g = mass of filter paper.
2.78 g = mass of filter paper and sediment.
25.21 g = mass of collection bottle and lid.

What is the mass of sediment? 1.54 g

What is the mass of water sample? 31.23g

What is the precent sediment load? 4.93%

"IT'S SEDIMENTARY" TEACHER KEY
(continued)

15-20. Construct and label the graph below with the following data:

% sediment load	Temperature °C
2.5	28
4.5	29
6.5	30
8.5	31
10.5	32