Erosion: Natural or Unnatural

Chicago River Classroom Activity

Summary

In this two-day experimental lesson students will explore: 1) how water has the power to erode, 2) how developing the land (building roads, buildings and parking lots) increases the amount of water reaching our rivers and 3) how this greater quantity of water increases erosion.

Standards

6.B.2, 6.B.3a, 6.B.3c, 11.A.2b, 11.A.3b, 11.A.3c, 11.A.2d, 11.A.2e, 11.A.3f, 12.E.2a, 12.E.2b, 12.E.3b, 13.B.2e

Background

Land is eroded by water (and air). In fact, erosion is responsible for the winding of rivers and the soaring canyons around them (a dramatic example being the Grand Canyon). The more energy water has the more erosive it will be. Greater quantities of water, moving at greater speeds will have more energy, and thus greater erosive power. The condition of the land will also affect how much erosion occurs. Land that is held together by plant roots will erode less than barren land. Water moving over land with a greater slope will move more quickly and will thus have more energy and more erosive power.

Water in a river comes from its watershed. A watershed is the land that drains into a body of water such as a stream, or lake. Because water flows downhill, watershed boundaries are always located on the top of hills or mountains. Water falling on one side of the hill will flow into one water body, while water falling on the other side of the hill will flow into another water body.

Rainwater falling on a watershed can either run off over the land, reaching the river quickly, or soak into the soil and move through the soil, reaching the river slowly. Water moving over the land can erode the land over which it flows. As the land in a watershed becomes developed – as forests, prairies, and wetlands are converted to roads, homes, offices, shopping malls and parking lots – less and less water is able to infiltrate into the ground. Consequently, more water runs

Grade Level: 5th-8th

Duration: 2 class periods

Objectives:

1. Students will be able to define erosion.
2. Students will be able to explain why erosion has increased in the river.

Materials:

Quantities are per group of five

Day One:

- Student directions and worksheets (1)
- Aluminum turkey pan (1)
- Bucket (1)
- Large, color plastic cups (2)
- Clear plastic cups (2)
- Large plastic spoon (1)
- Book or block to prop up stream table (1)
- Soil (3 part sand, 1 part humus, 1 part gravel), to fill all stream tables half full

Day Two:

- Picture of Chicago/your town today and about 200 years ago (See directions for sources) (1 each for class)
- Thick sponges (8)
- Thin sponges (2)
- Aluminum pan, 9” x 12” (1)
- Buckets (1)
- Cups with large holes from yesterday (1)
- Measuring cups (1)
- Craft sticks (8)
- Paper (1 sheet)
- Scissors (1)
- Crayons
- Student directions and worksheet (1)

off over the land (and through stormwater and sewer systems). In natural areas, 10% of the rainfall runs off the land compared to 55% in urban areas. Fifty percent of the rainwater soaks into the ground in natural areas, compared to 15% in urban areas. (The remaining water is evapotraspirated – transpired by plants, or evaporated from surfaces.)

With more rainwater quickly running off the land, huge quantities of water reach the river very quickly. For instance, a large rain storm on October 13, 2001 caused the Chicago River at Touhy Avenue to rise from 3.5 ft (already 2 ft above average) to just over 9 ft in the mater of hours. This large volume of water has the power to greatly erode the banks of the river.

Erosion is a natural process, but when so much water reaches a river so quickly the rate of erosion is way beyond the natural rate. Excessive erosion destroys the banks of the river, taking away the soil which supports trees and other plant life. All the sediment suspended in the water turns the river a murky color. The sediment clogs the gills of fish, clams and mollusks. It also makes the water so dark that aquatic plants have a difficult time photosynthesizing. In addition, it can bury small animals (macroinvertebrates) living on the river's bottom and cover their habitat with a layer of silt.

Procedure

Day One: Steam Table Experiment

Before Class

- Prepare the stream table. Cut a hole in the bottom of each turkey pan near one of the shorter sides.
- Mix up the soil mixture to be used in the stream tables. The mix should contain 3 parts sand, 1 part humus, and 1 part gravel. Add soil mixture to each of the stream tables, on the side opposite the hole.
- Prepare the cups. Pierce a small hole in the bottom of half of the colored plastic cups and a large hole in the bottom of the other half of cups. Mark a line on the inside of the cup near the top of the cup that represents an even amount of water (such as 1, 1 ½, or 2 cups). This will ensure that students always use the same amount of water and it will make their calculations on day two easier.

During Class

- At the beginning of class tell students that people have been noticing that the land seems to be disappearing, particularly the land around our rivers. Where is it going? Who or what is taking it away? They will be figuring that out, today and tomorrow.
- Divide students into groups of five. Each member of the group gets a role:
    - **Recorder:** records the groups predictions and results.
    - **Bucket holder:** places the bucket on the floor under the hole in the stream table and makes sure the bucket does not overflow.
    - **Water collector:** collects runoff water in the clear plastic cup (for the turbidity test) from under the hole in the stream table.
    - **Soil spreader:** moves the soil around to create the landscape and stream.
    - **Water maker:** drips water on the stream table.
- Pass out student directions and worksheets for day one. Depending on your students, you may want to model the activity for your students before having them carry out the experiment.

- Give students time to conduct their investigations.
- After students conduct the experiment, discuss the following as a class:
    - What happened to the banks and bottom of the stream?
    - What happened to the rocks and small pebbles?
    - What were the differences between the two trials?
    - What could explain these differences?
- At the end of the day, have students share their ideas for what would cause there to be more water flowing in the river. Write the students' answers on the board or somewhere they can be saved for the next time class meets.

Day Two: Water Flow Experiment

Before Class

- Wet and wring out all sponges just prior to class.
- Cut a hole in the middle of the 9" side of the 9"x12" aluminum pan.
- Download or photocopy pictures (Chicago today http://www.planetware.com/photos/US/ILCH146.HTMand historic Chicago pictures http://www.ci.chi.il.us/Environment/Rivertour/comm/tour/history3.html#start)

Introduction to Class

- Refer back to the students' ideas on what might cause there to be more water in a river. Most likely students will not know that development can increase the amount of water that reaches a river after a rainstorm.
- Show your students a picture of the Chicago River before much permanent settlement occurred and a picture from recent times. Or read them the description of the pre-European settlement river and watershed. Tell them that one of the answers to this puzzle lies in the pictures/story. Have students write a list of things that are different between the two pictures or between the historic description and what they know about how their neighborhood looks today. Let them know that they will be creating a model of both eras to understand what is happening.

    Description of the Chicago River before European settlement:

    "A shallow, little stream, formed by the junction of two branches half a mile inland, moved in graceful curves to the eastward and added its modest contribution to the great chain of marvelous fresh water seas…Along the shore was to be seen a succession of low sand hills, partly covered with a scrubby growth of cedars, junipers and pines. Beyond were detached groves, mostly of small black oaks. A little farther west, reaching to the north branch of the river, were a few noble elms, while further up the stream a fine belt of hickory, maple, beech and a variety of oaks spread gradually wider and wider towards the east until, joining the lake shore timber, they formed the southern outpost of that immense forest stretching to the north, covering the trackless regions…"

    - Edwin O. Gale, 1902 quoted from p. 31 of *The Chicago River: A Natural and Unnatural History* by Libby Hill 2000

Activity

Building the Pre-European Settlement Model

- Divide students into the same groups of five.
- Pass out materials – pans, sponges, craft sticks, paper, scissors, crayons, directions and student worksheet for day two.
- Describe what each of the materials represents.
  - The pan represents the watershed of the river. The bottom of the pan is where the river is flowing.
  - The sponges represent the water absorbing power of the soil beneath the prairies, forests and wetlands. (For this exercise, we are assuming that forests, prairies and wetlands all act identically and absorb the same amount of water. This is not necessarily perfectly accurate. If you want, you could have your students investigate each habitat and change the width of the sponges accordingly. The thicker the sponges, the greater the water absorbing capacity of that habitat.)
  - The craft sticks, paper and crayons are to be used to identify the different habitats that existed at that time. Each drawing will be taped to a craft stick and each craft stick will be inserted into a sponge.
- If necessary model the directions.
- Give students time to build their pre-European settlement Chicago River model.

Building the Current Model

- Now have the students build a model of the current watershed.
  - In this model there will be some areas of forest, prairie and wetlands, but most of the land should be buildings, roads, parking lots and some grass. The roads and parking lots will be represented by the bare pan and grass will be represented by the thin sponges.
  - Refer students to the directions for building the Present Day Chicago River Model. You may want to model the directions. Then have students build their present day Chicago River model.

Understanding the Models

Before the students begin their experiment, it is important that they understand the models they have just created. Have a discussion about the following items:

- What does the bottom half of the model represent? (*river*)
- What does the top half of the model represent? (*land/watershed*)
- If rain falls on the top half of the model, what will happen to it*? (run through the watershed to the river*)
- What do the sponges represent? (*thick ones – native habitats, thin ones – grass*)
- Why are the sponges under the forests, prairies and wetlands thicker than the sponges under the lawns and why are there no sponges under the roads and buildings? (*Native habitats can absorb a lot more water than grass lawns. Grass has short roots and the soil is often compacted. Buildings and roads are impervious, so not water is absorbed.*)

Testing the Model

Now the students are ready to test their models to see how much water reaches the river and how quickly the water reaches the river.

- Assign the members of the groups to the following roles:

Builder: props up the model and places the bucket under the hole.
Rain maker: fills cup with water and lets it flow over the top of the model.
Time keeper: times how long it takes for the rain water to stop flowing into the river.
Measurer: measures how much water reaches the river.
Recorder: records group's results and predictions.

- Refer students to the directions for conducting the experiment and the worksheet. Model the experiment if necessary.
- Give students time to conduct the experiment.

Comparing the Watershed over Time

Get back together as a class and discuss the two models, the results of the experiment and the implication for real rivers like the Chicago River.

- What percent of water reached the two streams?
- How long did it take for the water to reach the two streams?
- What caused these differences?
- Think about the steam table experiment. Would the change in water quantity and speed with which the water reached the stream matter? Would it affect the land, how about the river?
- What could you, your family or the community do to minimize the changes caused by our development of the watershed?

Extension

- Have students brainstorm a list of pollutants that they think might be entering the Chicago River. Guide them to think not only of trash, but also of pollution from roads, lawns, farms and construction sites.
- Have the students place drops of food coloring throughout the portions of their modern day river model that could be contributing pollution to the river. (Different colors could be used for different types of pollution.) Pour water on the top of the watershed. Pour the collected stream water into a clear container and check its color against the rainwater. NOTE: in real life not all pollution has a color. Many types of pollution are colorless and odorless. You can not always immediately tell from the look of a river whether it is polluted.
- Discuss with your students how the pollution reached the river and what they think would need to be done to prevent pollution from reaching the river.

Erosion: Natural or Unnatural: Day One Student Directions

Experiment One

Soil spreader

- Slope the soil down towards the edge of the pan with the hole in it, keeping the soil 3 inches away from the hole.
- Create a stream down the middle of the slope by digging a curved channel (no wider than 2 fingers) into the sand. The stream should not be dug all the way to the bottom of the pan.
- Place the stream table on the desk. Prop the stream table up with a book and extend the end with the hole in it just over the edge of the table.

Group

- Predict what you think will happen when water flows down the river.
  - Where will the water go?
  - What will happen to the land? To the water as it flows down the river?

Recorder

- Record the group's predictions.

Bucket Holder

- In preparation for the stream flow, place the bucket on the floor beneath the hole in the stream table.

Water collector

- Hold the clear plastic cup (without a hole in it) directly under the hole in the stream table to collect the runoff from the stream.

Water maker

- Fill the cup *with the small hole* up to the line with water (making sure to plug the hole with a finger)
- Place the cup at the beginning of the stream channel and release your finger

Group

- Observe what is happening to the stream channel.

Water Collector

- When the clear plastic cup is full, place it on the table.

Group

- Discuss the affects of rain on the soil and the appearance of the water collected in the cup.

Recorder

- Record the group's observations.

Experiment Two

Now, we will see what happens when more water flows down a river.

Group

- Discuss why you think, in the real world, there could be more water flowing in the river.

Recorder

- Record the group's thoughts.

Soil spreader

- Recreate a slope similar to the one you made at the beginning of the class.
- Dig a stream similar to the one dug in the first experiment.

Group

- Develop a hypothesis – how will the greater flow of water affect the land and water flowing in the river?

Everyone

- Repeat the instructions from Experiment One. This time the **water maker** should use the plastic cup with the *large hole*.

Group

- Compare and contrast what happened to the soil, how much water ran off the land, and how the runoff water from the two trials looked.

Recorder

- Record the group's ideas.

Erosion: Natural or Unnatural: Day One Student Worksheet

Experiment One

Make Predictions

When you add water to the stream, where will the water go?

What will happen to the land when you add water to the stream?

What will happen to the water as it flows through the stream?

Make Observations

What happened to the land around the stream after you added water?

Is the water you collected from the stream different from the water you added? If it is, describe the difference.

Erosion: Natural or Unnatural: Day One Student Worksheet

Experiment Two

Have a Discussion

In a real stream, what would cause there to be more water in the stream?

Make a Prediction

How will adding more water to the stream affect what happened to the land and water?

Make Observations

What happened to the land around the stream after you added water?

Is the water you collected from the stream different from the water you added? If it is, describe the difference.

Make Comparisons

How was the water you collected from the two experiments different?

How was the way the land changed the same or different between the two experiments?

Erosion: Natural or Unnatural: Day Two Student Directions

Building the Pre-European Settlement Chicago River Model

- Fill the top half of the pan with the thicker sponges that represent the soil beneath forests, prairies and wetlands.
  - Make sure that there are no spaces between the sponges or between the sponges and the edge of the pan.
  - Make sure that the sponges lie flat in the pan. You may cut the sponges to make them fit.
- Leave the bottom half empty with no sponges. This will be the river.
- Draw pictures of the different habitats that were around Chicago before Europeans moved here. You should have forests, prairies and wetlands.
- Tape your pictures to the craft sticks.
- With your scissors cut a slit in each sponge and insert the craft sticks into the holes.

Building the Present Day Chicago River Model

- The top half of the pan represents what the land around the river looks like today. Use the thick sponges to represent areas that are still forests, prairies or wetlands. Use the thin sponges to represent areas that are grass – like yards, golf courses and city parks. Leave the pan bare to represent the streets, sidewalks, buildings and parking lots. If you think there are more buildings and roads now than forests, you should have more of the pan's area in roads and buildings than forests.
- Leave the bottom half of the pan empty with no sponges. This will be the river.
- Draw pictures of the different areas that are around now (forests, prairie, wetland, parks, lawns).
- Tape your pictures to the craft sticks.
- With your scissors cut a slit in each sponge and insert the craft sticks into the holes.

Conducting the Experiment

Rain maker

- Fill the cup up to the line by plugging the hole at the bottom of the cup and pour into measuring cup.

Measurer

- Read the amount of water in the cup.

Recorder

- Record the amount.

Builder

- Tip the river model up on the desk, using a book to lift the end opposite the side with the hole. Extend the end with the hole just over the edge of the table and place a bucket below the hole.

Rain maker

- Fill the cup up to the line with water, being careful to plug the hole.
- Check with the time keeper to make sure he/she has their stopwatch ready.

Time keeper

- Practice starting, stopping and resetting the stopwatch.
- When you are ready, make sure the rain maker is ready to begin releasing the water on your call.
- Call out start and start the stopwatch.

Rain maker

- Release your finger from the hole and move the cup back and forth along the top edge of the model.

Time keeper

- Watch the model.
- When water first reaches the river, check your stop watch and give the time to the recorder to record.
- When the water stops flowing into the river, stop the stop watch and give the time to the recorder to record.

Recorder

- Record the times.

Measurer

- Pour the water from the bucket into the measuring cup and measure the amount of water that reached the river.

Recorder

- Record the volume.

Everyone

- Take a look at the model of the watershed as it is today. Predict whether you think the same amount of water, more water or less water will reach the river in this model. All members of the group should state their ideas and give their reasons.

Recorder

- Record the group's thoughts.

Everyone

- Repeat the experiment, starting with Step 2 using the model of the watershed as it is today.
- Answer all questions on the lab sheet.

Erosion: Natural or Unnatural: Day Two Student Worksheet

Experiment One: Pre-European Settlement Watershed

Collect Data

Amount of water in cup filled to line: _____

Time took for the water to begin flowing into the river: _____

Time took for water to stop flowing from the land and into the river: _____

Amount of water that reached river: _____

Percentage of rainwater that reached the river: _____

$$\frac{\text{Amount of Rain} - \text{Amount in River}}{\text{Amount of Rain}} \times 100\%$$

Experiment Two: Today's Watershed

Make a Hypothesis

Will more or less of the rain reach the stream in the watershed today or in the watershed model of a long time ago? Explain your answer.

Will it take a longer or shorter time for the water to reach the stream? Explain.

Collect Data

Amount of water in cup filled to line: _____

Time took for the water to begin flowing into the river: _____

Time took for water to stop flowing from the land and into the river: _____

Amount of water that reached river: _____

Percentage of rainwater that reached the river: _____

$$\frac{\text{Amount of Rain} - \text{Amount in River}}{\text{Amount of Rain}} \times 100\%$$