STREAM EROSION

Erosion is an ongoing process on all bodies of water, especially moving water. Both natural and human-caused factors affect the amount of erosion a stream may experience. Natural factors include the gradient (or steepness) of the streambed since that affects the speed of the flow of water. Rainfall and snowmelt affect the amount of water in a stream as well as the speed of the flow.

Human factors include run-off from farm fields and parking lots and water releases from dams that increase the amount of water flowing in streams. Removal of trees and shrubs from stream banks and deadfall from within the stream makes them more susceptible to erosion and increases stream flow.

When there is too much erosion in a stream or on lands that drain into a stream, there is an increase in silting, a serious problem that affects our drinking water and the plants and creatures that live there. Serious problems are also caused by flash floods, when a river or stream is carrying a far greater than normal amount of water. Flash floods damage streams because they tear up stream banks and bottoms and move silt downstream and into lakes and ponds and slow spots in a stream. Causes of flash floods can be natural, human-made or a combination of both.

Our experiments will examine three variables that affect water flow in a stream and test for their effect on erosion: slope (gradient) of the streambed, total amount of water flowing in a streambed (discharge), and pulses (spikes) in water. In these experiments a length of gutter will serve as the streambed.

Pre-Activity Discussion (Answers can be found in the Background Information section below)
Before beginning the activity, ask students:
1) How do water and its movement affect a streambed?
2) What are some of the things that affect the way water flows in a stream? (With this question the goal is to establish the variables that will form the basis of the activities for this lesson on stream erosion. The three variables are listed just above these questions.)

The Activity

Equipment needed

2 5-ft sections of roof gutter closed at one end, marked at 1 in. intervals.
1 low stand for the lower ends of the gutter sections
1 taller stand (with two bars of variable height) to support the upper ends of the gutter sections
2 plastic 1/3 or ½ cup measures
3 cups sand
2 large rectangular dish tubs to catch the runoff from the two gutters
2 large (2-L.) bottles
1 smaller plastic bottle
Optional: screens to fit into gutter (2” – 3”)
Optional: assorted sizes of rocks

Equipment Set-up

1. Set up the 2 stands about 5 feet apart. The bar on the downstream stand is fixed at zero. For the upstream stand, use the C-clamps to set the adjustable low bar at zero and the high bar just a little above the 6-inch mark (see scale on stand). The low (open) ends of both gutters are placed on the downstream stand. Place the upstream (closed) end of one gutter on the upstream low bar. Place the upstream end of

the other gutter on the upstream high bar. Place the dish tubs below the downstream ends of the gutters to catch the runoff.

2. Fill the 2-L bottles with water. Fill the 2 plastic cups with equal amounts of sand.

3. Have two students pour the sand into the marked areas of the gutters. The areas should be at the same distance (two feet) from the high end of the gutter. The sand should be poured so that it is evenly spread and level across the gutter and extends about 4 inches along the length of the gutter.

The Activities

In each of the 3 activities below, one of the 3 identified variables will be explored. Explain that the first variable first will be slope (gradient), then amount of water (discharge), and lastly pulse (spike).

Slope (gradient) of the Streambed

1) Have students compare the gutter/sand set up to a stream. What does the gutter represent? (The streambed) What does the sand represent? (The stream bottom) What does the poured water represent? (The flow of the stream) What do the different heights of the gutter represent? (Different slopes or degrees of steepness- the gradient) Explain that some streams are steeper than others. Have the students identify the steeper slope and explain that the steep slope is more like a mountain stream. The gentler slope is more like the Huron River.
2) Ask students to predict how the degree of steepness will affect the movement of the water and also how it will affect the sand that makes up the stream bottom. Then instruct them to observe carefully how the sand moves when the water is poured into each gutter. (Since the amount of water, the method for pouring, and the sand are the same for both gutters, the slope is the only variable.)
3) It is important that the water is poured in a similar manner in each gutter. Show them the approximately 45º-angle at which you want them to pour the water. The water should be poured into the gutters about 1 ½ feet upstream from the sand into the middle of the gutter, relatively low and from the side, and at the same rate. Assign a student to each gutter and explain that when you say start they should slowly pour the water as instructed into the gutters.
4) Now that the instructions have been given, proceed with the experiment. The students should take note of how far "downstream" the sand moves from the upper boundaries towards the tub. Have the students explain their observations and compare the movement of the sand down the gutter and into the tub. (Remind them that the sand represents the stream bottom.)
5) If the test was inconclusive or sloppily done, repeat. If not, point out that generally streams don't change their slopes, although sections of the same stream can have different slopes.
6) Sluice out the gutters and empty the dishpan prior to the next activity.

Amount of Water (discharge)

7) Explain that for this experiment a different variable will be explored, the amount (total volume or discharge) of water. This time, place the upper ends of both gutters on the lower bar of the upstream stand. The bar should be set at zero on the scale on the stand. To change the "amount" variable, use the 2-L bottle and the smaller bottle.
8) Have 2 students set up the sand as in the experiment above. (4 inches of sand along the length of the gutters, 2 feet below the upstream side, spread evenly and levelly.) Ask: How will the amount of water affect the stream bottom? Have students make predictions about the outcome of this experiment where the one variable is the volume of water.

9) Repeat the pouring instructions from above. Important: Since the water should be poured at the same rate, the student pouring from the 2-L should require about twice as much time. Ask the students to observe the movement of sand as the water is poured.
10) Have students explain their observations and compare the movement of the sand down the gutter and into the tub. Ask: What could change the amount of water flowing through a stream? (Rainfall, snowmelt, runoff due to conditions upstream such as pavement, lawn, forest, etc.)
11) If this test was inconclusive or sloppily done, repeat. You may need to try different pouring angles to get faster or slower stream flow rates in order to clearly observe differences.
12) Sluice out the gutters and empty the dishpan prior to the next activity.

Pulses (spikes) of Water Flow (a sudden, large increase in water flowing down a river or stream)

13) Explain that this experiment will explore yet a different variable, the flow rate of water down a stream. Define pulses (or spikes) as it relates to water flow. Define flash flood. Explain how speed and quantity affect flow rates of water and how this is related to flash floods.
14) To make the flow rate the single variable, keep the upper ends of both gutters on the lower bar of the upstream stand. The bar should be set at zero. The sand should be set up in both gutters identically as in the first experiment (4 inches of sand, 2 feet below the upstream side, spread evenly and levelly). Each pitcher should have the same amount of water, 2-L. Now for the variable: To simulate a flash flood, make a "pulse" of water rush down one of the streams by having a student pour the pitcher of water very quickly. The other student will pour the water more slowly by holding the pitcher at same gentle angle as in the earlier experiments.
15) Before the students begin pouring, have them predict what will happen. Then ask all the students to observe the movement of sand when the water is poured. Next the water should be poured into the middle of each gutter 1½ feet upstream from the upper boundary of the sand at the different rates as explained above.
16) Have the students explain their observations and compare the movement of the sand down the gutter and into the tub. Have them compare the results of the "flash flood" with the results of the earlier experiments.
17) If the test was inconclusive or sloppily done, repeat. If you have obtained clean results, ask: What could change the speed of water flowing through a stream? (Different amounts of rainfall, snowmelt, different conditions upstream such as pavement, lawn, forests, etc.)
18) Sluice out the gutters and empty the dishpan to aid with cleanup.

Optional

19) Additional variables to test could include adding rocks to one stream, varying the amount or size of rocks in each stream, or putting in screens over the sand. Students may suggest other variables they would like to test.

Post-activity discussion questions:

1) What did you discover about a streambed's slope and its affect on erosion?
2) What did you discover about the amount of water a stream carries and erosion?
3) What did you discover about sudden increases of water as from a downpour and erosion?
4) What human activities affect the flow of a stream?
5) What can people do to reduce erosion and flash floods and the problems they cause?

Background Information

Moving water causes erosion, whether it is from waves upon a beach or the current in a river or stream. The amount of erosion is dependent on many factors; some may be naturally occurring and others the result of human activity. It is the process of erosion that created geologic wonders such as the Grand Canyon. This was a natural process that occurred over millennia. But the process of erosion has also silted waterways, degraded drinking water, washed away valuable topsoil, caused flooding and damaged habitat for water-dwelling creatures. Much of this has occurred as the result of human activity.

In a natural watershed undisturbed by human activity, rivers and streams along with wetlands that occur within the watershed are capable of managing a wide range of weather conditions. Woodlands and wetlands are capable of holding onto great quantities of water and mitigate against flooding from large storms or unusually rainy periods. But even under the best of circumstances, flooding can and does occur along with the erosion it causes.

Human activity has exacerbated issues related to erosion and flooding. Impervious surfaces and farm fields along with loss of wetlands and woodlots result in more run-off and increased flooding and erosion. Removing deadfall from waterways and trees and shrubs from banks increases the flow of water and the erosive potential of the stream or river. Ultimately there is more silting in the river and streams along with the resultant serious consequences: loss of habitat for aquatic creatures including fish; water that is more difficult and expensive to clean before it can be used for drinking; problems for industries that use water from our rivers and streams.

In the experiments that make up this activity we explore 3 variables that affect the flow of water in a stream or river and its resulting affect on the streambed. For these activities the gutter represents the stream and sand represents the streambed. These variables may seem obvious to us as adults but for younger students a visual representation can be a good tool for learning. The points that will be made are these: 1) Water moves faster when the gradient (slope) is greater, and when water moves faster it is capable of moving more sand more quickly; therefore it is more erosive. 2) Greater quantities of water are capable of moving more sand and are therefore more erosive. 3) A sudden deluge- a spike or pulse in the amount of water- is more erosive than an equal amount of water rain that comes more slowly and it can cause flash flooding. Spikes or pulses in water can be highly erosive.

Since human activity has added to the problem of erosion, it can also help remedy it. Control of runoff from fields and impervious surfaces; restoration of wetlands; stabilizing the banks of rivers and streams with natural vegetation; these are all ways we can protect our river and streams and improve our watersheds for all living creatures.

Stream Flow and Erosion - Student Worksheet

Experiment 1- Slope of Streambed (gradient)

1. Tell how the sand moved in the steeper gutter versus the gutter with the lesser slope.

Experiment 2- Amount of Water (discharge)

2. Tell how the sand moved with the smaller bottle of water versus the larger bottle of water.

Experiment 3- Pulses (or spikes) in Amount of Water

3. Tell how the sand moved with a fast pulse versus a regular pour of water.

Summary

4. What effects could these variables have on a stream?

5. What can people do to protect their streams from flashfloods?

Stream Flow and Erosion (KEY)

Experiment 1- Slope of Streambed (gradient)

1. Tell how the sand moved in the steeper gutter versus the gutter with the lesser slope.

   Answers will vary but should note that the steeper gutter moved more sand, moved it more quickly, and moved it further.

Experiment 2- Amount of Water (discharge)

2. Tell how the sand moved with the passage of the smaller bottle of water versus the larger bottle of water.

   Answers will vary but should note that the greater quantity of water moved more sand and moved more of it all the way to the bottom of the gutter.

Experiment 3- Pulses (or spikes) in Amount of Water

3. Tell how the sand moved with a fast pulse versus a regular pour of water.

   Answers will vary but should note that a pulse of water moves more sand and moves it more quickly.

Summary

4. What effects could these variables have on a stream?

   Answers might include: Erosion of the streambed; movement of silt downstream; degradation of banks; degradation of habitat for stream-dwelling fish and insects;

5. What can people do to protect their streams from flashfloods,

   Answers might include: Stabilization of stream banks by planting trees and shrubs; maintaining banks that presently have trees and shrubs; controlling run off from lawns, parking areas and other impervious surfaces; control of runoff by using rain barrels and retention ponds; improvement in storm water management; protection of wetlands that catch and hold storm water; returning former wetlands to their previous state